

THE GOVERNMENT OF THE REPUBLIC OF INDONESIA

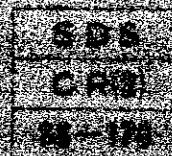
THE STUDY
ON
THE FLOOD CONTROL PLAN
OF
THE UPPER CITARUM BASIN

EXECUTIVE SUMMARY



DECEMBER 1988

JAPAN INTERNATIONAL COOPERATION AGENCY



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マイクロ
フィルム作成

PREFACE

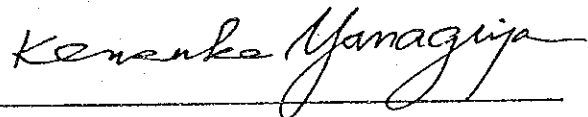
In response to a request from the Government of the Republic of Indonesia, the Government of Japan decided to conduct the Study on the Flood Control Plan of the Upper Citarum Basin and has entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Indonesia a study team headed by Mr. Naohito MURATA of Pacific Consultants International, from May 1987 to October 1987 and January 1988 to June 1988.

The team exchanged views with concerned officials of the Government of the Republic of Indonesia and conducted a field survey in Bandung City. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the development of the project and to the promotion of the friendly relations between our two countries.

I wish to express my appreciation to the officials concerned of the Government of the Republic of Indonesia for the close cooperation they extended to the team.

December, 1988



Kensuke YANAGIYA

President

Japan International Cooperation Agency

THE STUDY
ON
THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

Mr. Kensuke YANAGIYA
President
Japan International
Cooperation Agency

LETTER OF TRANSMITTAL

Dear Sir,


We are pleased to submit to you the final report entitled "THE STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN". This report has been prepared by the Study Team in accordance with the contract signed on 19 March 1987, 1 November 1987, and 27 April 1988 between the Japan International Cooperation Agency and Pacific Consultants International.

The report examines the flood control problems in the basin, presents an overall flood control plan and the results of a feasibility study on an urgent project comprising river improvement works, and the establishment of a flood forecasting and warning system.

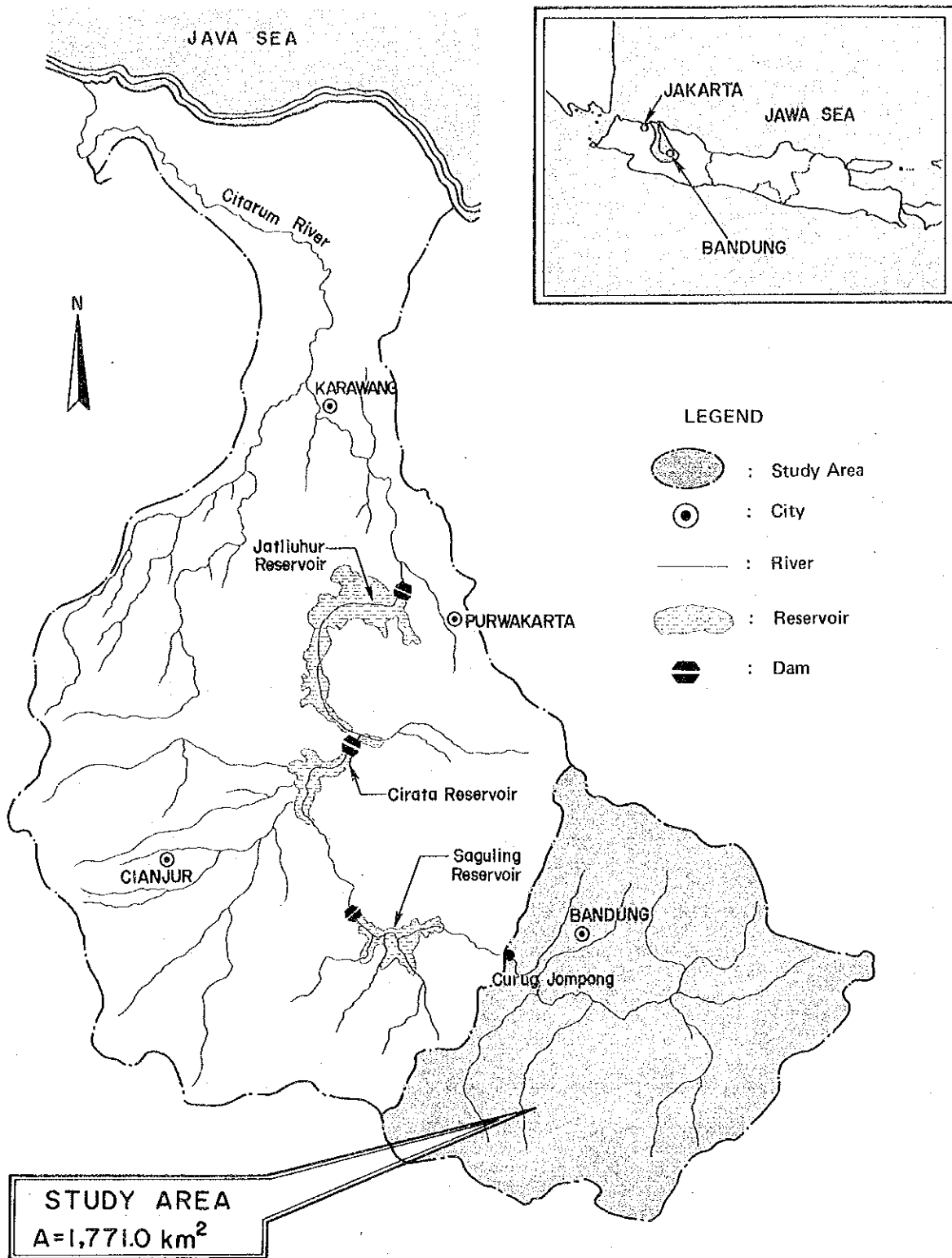
The report consists of the Executive Summary, Main Report, and Supporting Study Reports. The Summary summarises the results of all studies. The Main Report contains background conditions, overall flood control plan, urgent flood control project, conclusions and recommendations. The Supporting Report includes data and technical details. In addition, a Data Book has been prepared and is submitted herewith.

All members of the Study Team wish to express grateful acknowledgement to the personnel of your Agency, Advisory Committee, Ministry of Foreign Affairs, Ministry of Construction, and Embassy of Japan in Indonesia also to officials and individuals of the Government of Indonesia for their assistance extended to the Study Team. The Study Team sincerely hopes that the results of the study will contribute to the socio-economic development and well-being of the upper Citarum basin.

Yours faithfully,

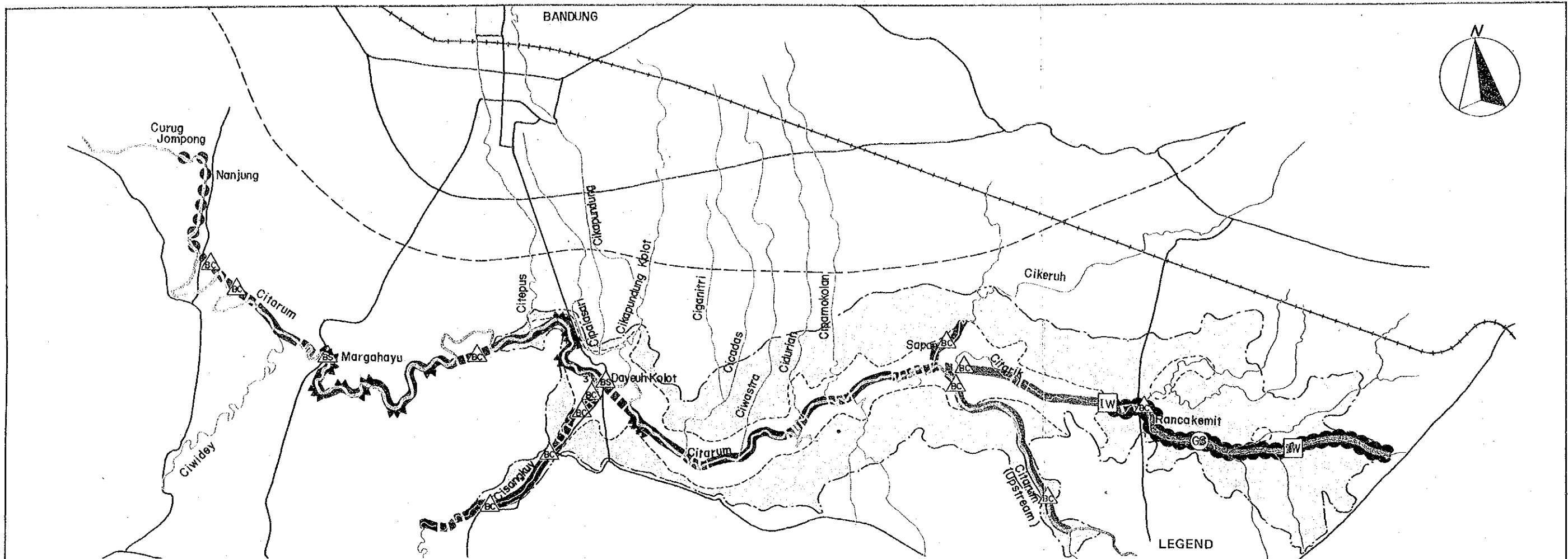


Naohito MURATA
Team Leader



LOCATION OF STUDY AREA

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN



CONSTRUCTION WORKS

Item	Unit	Long-Term Project	Urgent Project
I Civil Work			
A Existing River			
(a) Dredging			
(1) Common Soil	10 ³ m ³	4,124	2,742
(2) Stiff Soil	10 ³ m ³	1,123	674
(3) Soft Rock	10 ³ m ³	1,322	935
(b) Bank Clearing / Grubbing	m ²	29,750	118,800
(c) Dike	m ³	54,043	-
(d) Bank Protection	m	6,100	6,100
(e) Bridge			
New Construction	m ² (place)	2,424 (9)	1,024 (4)
Improvement	place	4	4
(f) Ground Sill	m (place)	7.5 (1)	-
(g) Irrigation Weir	m (place)	54 (2)	-
(h) Maintenance / Connection Road		10,300	250
B Cut-off Channel			
(a) Dredging			
(1) Common Soil	10 ³ m ³	1,187	1,109
(2) Stiff Soil	10 ³ m ²	1,205	1,147
(3) Soft Rock	10 ³ m ²	448	246
(b) New Bridge	m ²	2,112	2,016
Construction	(place)	3	3
(c) Maintenance / Connection Road	m	87,000	2,150
II Flood Warning System	set	1	1
III Land Acquisition Compensation			
A Land Acquisition			
(a) Existing River	10 ³ m ²	1,282	750
(b) Cut-off Channel	10 ³ m ²	375	362
B House Resettlement			
(a) Existing River	house	174	137
(b) Cut-off Channel	house	80	80

PROJECT COST

Cost Item	Long-Term Project			Urgent Project		
	L/C (10 ⁶ Rp)	F/C (10 ³ US\$)	Equiv.Total (10 ⁶ Rp)	L/C (10 ⁶ Rp)	F/C (10 ³ US\$)	Equiv.Total (10 ⁶ Rp)
A. Direct Cost	14,205.0	43,246.8	85,778.2	9,381.3	28,784.2	57,019.2
(1) Civil Work	(13,952.6)	(42,634.8)	(84,513.0)	(9,128.9)	(28,172.2)	(55,754.0)
(2) Flood Warning System	(252.4)	(612.0)	(1,265.2)	(252.4)	(612.0)	(1,265.2)
B. Indirect Cost	13,119.0	6,487.0	23,854.9	10,970.7	3,667.3	17,040.1
(1) Land Acquisition/Compensation	(9,555.0)	(-)	(9,555.0)	(6,645.0)	(-)	(6,645.0)
(2) Administration	(3,564.0)	(6,487.0)	(14,299.9)	(3,183.2)	(-)	(3,183.2)
(3) Engineering Service	-	-	-	(1,142.5)	(3,667.3)	(7,211.9)
C. Physical Contingency	2,732.4	4,973.4	10,963.3	2,035.2	3,245.2	7,405.9
Total (1)	30,056.4 (24.9%)	54,707.2 (75.1%)	120,596.4 (100%)	22,387.2 (27.5%)	35,696.7 (72.5%)	81,465.2 (100%)
D. Price Escalation	-	-	-	10,324.1	6,014.0	20,277.1
Total (2)	-	-	-	32,711.3 (32.2%)	41,710.7 (67.8%)	101,742.3 (100%)

- LEGEND**
- : Bank Clearing / Grubbing (Long-Term / Urgent Project)
 - ▬▬▬▬ : Existing River Dredging (Long-Term / Urgent Project)
 - ▬▬▬▬ : Existing River Dredging (Long-Term Project)
 - ▬▬▬▬ : Cut-off Channel (Long-Term / Urgent Project)
 - ▬▬▬▬ : Cut-off Channel (Long-Term Project)
 - ▬▬▬▬ : Dike (Long-Term Project)
 - △ : New Bridge Construction (Urgent Project)
 - △ : New Bridge Construction (Long-Term Project)
 - △ : Bridge Strengthening (Long-Term / Urgent Project)
 - ⊙ : Ground Sill (Long-Term Project)
 - ⊔ : Irrigation Weir (Long-Term Project)
 - ▬▬▬▬ : Bank Protection (Long-Term / Urgent Project)
 - ▬▬▬▬ : Potential Flood Area (7,249 ha)
 - ▬▬▬▬ : Frequent Flood Area (2,000 ha)

PROPOSED FLOOD CONTROL WORKS

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

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SUMMARY

1. Introduction

The Upper Citarum Basin (the Study Area) is located in the central part of the West Java Province. The Basin is affected by recurrent floods of the Citarum River. Mitigation of the flood damages is essential for development of the Basin.

This Study on the Flood Control Plan of the Upper Citarum Basin was carried out by the Study Team of the Japan International Cooperation Agency (JICA) in collaboration with the officials concerned of the Government of Indonesia from May 1987 to December 1988.

2. Study Area

The Study Area is 1,771 km² in area and bounded by mountain ridges with an altitude of about 2,000 m. The Citarum River flows through the South Bandung plateau at an elevation of about 660 m which is located in the center of the Study Area.

Average annual rainfall ranges from 1,800 mm to 2,800 mm. Rainy season extends from November to April during which approximately 70% of the annual rainfall occurs.

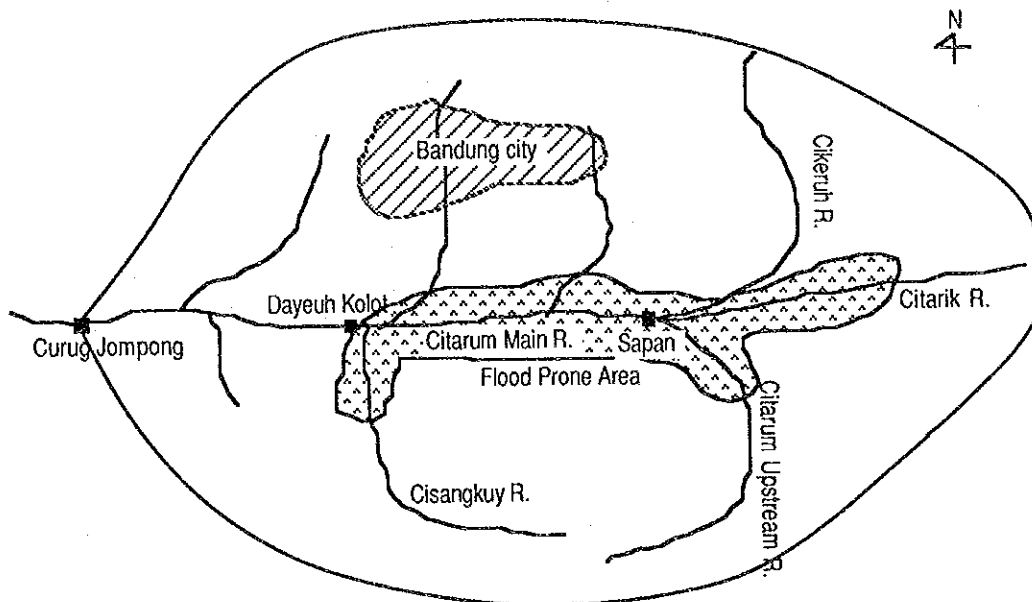
The Study Area includes the areas of three (3) administrative autonomies: the whole area of Kotamadya Bandung, about a half portion of Kabupaten Bandung and a small portion of Kabupaten Sumedang.

The population of the Study Area increased from 3.6 million in 1980 to 4.0 million in 1985. It is expected to increase further to 5.5 million in 2005. The population density in 1985 was 1,758 persons/km².

The present land-use distribution of the Study Area is built-up area of 7.1%, agricultural land of 68.7%, and forest and water areas of 24.2%. The built-up area is expected to increase up to 16.0% in order to accommodate the growing population in 2005.

3. River Condition and Flood Damage

The Citarum River consists of the Citarum Main River, and the tributaries, the Citarum Upstream River, Citarik River, Cikeruh River, Cisangkuy River and others. The Citarum Main River drains 755 km² at Sapan, 1,332 km² at Dayeuh Kolot and 1,771 km² at Curug Jompong. The Citarum River system is illustrated in the figure shown below.



Citarum River System

The discharge capacity of the Citarum River is too small, especially in its lower reaches of about 25 km in-between Dayeuh Kolot and Curug Jompong, to carry the flood run-off from the catchment area. This imbalance is the cause of flooding in the low-lying areas of the River. The potential flood prone area extends over more than 7,000 ha in the upstream of Dayeuh Kolot.

A low-lying land of 2,000 ha is inundated by frequent floods, two (2) or three (3) times a year, affecting approximately 40,000 residents and 10,000 houses.

In March 1986 floods, the Basin suffered from serious flood damages as described below.

- Total flooded area : 7,249 ha
- Number of affected residents : 112,252
- Number of damaged houses : 27,310

The expected average annual flood damage is estimated to be Rp. 17,508 million at 1987 prices.

4. Overall Flood Control Plan

An integrated approach of both structural and non-structural flood control measures is required to attain a satisfactory solution of the flood problems in the Citarum River. The proposed overall flood control plan consists of river improvement works as structural measures and flood plain management as non-structural measures.

4.1 Long-Term River Improvement Plan

The long-term river improvement is planned and designed in accordance with the following policy and criteria.

- (1) The plan is prepared to meet the population and land-use condition projected in the year 2005.
- (2) A 20-year frequency flood is applied for the design of river improvement works.
- (3) Complete flood control of the Citarum River is not attainable. Inundation of approximately 1,000 ha in the low-lying area is allowed for the design floods.

The proposed river improvement is in the Citarum Main River and its major tributaries, Citarum Upstream, Citarik, Cikeruh and Cisangkuy. The total river improvement length is 61.4 km with the following break-down.

- Citarum Main River : 31.2 km
- Citarum Upstream River : 6.0 km

- Citarik River : 14.8 km
- Cikeruh River : 2.0 km
- Cisangkuy River : 7.4 km

The major river improvement works are river dredging including 14 cut-off channels and the construction of related river structures. No dike construction is proposed in the rivers other than the Citarik River.

The proposed construction works are as follows:

- River dredging : 9,409 x 10³ m³
- Bank clearing and grubbing : 1.0 km
- Dike : 12.90 km
- Bank protection : 6.1 km
- Bridge : 16 places
- Ground sill : 1 place
- Irrigation weir : 2 places
- Maintenance/Connection road : 97.3 km
- Land acquisition : 165.7 ha
- Resettlement : 254 houses

4.2 Flood Plain Management

Flood plain management is planned to supplement structural measures of the flood control. Flood plain management will be performed for the flood risk area of a 50-year floods, after completion of the proposed long-term river improvement plan. The target area is approximately 1,300 ha. The recommended non-structural measures of flood plain management are as follows.

- Land-use regulation including relief to house damage by non-structural measures
- Establishment of flood forecasting and warning system

4.3 Economic Evaluation

The estimated project cost is Rp. 120,596 million at 1987 prices. The estimated project benefit, expected flood damage reduction, is Rp. 16,006 million per annum at 1987 prices.

The economic internal rate of return for the Project is estimated to be 11.6%.

5. Urgent Flood Control Plan

The proposed urgent flood control plan consists of urgent river improvement works and flood plain management.

5.1 Urgent River Improvement Plan

The most serious flood problems occur in the flood plain located between Sapan and Dayeuh Kolot. Hence the urgent river improvement plan is prepared to mitigate the recurrent flood damages in this area.

The urgent river improvement plan is formulated within the framework of the long-term plan and in conformity with it. A 5-year frequency flood is applied for the design of river improvement works. Approximately 1,000 ha of the low-lying land within the target flood plain is allowed to be inundated, since complete elimination of flood waters from the target area is not attainable.

Reaches to be improved are the Citarum Main River of 31.2 km long between Curug Jompong and Sapan, and its tributary Cisangkuy River of 7.4 km long. The major river improvement works are river dredging including eight (8) cut-off channels of the Citarum Main River and three (3) small cut-off channels of the Cisangkuy River, and the construction of related river structures.

The proposed construction works are as follows:

- River dredging : 6,953 x 10³ m³
 - Existing channel : 4,351 x 10³ m³
 - Cut-off channel : 2,602 x 10³ m³
- Bank clearing and grubbing : 3.0 km
- Bank protection : 6.1 km
- Bridge improvement : 11 places
 - New construction : 7 places
 - Strengthening : 4 places
- Maintenance/Connection road : 2.15 km
- Land acquisition : 110.6 ha
- Resettlement : 223 houses

5.2 Flood Plain Management

Flood plain management of the urgent flood control plan consists of the land-use regulation in the flood risk area, and the establishment of a flood forecasting and warning system.

The flood risk area of 50-year flood is considered as the target area of the flood plain management. The area is approximately 5,600 ha for the period after the completion of the urgent river improvement plan in which 27 desas are included. However, it will decrease to approximately 1,300 ha after completion of the long-term river improvement plan.

The land-use regulation will include the following measures.

- Restriction of housing development in critical flood prone areas
- Guidance for flood-proof housing development
- Relief of the existing houses in the flood prone areas by non-structural measures

A flood forecasting and warning system will be established to support the flood evacuation activities. The required hydrological data collection and transmission system will be fully accomplished by improving the existing system of the Sagling Hydropower Project. The required additional facilities are as follows.

- Six (6) telemeters at the existing water level stations
- One (1) expansion of existing monitoring station at Institute of Hydraulic Engineering
- One (1) master station at Provincial Public Works

5.3 Project Cost and Implementation Schedule

The estimated project cost is Rp. 81,465.2 million (equivalent to US\$49.22 million) at 1987 prices. The proposed works and facilities will be completed within five (5) years. The project cost including price contingency for five (5) years is estimated to be Rp. 101,742.3 million (equivalent to US\$61.48 million).

Breakdown of the project cost is shown below.

Cost Item	L/C (10 ⁶ Rp)	F/C (10 ³ US\$)	Equiv.Total (10 ⁶ Rp)
A. Direct Cost	9,381.3	28,784.2	57,019.2
(1) Civil Work	(9,128.9)	(28,172.2)	(55,754.0)
(2) Warning System Equipment	(252.4)	(612.0)	(1,265.2)
B. Indirect Cost	10,970.7	3,667.3	17,040.1
(1) Land Acquisition/Compensation	(6,645.0)	(-)	(6,645.0)
(2) Administration	(3,183.2)	(-)	(3,183.2)
(3) Engineering Service	(1,142.5)	(3,667.3)	(7,211.9)
C. Physical Contingency	2,035.2	3,245.2	7,405.9
Total (1) without price escalation	22,387.2 (27.5%)	35,696.7 (72.5%)	81,465.2 (100%)
D. Price Escalation (1990/1991~1994/1995)	10,324.1	6,014.0	20,277.1
Total (2) with price escalation	32,711.3 (32.2%)	41,710.7 (67.8%)	101,742.3 (100%)

Note: Exchange rate: US\$1.00 = Rp. 1,655 = ¥135

6. Project Evaluation

After the completion of this project, land and number of houses relieved of flood damage against 5 and 20-year floods are estimated as follows:

Flood	Relieved Area (ha)	Number of Relieved House	
		Completely Free	Free from Serious Inundation Depth (50cm)
5-year	4,090	19,300	24,100
20-year	2,550	12,300	20,300

Annual economic benefit is estimated to be Rp. 13.2 billion under the present socio-economic conditions. The estimated project economic cost at 1987 prices is Rp. 79.2 billion. The required annual operation and maintenance cost is Rp. 285 million.

The estimated investment efficiency of the Project is as follows:

Economic Internal Rate of Return (EIRR)	:	14.1%
Benefit Cost Ratio (B/C)	:	1.44
Net Present Value (NPV)	:	Rp. 26.9 billion

Taking into consideration of future conditions such as improvement of living standards and increase in crop yield in the flood area, EIRR would increase from 14.1% to 18.5%.

7. Recommendation

- (1) The proposed Project is technically, economically and socially justified. Immediate implementation of the Project is recommended in consideration of the existing serious flood problems.

- (2) On-going projects, watershed management and improvements of tributaries flowing through the Bandung Urban Area, are recommended to be progressed under the proposed plan by the Government of Indonesia in view of necessity for the Overall Flood Control Plan of the Upper Citarum Basin.
- (3) Because of the high costs required for the implementation of the Urgent Project, foreign financial assistance may be necessary.
- (4) Flood plain management consisting of land-use regulation and flood forecasting, warning, and evacuation system shall be implemented for the proposed flood risk area of approximately 5,600 ha.
- (5) Some low-lying Kampung are still flood prone even after completion of the Urgent Project. Main Drainage system in such Kampung shall be improved to drain the stagnant flood water soon after the flood in the river recedes.
- (6) Garbage disposal into rivers causes a river bed rising, resulting in decrease of the discharge capacity of the rivers. Garbage disposal shall be well controlled for maintenance of the proper river conditions.
- (7) Dredged materials of good quality shall be considered to be used profitably for beneficial purposes.

PHOTOGRAPH

EXISTING WATERSHED AND RIVER CONDITION

- 1. FLOODS AND LAND DEVELOPMENT**
- 2. CITARUM RIVER**
- 3. TRIBUTARIES**

FLOODS



Jan. 1984 Floods (Flooding around Dayeuh Kolot)



Jan. 1988 Floods (Flooding of Ciaangkuy River near confluence of the Citarum River)



Jan. 1988 Floods (Flooding of low-lying areas along left bank of the Citarum River at upstream of Dayeuh Kolot)

LAND DEVELOPMENT



Urbanization of flood prone areas along right bank of the Citarum River at upstrea of Dayeuh Kolot



Dry field development of Citarum Basin



Tea plantation development of Citarum Basin

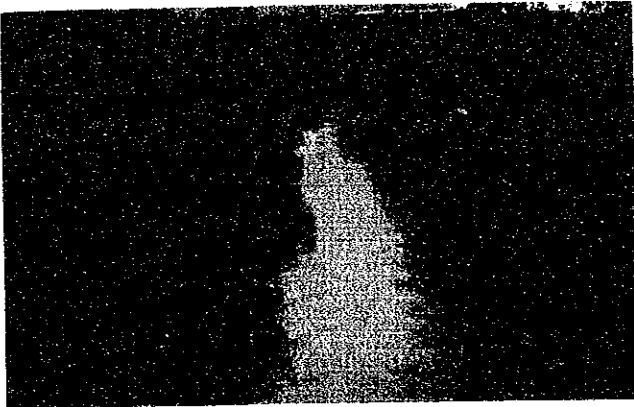
CITARUM RIVER



Curug Jompong Fall (Starting point of River Improvement Plan)



Upstream stretches of Curug Jompong



Downstream stretches of Nanjung Bridge



Gilampeni Bridge near Marugahayu



Dayeuh KoIot Road Bridge (See from downstrea to upstream)

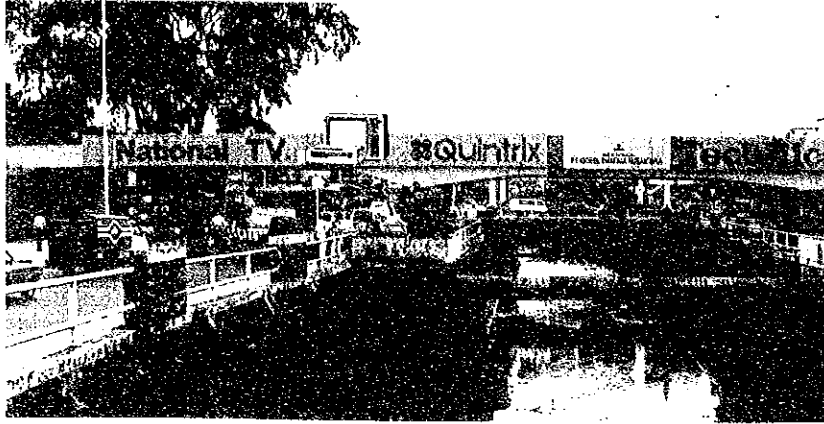


Upstream stretches of confluence of the Cidurian River (See from downstream to upstream)



Downstream stretches of Sapan (See from downstream to upsteraam)

TRIBUTARIES



Cikapundung River, right tributary of Citarum River, in Bandung City



Cicadas River, right tributary of Citarum River, after completion of urgent river improvement project



Downstream stretches of the Cikeruh River, right tributary of the Citarum River



Irrigation weir at Rancaemit of the Citarik River, right tributary of the Citarum River



Upstream stretches at Rancaek of the Citarik River (See from down stream to upstream)



Cisangkuy River, left tributary of the Citarum River, at about 4 km upstream from the confluence of the Citarum River

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