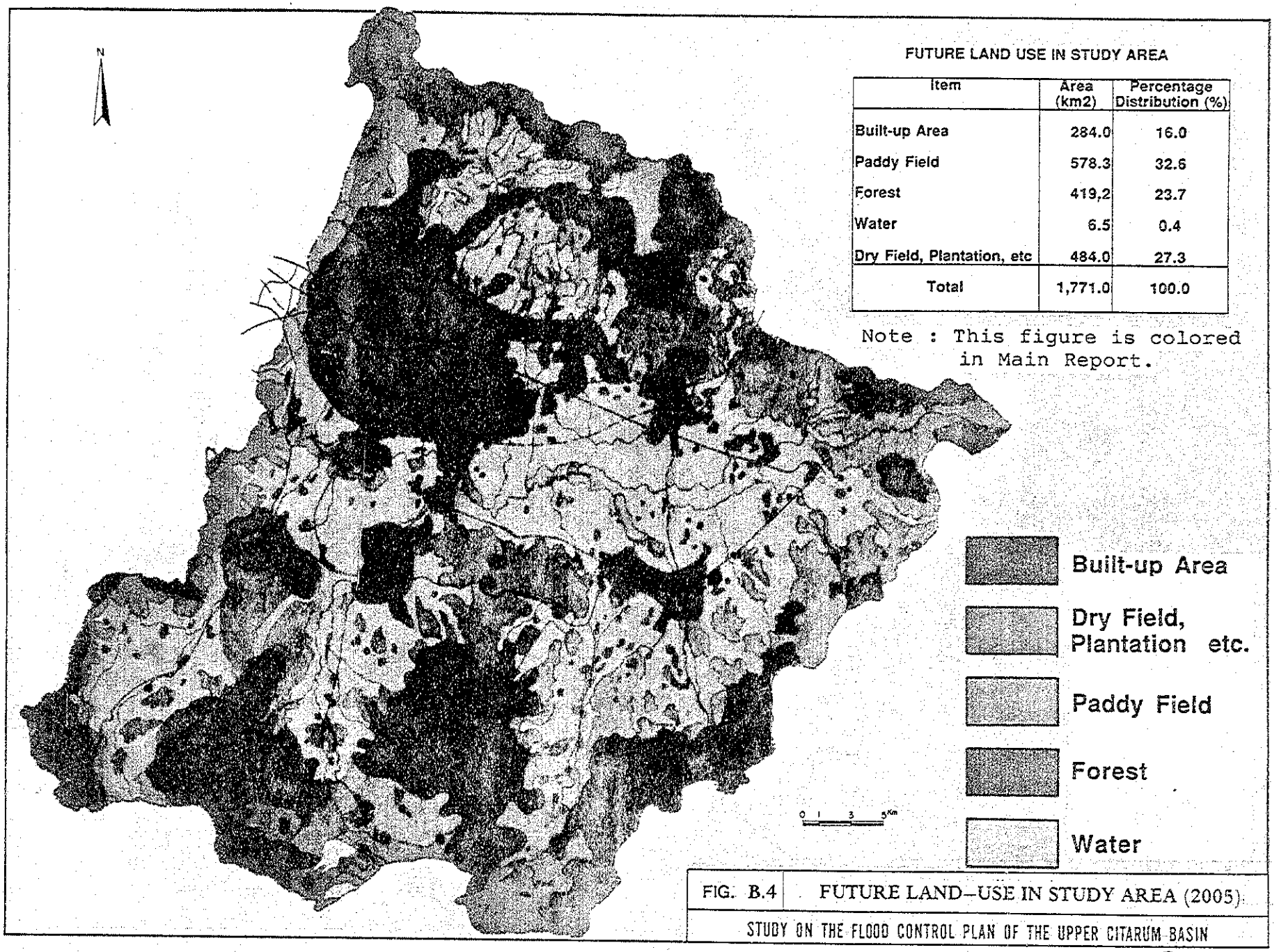

FIG. B.4 FUTURE LAND–USE IN STUDY AREA (2005)

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

SUPPORTING REPORT C

PRESENT WATERSHED AND RIVER CONDITION

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SUPPORTING REPORT C
PRESENT WATERSHED AND RIVER CONDITION

1. Watershed Condition

1.1 River System

The Citarum River and its major tributaries are shown in Fig. C.1. Slope of the tributaries are steep ranging from 2% to 10% as shown in the same figure. Altitudes of the mountain ridges are around 2000 m and ground elevation at Sapan is 660 m. Middle and down stream reaches of the Citarum River, and downstream reaches of the Citarik and Cikeruh Rivers are located in the former lake area and the river bed slopes are rather mild.

1.2 Division of Drainage Basin

The Upper Citarum River Basin (1,771 km^2) is divided into 15 major sub-basins (see Fig. C.2).

The covered drainage areas are:

- 754.7 km^2 at Sapan
- 1,332.1 km^2 at Dayeuh Kolot
- 1,718.0 km^2 at Nanjung
- 1,771.0 km^2 at Curug Jompong

1.3 Land-use Classification

The land-use of the Basin can be roughly classified into five (5) categories: Water, Forest, Paddy Field, Field (upland, plantation, grass land, etc.) and Built-up Area.

The existing and future (year 2005) land-uses of the Basin were classified into the above five (5) categories respectively by sub-basin.

The results are shown in Table C.1.

1.4 Land Erosion

The land of the Basin is affected by serious erosion. An average erosion depth of the Basin is estimated to be 2.1 mm/year.
(Source: Saguling Hydro Power Project, F/S Report)

The land rehabilitation and soil conservation of the Upper Citarum Basin were studied by Ministry of Forestry in March 1987.

According to the Study, the land and soil of the Upper Citarum Basin are classified as shown in Fig. C.3 and Fig. C.4. Slope of the land, damaged land area and serious land erosion area are also presented in Fig. C.5, Fig. C.6 and Fig. C.7 respectively.

2. River Condition

2.1 River Profile and Cross Section

The existing average bed and bank slopes of the Citarum River and its major tributaries in the flood prone stretches are as follows:

Citarum River

Main: For 40 km stretches between Curug Jompong and Sapan (Fig. C.8)

Bed slope : 1/6,000 (0.00017)
Bank slope : 1/6,800 (0.00015)

Upstream: For 6 km stretches upstream from Sapan (Fig. C.9)

Bed slope : 1/3,600 (0.00028)
Bank slope : 1/3,600 - 1/1,000 (0.00028 - 0.001)

Citarik River: For 15 km stretches upstream from the confluence with the Citarum River at Sapan (Fig. C.10)

Bed slope : 1/4,500 - 1/1,100 (0.00022 - 0.00091)

Bank slope : 1/4,500 - 1/1,100 (0.00022 - 0.00091)

Cikeruh River: For 5 km stretches upstream from the confluence with the Citarum River at Sapan (Fig. C.9)

Bed slope : 1/2,250 (0.00044)
Bank slope : 1/4,500 (0.00022)

Cisangkuy River: For 9 km stretches upstream from the confluence with the Citarum River at Dayeuh Kolot (Fig. C.11)

Bed slope : 1/2,800 (0.00036)
Bank slope : 1/2,800 (0.00036)

The cross sections of the Citarum, Citarik, Cikeruh and Cisangkuy Rivers are of single section with no major embankment. The river width and depth are as shown below.

Name of River	Width (m)	Depth (m)	Remarks
Citarum River			
Main	30 ~ 70	3 ~ 6	Downstream of Sapan
Upstream	25 ~ 30	3 ~ 6	Upstream of Sapan
Citarik River	10 ~ 25	2 ~ 4	
Cikeruh River	10 ~ 20	2 ~ 3	
Cisangkuy River	15 ~ 30	3 ~ 6	

The typical cross sections of the Citarum, Citarik, Cikeruh and Cisangkuy Rivers are shown in Fig. C.12 and C.13.

2.2 Roughness Coefficient

Manning's roughness coefficient of the Citarum River was estimated by collating the water level profile of the 1986 flood obtained by non-uniform flow computation with the actual water level trace.

The estimated roughness coefficients under the existing river conditions are :

0.040 : For the stretches between Curug Jompong and the confluence of the Ciwidey River.

0.035 : For the stretches between the confluences of the Ciwidey River and the Cisangkuy River.

0.030 : For the stretches upstream from the confluence of the Cisangkuy River.

2.3 Hydraulic Characteristics

Hydraulic characteristics of the Citarum, Citarik, Cikeruh and Cisangkuy Rivers are expressed in terms of flow area, ratio of river width to depth, discharge capacity and mean flow velocity.

Longitudinal variation of the hydraulic characteristics of the rivers is shown in Table C.2 to Table C.6 and Figs. from C.14 to C.18.

The main stream of the Citarum River, the distance expressed in km from Curug Jompong, (0 ~ 40 km) undergoes a clear change in its hydraulic characteristics at the sections between 20 km and 25 km distances at mid stream. The discharge capacity of the downstream stretches (0 ~ 20 km) is approximately two (2) times larger than that of the upstream stretches (20 ~ 40 km). Ratio of the river width to depth varies from 8 to 20 in the downstream stretches (0 ~ 20 km), while it remains rather constant at 8 ~ 10 in the upstream stretches (25 ~ 40 km).

Mean velocity of the bankful discharge is 1.0 m/s or less in all stretches (0 ~ 40 km).

2.4 River Facilities

The existing river facilities related to the Project are 12 bridges, 13 irrigation weirs, dike of 10,720 m length and revetment of 250 m length.

Lists and location of the facilities are shown in Table C.7, C.8 and Fig. C.19.

2.5 River Bed Materials

Sampling tests of the bed materials of the Citarum River were conducted by this Study Team. The materials were sampled at three (3) points of the river section (left, center and right) of the following four (4) locations respectively.

Bojongrangkas : mid point between Sapan and Majalaya, 47 km distance from Curug Jompong

Haurhapit : mid point between Dayeuh Kolot and Sapan, 32 km distance from Curug Jompong

Dayeuh Kolot : just downstream of the confluence of Cisangkuy River, 25 km distance from Curug Jompong

Pameuntasan : just downstream of the confluence of Ciwidey River, 9 km distance from Curug Jompong

Location of the sampling points are shown in Fig. C.20.

The river bed materials are fine sand or coarse sand at Bojongrangkas, fine sand or silt at Haurhapit, coarse sand or sandy gravel at Dayeuh Kolot, and gravel or coarse sand at Pameuntasan. The mean diameters of the materials are 0.86 ~ 1.01 mm at Bojongrangkas, 0.37 ~ 0.72 mm at Haurhapit, 0.52 ~ 2.62 mm at Dayeuh Kolot and 8.67 ~ 28.4 mm at Pameuntasan.

The river bed material is the minimum in size at Haurhapit located in the middle of the flood area. This fact shows that tractive force on sediment is decreased due to flood retarding effects in this location.

Specific gravity of the river bed materials is 2.73 ~ 2.80.

Results of the sampling tests are summarized in Tables C.9, C.10 and Fig. C.20.

2.6 Suspended Load

Suspended loads were measured by IHE and WJRRDP office at the stream gauge stations shown in Fig. C.21. The available data is for a period from 1987 to 1988 at Dayeuh Kolot and 1984 to 1986 at the other stations. The observed data are tabulated in Data Book III.

High concentration of suspended solids are recognized in the following rivers.

River (Station)	Concentration	Date
- Citarum (Majalaya)	1,782 mg/l	Dec. 5, 1984
- Cipamokolan (Lis)	7,238 mg/l	Sep. 12, 1984
- Citarum, Cisarea (Andir)	2,579 mg/l	Oct. 4, 1984
- Citarik, Cijalupang (Peundeuy)	3,128 mg/l	Dec. 6, 1984
- Cibodas (Jatisari)	2,124 mg/l	Sep. 15, 1984

Average suspended loads at Dayeuh Kolot during the flood season is 200 - 400 mg/l as shown below.

Obervation Period	Range	Average
Dec. 11 - 23, 1987	112 - 424 mg/l	218 mg/l
Jan. 6 - 27, 1988	109 - 484 mg/l	309 mg/l
Feb. 1 - 29, 1988	284 - 443 mg/l	364 mg/l

2.7 River Bed Sedimentation

The flood water stage of the Citarum River has risen from year to year since 1982. The yearly maximum water stage at Dayeuh Kolot rose by about 2 m during the four (4) years from 1982 to 1986 (Refer to Supporting Report G). The yearly minimum water stage has also risen since 1982. It rose by 0.6 m at Dayeuh Kolot during these four (4) years. However, it lowered again in 1987 to that of 1982 level due to the effects of the dredging works conducted by WJRDP office (See Fig. C.24).

The rising of the flood and low water stages might have been caused by the sediment deposits including garbages in the downstream of Dayeuh

Kolot. In fact, large quantities of sediments and garbages flow into the Citarum River every year as illustrated below.

(1) The yearly sediment yield of the Upper Citarum Basin is estimated to be 3.7 million m^3/year (= 2.1 ^{mm} x 1,771 km^2).

(2) Volume of solid waste production in Kotamadya Bandung has rapidly increased as follows (Source : BUDP).

- 1978 year : 0.5 million m^3/year
- 1981 year : 0.7 million m^3/year
- 1986 year : 1.93 million m^3/year

In October 1986, the volume of garbages flowing into the Sagling Reservoir was measured as 25,000 m^3 per week. It is equivalent to 1.3 million per year (= 25,000 x $\frac{365}{7}$).

The garbage deposits of the Citarum River and tributaries were identified by the field reconnaissance as follows.

(1) Garbage accumulation is high in the downstream of the junction with the Cikapundung River extending over approximately 8.0 km (Station at 20 km to Station at 28 km). The garbage deposits are mixed in sediments. (See Fig. C.22).

(2) Much garbage deposits are observed in the tributaries, Cikapundung and Citepus, which flow through Bandung urban areas. Those are the major garbage sources of the Citarum Main River (See Fig. C.23).

2.8 River Bed Stability

(1) Dominant Discharge

Dominant discharge is the discharge which causes the largest effect on the formation of a river section and profile.

The existing river channel was formed by repetition of scouring and deposition for a long period. Therefore, it is considered to be in a stable condition. Bankful discharge of the existing river channel is usually considered as the dominant discharge which is used in design of river channel improvements.
The bankful discharge of the exisiting Citarum River at Dayeuh Kolot is approximately 160 m^3/s, which is equivalent to a 1-year frequency flood.

(2) Macro Check of Stability

The stability of the existing Citarum River is investigated from a macro-viewpoint, as explained below.

The Ministry of Construction of Japan conducted an empirical research on sand bar formation for 4 years from 1975 to 1979 using actual data of many rivers in Japan. According to the research results, the Citarum River is classified as a weak sand bar river as shown in Fig. C.25. Therefore the existing Citarum River is considered to be a relatively stable river since it is classified as a weak sand bar formation.

3. Water Use

3.1 Urban Water Supply

According to the Bandung Urban Water Supply Study (BUDS), future water demand of the Bandung Urban Area is predicted as shown below. (Refer to Table C.11)

	Year 1990	2000	2010
Domestic demand	1570 l/s	2456 l/s	3336 l/s
Non-domestic demand	523	819	1112
Total demand	3170	4710	6510
Incremental demand	1400	2800	4600

The existing water sources of the Bandung Urban Area are:

- Cisangkuy River	:	800 l/s
- Cikapundung River	:	150 l/s
- 19 wells	:	470 l/s
- 9 springs	:	150 l/s
Total	:	1570 l/s

The possible sources of additional water abstraction are shown in Table C.12.

3.2 Irrigation Area

The existing irrigation areas in the upper Citarum basin are summarized below.

	Irrigation Area (ha)
Public Works Irrigation	33,608
Technical	21,709
Semi technical	11,899
Desa Irrigation (Non technical)	33,750
Rainfed Irrigation	8,844
Total	76,202

(Source: "Bina Program; Final Report, Upper Citarum Water Resources Development and Flood control Study, 1986.")

Location of the irrigation area is shown in fig. C.26.

Table C.1 LAND-USE OF BASIN

Name of Drainage basin	Area (km2)	Present Land Use										Future Land Use									
		Water		Forest		Paddy Field		Dry Field Plantation etc		Built-up Area		Water		Forest		Paddy Field		Dry Field Plantation etc		Built-up Area	
		Area (km2)	Percent (%)	Area (km2)	Percent (%)	Area (km2)	Percent (%)	Area (km2)	Percent (%)	Area (km2)	Percent (%)	Area (km2)	Percent (%)	Area (km2)	Percent (%)	Area (km2)	Percent (%)	Area (km2)	Percent (%)	Area (km2)	Percent (%)
1. Citarum	197.0	0.5	0.2	88.7	45.0	49.0	249.0	55.7	28.3	3.1	1.6	0.5	0.3	88.7	45.0	47.1	23.9	55.7	28.3	5.0	2.5
2. Cirasea	93.1	0.0	0.0	20.1	21.6	42.7	45.8	26.8	28.8	3.5	3.8	0.0	0.0	20.1	21.6	34.7	37.2	25.1	27.0	13.2	14.2
3. Citarik	281.4	0.8	0.3	35.0	12.4	137.5	48.9	99.0	35.2	9.1	3.2	0.8	0.3	35.0	12.4	134.2	47.7	96.5	34.3	14.9	5.3
4. Cikeruh	204.6	0.0	0.0	43.6	21.3	90.9	44.5	62.5	30.5	7.6	3.7	0.0	0.0	43.6	21.3	77.9	38.1	48.7	23.8	34.4	16.8
5. Kopo	53.7	0.0	0.0	0.8	1.5	33.6	62.6	18.2	33.9	1.1	2.0	0.0	0.0	0.8	1.5	33.6	62.6	18.2	33.9	1.1	2.0
6. Cibodas	29.7	0.0	0.0	0.0	0.0	16.3	54.8	10.5	35.4	2.9	9.8	0.0	0.0	0.0	0.0	14.3	48.2	4.6	32.3	5.8	14.5
7. Cidurian	51.8	0.0	0.0	1.5	2.9	33.6	64.9	5.4	10.4	11.3	21.8	0.0	0.0	1.5	2.8	26.4	51.0	4.5	8.7	19.4	37.5
8. Cikapundung	144.3	0.0	0.0	38.7	26.8	13.8	9.6	48.0	33.3	43.8	30.3	0.0	0.0	38.7	26.8	4.2	2.9	45.6	31.6	55.8	38.7
9. Cisangkuy	276.5	4.9	1.8	92.6	33.5	77.2	27.9	98.3	35.5	3.5	1.3	4.9	1.8	92.2	33.3	68.2	24.7	96.8	35.0	14.4	5.2
Dayeuh Kolot	1332.1	6.2	0.5	321.0	24.1	494.5	37.1	424.5	31.9	85.9	6.4	6.2	0.5	320.6	24.1	440.6	33.0	400.7	30.1	164.0	12.3
10. Cijalupang	60.1	0.0	0.0	0.0	0.0	44.4	73.9	14.5	24.1	1.2	2.0	0.0	0.0	0.0	0.0	34.6	57.6	13.1	21.8	12.4	20.6
11. Ciwidey	200.6	0.0	0.0	73.9	36.8	78.4	39.2	48.0	23.9	0.3	0.1	0.0	0.0	73.9	36.8	73.9	36.8	45.3	22.6	7.5	3.8
12. Cibaeureum	117.2	1.6	1.4	7.9	6.7	51.6	44.0	19.1	16.3	37.0	31.6	0.0	0.0	7.9	6.7	11.5	9.8	12.0	10.2	85.5	73.3
13. The basin of the rest	8.0	0.0	0.0	0.0	0.0	5.1	63.7	2.7	33.8	0.2	2.5	0.0	0.0	0.0	0.0	5.1	63.8	2.7	33.8	0.2	2.4
Nanjung	1718.0	7.8	0.4	402.8	23.4	674.0	39.2	508.8	29.7	124.6	7.3	6.2	0.4	402.4	23.4	565.7	32.9	473.8	27.6	269.9	15.7
14. Cimahi	48.0	0.3	0.6	16.8	35.0	18.8	39.2	10.7	22.3	1.4	2.9	0.3	0.6	16.8	35.0	10.5	21.9	6.7	14.0	13.7	28.5
15. The basin of the rest	6.0	0.0	0.0	0.0	0.0	2.1	35.0	3.5	58.3	0.4	6.7	0.0	0.0	0.0	0.0	2.1	35.0	3.5	58.3	0.4	6.7
Curug Jompong	1771.0	8.1	0.5	419.6	23.7	694.9	39.2	523.0	29.5	126.4	7.1	6.5	0.4	419.2	23.7	578.3	32.6	484.0	27.3	284.0	16.0

Table C.2 HYDRAULIC CHARACTERISTICS OF CITARUM RIVER

Station NO.	River Width B (m)	Flow Area A(m2)	Wetted Perimeter P (m)	Hydraulic Radius R (m)	Roughness Coefficient n	Velocity V (m/s)	Discharge Q (m3/s)
10.88	60.0	478.0	64.7	7.388	0.040	1.021	488
10.62	71.0	297.0	62.5	4.752	"	0.760	226
10.35	57.0	325.0	67.0	4.851	"	0.771	251
10.22	76.0	261.0	60.0	4.350	"	0.717	187
9.93	68.0	268.6	67.8	3.953	"	0.673	181
9.66	64.0	260.5	64.9	4.014	"	0.657	171
9.37	63.4	287.5	60.8	4.729	"	0.758	218
9.09	64.0	259.2	68.0	3.812	"	0.844	219
BTMC IX	57.0	197.0	54.2	3.635	"	0.818	161
8.88	54.0	272.1	55.3	4.920	"	1.001	272
8.61	56.0	308.5	59.6	5.176	"	1.035	319
8.34	39.0	207.5	45.0	4.611	"	0.959	199
8.05	47.0	296.6	52.1	5.693	0.035	1.103	327
7.78	49.0	242.1	53.6	4.517	"	0.946	229
7.48	50.0	293.3	61.8	4.746	"	0.977	287
7.19	70.0	262.5	68.5	3.832	"	0.847	222
6.104	42.0	176.0	54.4	3.235	"	0.757	133
6.66	38.5	158.0	41.3	3.826	"	0.846	134
6.33	58.9	169.0	59.5	2.840	"	0.694	117
6.07	51.2	165.5	59.9	2.763	"	0.681	113
C.435	34.8	72.4	34.4	2.105	"	0.663	48
C.426	47.7	97.2	42.2	2.303	"	0.705	68
C.409	27.2	110.0	31.5	3.492	"	0.930	102
C.367	31.8	133.0	35.2	3.778	"	0.980	130
C.332	25.2	94.5	29.6	3.193	"	0.876	83
C.309	30.8	125.8	34.9	3.606	0.030	0.950	119
C.269	30.0	119.1	33.6	3.545	"	0.939	112
C.242	31.0	133.1	34.9	3.814	"	0.986	131
C.127	33.0	117.6	34.8	3.379	"	0.910	107
C.99	37.0	145.0	38.2	3.796	"	0.983	143
C.71	34.0	122.2	36.7	3.330	"	0.901	110

Table C.3 HYDRAULIC CHARACTERISTICS OF CITARUM RIVER (UPSTREAM)

Hydraulic Gradient i	Station No	River Width B(m)	Flow Area A(m2)	Wetted Perimeter P(m)	Hydraulic Radius R(m)	Roughness Coefficient n	Velocity V(m/s)	Discharge Q(m3/s)	H
1/5500	40.00	29.90	81.80	32.70	2.50	0.03	0.82	67.70	5.30
	41.00	26.10	62.30	28.10	2.22	0.03	0.76	47.70	3.90
	42.00	27.90	81.30	30.00	2.71	0.03	0.87	71.00	4.70
	43.00	25.80	59.00	27.70	2.13	0.03	0.74	43.90	3.20
1/1000	44.00	27.10	76.50	29.10	2.63	0.03	2.00	153.60	4.20
	45.00	27.40	101.00	30.90	3.27	0.03	2.32	234.50	6.40
	46.00	28.90	135.10	35.20	3.84	0.03	2.58	349.20	6.40

Table C.4 HYDRAULIC CHARACTERISTICS OF CITARIK RIVER

Hydraulic Gradient i	Station No	River Width B(m)	Flow Area A(m2)	Wetted Perimeter P(m)	Hydraulic Radius R(m)	Roughness Coefficient n	Velocity V(m/s)	Discharge Q(m3/s)	H
1/4500	0.45	23.00	56.80	24.80	2.29	0.03	0.86	48.80	3.90
	1.00	15.20	36.60	17.00	2.15	0.03	0.83	30.40	4.00
	2.00	22.60	49.20	24.30	2.02	0.03	0.79	39.10	3.30
	3.15	15.40	42.20	18.80	2.24	0.03	0.85	35.90	3.60
	4.15	25.00	63.20	27.00	2.34	0.03	0.88	55.60	3.60
	5.00	16.00	38.10	17.40	2.19	0.03	0.84	31.90	3.40
	5.95	16.00	33.70	17.60	1.91	0.03	0.76	25.60	3.20
	6.40	17.60	40.30	20.90	1.93	0.03	0.77	31.00	4.40
	7.10	13.60	31.60	15.90	1.99	0.03	0.79	25.00	3.30
	8.16	12.00	38.40	16.20	2.37	0.03	0.88	33.80	4.00
	9.28	13.60	28.40	15.80	1.80	0.03	0.74	21.00	3.20
1/1100	10.20	10.40	15.80	12.30	1.28	0.03	1.18	18.60	2.10
	11.00	7.60	13.96	10.90	1.28	0.03	1.18	16.50	2.00
	12.00	10.80	21.40	13.40	1.60	0.03	1.37	29.30	2.50
	12.90	13.90	18.90	15.00	1.26	0.03	1.17	22.10	1.60
	13.80	10.80	16.20	12.30	1.32	0.03	1.21	19.60	1.80
	14.40	12.40	13.30	13.30	1.00	0.03	1.00	13.30	1.00
	14.60	15.70	15.10	16.70	0.90	0.03	0.94	14.10	1.20

Table C.5 HYDRAULIC CHARACTERISTICS OF CIKERUH RIVER

Hydraulic Gradient i	Station No	River Width B(m)	Flow Area A(m2)	Wetted Perimeter P(m)	Hydraulic Radius R(m)	Roughness Coefficient n	Velocity V(m/s)	Discharge Q(m3/s)	H
1/5500	0.35	18.30	40.90	20.10	2.03	0.03	0.72	29.50	2.90
	1.00	14.70	26.80	16.30	1.64	0.03	0.62	16.80	3.20
	1.50	17.30	34.60	19.30	1.79	0.03	0.66	22.90	3.00
	1.70	12.60	21.60	14.30	1.51	0.03	0.59	12.80	3.20
	3.00	9.00	14.50	10.70	1.36	0.03	0.55	8.00	2.00
	4.00	9.40	14.70	11.20	0.76	0.03	0.37	5.50	2.50
	5.00	6.10	2.50	6.70	0.37	0.03	0.23	0.60	0.60

Table C.6 HYDRAULIC CHARACTERISTICS OF CISANGKUY RIVER

Hydraulic Gradient i	Station No	River Width B(m)	Flow Area A(m2)	Wetted Perimeter P(m)	Hydraulic Radius R(m)	Roughness Coefficient n	Velocity V(m/s)	Discharge Q(m3/s)	H
1/2800	BM.17	25.80	80.80	28.70	2.82	0.03	1.08	87.00	3.90
	P.18	18.00	78.09	24.66	3.17	0.03	1.16	90.90	7.07
	P.31	16.50	61.02	21.09	2.89	0.03	1.10	67.00	4.91
	P.41	20.00	66.84	23.26	2.87	0.03	1.09	72.96	5.28
	P.59	23.00	92.24	28.32	3.26	0.03	1.19	109.46	6.78
	P.73	21.50	78.75	25.54	3.08	0.03	1.15	90.09	9.80
	P.82	22.00	71.68	26.06	2.75	0.03	1.07	77.77	3.78
	P.88	24.50	76.93	26.32	2.92	0.03	1.11	89.93	4.29
	BM.18	28.00	83.69	29.74	2.81	0.03	1.08	90.08	3.85
	S/29	24.90	54.26	25.21	2.24	0.03	0.90	48.83	3.17
	S/40	22.60	52.84	24.70	2.14	0.03	0.90	47.38	4.94
	S/53	24.50	75.01	26.58	2.82	0.03	1.08	80.86	5.83
	S/71	20.10	58.56	24.42	2.40	0.03	0.97	56.66	5.34
	S/90	28.80	70.57	27.52	2.56	0.03	1.01	71.39	4.79

Table C.7 LIST OF EXISTING IRRIGATION WEIR

No	Name of Weir	River	Desa	Irrigation Area (ha)	Ramarks
1	Bugel	Cikeruh	Sukamanah	182	Non PU
2	Ciyasana	Cikeruh	Rancaekek	1,682	PU
3	Tanggeung	Citarik	Bojongloa	138	Non PU
4	Citarik	Citarik	Sukamanah	140	Non PU
5	Bojongmonyec	Cibodas	Bojongsalam	48	Non PU
6	Bojongbraja	Citarik	Bojongsalam	79	Non PU
7	sangiang	Citarik	Bojongsalam	309	Non PU
8	Sawahgede	Cibodas	Cikuya	55	Non PU
9	Nyalindung	Cimande	Linggar	454	Non PU
10	Ciendog	Cikeruhanak		50	Non PU
11	Ciwirahma/ Situkuluwung	Ciwirahma/ Tanjunglya		100	Non PU
12	Citangkrak	Talun			Non PU
13	Buah Batu	Cibeuwying			Non PU

Table C.8 LIST OF EXISTING BRIDGE

No	Brige Name	Super - Structure			Pier type	Abutment Type
		Type	Length (m)	Width (m)		
1	Nanjung	Truss/Steel Cirder			RC	RC
2	Cilampeni	Steel Cirder	46.0	9.0	RC	RC
3	Dayeuh Kolot (Road)	Concrete Cirder	88.3	8.5	Masonry	Masonry
4	Dayeuh Kolot (Water Supply)	Concrete Cirder			Pile Bent	RC
5	Dayeuh Kolot (Railway)	Truss	87.2	7.7	Masonry	Masonry
6	Jemb Cipurut	Concrete Slab	10.0		-	Masonry
7	Jemb Leuwikuray	Steel Cirder	31.0	3.0	Masonry	Masonry
8	Sapan - 1	Steel Cirder			Masonry	Masonry
9	Sapan - 2	Steel Cirder			RC	Masonry
10	Rantjatuodjung	Truss	30.0	3.5	RC	RC
11	Bodjonggede	Suapendid	35.0	2.5	-	Masonry
12	Jemb Citaric	Steel Cirder	22.0		Masonry	Masonry

Table C.9 PROPERTY OF BED MATERIAL OF CITARUM RIVER

Item \ Sampling Location	Bojongrangkas			Haurhapit			Dayeuh Kolot			Pameuntasan		
	Left	Center	Right	Left	Center	Right	Left	Center	Right	Left	Center	Right
Gravel (%)	0.0	1.0	2.0	2.0	0.0	0.0	0.0	0.0	9.0	69.0	72.0	63.0
Sand (%)	68.0	78.0	82.0	72.0	48.0	74.0	86.0	68.0	65.0	29.0	24.0	33.0
Silt (%)	30.0	17.0	14.0	26.0	33.0	26.0	14.0	24.0	26.0	2.0	4.0	4.0
Clay (%)	2.0	4.0	2.0	-	19.0	-	-	0.0	0.0	-	-	-
Visual classification	Fine & Middle Sand	Coarse Sand	Fine Sand	Fine Sand	Silt	Fine Sand	Corse Sand	Corse Sand	Sand Gravel	Gravel Sand	Gravel	Gravel, Coarse Sand
Maximum Size (mm)	4.76	4.76	4.76	4.76	2.00	2.00	2.00	2.00	19.10	38.10	38.10	9.52
Mean Size (mm)	0.90	0.86	0.86	0.72	0.37	0.40	0.57	0.52	2.62	28.40	16.80	8.67
Medium Size (mm)	0.38	0.32	0.32	0.23	0.04	0.22	0.34	0.13	0.28	9.50	9.20	2.40
Dispersion Coefficient	1.51	3.45	3.45	2.00	4.47	1.80	1.49	3.61	2.59	5.98	3.38	3.18
Standard Deviation	2.34	4.64	4.64	2.85	13.54	2.60	2.12	8.40	5.99	10.64	9.13	5.70
Uniformity Coefficient	12.40	20.60	20.60	9.00	-	6.60	12.30	62.50	20.60	83.30	413.80	12.10
Curvature Coefficient	5.10	0.51	0.51	1.53	-	1.26	5.61	3.16	2.29	0.74	22.50	1.78
Specific Gravity	2.77	2.79	2.79	2.79	2.73	2.80	2.77	2.75	2.76	2.80	2.80	2.79

Note: Mean size is weighted mean size. Medium size is 50% passing size.

Table C.10 GRAIN SIZE DISTRIBUTION OF RIVER BED MATERIAL

(Unit: mm)

Passing Percentage	Bojongrangkas			Haurhapit			Dayeuh Kolot			Pameuntasan		
	Left	Center	Right	Left	Center	Right	Left	Center	Right	Left	Center	Right
10	0.017	0.013	0.034	0.027	-	0.034	0.031	0.0032	0.016	0.21	0.029	0.28
20	0.029	0.055	0.18	0.053	0.003	0.057	0.185	0.013	0.035	0.57	0.40	0.51
30	0.055	0.158	0.27	0.10	0.012	0.098	0.257	0.045	0.11	1.65	2.80	1.30
40	0.25	0.25	0.34	0.19	0.027	0.17	0.30	0.085	0.21	4.60	6.00	2.00
50	0.32	0.34	0.38	0.23	0.043	0.215	0.34	0.130	0.28	9.50	9.20	2.40
60	0.35	0.42	0.42	0.24	0.060	0.225	0.38	0.200	0.33	17.50	12.00	3.40
70	0.40	0.55	0.48	0.26	0.083	0.234	0.45	0.330	0.40	28.00	14.50	6.60
80	0.48	0.73	0.56	0.31	0.18	0.254	0.525	0.48	0.65	39.00	18.00	11.00
90	0.70	1.10	0.69	0.44	0.40	0.30	0.78	0.70	1.80	47.00	24.00	15.50
100	4.76	4.76	4.76	4.76	2.00	2.00	2.00	2.00	19.10	50.80	38.10	19.10

Table C.11 FUTURE WATER DEMAND FOR BANDUNG WATER SUPPLY

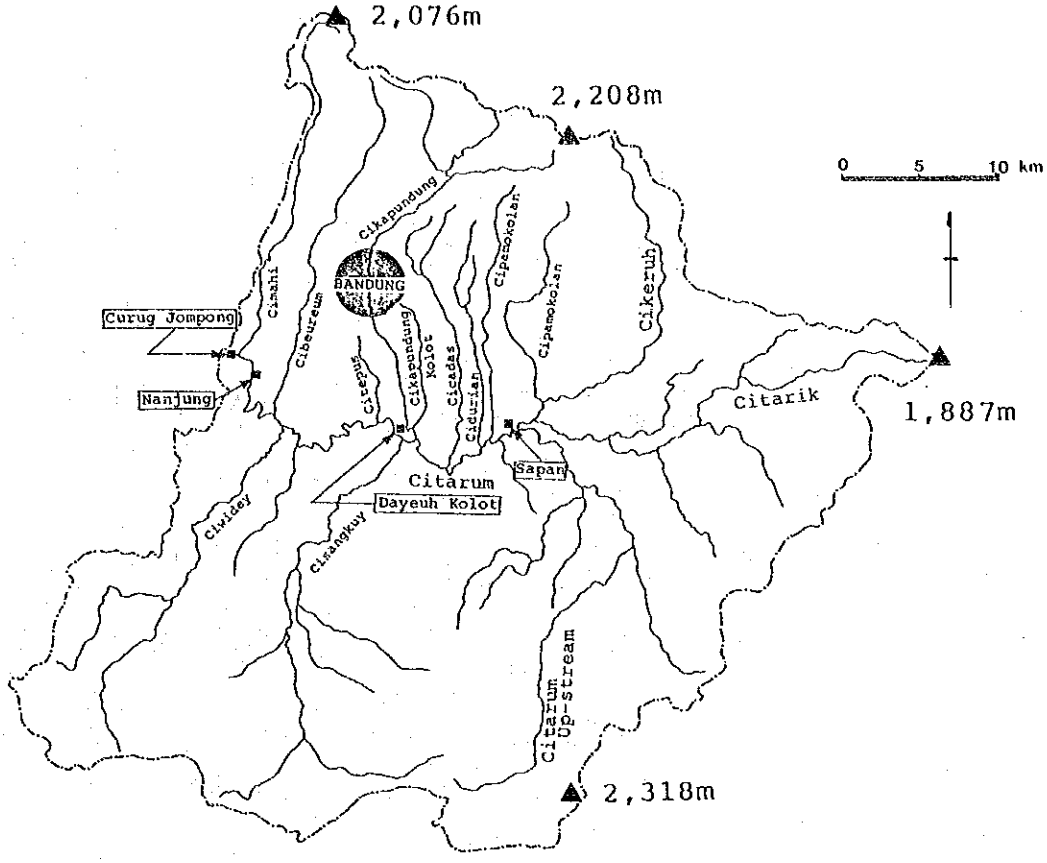
Descriprion		1990 excl.Cimahi	2000 incl.Cimahi	2010 incl.Cimahi
Population		2,160,200	3,093,300	3,771,200
Population urban supply area		1,858,529	2,773,200	3,479,600
Population served	(%)	75	80	85
Population served		1,403,379	2,218,600	2,957,700
Houseconnections	(%)	61	63	66
Demand houseconnections	(l/cd)	139	135	132
Demand public taps	(l/cd)	30	30	30
Average dom.demand	(l/cd)	97	96	97
Domestic demand	(l/s)	1,570	2,456	3,336
Non domestic demand	(l/s)	523	819	1,112
Total demand	(l/s)	2,093	3,275	4,448
Physical loss	(l/s)	583	702	1,045
Total distributed	(l/s)	2,676	3,977	5,493
In-plant losses	(l/s)	80	119	168
Raw water demand (average)	(l/s)	2,756	4,096	5,660
Raw water demand (maximum)	(l/s)	3,170	4,710	6,510
Existing capacity	(l/s)	1,770	1,910	1,910
Incremental demand	(l/s)	1,400	2,800	4,600

Table C.12 SUMMARY OF ADDITIONAL ABSTRACTION POSSIBILITIES

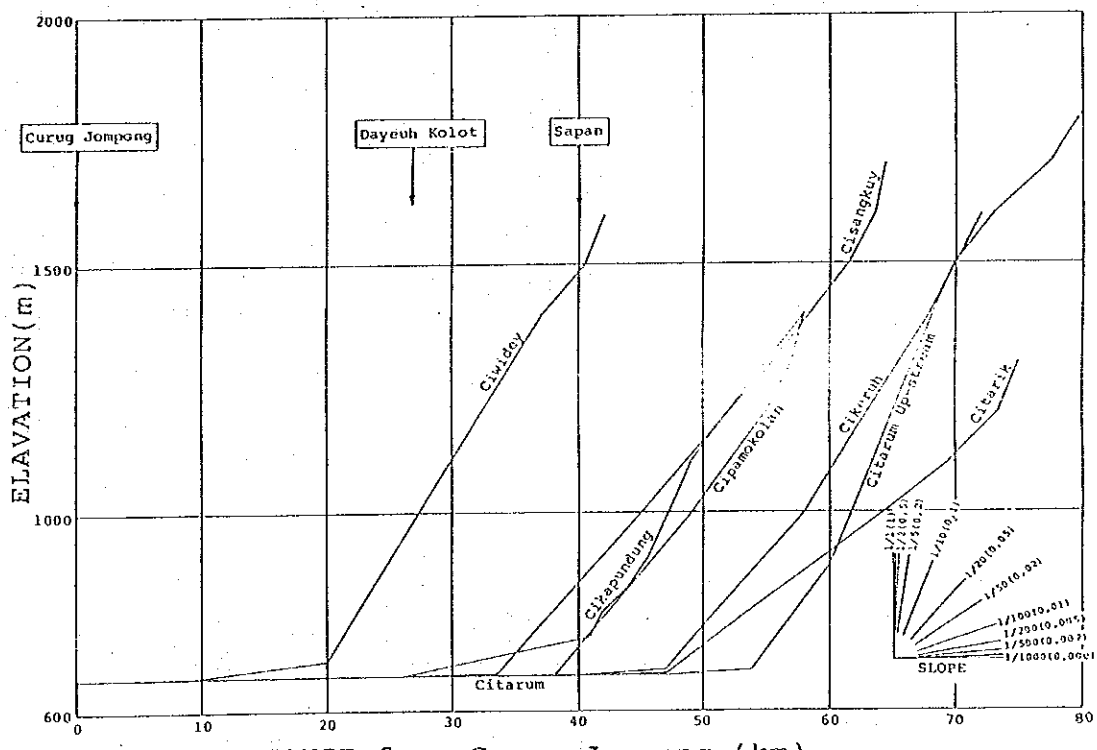
No. Source	Location	Max.pdd. capacity (m3/s)	Remarks
1. Cikapundung	downstream Dago	0.63	Irrigation affected
2. Cikapundung	upstream Pakar	0.63 1)	Irrigation and PLN affected
3. Cikapundung	reservoir needed	0.60 2)	Reservoir location not very suitable
4. Cisangkuy	downstr.Cikalong	0.80	PLN should co-operate
5. Cisangkuy	downstr.Cikalong	0.60 3)	Enlarge reservoirs to 42 million m3
6. Citarum	near Cioray	0.80	Much sediment
7. Citarum	downstream Dayeuhkolot	1.80 4)	Includes Bandung's wastewaters
8. Saguling	from ex.reservoir	"	Large distance,large static head.

1) abstracted volume same as option 1
2) volume is extra above option 1 or 2
3) volume is extra above option 4
4) volume will alter if their will be abstractions from option 1-6 as well

Source:Bandung Water Supply Study



RIVER SYSTEM OF STUDY AREA



RIVER BED SLOPE

FIG. C.1 CITARUM RIVER SYSTEM AND RIVER SLOPES

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

Name of Drainage basion	Area (km2)
1. Citarum	197.0
2. Cirasea	93.1
3. Citarik	281.4
4. Cikeruh	204.6
5. Kopo	53.7
6. Cibodas	29.7
7. Cidurian	51.8
8. Cikapundung	144.3
9. Cisangkuy	276.5
Dayeuh Kolot	1332.1
10. Cijalupang	60.1
11. Ciwidey	200.6
12. Cibeureum	117.2
13. The basin of the rest	8.0
Nanjung	1718.0
14. Cimahi	48.0
15. The basin of the rest	6.0
Curug Jompong	1771.0

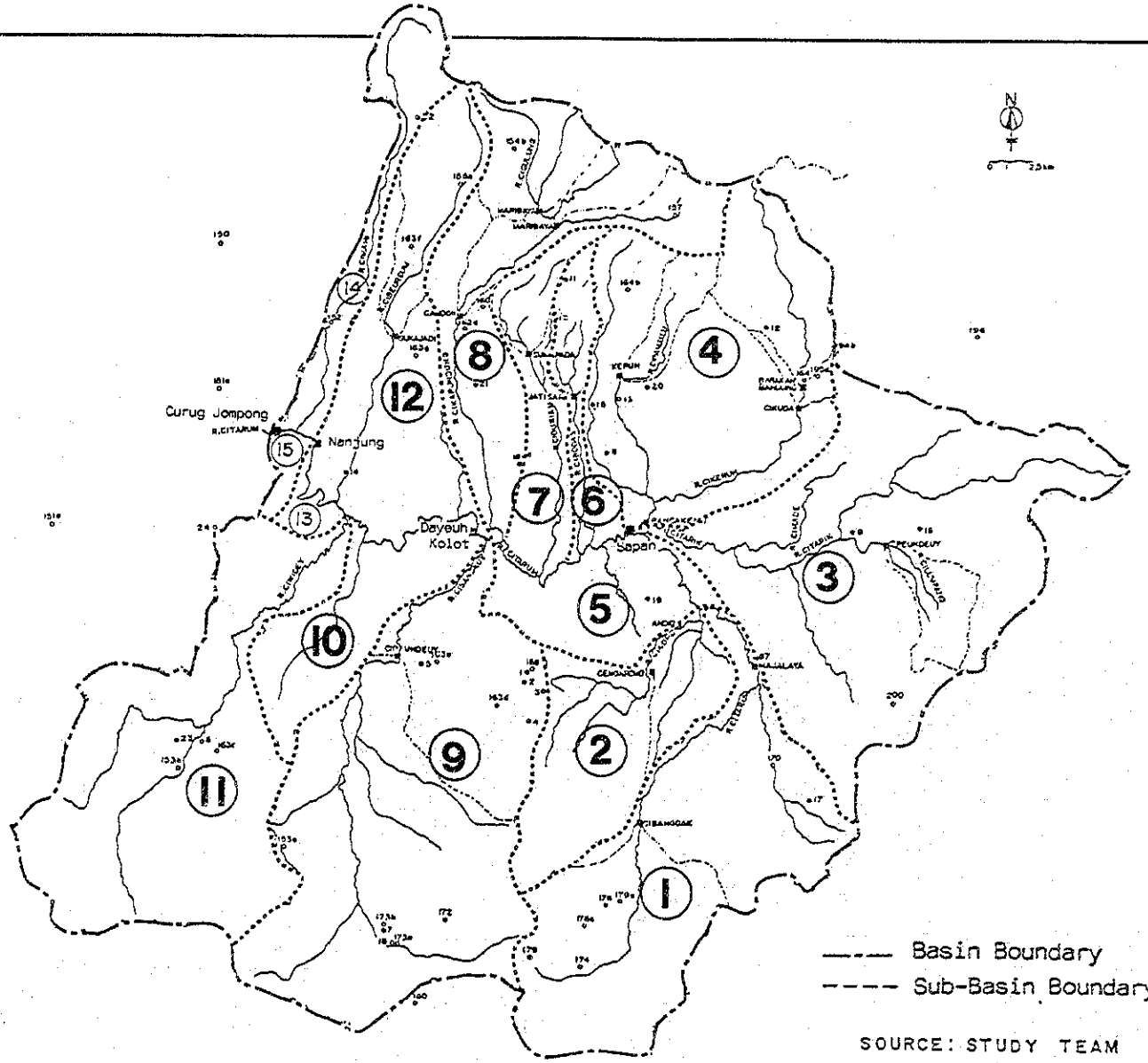


FIG. C.2 DIVISION OF DRAINAGE BASIN

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

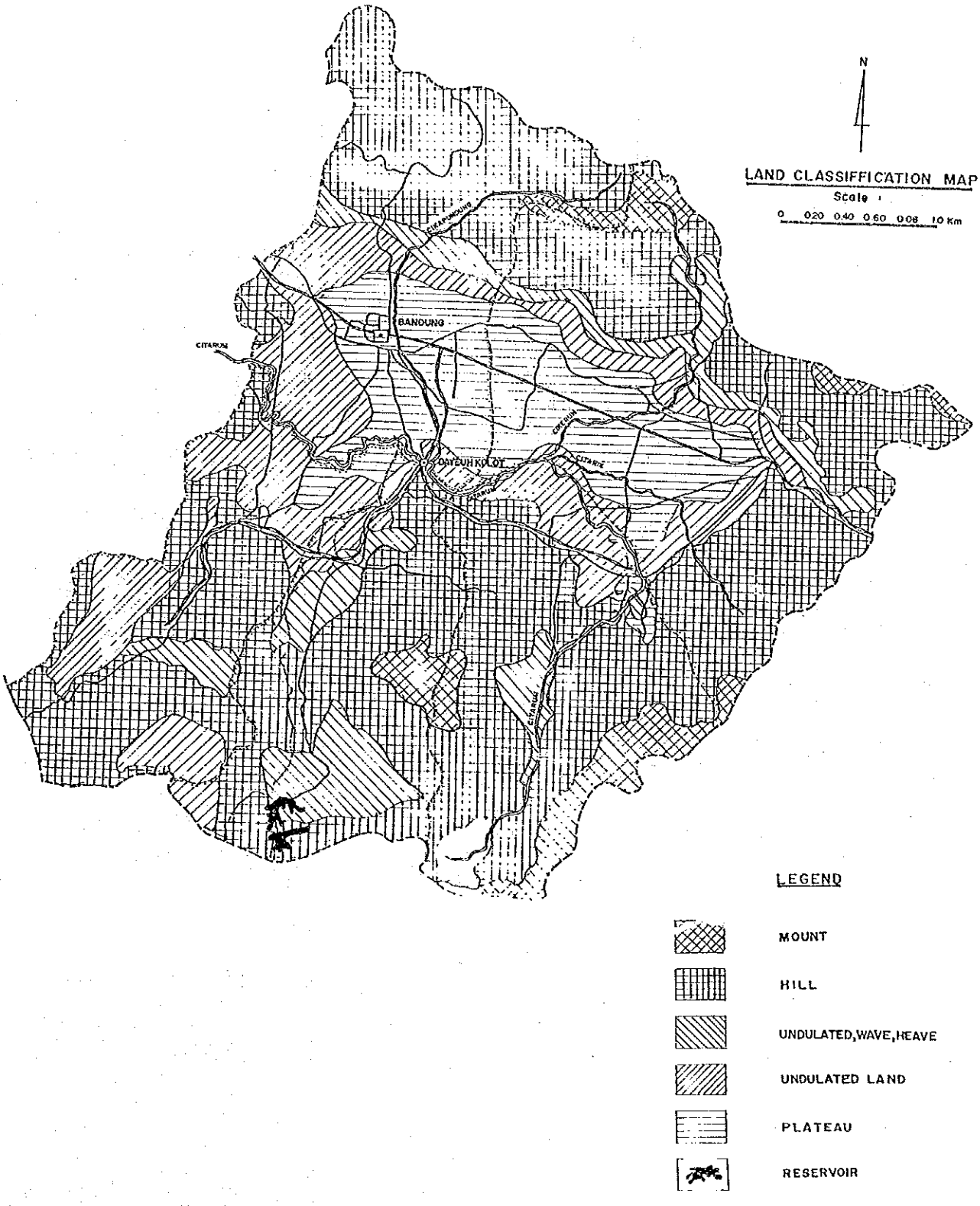


FIG. C.3 | LAND CLASSIFICATION MAP

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

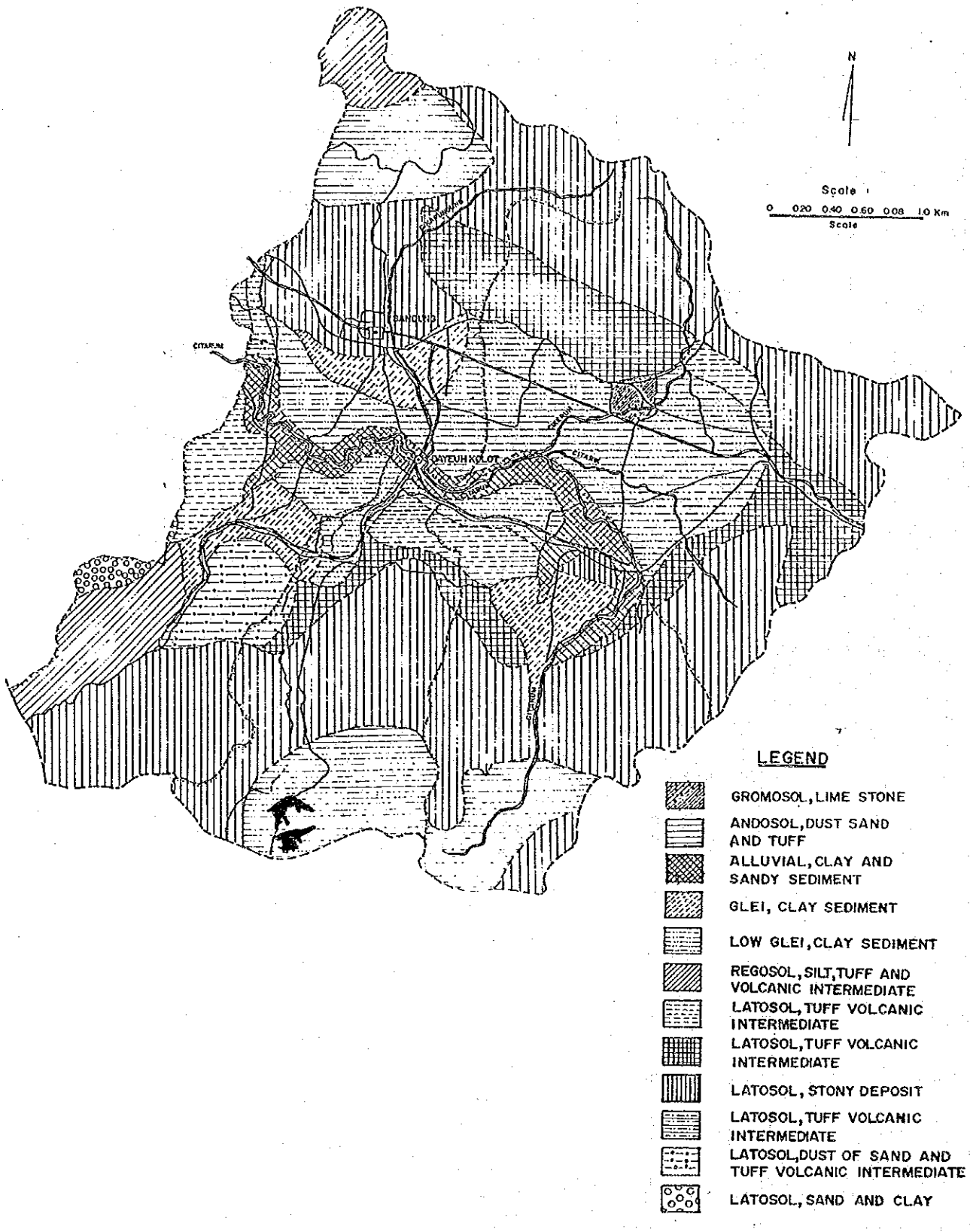


FIG. C.4 SOIL CLASSIFICATION MAP

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

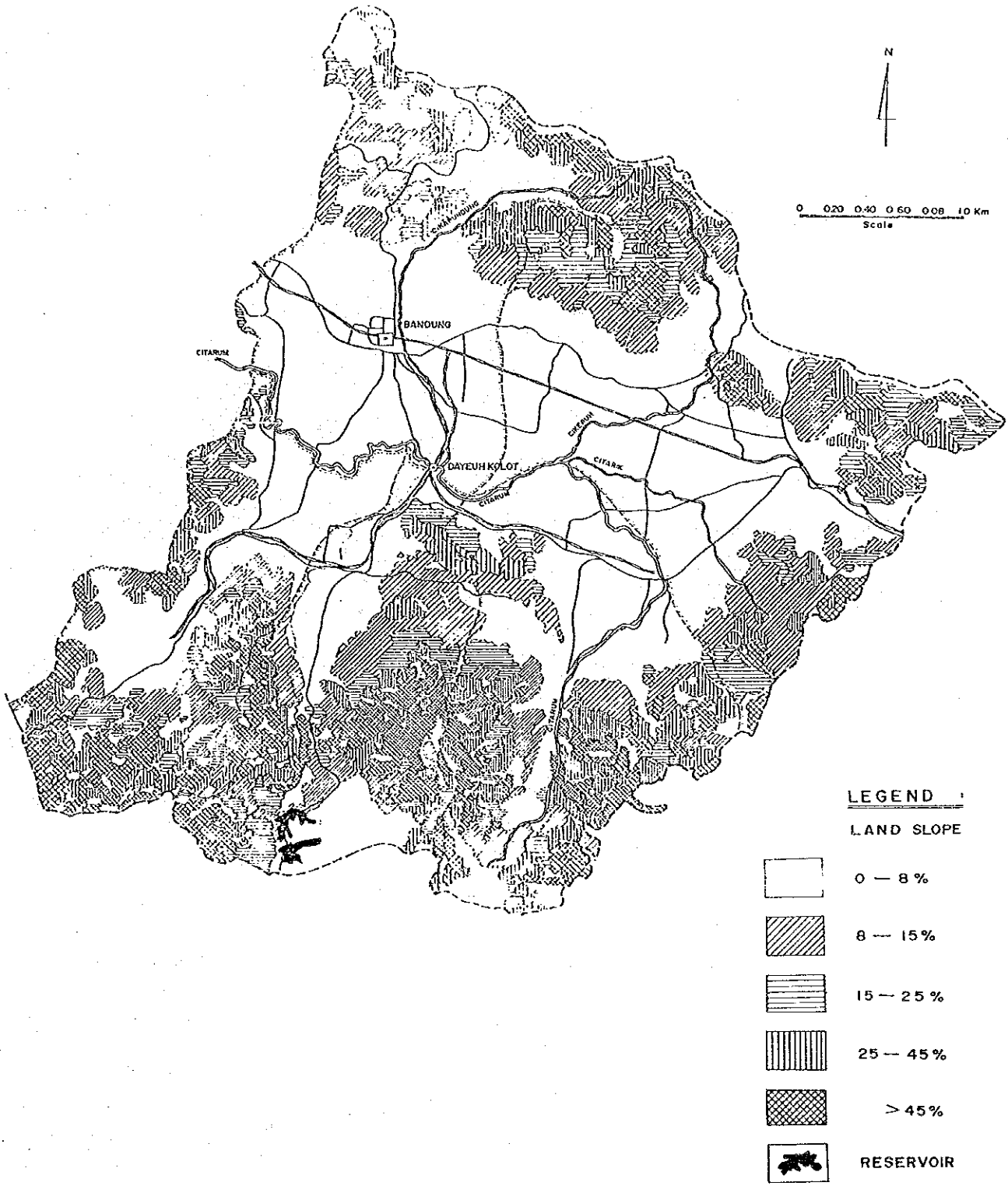


FIG. C.5 LAND SLOPE

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

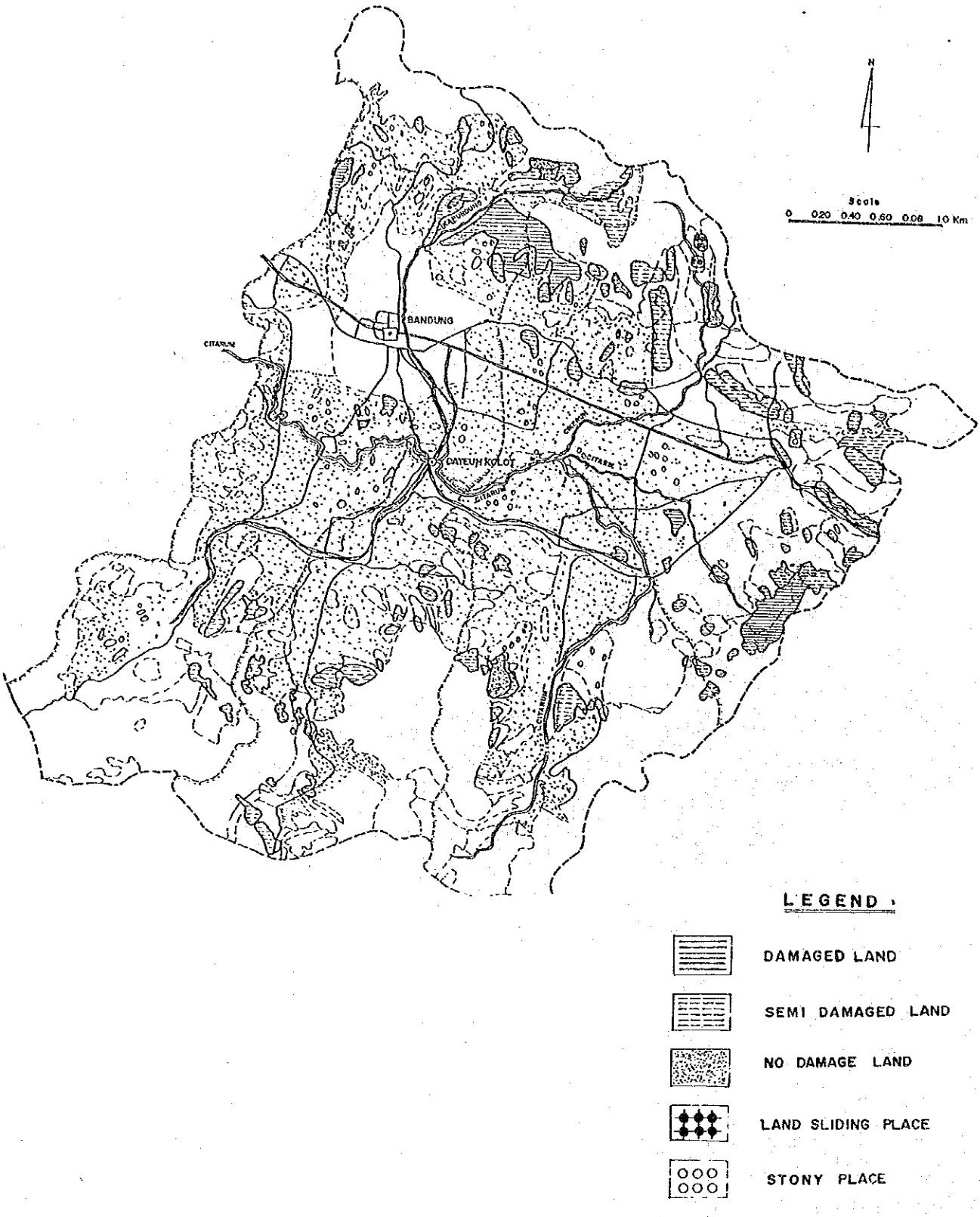
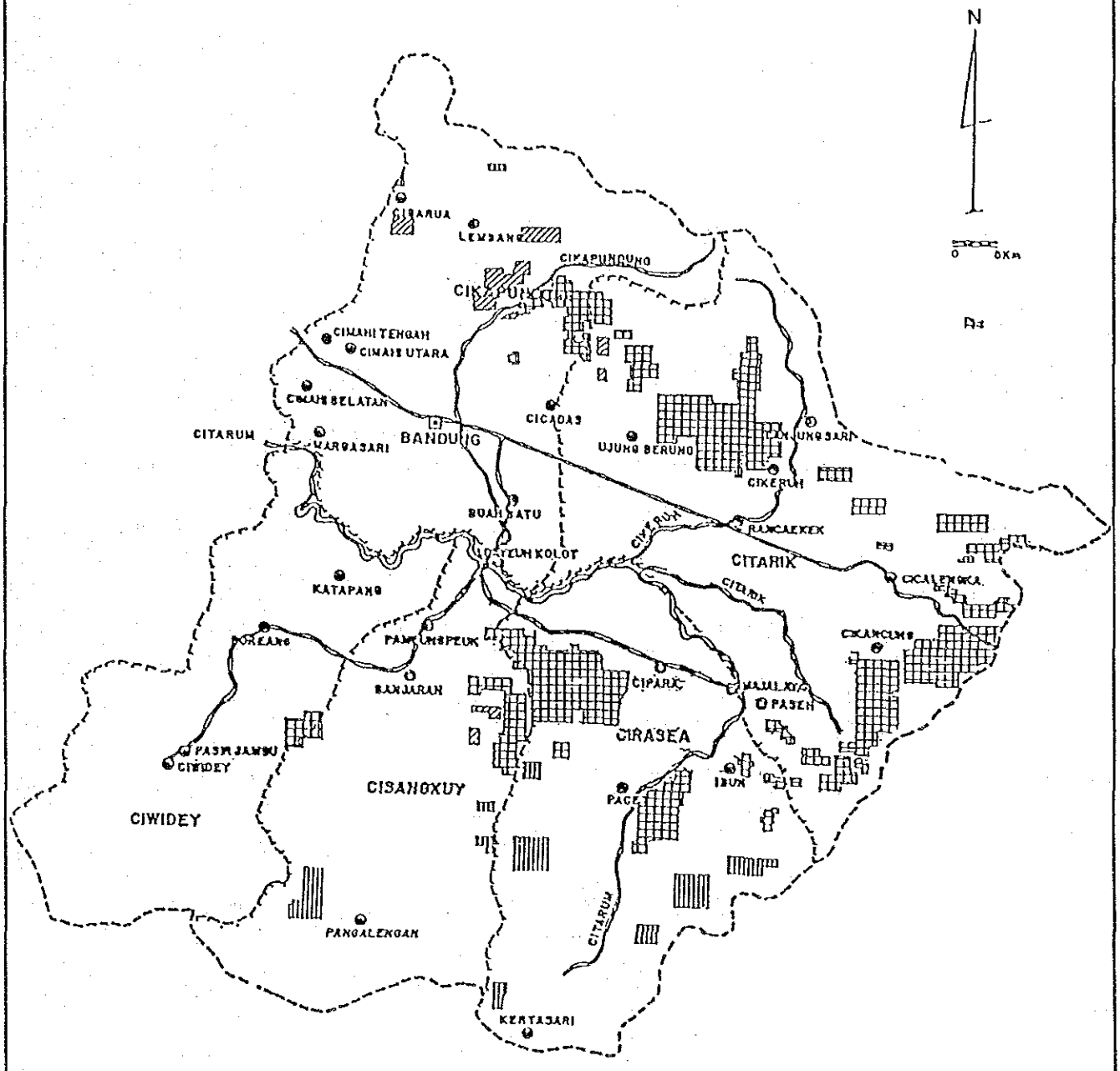


FIG. C.6 DAMAGED LAND AREA

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA



LEGEND

CATCHMENT BOUNDARY	FOREST AREA
SUB-CATCHMENT BOUNDARY	DRY FIELD AREA
RIVER AND TRIBUTRIES	MIX PLANTATION AREA
RAILWAY	

FIG. C.7 AREAS OF SERIOUS LAND EROSION

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

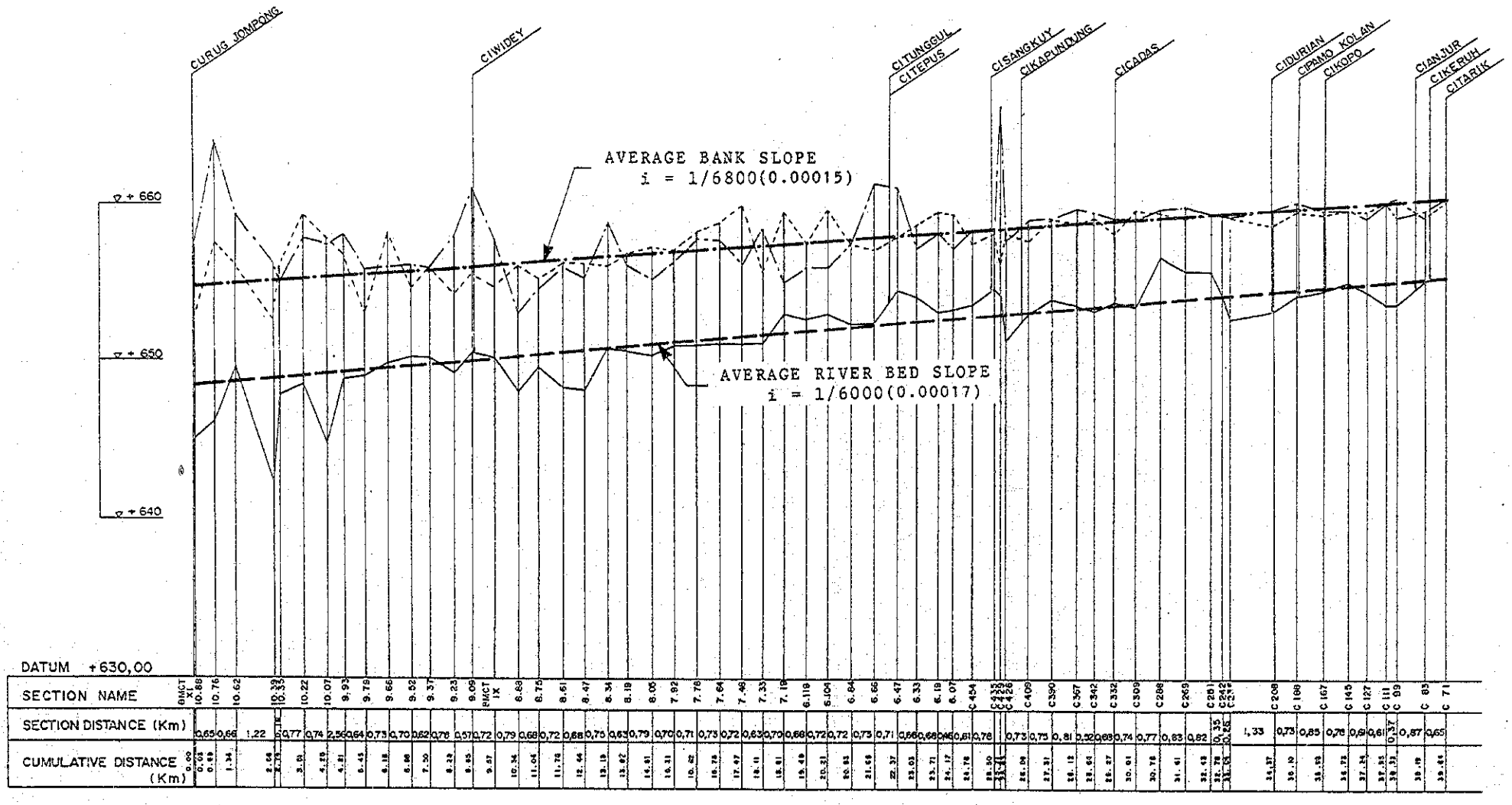
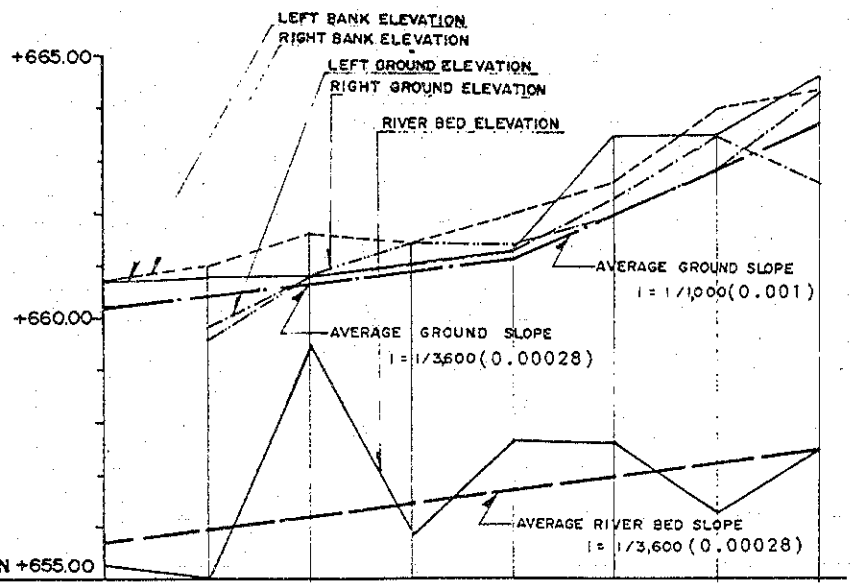


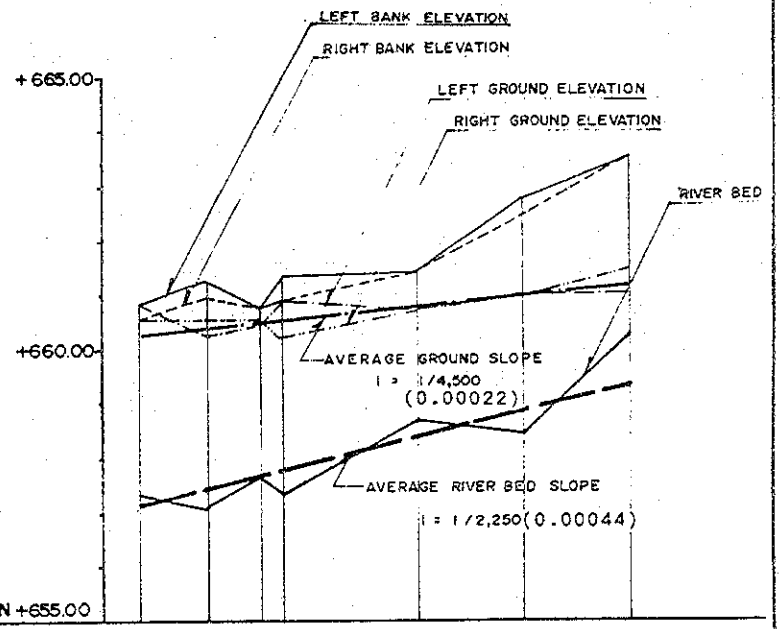
FIG. C.8 PROFILE OF CITARUM RIVER

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

LONGITUDINAL PROFILE CITARUM RIVER



LONGITUDINAL PROFILE CIKERUH RIVER



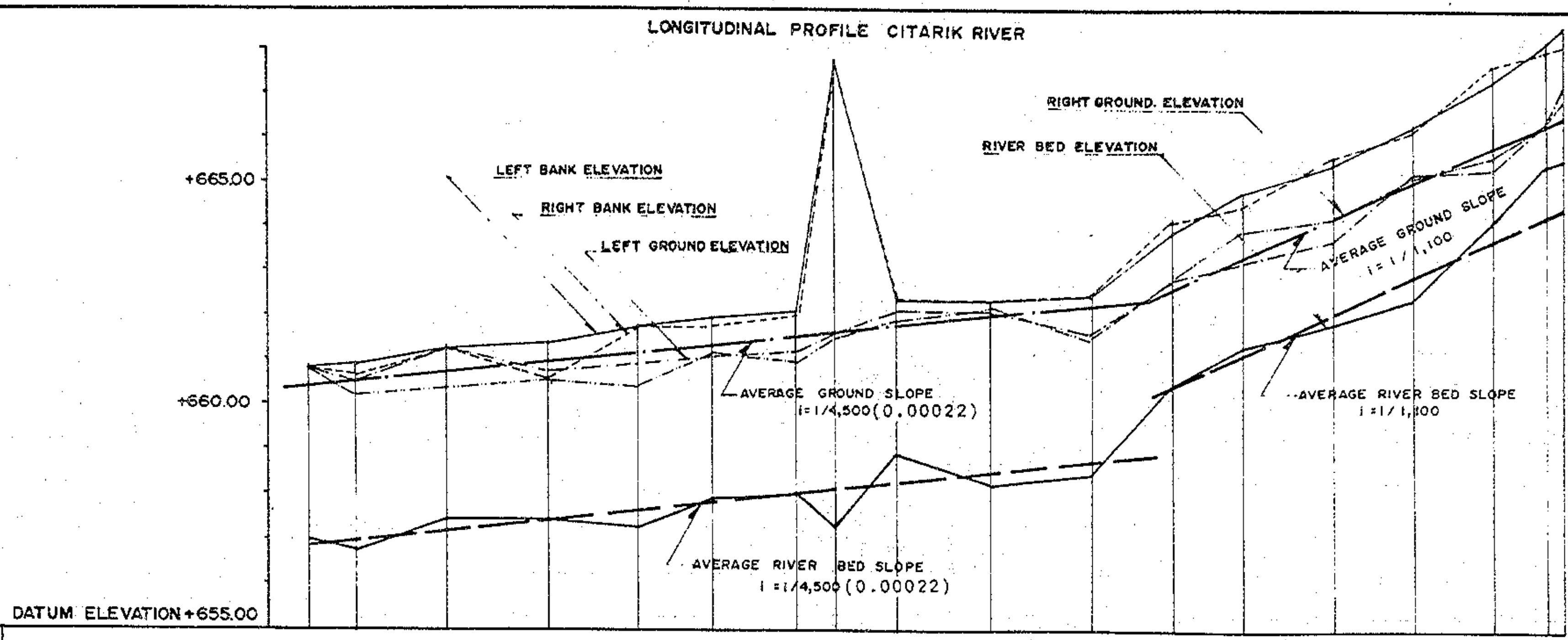
PROPOSED	BANK ELEVATION (M)								
	FLOOD WATER LEVEL (M)								
	RIVER BED ELEVATION (M)								
EXISTING	LEFT BANK ELEVATION (M)	660.30 660.20	660.60 659.60	660.80 660.80	661.17 661.00	661.34 661.30	662.09 662.30	663.12 662.90	662.70 662.60
	RIGHT BANK ELEVATION (M)	659.40 659.80	661.16 659.80	660.80 659.80	661.70 661.40	661.06 661.40	662.28 662.00	663.50 663.30	664.34 664.30
	RIVER BED ELEVATION (M)	656.26	654.93	659.50	655.91	657.67	657.65	656.30	657.50
CUMULATIVE DISTANCE (KM)		39.00	40.00	41.00	42.00	43.00	44.00	45.00	46.00
SECTION DISTANCE (KM)		0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SECTION NAME		39.00	40.00	41.00	42.00	43.00	44.00	45.00	46.00

PROPOSED	BANK ELEVATION (M)								
	FLOOD WATER LEVEL (M)								
	RIVER BED ELEVATION (M)								
EXISTING	LEFT BANK ELEVATION (M)	660.90	661.24	660.89	661.36	662.39	663.05		
	RIGHT BANK ELEVATION (M)	660.80	660.89	660.87	661.51	662.24	663.51		
	RIVER BED ELEVATION (M)	657.26	657.13	657.66	656.73	658.48	660.62		
CUMULATIVE DISTANCE (KM)		0.35	1.00	1.50	3.00	4.00	5.00		
SECTION DISTANCE (KM)		0.35	0.65	0.50	1.50	1.00	1.00		
SECTION NAME		0.35	1.00	1.50	3.00	4.00	5.00		

FIG. C.9 PROFILES OF CITARUM(UPSTREAM) AND CIKERUH RIVER

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

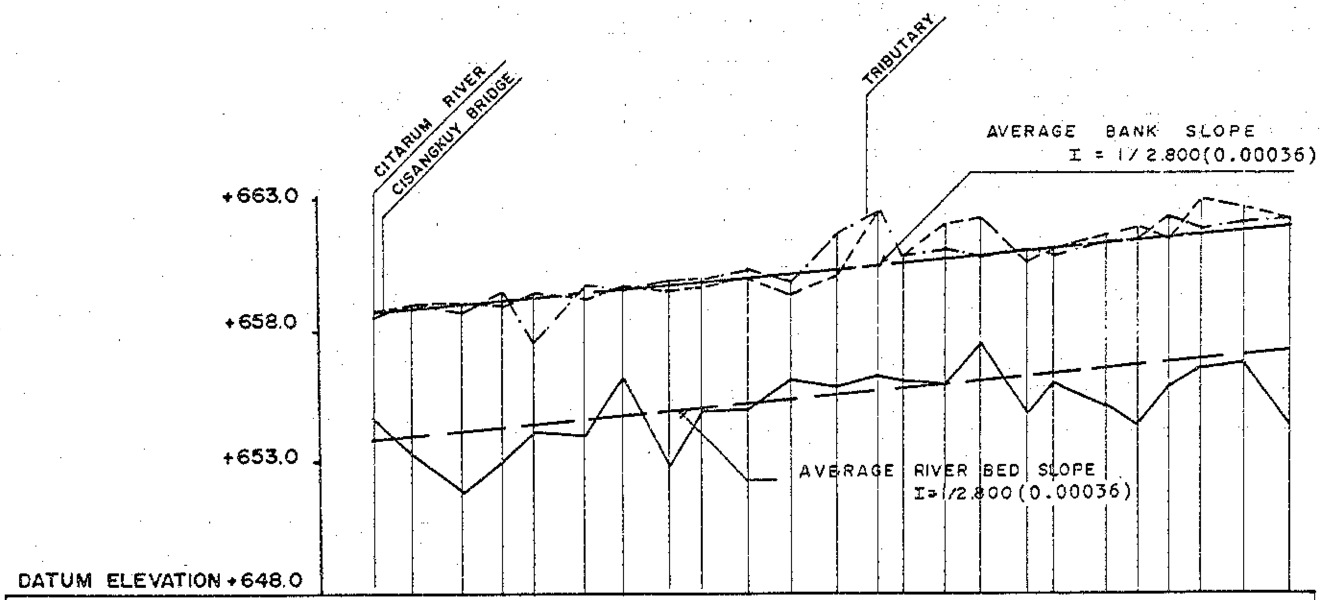
JICA



PROPOSED	BANK ELEVATION (M)																		
	FLOOD WATER LEVEL (M)																		
	RIVER BED ELEVATION (M)																		
EXISTING	LEFT BANK ELEVATION (M)	660.65 660.70	660.84 660.50	661.28 661.30	661.36 660.70	661.76 660.90	661.94 661.10	662.08 661.20	661.86 661.80	662.24 662.10	662.33 662.10	662.51 661.80	663.90 662.90	664.80 663.20	665.40 663.70	666.31 665.20	667.32 665.30	666.40 668.22	668.60 667.20
	RIGHT BANK ELEVATION (M)	660.78 660.70	660.62 660.20	661.25 660.35	660.57 660.50	661.74 660.40	661.78 661.20	662.00 661.00	661.74 661.50	662.34 661.80	662.39 662.20	662.80 661.50	664.14 662.80	664.47 663.90	665.58 664.20	666.20 665.10	667.71 665.60	665.40 667.00	666.12 667.00
	RIVER BED ELEVATION (M)	656.99	656.78	657.45	657.45	657.29	657.89	658.01	657.27	658.94	658.21	658.44	660.51	661.34	661.84	662.38	664.13	665.59	665.42
CUMULATIVE DISTANCE (KM)		0.45	1.00	2.00	3.15	4.15	5.00	5.95	6.40	7.10	8.16	9.28	10.20	11.00	12.00	12.90	13.80	14.40	14.60
SECTION DISTANCE (KM)		0.45	0.55	1.00	1.15	1.00	0.85	0.95	0.45	0.70	1.06	1.12	0.92	0.80	1.00	0.90	0.90	0.60	0.20
SECTION NAME		0.45	1.00	2.00	3.15	4.15	5.00	5.95	6.40	7.10	8.16	9.28	10.20	11.00	12.00	12.90	13.80	14.40	14.60

FIG. C.10 PROFILE OF CITARIK RIVER

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN



SECTION NAME	SECTION DISTANCE (KM)	COMULATIVE DISTANCE(KM)	EXISTING RIVER BED ELEVATION (M)	EXISTING RIGHT BANK ELEVATION (M)	EXISTING LEFT BANK ELEVATION (M)	PROPOSED RIVER BED ELEVATION (M)	PROPOSED FLOOD WATER LEVEL (M)	PROPOSED BANK ELEVATION (M)
BM.17	0.00	0.00	654.81	658.47	658.64			
17	0.35	0.35	653.26	658.97	658.99			
18	0.47	0.82	651.72	658.67	659.01			
26	0.38	1.20	652.99	658.67	659.43			
32	0.30	1.50	654.13	657.53	659.45			
41	0.50	2.00	655.93	659.71	659.17			
50	0.35	2.35	656.10	659.52	659.89			
59	0.45	2.80	652.72	659.65	659.47			
65	0.30	3.10	654.82	659.90	659.58			
73	0.45	3.55	654.98	660.25	659.94			
82	0.40	3.95	656.13	659.91	659.38			
88	0.45	4.40	655.78	661.58	660.01			
95	0.40	4.80	656.18	662.57	662.32			
BM.16	0.25	5.05	656.04	661.21	661.12			
S/10	0.40	5.45	655.95	661.11	662.19			
S/29	0.35	5.80	657.42	660.72	662.25			
S/32	0.45	6.25	654.65	661.05	660.54			
S/40	0.25	6.50	655.88	660.60	661.10			
S/53	0.50	7.00	656.17	661.31	661.58			
S/62	0.30	7.30	654.34	661.44	661.90			
S/71	0.30	7.60	655.87	662.26	661.40			
S/78	0.30	7.90	656.52	661.83	662.92			
S/90	0.40	8.30	656.72	662.03	662.62			
S/101	0.45	8.75	654.25	662.23	662.24			

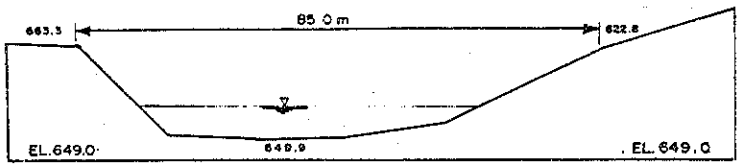
FIG. C.11 PROFILE OF CISANGKUY RIVER

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

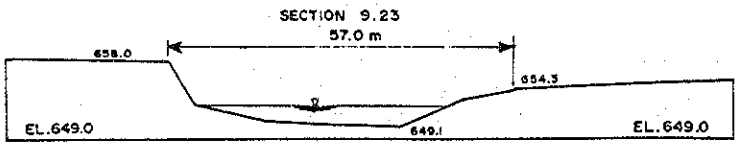
JICA

CITARUM

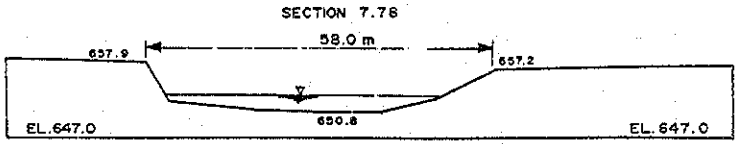
SECTION 10.78



SECTION 9.23



SECTION 7.76



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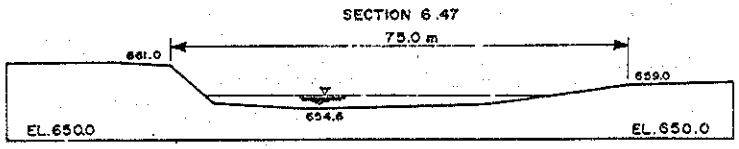

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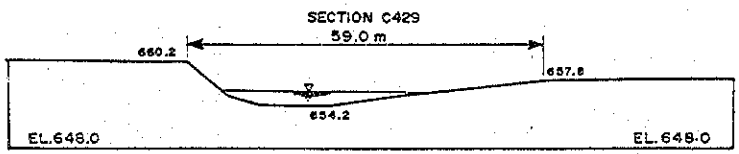

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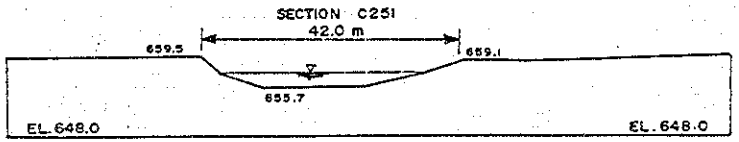

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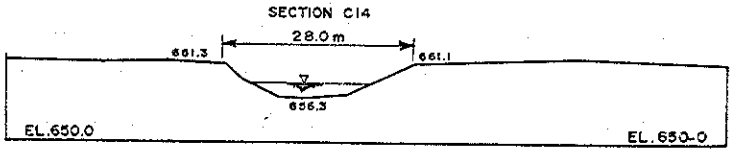
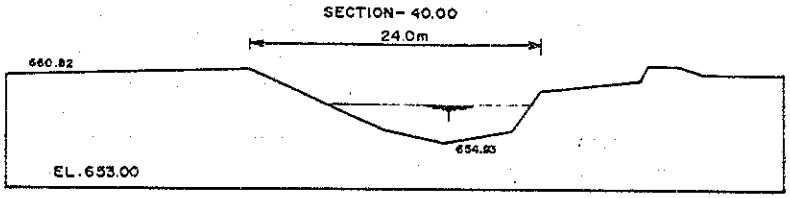


UPSTREAM CITARUM

SECTION-40.00



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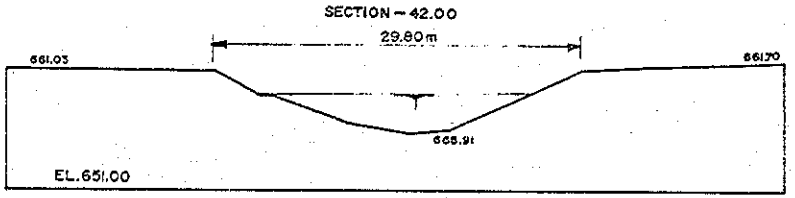

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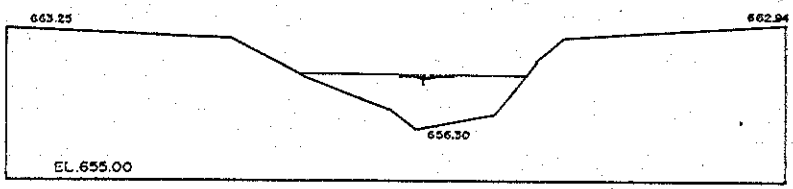
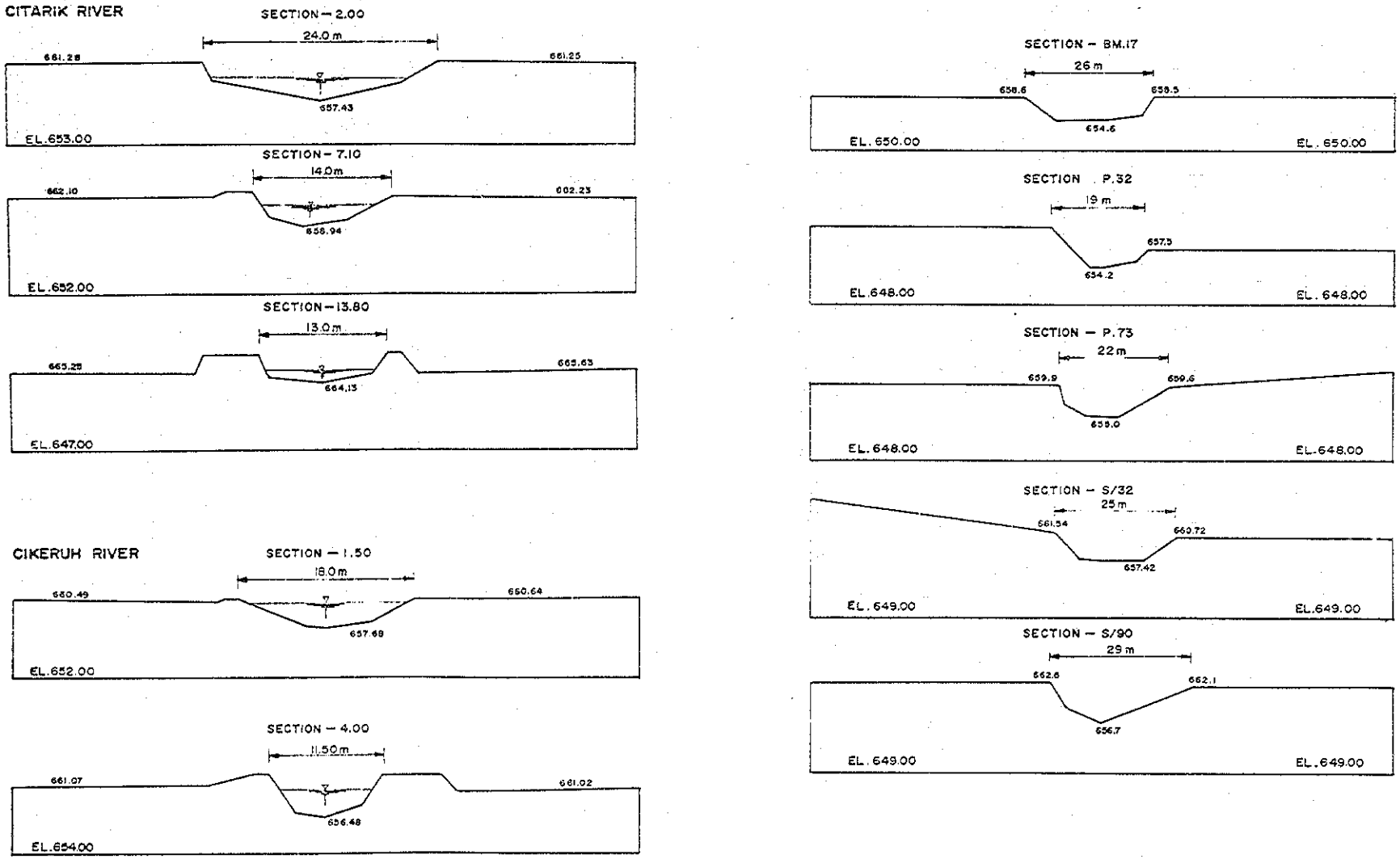


FIG. C.12 TYPICAL RIVER CROSS SECTIONS OF CITARUM AND CITARUM(UPSTREAM) RIVER

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

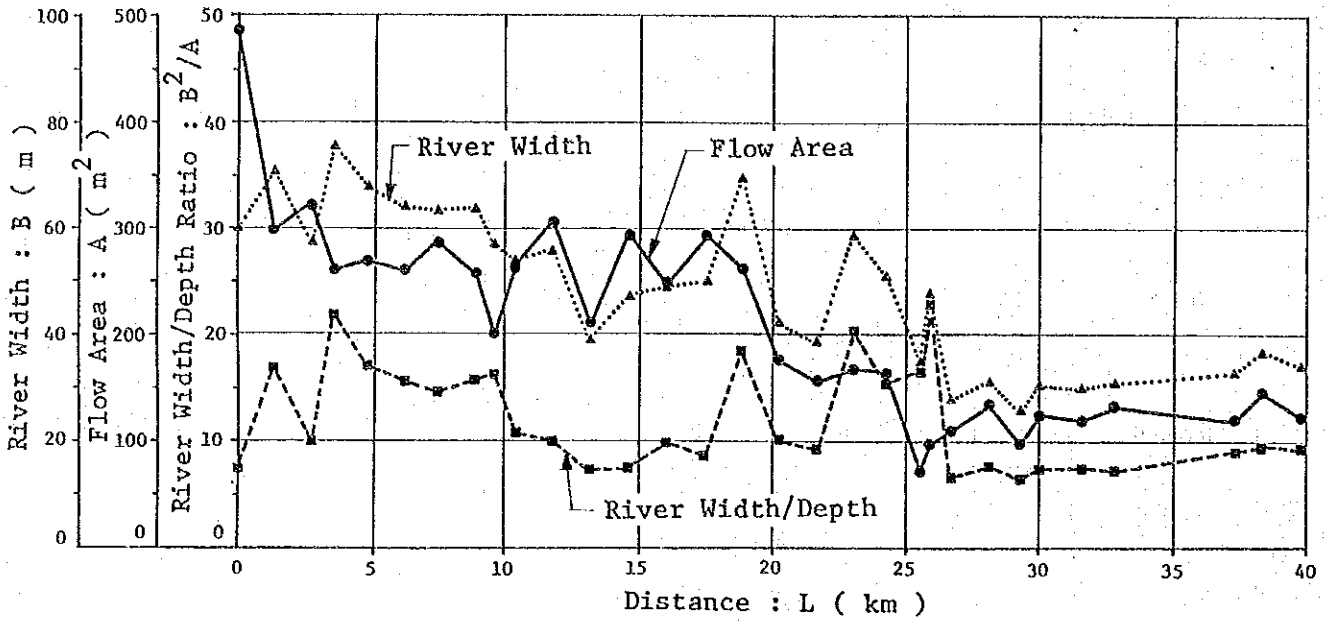


C-31

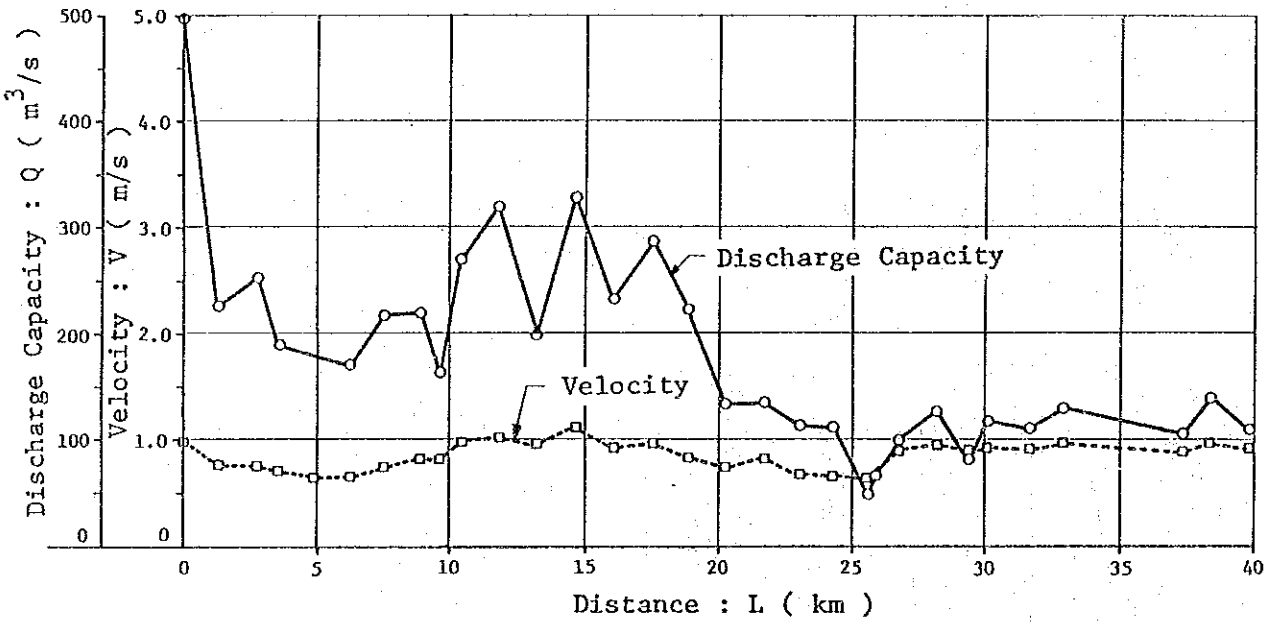
FIG. C.13 TYPICAL RIVER CROSS SECTIONS OF CITARIK, CIKERUH, AND CISANGKUY RIVER

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA



VARIATION OF FLOW AREA, RIVER WIDTH AND RIVER WIDTH/DEPTH

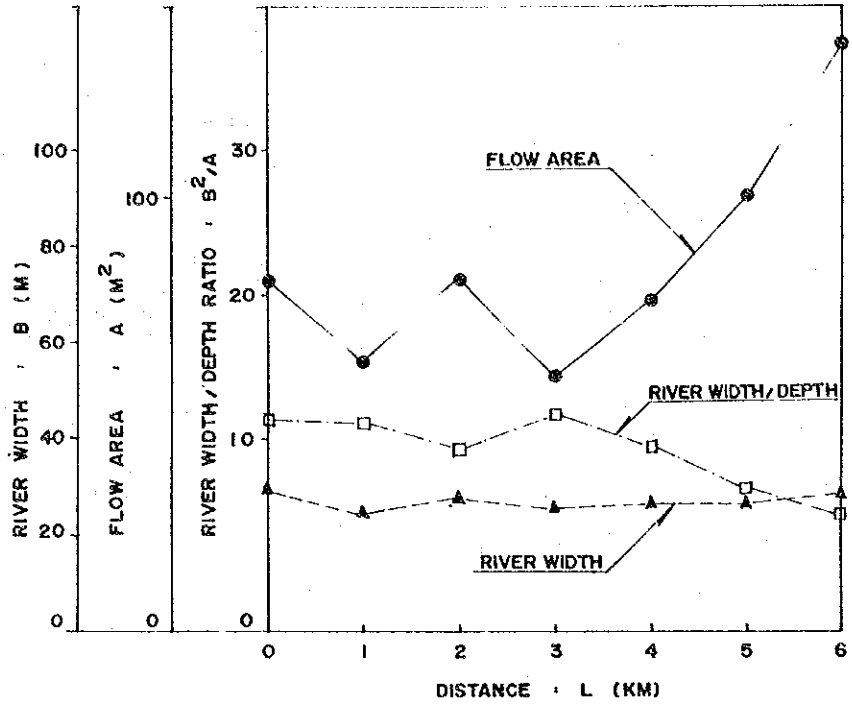


VARIATION OF VELOCITY AND DISCHARGE CAPACITY

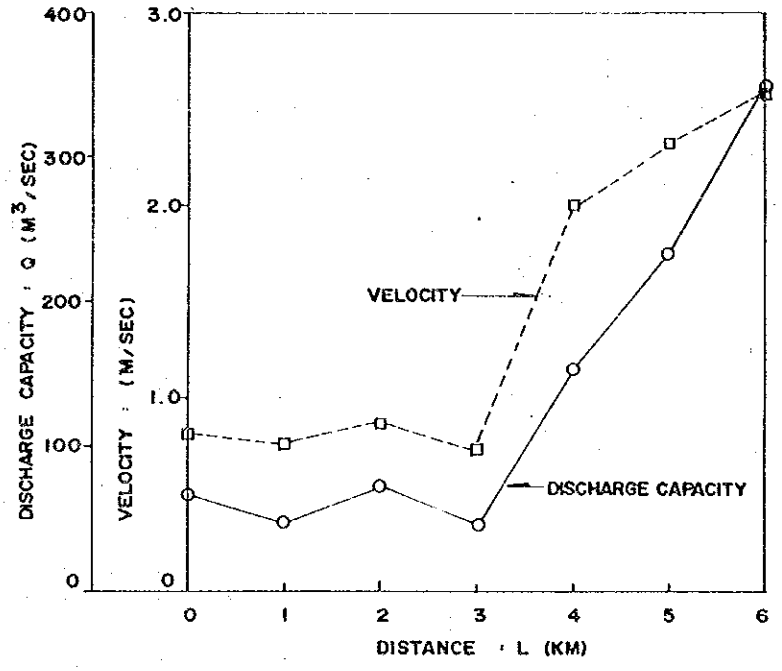
FIG. C.14 HYDRAULIC CHARACTERISTICS OF CITARUM RIVER

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA



VARIATION OF FLOW AREA, RIVER WIDTH (CITARUM RIVER)
AND RIVER WIDTH / DEPTH

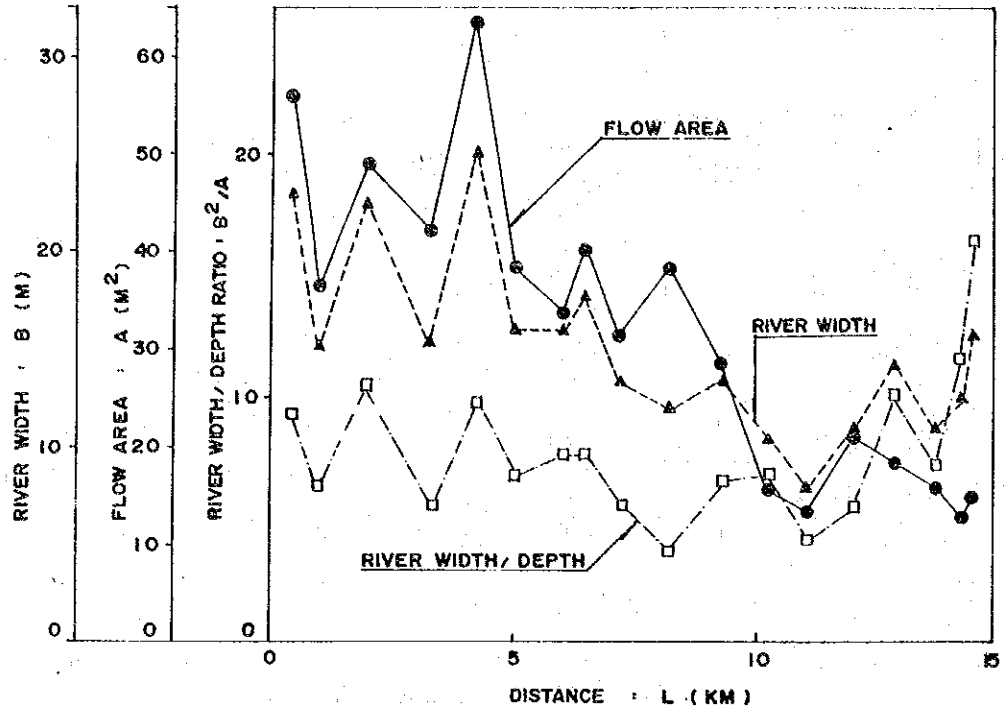


VARIATION OF VELOCITY AND DISCHARGE CAPACITY (CITARUM RIVER)

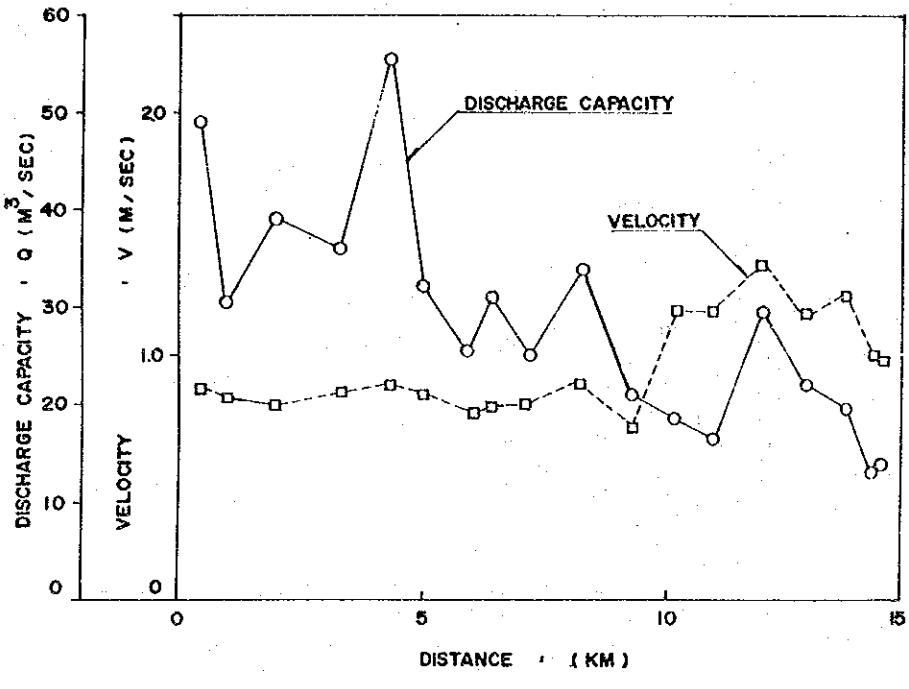
FIG. C.15 HYDRAULIC CHARACTERISTICS OF CITARUM(UP-STREAM) RIVER

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA



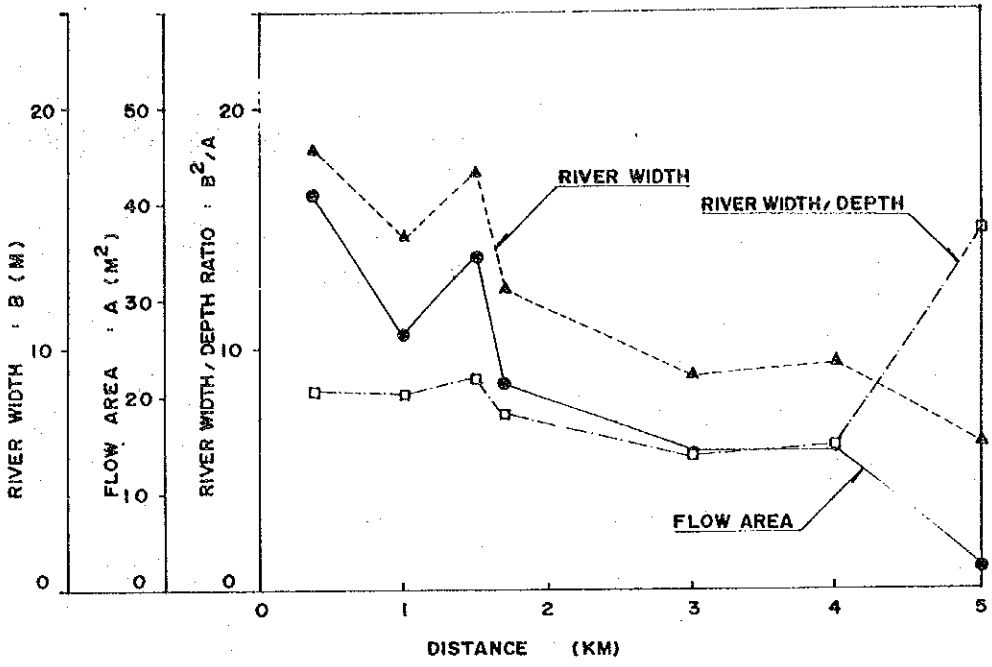
VARIATION OF FLOW AREA, RIVER WIDTH (CITARIK RIVER) AND RIVER WIDTH / DEPTH



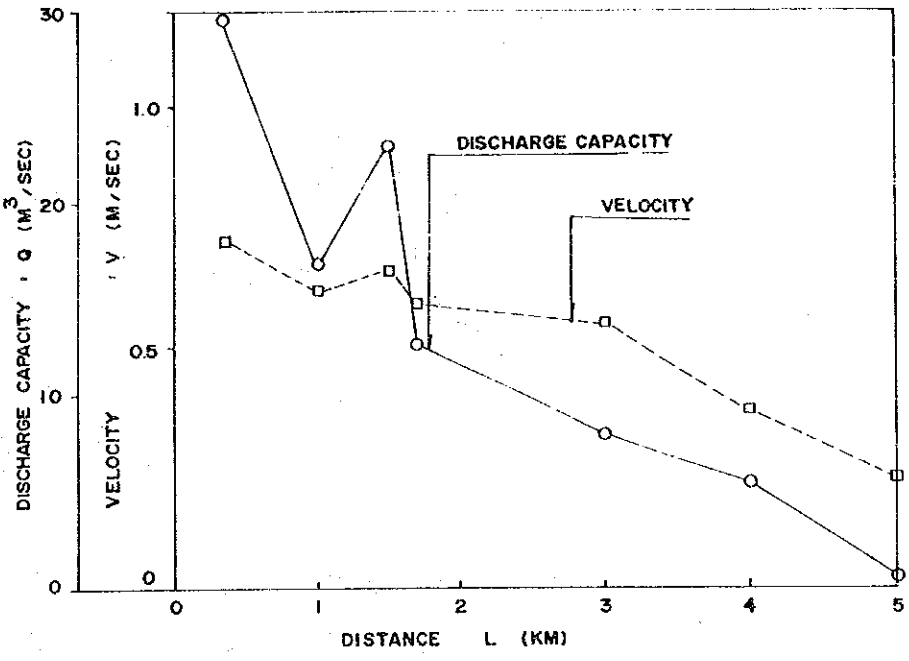
VARIATION OF VELOCITY AND DISCHARGE CAPACITY (CITARIK R.)

FIG. C.16 HYDRAULIC CHARACTERISTICS OF CITARIK RIVER

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN



VARIATION OF FLOW AREA, RIVER WIDTH (CIKERUH RIVER)
AND RIVER WIDTH / DEPTH



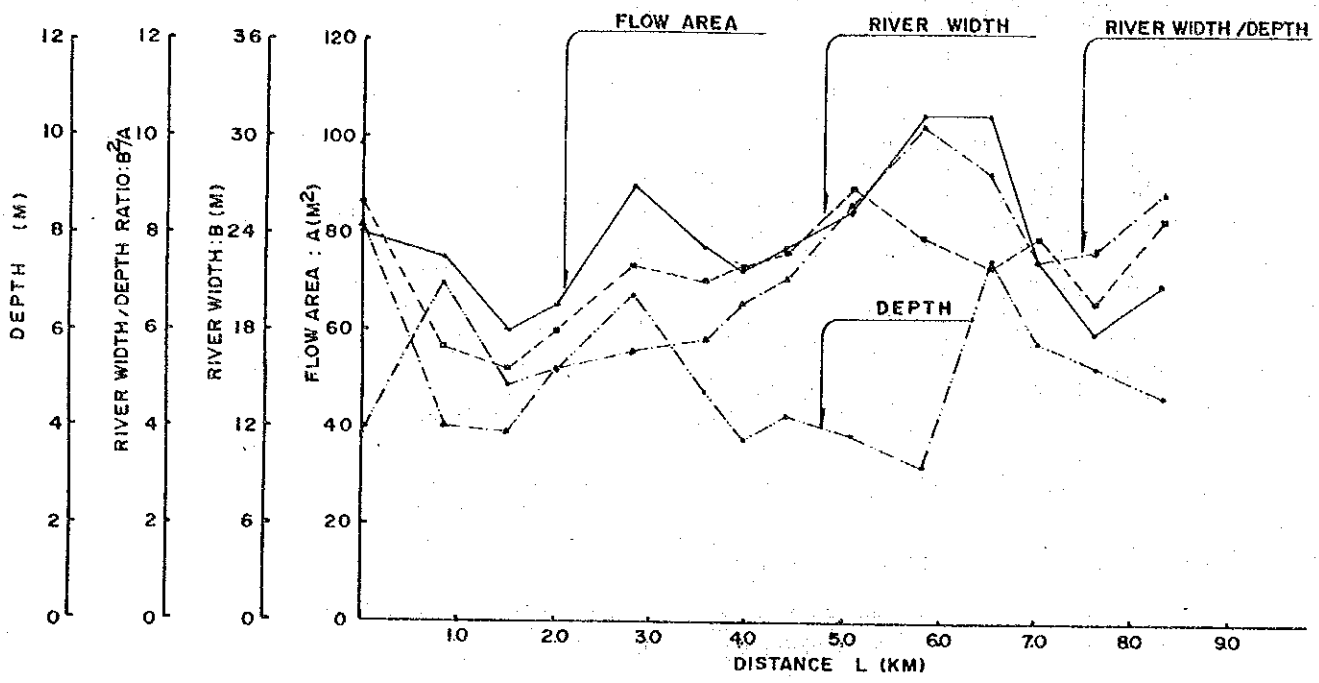
VARIATION OF VELOCITY AND DISCHARGE CAPACITY (CIKERUH RIVER)

FIG. C.17 HYDRAULIC CHARACTERISTICS OF CIKERUH RIVER

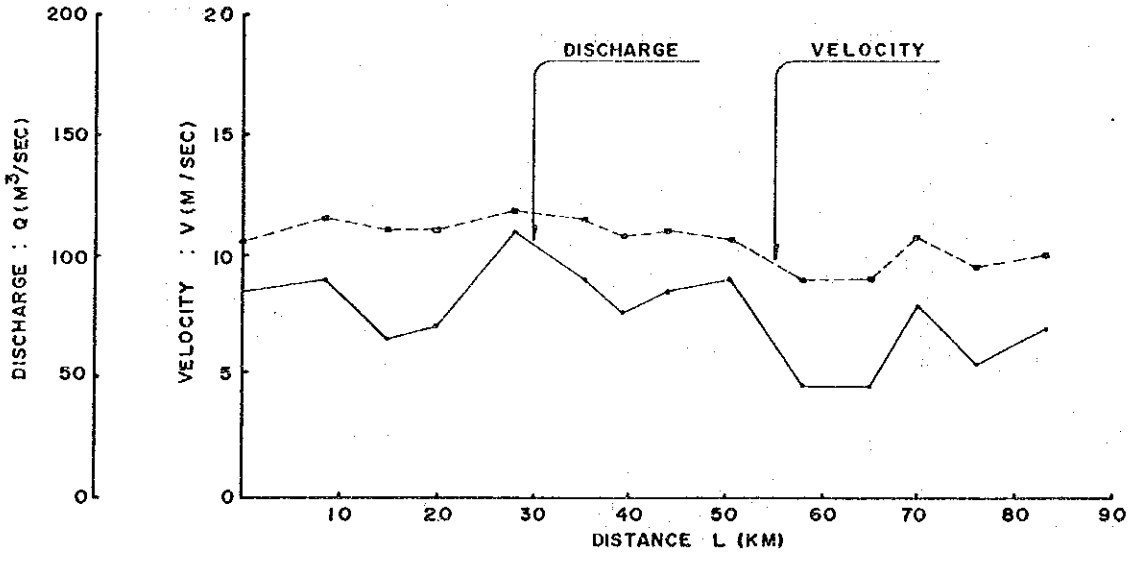
STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

CISANGKUY RIVER



VARIATION OF FLOW AREA, RIVER WIDTH, DEPTH AND RIVER WIDTH/DEPTH



VARIATION OF VELOCITY AND DISCHARGE CAPACITY

FIG. C.18 HYDRAULIC CHARACTERISTICS OF CISANGKUY RIVER

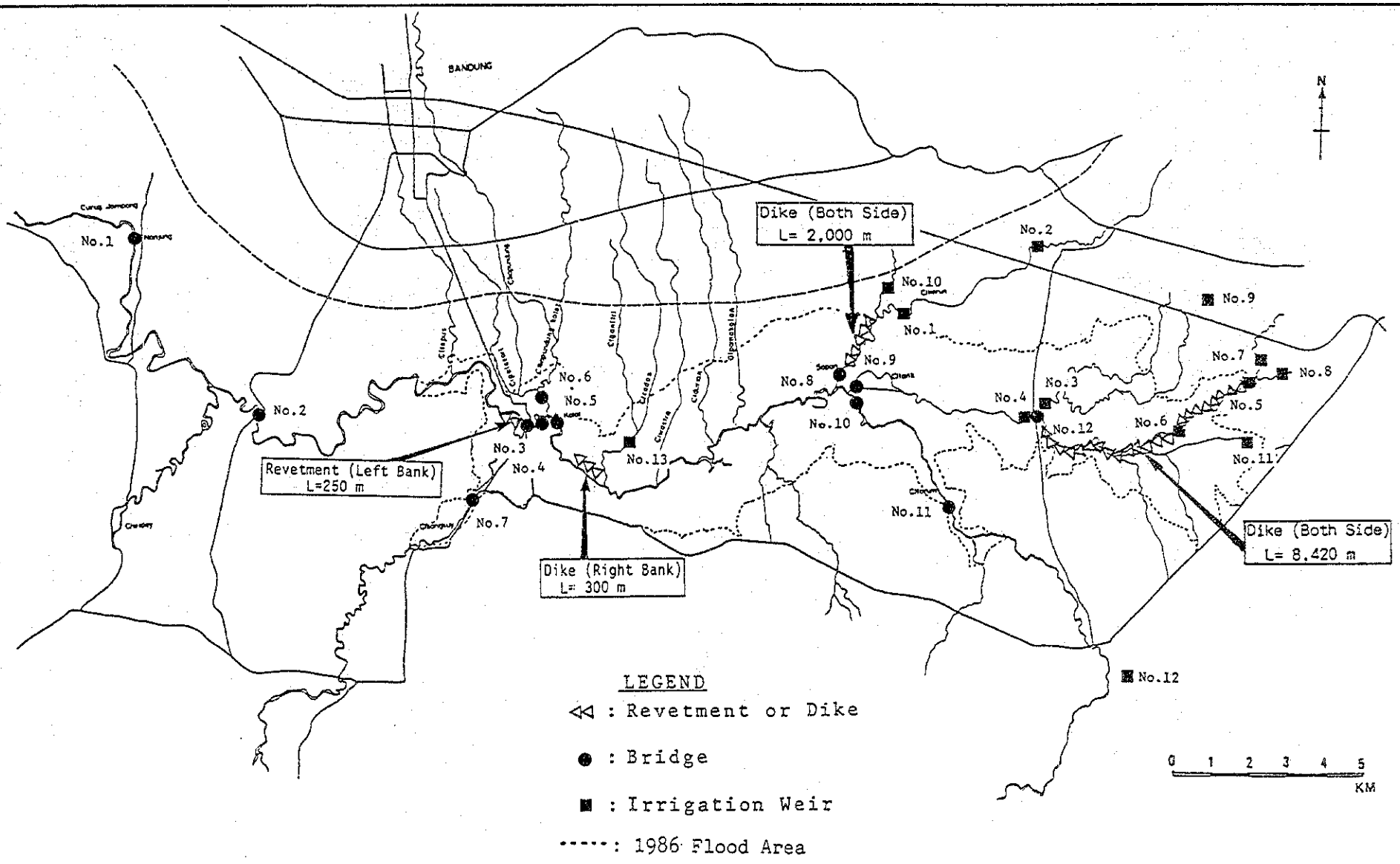


FIG. C.19 EXISTING MAJOR RIVER FACILITIES

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

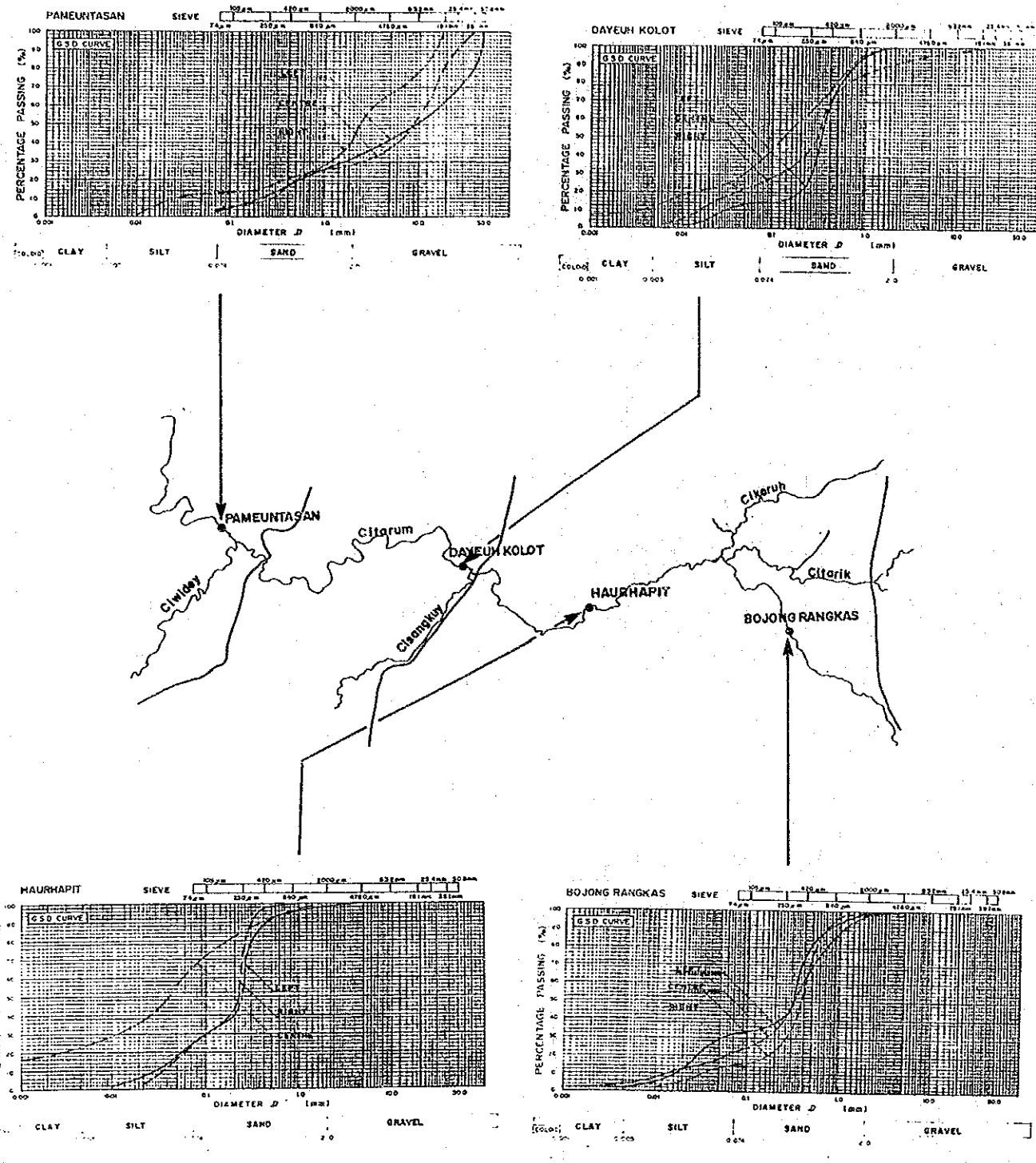


FIG. C.20 LOCATION OF SAMPLING POINTS AND RESULTS OF RIVER BED MATERIAL TESTS

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

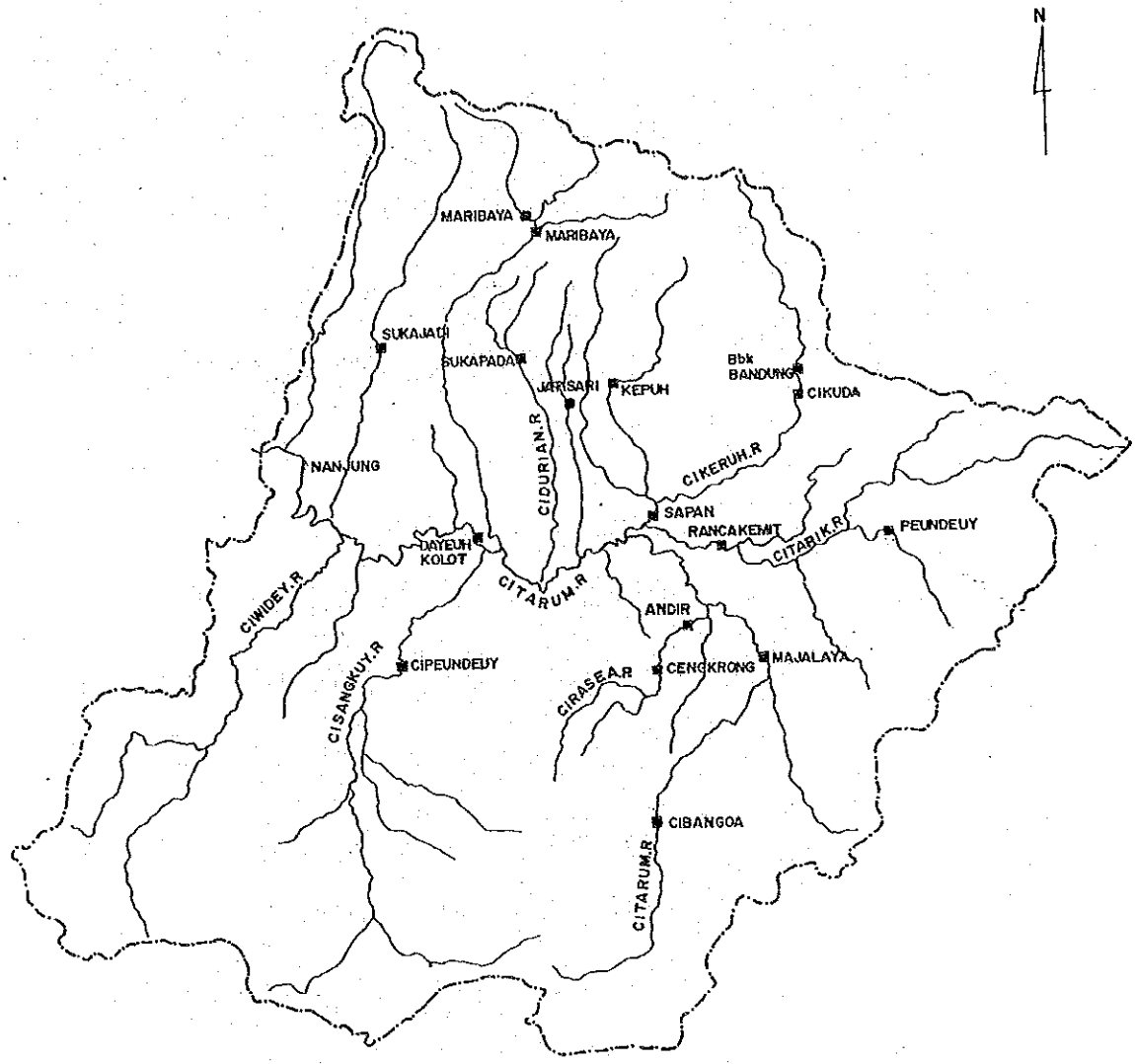
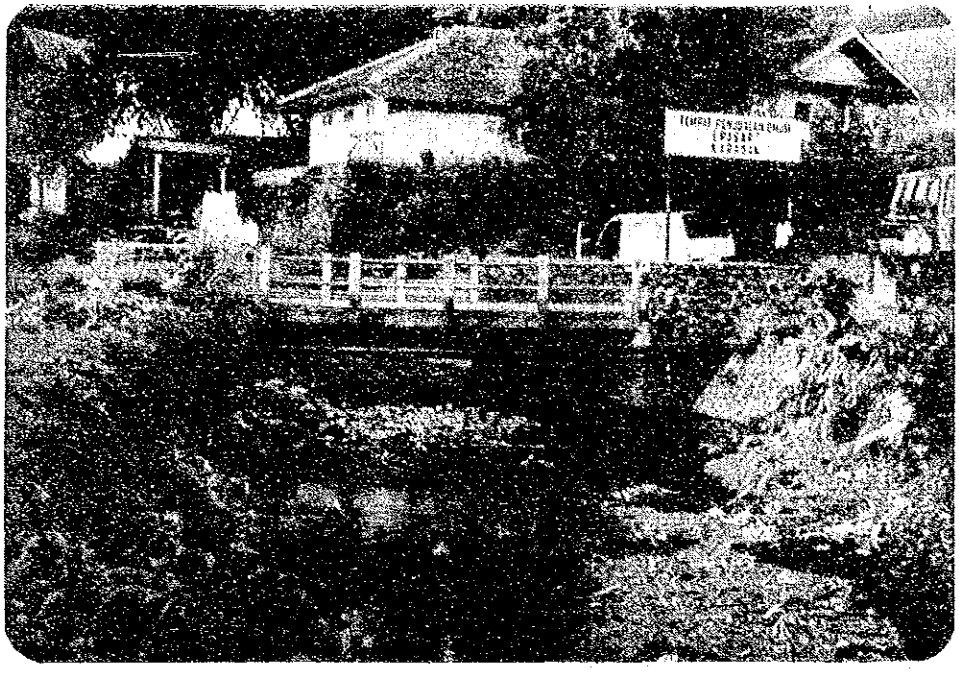
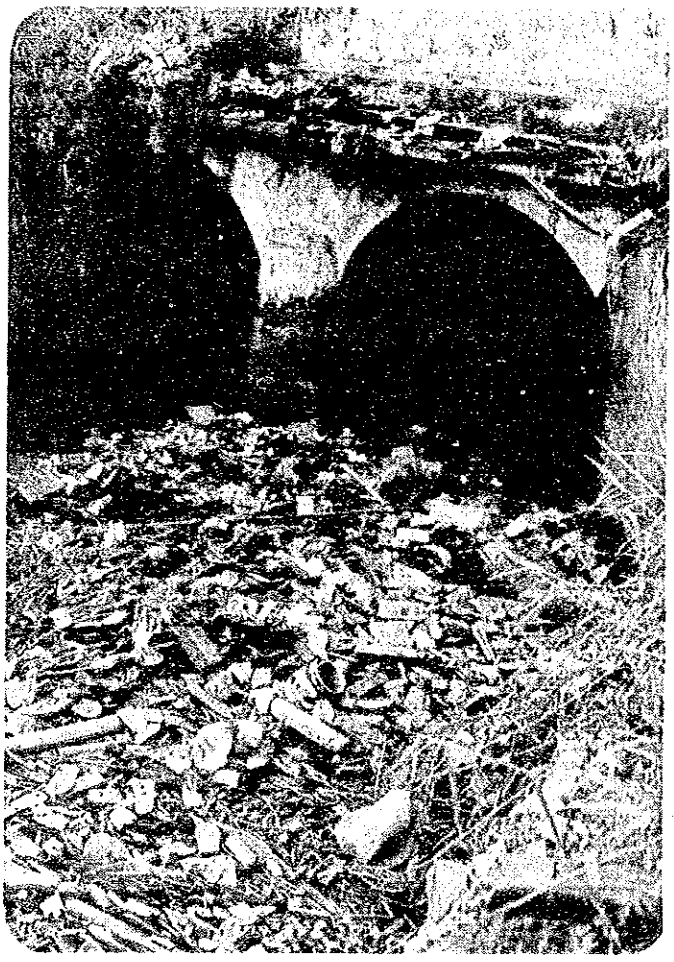


FIG. C.21	LOCATION OF SUSPENDED LOAD MEASUREMENT STATIONS

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA



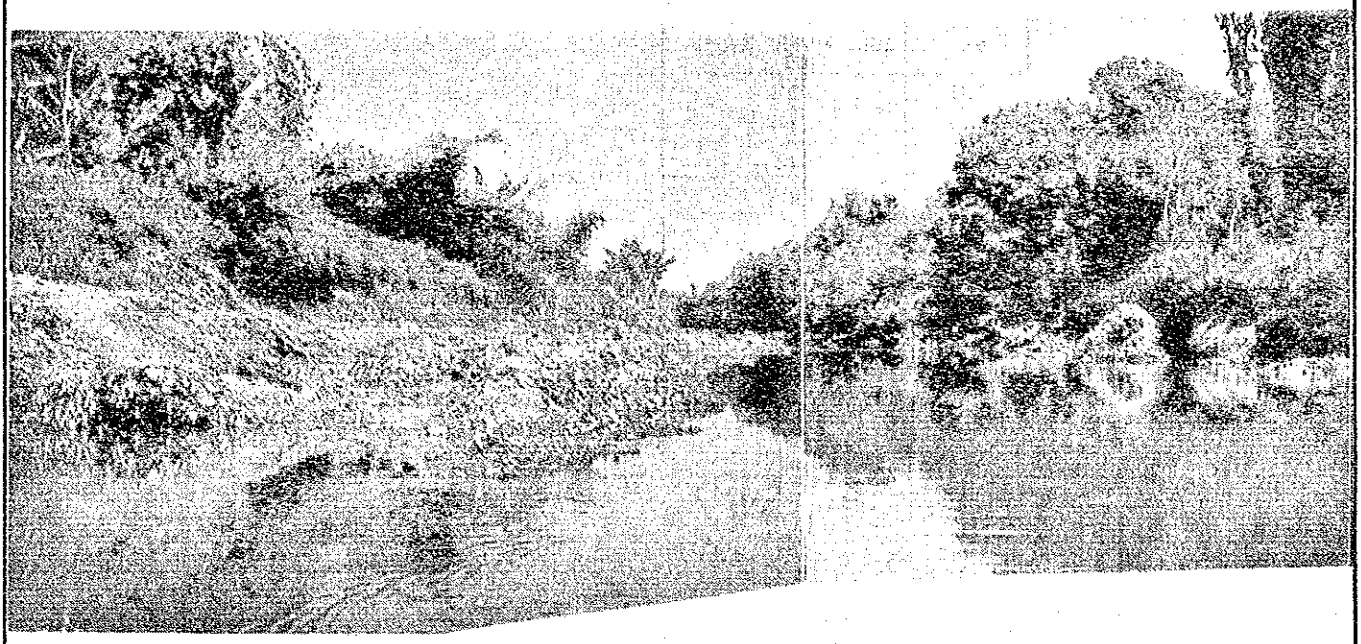


CITEPUS RIVER

FIG. C.22	ACCUMULATED GARBAGE IN THE TRIBUTARIES

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

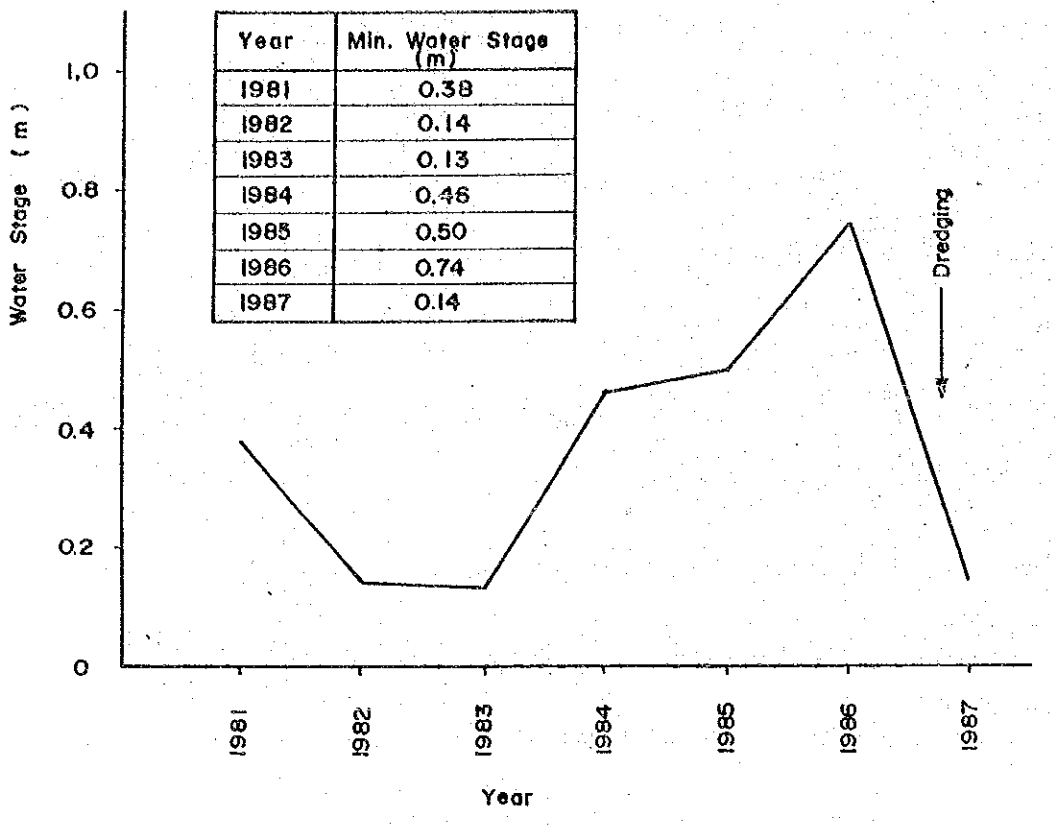


CITARUM RIVER (Approx.5km downstream of Dayeuh Kolot)
Upstream stretch of this section has been dredged.

CITARUM RIVER

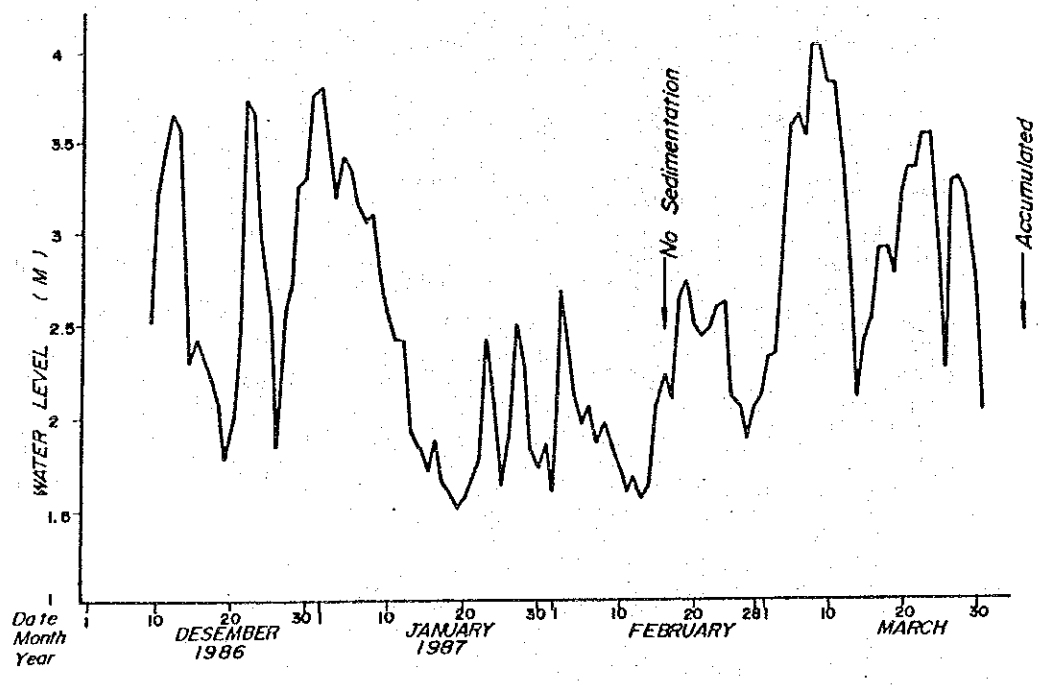
FIG. C.23 ACCUMULATED GARBAGE IN THE CITARUM RIVER

Year	Min. Water Stage (m)
1981	0.38
1982	0.14
1983	0.13
1984	0.46
1985	0.50
1986	0.74
1987	0.14



Source: WJRDP Office

Yearly Minimum Water Stage
at Dayeuh Kolot Gauging Station

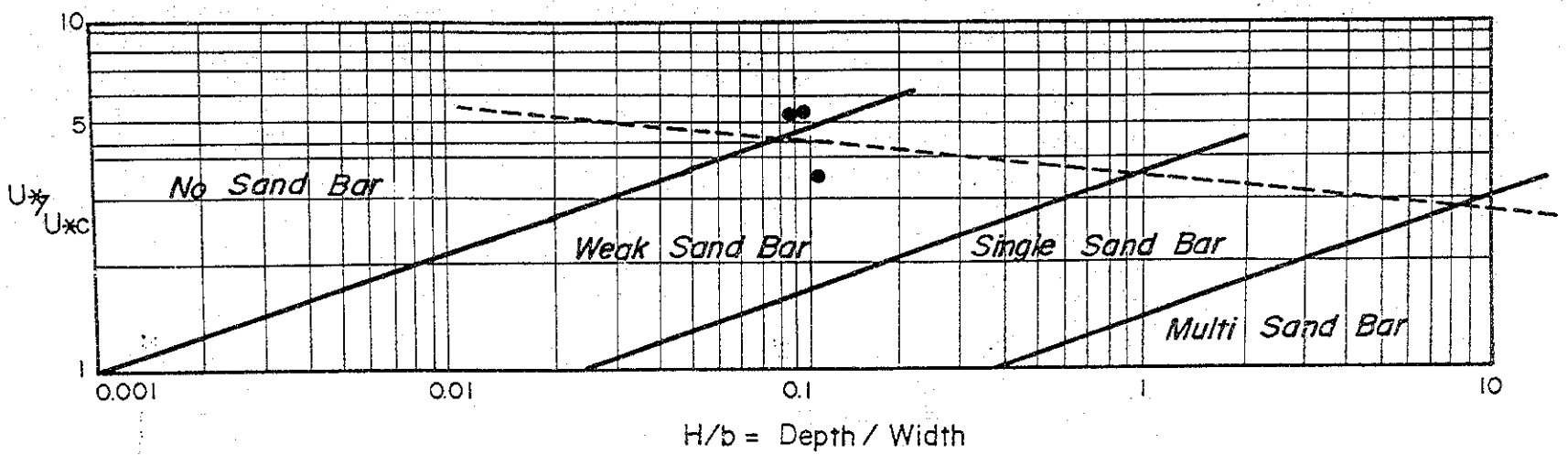


Daily Water Level at Dayeuh Kolot

FIG. C.24 OCCURRENCE OF SEDIMENTATION IN THE CITARUM RIVER

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

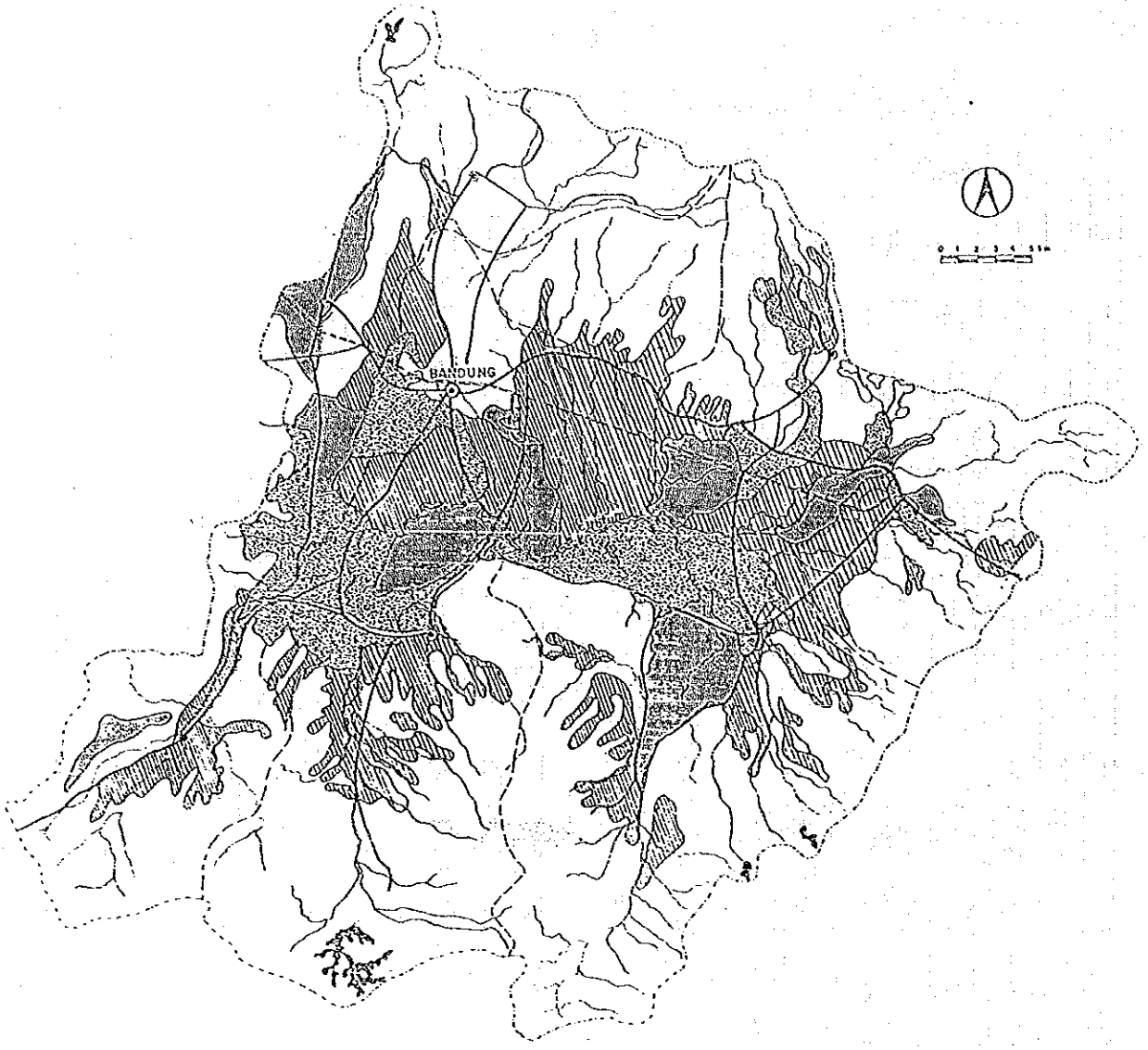
JICA



	(Nanjung ~ Ciwidey)	(Ciwidey ~ Cisangkuy)	(Cisangkuy ~ Sapan)	(Sapan ~ Majalaya)
Locution	Pameuntasan	Dayeuh Kolet	Haurhapit	Bojong rangkas
U* / U*c	0.8	5.1	5.3	3.6
H / b	0.07	0.10	0.11	0.13

FIG. C.25 MEANDERING CONDITION OF EXISTING CITARUM RIVER

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN



LEGEND

RESERVOIR

DESA IRRIGATION AREA (NON-TECHNICAL)

PUBLIC WORKS IRRIGATION AREA (TECHNICAL)

ditto (SEMI-TECHNICAL)

FIG. C.26 LOCATION OF IRRIGATION AREA

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

SUPPORTING REPORT D

FLOOD CONDITION

TABLE OF CONTENTS

LIST OF FIGURES

SUPPORTING REPORT D
FLOOD CONDITION

1. Historical Floods

Large floods in Bandung and its surrounding area have occurred in the years 1931, 1945, 1977, 1982, 1983, 1984 and 1986. Among these floods, 1931, 1984 and 1986 floods were very severe.

The available records of the large floods are tabulated below.

Year	(1) Max. Flood Level at Dayeuh Kolot (m)	(2) Basin Average Rainfall Depth (mm) 5 days	Monthly	(3) Max. Discharge at Nanjung (m^3/s)
1931, Mar.	-	177 (14)	476	455
1982, Apr.	3.88	107 (1.4)	437	261
1983, Feb.	3.98	109 (1.4)	351	303
1984, Jan.	4.78	141 (3.0)	353	335
1986, Mar.	5.38	116 (1.5)	357	310

Source : (1), (3): IHE, (2): Study Team

Note : Figure in parenthesis is recurrent interval of basin rainfall depth at Dayeuh Kolot (year).

From the year 1982 until 1986, the maximum flood water level at Dayeuh Kolot has risen year to year. The March 1986 flood marked the highest flood water level at Dayeuh Kolot although the average basin rainfall depth and maximum flood discharge at Nanjung was not the largest. This fact shows that the discharge capacity of the downstream stretches of Dayeuh Kolot has decreased in the recent year due to sediment and garbage deposit, resulting in increase of back-water effect on the upstream reaches.

2. Frequent Flood Area

A frequent flood area which has been flooded two (2) or three (3) times a year is shown in Fig. D.1. The area was obtained by interviewing the residents. The area is located in the low-lying area along the Citarum, Citarik and Cisangkuy rivers with a total area of 2,000 ha and a width of about 1 km.

The area includes Kampungs in Dayeuh Kolot and Sapan. In the area between Dayeuh Kolot and Sapan, there is a low area that consists of some former rivers.

Flood water levels of frequent flood area at each block are lower than that of 1986 flood by 0.75 m at Dayeuh Kolot, 1.5 m at the confluence with the Cicadas River, 0.9 m at Sapan and Lancakemit.

3. 1986 March Flood

3.1 Flood Depth and Flood Duration

Flood condition survey was carried out to investigate the actual flood situation for the March 1986 flood and frequent floods at 67 Kampungs in the flood plain along the Citarum river. Through this survey, the inundation depths and durations were interviewed with the residents at 728 locations and a flood depth contour map was prepared.

Objectives of the survey are:

- To identify the actual flood circumstances.
- To prepare materials for the inundation analysis and river improvement planning.
- To prepare the flood condition data for analysis of the relation between assets and damages.

Ground elevations of the Kampungs are often higher than that of paddy field nearby. Therefore, the interviews were conducted both for residential lands and paddy fields at every survey points in Kampung.

The total inundation area of the March 1986 flood was 7,249 ha with about 66 million m^3 of water volume. The inundation depth and area are summarized as follows:

Depth (m)	Area (ha)	Ratio (%)
Less than 0.5	1,894	26.1
0.5 - 1.0	2,484	34.3
1.0 - 1.5	1,854	25.6
More than 1.5	1,017	14.0
Total	7,249	100.0

The flood depth contour map and flood duration distribution map of the 1986 March flood are shown in Fig. D.2 and Fig. D.3 respectively.

3.2 Flood Water Stage Profile

The maximum water stage profile of the March 1986 flood was surveyed for the Citarum and Citarik Rivers. The results are shown in Fig. D.4 and Fig. D.5. The flood water was dammed up by about 2.0 m due to the narrow sections extending over a 6 - 7 km in the downstream reaches of Dayeuh Kolot.

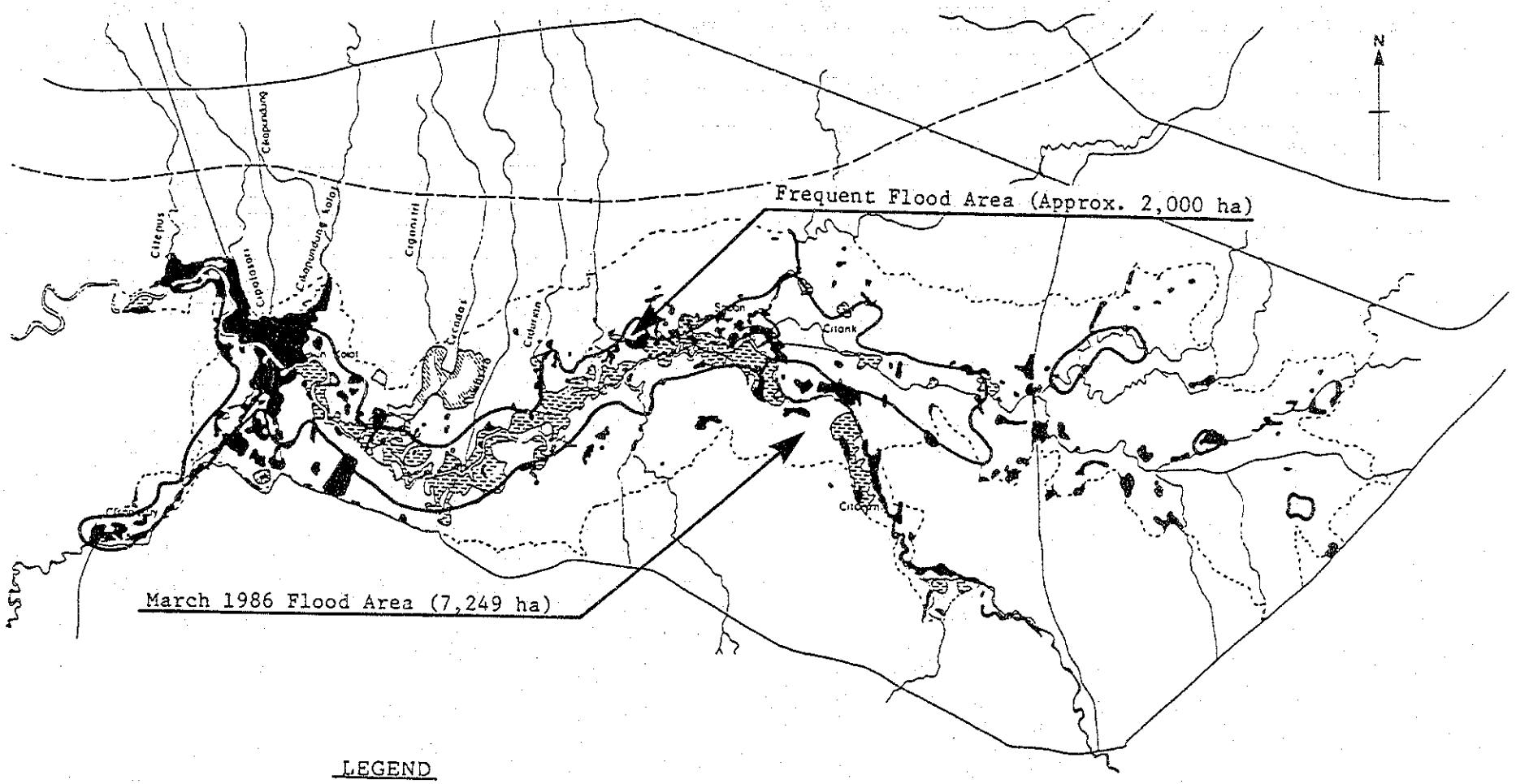
The slope of the flood water stage was:

- 1/23000 (0.00004) in the stretches between Dayeuh Kolot and the site of 35 km distance of the Citarum River.
- 1/9400 (0.00011) in the stretches between the site of 35 km distance and Sapan of the Citarum River.
- 1/6100 (0.00016) in the Citarik River.

The above facts show that dredging or widening of the narrow sections in the downstream of Dayeuh Kolot is essential for draw-down of the flood water level in the upstream reaches.

3.3 Typical Cross Sections of Flood Area

Cross section survey for four (4) locations of the March 1986 flood area was conducted to obtain the data for river improvement and flood plain management planning. The results are shown in Figs. D.6 and D.7.



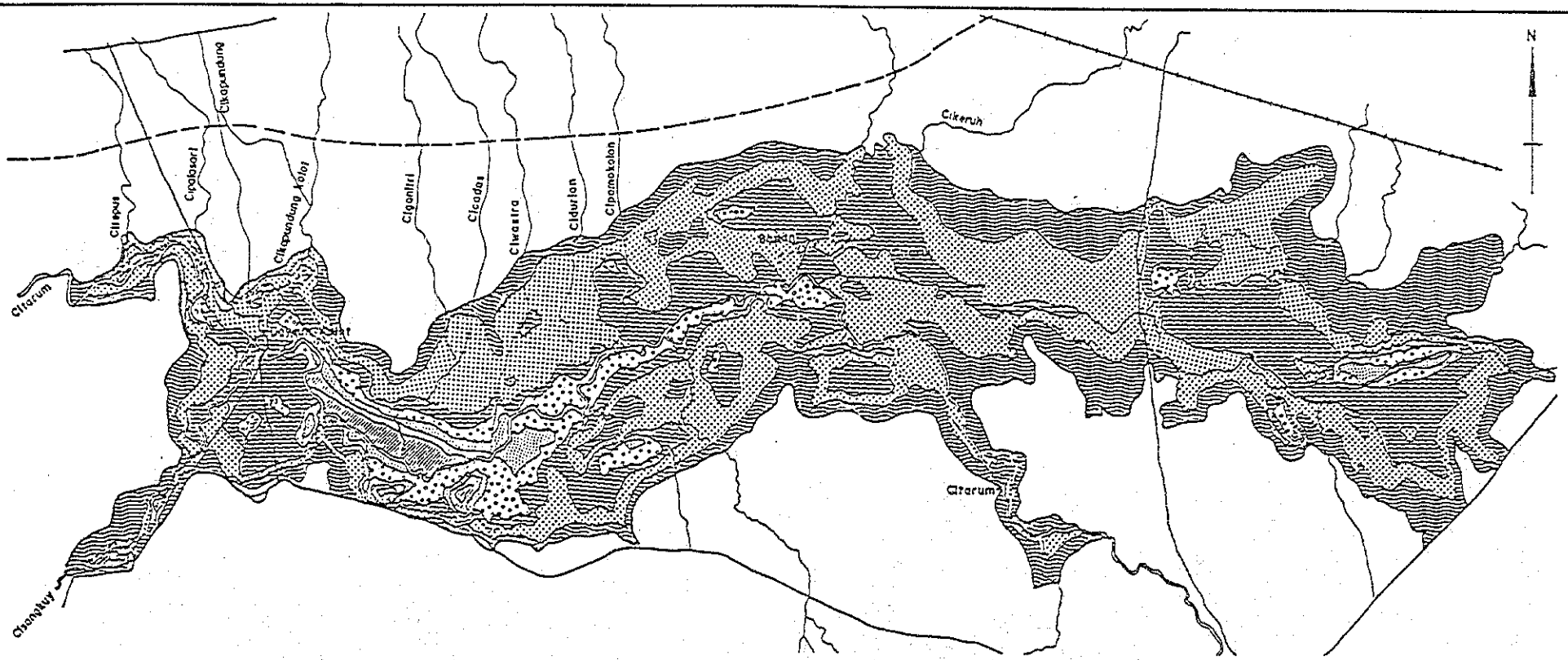
LEGEND

- : Built-up Area
- : Fishpond
- : Paddy Field
- : Plantation
- : Upland Field
- : Grass Land
- : March 1986 Flood Area
- : Frequent Flood Area

FIG. D.1 FREQUENT FLOOD AREA

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA



Flood Depth	Area (Unit ; ha)
3,7 - 2,5 m	98,1
2,5 - 2,0 m	145,6
2,0 - 1,5 m	773,5
1,5 - 1,0 m	1853,7
1,0 - 0,5 m	2484,4
0,5 - 0,0 m	1893,7

LEGEND

- 3,7 m — 2,5 m
- 2,5 — 2,0
- 2,0 — 1,5
- 1,5 — 1,0
- 1,0 — 0,5
- 0,5 — 0,0

SCALE

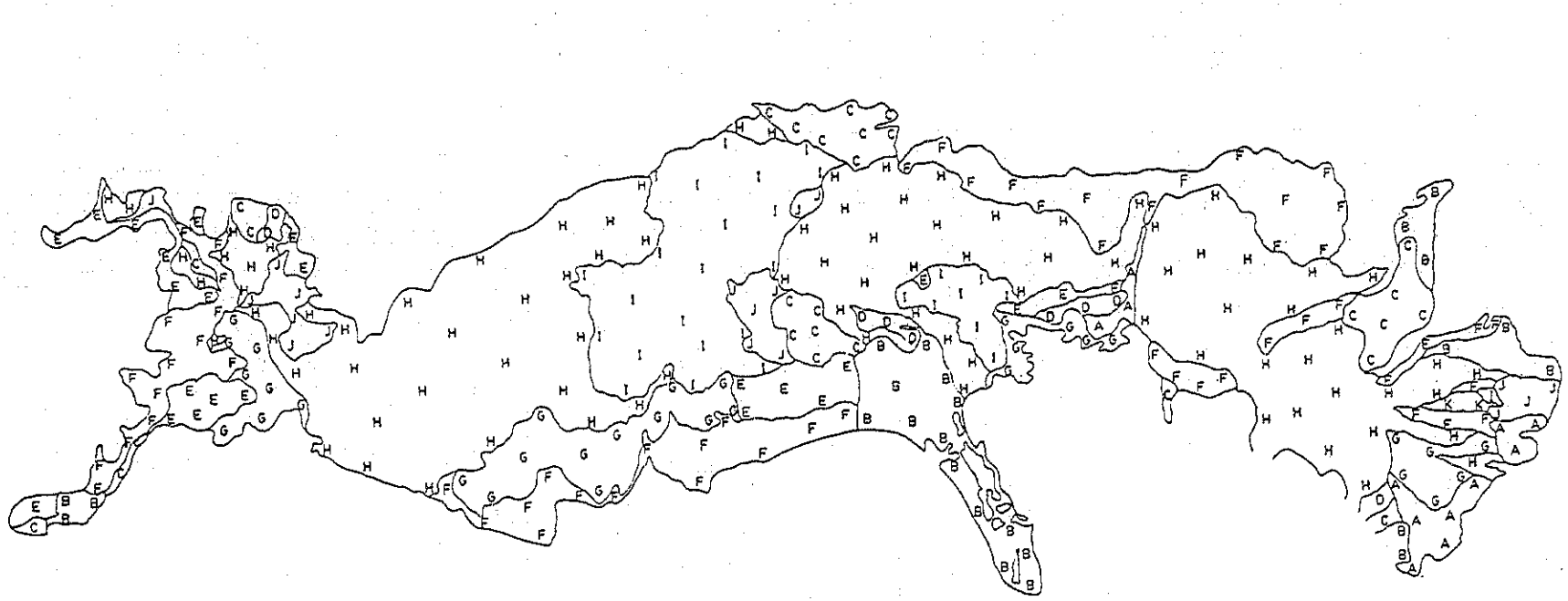
0 1 2 3 4 5 KM

NOTE : FLOOD DEPTHS ARE VALUES ON PADDY FIELD

FIG. D.2 FLOOD DEPTH CONTOUR MAP OF 1986 FLOOD

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA



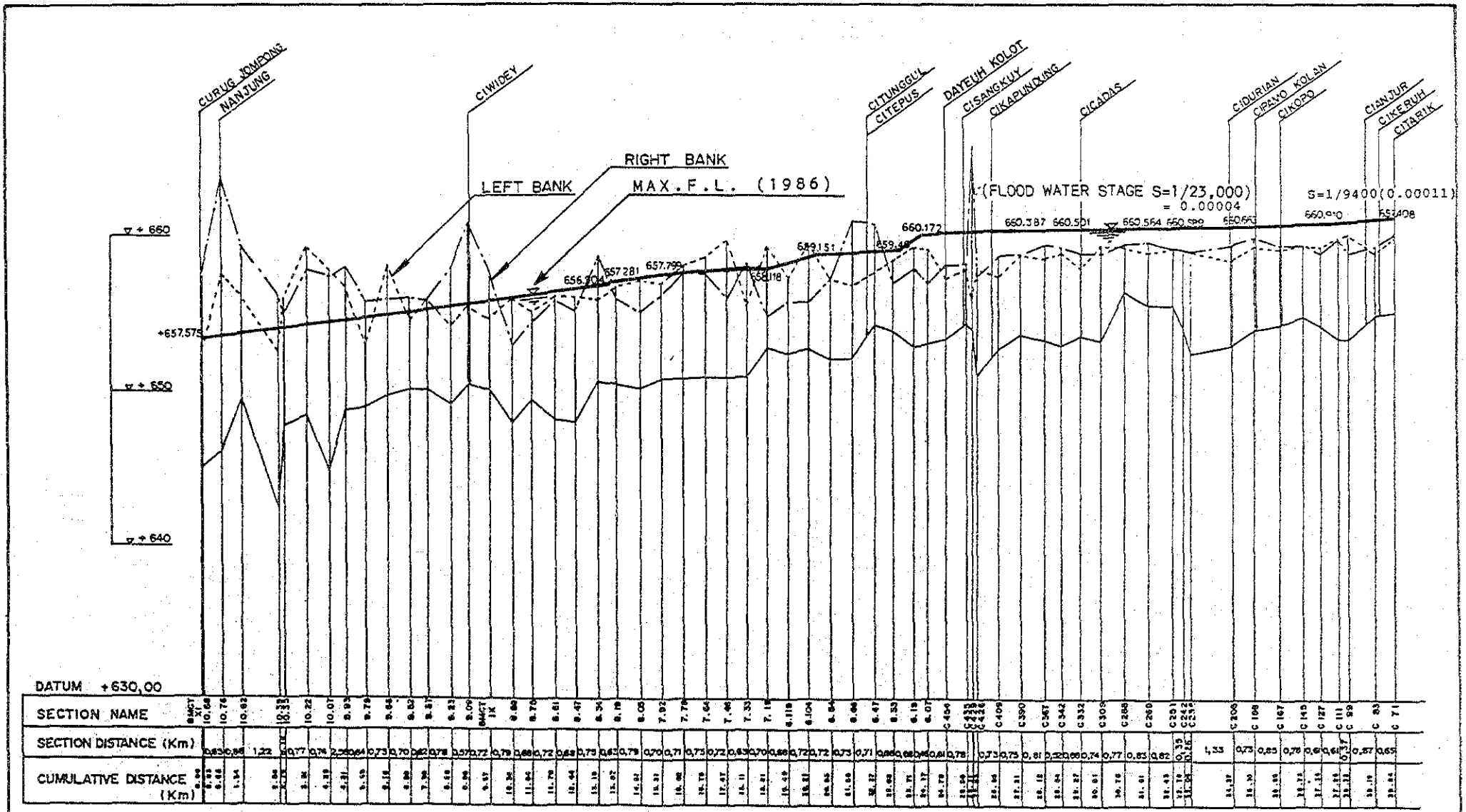
LEGEND

Sign	Flood Duration	Sign	Flood Duration
A:	t< 1day	G:	21days ≤t< 30days
B:	t= 1day	H:	30days ≤t< 45days
C:	1day ≤t< 3days	I:	45days ≤t< 60days
D:	3days ≤t< 7days	J:	60days ≤t< 90days
E:	7days ≤t< 14days	K:	90days ≤t
F:	14days ≤t< 21days		

FIG. D.3 FLOOD DURATION MAP OF 1986 FLOOD

Source;STUDY TEAM

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

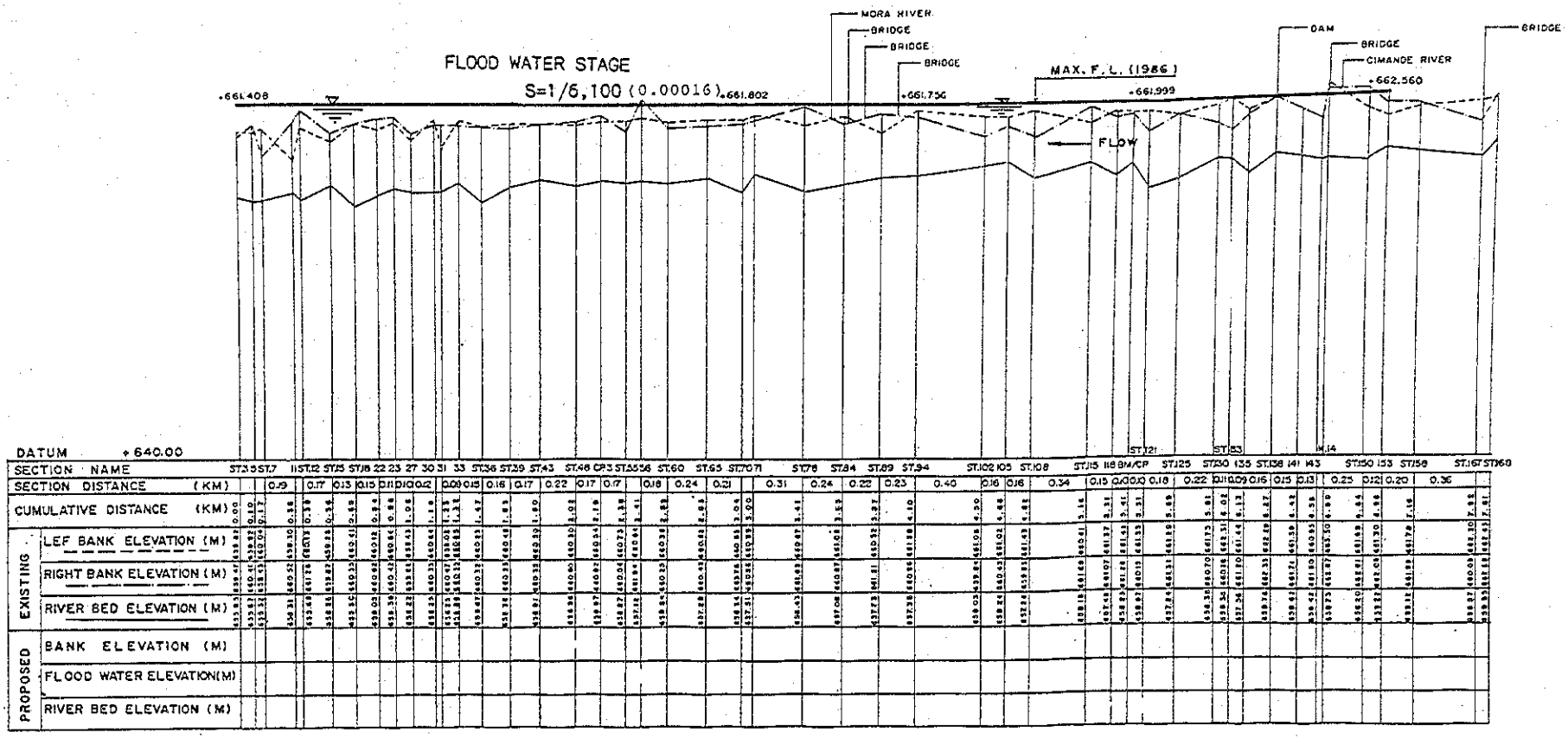


LEGEND

- - - - - - - : LEFT BANK
—·—·—·— : RIGHT BANK
——————— : RIVER BED

FIG. D.4 MAXIMUM FLOOD WATER STAGE PROFILE OF CITARUM RIVER IN 1986 FLOOD

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN



LEGEND

- - - - - - - - : LEFT BANK
—·—·—·— : RIGHT BANK
———————— : RIVER BED

FIG. D.5 MAXIMUM FLOOD WATER STAGE PROFILE OF CITARIK RIVER IN 1986 FLOOD

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

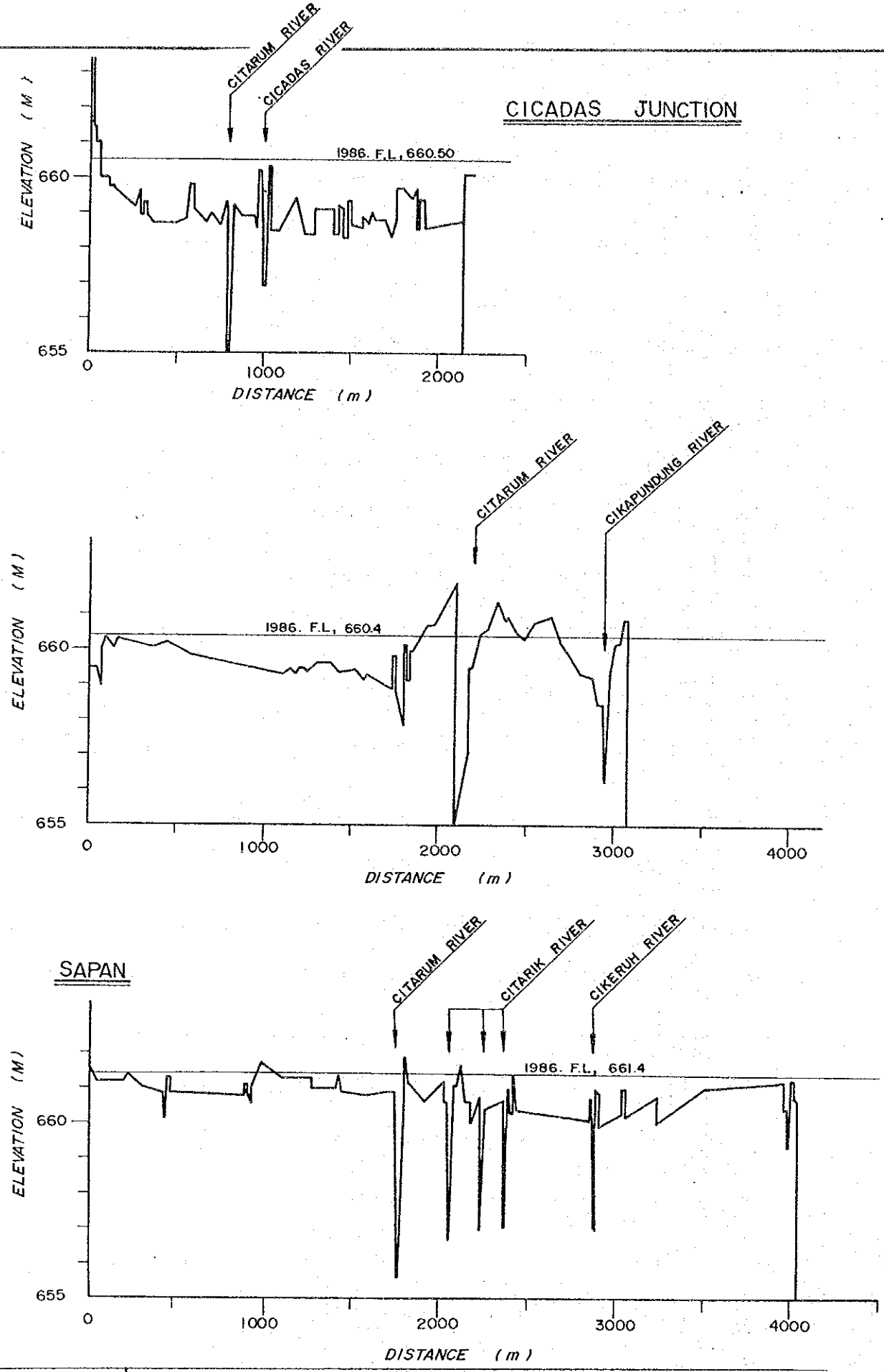


FIG. D.6 TYPICAL CROSS SECTIONS OF FLOOD AREA (1)

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA