REPUBLIC OF CAMEROON
MINISTRY OF AGRICULTURE

FEASIBILITY REPORT
ON
BAIGOM AGRICULTURAL DEVELOPMENT PROJECT

ANNEX VOLUME 1

SEPTEMBER 1986

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO, JAPAN

REPUBLIC OF CAMEROON
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ABBREVIATIONS

(ABREVIATIONS)

A

ADRAO	Association pour le Développment de la Riziculture en Afrique de l'Ouest (West Africa Rice Development Association: WARDA)

B

BCD	Banque Camerounaise de Développement (Cameroon Development Bank)
BEAC	Banque des Etats de l'Afrique Centrale (Central Africa States Bank)
BIAO	Banque Internationale pour l'Afrique Occidentale (International Bank for Western Africa)
BICIC	Banque Internationale pour le Commerce et l'Industrie (International Bank for Trade and Industry)

C

CA	Catchment Area (Bassin Versant)
CAEFC	Chambre de l' Agriculture, de l'Elevage et des Forêts du Cameroun (Cameroon Chamber of Agriculture, Livestock and Forests)
CAMSEED	Cameroon Popcorn Company
CAPLABAM	Coopérative Agricole des Planteurs du Bamboutos (Agricultural Cooperative of Planters in Bamboutos)
CAPLAHN	Coopérative Agricole des Planteurs du Haut Nkam (Agricultural Cooperative of Planters in Haut Nkam)
CAPLAME	Coopérative Agricole des Planteurs de la Ménoua (Agricultural Cooperative of Planters in Ménoua)
CAPLAMI	Coopérative Agricole des Planteurs de la Mifi (Agricultural Cooperative of Planters in Mifi)
CAPLANDE	Coopérative Agricole des Planteurs du Ndé (Agricultural Cooperative of Planters in Ndé)
CAPLANOUN	Coopérative Agricole des Planteurs du Noun (Agricultural Cooperative of Planters in Noun)
CAPME	Centre National d'Assistance aux Petites et Moyennes Entreprises (National Center for Assistance to Small and Medium-size Enterprises)
CCCE	Caisse Centrale de la Coopération Economique (Central Fund for Economic Cooperation)
CEIPS	Centre d'Etudes, d'Instruction et de Production des Semences Légumières (Vegetable Seeds Research, Training and Production Centre)

CENADEFOR	Centre Nationale de Développement des Forêts (National Center for Forest Development)
CENEEMA	Centre National d'Etude et d'Experimentation du Machinisme Agricole (National Center for Studies and Experimentation of Agricultural Mechanization)
COOPAGAL	Coopérative Agricole des Pionniers de Galim (Agricultural Cooperative of Pioneers in Galim)
COOPAGRO	Coopérative Agricole de l'Ouest (Agricultural Cooperative of the West)
COOP COPEL	Coopérative de Commercialisation des Produits de l'Elevage à Bafoussam (Marketing Cooperative of Livestock Products in Bafoussam)
COOPEC	Coopérative d'Epargne et de Crédit (Saving and Credit Cooperative)

D

DGRST	Délégation Générale à la Recherche Scientifique et Technique (General Delegation for Scientific and Technical Research)

E

ENSA	Ecole Nationale Supérieure Agronomique (National Advanced School of Agriculture)

F

FAC	Fonds d'Aide et de Coopération (Assistance and Cooperation Fund)
FAO	Food and Agricultural Organization (Organisation des N.U. pour l'Alimentation et l'Agriculture: OAA)
FED	Fonds Européen de Développement (European Development Fund)
FIDA	Fond International de Développement Agricole (International Agricultural Development Fund)
FOGAPE	Fonds d'Aide et de Garantie des Crédits aux Petites et Moyennes Entreprises (Aid and Loan Guarantee Fund to Small and Medium-sized Enterprises)
FONADER	Fonds National de Développement Rural (National Fund for Rural Development)

G

GAM	Groupements d'Agriculteurs Modernes (Modern Farmers Groups)

I

IBRD	International Bank for Reconstruction and Development (World Bank) (Banque Internationale pour la Reconstruction et le Développement: BIRD)
IDA	International Development Association (Association Internationale de Développement: AID)
IFCC	Institut Français du Café, du Cacao et Autres Plantes Stimulantes (French Institute of Coffee, Cacao and Other Stimulative Plants)
IITA	International Institute of Tropical Agriculture (Institut International pour l'Agriculture Tropicale)
INADES	Institut Africain de Développement Economique et Social (African Institute of Economic and Social Development)
IRA	Institut de la Recherche Agronomique (Institute of Agricultural Research)
IRAT	Institut de Recherches Agronomiques Tropicales et de Cultures Vivrières (Research Institute for Tropical Agriculture and Food Products)
IRRI	Institut International de Recherches Rizicoles (International Rice Research Institute)
ITA	Institut des Techniques Agronomiques (Institute of Agricultural Technology)

J

JICA	Japan International Cooperation Agency (Agence Japonaise de Coopération Internationale)

M

MIDEVIV	Mission de Développement des Semences et des Cultures Vivrières (Seeds and Food Development Authority)
MESRES	Ministère de l'Enseignement Supérieur et de la Recherche Scientifique (Ministry of Higher Education and Scientific Research)
MINAGRI	Ministère de l'Agriculture (Ministry of Agriculture)
MINCI	Ministère du Commerce et de l'Industrie (Ministry of Trade and Industry)
NIMEPIA	Ministère de l'Elevage, des Pêches et des Industries Animales (Ministry of Livestock, Fisheries and Animal Industries)
MINEQ	Ministère de l'Equipement (Ministry of Equipment)
MINFI	Ministère des Finances (Ministry of Finance)
MINPAT	Ministère du Plan et de l'Aménagament du Territoire (Ministry of Planning and Regional Development)

MINTR	Ministère des Transports (Ministry of Transportaion)
MINUH	Ministère de l'Urbanisme et de l'Habitat (Ministry of Urbanism and Housing)

N

NCRE	National Cereals Research and Extension Project (Projet National pour la Recherche et la Vulgarisation des Céréales)

O

OC	Office Céréalier (Cereales Office)
OECF	Overseas Economic Cooperation Funds (Japan) (Fonds de Coopération Economique d'Outre-mer du Japon)
ONAREF	Office National de Regénération des Forêts (National Office of Reforestation)
ONCPB	Office National de Commercialisation des Produits de Base (National Produce Marketing Board)
ONDAPB	Office National de Développement de l'Aviculture et du Petit Bétail (National Office of Aviculture and Small Animals)
ONPD	Office National de Participation au Développement (National Office for Participation in Development)
ORSTOM	Office de Recherche Scientifique et Technique d'Outre-mer (Overseas Scientific and Technical Research Office)

P

PDRPO	Projet de Développement Rural de la Province de l'Ouest (Rural Development Project in the West Province)

R

RII	Redpath International Incorporated

S

SACTA	Société Agricole et de Collecte de Tabacs (Agricultural and Tobacco Collecting Company)
SCB	Société Camerounaise de Banque (Cameroonian Banking Company)
SEABA	Société d'Exploitation Agricole du Bamoun (Bamoun Agricultural Production Company)
SEDA	Société d'Etudes pour le Développement de l'Afrique (Study Company for African Development)

SEFN	Société d'Exploitation Forestière du Noun (Noun Forest Exploitation Company)
SEMRY	Société d'Expansion et de Modernisation de la Riziculture de Yagoua (Agency for Promotion and Modernization of Rice Cultivation, Yagoua)
SEPCAE	Société d'Engrais et de Produits Chimiques d'Afrique Equatoriale (Equatorial African Fertilizer and Chemical Products Company)
SEPCAM	Société d'Etudes pour la Promotion de la Culture et de l'Exploitation du Maïs (Study Company for the Promotion of Maize Culture and Production)
SNI	Société Nationale d'Investissement du Cameroun (National Investment Corporation)
SOCAF	Société de Conserverie Africaine (Ex-SAFEL) (African Canning Company)
SOCALEG	Société Camerounaise de Légumes (Cameroonian Vegetable Company)
SNEC	Société Nationale des Eaux du Cameroun (National Water Company of Cameroon)
SODERIM	Société de Développement de la Riziculture de la Plaine des Mbos (Mbo Plains Rice Development Corporation)
SONEL	Société Nationale d'Electricité du Cameroun (National Electric Corporation of Cameroon)
SPC	Société des Provenderies du Cameroun (Cameroon Feeds Company)

U

UCCAO	Union Centrale des Coopératives Agricoles de l'Ouest (Central Union of Agricultural Cooperatives in the West Provinciel)
UDEAC	Union Douanière et Economique de l'Afrique Centrale (Central African Customs and Economic Union)
UNVDA	Upper Noun Valley Development Authority (Société de Développement de la Haute Vallée du Noun)
USAID	United States Agency for International Development (USA) (Agence des Etats-Unis pour le Développement International)

V

VRD	Voirie et Réseaux Divers (Roads and Other Networks)

W

WADA	Wum Area Development Authority (Autorité de Développement de la Région de Wum)

UNITS OF MEASUREMENT
(UNITES DE MESURE)

Length (Longueur)	Kilometre	km
	metre	m
	centimetre	cm
	millimetre	mm
Area (Surface)	square metre	m^2
	hectare	ha
Velocity (Vitesse)	metre per second	m/s
	kilometre per hour	km/h
	million cubic meters	MCM
Volume (Volume)	cubic metre	m^3
	litre	l
Weight (Poids et Masse)	kilogramme	kg
	ton	t
Time (Temps)	hour	hr
	minute	min
	second	s
Power (*Energie*)	*ampere*	A
	volt	V
	kilovoltampere	kVA
	watt	W
	kilowatt	kW
Temperature (Température)	degree Celsius	°C

UNITS OF MONEY
(UNITES DE MONNAIE)

CFA Francs	CFA F / F CFA (or CFA)
US Dollar	US $ / $ EU
Japanese Yen	¥

US 1.0$ = CFA F 384.5 = ¥ 203 (as of Dec. 1985)

ANNEX I

HYDROLOGY

ANNEX I

HYDROLOGY

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CHAPTER 1 GENERAL

1.1 Scope

The meteorological and hydrological investigation and study were conducted to make clear the meteorological and hydrological properties in and around the study area for the development plan of the Project with the following activities:

(1) Collection of meteorological and hydrological data,

(2) Review and examination of available basic data collected,

(3) Installation of three staff gauges,

(4) Discharge measurement, and

(5) Study of drought and flood discharges.

All the meteo-hydrological records collected and the computer outputs of simulation analysis made in the hydrological study are listed in the "Data Book".

1.2 River Basin

In the study area, there are three major rivers, namely the Ndoup, Nja and Nkoup rivers. The Ndoup and Nja rivers are expected as the irrigation water sources for the Project. The Nkoup river is the only outlet from the plain. The general characteristics of these river basins illustrated in Fig. 1.1 are as follows:

The Ndoup river originates in the Pouo Loum with a summit of El. 1,620 m and runs in the intermediate plateau which follows after a high catchment area. After passing the intake weir site for water supply to the Koundja military camp, the Ndoup river penetrates between the geneiss hills and enters into the Baigom plain after crossing the national road No. 2. The total length of the river within the catchment area is about 12 km and the average slopes of the river are estimated to be about 1/8 in the upper part (El. 1,620 m - El. 1,260 m), about 1/83 in the middle part (El. 1,260 m - El. 1,200 m) and about 1/53 in the lower part (El. 1,200 m - El. 1,125 m).

The Nja river originating in the basaltic plateau with a summit of El. 1,350 m on the north of Koundja, runs in the fairly well cultivated basaltic plateau and flows down between the hills of metamorphic insular shelf to the plain. The length of river totals about 7 km within the catchment area with the average slopes of about 1/10 in the upper part (El. 1,350 m - El. 1,200 m), about 1/83 in the middle part (El. 1,200 m - El. 1,140 m) and about 1/50 in the lower part (El. 1,140 m - El. 1,130 m).

After the join of these two rivers, the river is called the Nkoup. The Nkoup river flows down southward through Foumbot city and joints to the Noun river at 29 km south of Foumbot.

CHAPTER 2 METEOROLOGICAL AND HYDROLOGICAL DATA

2.1 Meteorological Data

The climate in the study area is relatively mild throughout the year and distinct two seasons are observed: rainy season from March to October and dry season from November to February.

The meteorological condition of the study area is represented by the available records at the Koundja meteorological station. This station is situated very close to the study area and lies in the Nja catchment basin which is one of the two major external drainage basins providing the Baigom plain with water. The elevation of the station is 1,208 m, that is to say about 100 m above the Baigom plain. The location of the station is shown in Fig. 1.2. The mean monthly meteorological records for recent 10 years from 1975 to 1984 at the Koundja station is summarized in Table 1.1 and Fig. 1.3.

(1) Temperature

As the Baigom plain is about 100 m below the Koundja meteorological station, the temperatures in the plain are estimated by adding 0.6°C to the records at the Koundja station as shown below.

(Unit: °C)

Month	Mean	Mean Max. (A)	Mean Min. (B)	(A) - (B)
Jan.	21.9	29.9	15.1	14.8
Feb.	23.7	31.2	16.7	14.5
Mar.	23.6	30.3	18.0	12.3
Apr.	23.0	28.8	18.4	10.4
May	22.0	27.3	17.8	9.5
Jun.	21.0	26.3	17.1	9.2
Jul.	20.2	25.4	16.9	8.5
Aug.	20.2	25.4	17.1	8.3
Sep.	20.3	25.7	16.7	9.0
Oct.	21.0	26.7	16.9	9.8
Nov.	21.3	28.9	15.9	12.1
Dec.	21.1	29.1	14.5	14.6
Average	21.6	27.8	16.8	11.0

From the above table, it can be said that the mean maximum temperature in the dry season is higher than that in the rainy season, while the mean minimum temperature in the dry season becomes lower than that in the rainy season. Therefore, the difference between the mean maximum and the mean minimum becomes big in the dry season.

(2) Relative humidity

The mean relative humidity varies between about 78% during the rainy season and about 61% during the dry season. The mean maximum relative humidity is almost 100% in the rainy season and about 90% in the dry season. While the mean minimum one is about 57% in the rainy season and about 30% in the dry season.

(3) Sunshine duration

The annual mean sunshine duration is 2,437.5 hours, equivalent to the daily mean of about 6.7 hours/day. The maximum of sunshine duration occurs in January showing 268.9 hours (8.7 hours/day) and the minimum one is 125.3 hours (4.0 hours/day) in August. The mean sunshine duration is 5.8 hours/day during the rainy season and 8.5 hours/day during the dry season.

(4) Pan evaporation

The annual mean A-pan evaporation is 1,586.6 mm. It is equivalent to the daily mean of 4.3 mm/day ranging from 6.5 mm/day in February to 2.8 mm/day in August. The mean pan evaporations in the dry and rainy seasons are 5.2 mm/day and 3.9 mm/day, respectively.

(5) Wind velocity

The monthly mean wind velocity varies from 1.0 m/sec to 1.6 m/sec with the annual mean of 1.2 m/sec. The annual mean maximum wind velocity is 9.3 m/sec with the maximum of 11.6 m/sec in March and the minimum of 7.2 m/sec in December and January.

2.2 Rainfall Data

There are five rainfall stations around the study area. The locations, altitudes and recording periods of these five stations are as follows:

Name	Longitude	Latitude	Altitude	Recording Period
Koundja	10°45'	5°37'	1,208 m	1951 - 1984
Kounden	10°48'	5°42'	1,290 m	1951 - 1984
Foumban	10°54'	5°44'	1,238 m	1955 - 1984
Foumbot	10°48'	5°31'	1,050 m	1951 - 1984
Bafoussam	10°26'	5°28'	1,410 m	1951 - 1984

The monthly rainfalls at the above stations for recording periods are shown in Table 1.2, and the mean monthly rainfalls are summarized below.

(Unit: mm)

Month	Koundja	Kounden	Foumban	Foumbot	Bafoussam
Jan.	4.7	6.7	4.6	7.8	8.2
Feb.	24.9	28.0	19.3	21.2	32.6
Mar.	110.7	107.1	106.2	100.9	114.3
Apr.	162.2	156.7	160.0	133.8	173.8
May	188.6	205.6	208.6	153.9	170.5
Jun.	198.0	219.1	176.5	168.3	195.0
Jul.	319.2	325.4	290.7	225.7	232.0
Aug.	331.2	337.7	296.3	249.1	255.7
Sep.	351.2	347.1	319.6	299.3	281.9
Oct.	257.9	253.3	255.9	240.9	262.5
Nov.	59.4	52.6	60.6	53.6	60.9
Dec.	8.3	11.7	7.7	9.3	7.4
Average	2,016.3	2,051.0	1,906.0	1,663.8	1,794.8

The above stations belong to the western mountain climatological domain. This domain is under summer effect of the monsoon from the south-west which brings heavy rainfalls from June to October. However, the annual total or monthly totals during heavy rainfall months are very much lower than those in littoral zone which is subjected to the pressure of the monsoon directly.

The Koundja station which is located in the ridge opened toward the west between Mbetpit and Nkogam masses of mountains, receives relatively high rainfalls because of its fairly eastern position. The Kounden station is located about 13 km northwest from Koundja station and is further locked in the mountain. At this station, the direct effect of the monsoon is more obvious than at Koundja and rainfalls depend on the eastern squalls much more.

The Foumbot station located about 20 km southwest from Koundja and the Bafoussam station located about 25 km west apart from Foumbot are more sheltered from the monsoon regime and have less rainfalls comparing the Koundja station. The Foumban station is situated on the Bamoun plateau about 20 km northeast from Koundja and holds relatively high annual rainfalls depending on the eastern squalls.

The Koundja station is located very close to the study area and therefore allows to characterize well the pluviometric regime of the area, especially for the two major external drainage basins of Nja and Ndoup.

The mean annual rainfall for 34 years from 1951 to 1984 at the Koundja station is about 2,016 mm showing the maximum monthly rainfall of 351 mm in September and the minimum of 4.7 mm in January. The total rainfall during the rainy season of 8 months from March to October is estimated to be about 1,919 mm or 95% of the annual rainfall. The fluctuation of annual rainfalls is shown in Fig. 1.4.

The annual mean rainy days during recent 9 years from 1976 to 1984 is 174 days, of which 164 days or 94% are recorded during the rainy season from March to October as shown below.

(Unit: days)

Month	Year									Average
	'76	'77	'78	'79	'80	'81	'82	'83	'84	
Jan.	0	2	2	0	1	1	7	0	0	1
Feb.	13	2	2	3	2	1	2	1	0	3
Mar.	7	3	13	11	10	8	15	3	16	10
Apr.	18	13	22	18	13	13	14	10	15	15
May	18	18	19	22	15	21	19	21	20	19
Jun.	19	19	22	22	18	18	20	19	19	20
Jul.	28	26	19	23	23	24	26	22	28	24
Aug.	29	24	28	24	27	29	28	26	27	27
Sep.	26	27	30	23	28	28	24	26	23	26
Oct.	24	22	27	23	28	23	27	12	25	23
Nov.	12	0	5	13	8	5	3	0	5	6
Dec.	0	0	0	0	0	0	0	2	0	0
Annual	194	156	189	182	173	171	185	142	178	174

The maximum daily rainfalls for the above same period at the Koundja station are shown below. The biggest one is 93.8 mm/day in May, 1979 and every year high values more than 50 mm/day are recorded.

(Unit: mm)

Month	Year									Average
	'76	'77	'78	'79	'80	'81	'82	'83	'84	
Jan.	0	3.5	10.2	0	0.5	0.7	23.1	0	0	4.2
Feb.	32.0	0.2	20.8	2.3	1.8	19.0	4.7	1.0	0	9.1
Mar.	23.0	18.6	38.0	23.7	38.2	31.5	22.4	7.2	42.7	27.3
Apr.	71.9	28.6	26.6	58.2	35.6	15.6	33.0	9.4	29.0	34.2
May	19.2	34.8	23.6	93.8	43.1	50.2	25.4	28.9	21.1	37.8
Jun.	43.4	45.0	28.5	29.1	39.4	35.1	41.1	58.7	36.0	39.6
Jul.	41.7	52.9	46.4	52.9	72.2	30.8	55.2	43.0	42.5	48.6
Aug.	56.7	56.7	50.2	41.9	55.9	64.8	47.9	40.2	53.7	52.0
Sep.	52.9	35.3	44.7	43.0	49.9	46.5	42.5	35.6	44.5	43.9
Oct.	40.5	29.6	37.1	44.5	38.8	36.7	40.2	56.0	28.1	39.1
Nov.	47.6	0	38.5	39.0	29.4	20.3	41.7	0	11.4	25.3
Dec.	0	0	0	0	0	0	0	16.4	0	1.8

The daily rainfall records at the Koundja station are shown in Table 1.3.

The hourly rainfall records for the flood discharge analysis were collected at the Koundja meteorological station in the course of the field survey by the Study Team. These data are compiled in the Data Book.

Periods of all the rainfall data available are summarized in Fig. 1.5.

2.3 Runoff Data

SEDA carried out the discharge measurements for about 15 months from March 1980 to May 1981 in the Ndoup, Nja and Nkoup rivers. Only these are available runoff data in the past. The discharge records collected by SEDA are shown in Table 1.4.

2.4 Discharge Measurement

Further, the JICA Study Team also carried out the measurements during this survey period though it was very short period. For the measurements, the Study Team installed three staff gauges newly at upstream of the existing intake weir for drinking water to the military camp, at downstream of the Baigom bridge, and at upstream of the pump station for water supply to Foumbot city. At both entrance points to the plain of the Ndoup and Nja rivers, there exist two staff gauges which were installed by SEDA. The discharge measurements by the Study Team were carried out at the five points mentioned above.

The results of discharge measurements by the Study Team are shown in Table 1.5. The locations of the water level staff gauges are shown in Fig. 1.6. The river cross sections at the gauging stations are shown in Fig. 1.7.

The rating curves at the five gauging stations are shown in Fig. 1.8. The SEDA's records and the Study Team's measurement results are used to prepare these rating curves.

2.5 Water Quality

For the purpose of checking water qualities of the Ndoup and Nja rivers for irrigation, the electric conductivity and pH tests were executed. Water samples were collected at the following locations:

- Ndoup River : at Ndoup No. 2 gauging station
- Nja River : at Nja gauging station
- Nkoup River : at Nkoup No. 1 gauging station

The results are as shown below.

Location	EC at 25°C (μ mho/cm)	pH
Ndoup No. 2	215	7.2
Nja	200	7.5
Nkoup No. 1	29	6.8

From the above results, it can be said that the water qualities of the Ndoup and Nja rivers are satisfactory for irrigation water, because the EC values are less than 250 μ mho/cm, and pH values are almost neutral.

CHAPTER 3 WATER RESOURCES

3.1 General

The water resources analysis was made for the Ndoup and Nja rivers in the drought year with a five-year return period. The rainfall data at the Koundja meteorological station and the runoff data of SEDA were applied to the analysis.

3.2 Evaluation of Rainfall

As shown in Fig. 1.4, the monthly rainfall data are available for 34 years from 1951 to 1984, but the daily rainfall data are available only for 9 years from 1976 to 1984. So, the daily rainfalls with a five-year return period for the runoff calculation were estimated as follows:

- Estimate of the annual rainfall (1,818 mm) in the drought year with a five-year return period from the monthly rainfall data from 1951 to 1984.

- Estimate of daily rainfalls by the conversion of the above annual rainfall to daily ones based on the distribution pattern made by the daily rainfall data from 1976 to 1984.

The probable annual rainfalls of non-exceedance are shown in Table 1.6. The daily rainfall data in the drought year with a five-year return period are shown in Table 1.7.

3.3 Evaluation of River Runoff

(1) Evaluation method

The Tank Model Method was selected suitable to analyze especially long-term runoff. The Tank Model was used to generate daily streamflow discharges from daily rainfalls. Coefficients of Tanks were determined through simulation until obtaining the nearest possible discharges with the observed discharges by trial and error. Accuracy of the model depends on the accuracy of streamflow observation data.

The simulation was made based on the daily rainfall data shown in Table 1.8 at Koundja meteorological station and the discharge data of SEDA during the period from March 1980 to February 1981.

(2) Analysis of discharge data

It was found that an adjustment of the Ndoup discharge data after September 1980 is necessary, because the relation of rainfall and discharge between before and after September 1980 is not reasonable as explained in the SEDA's Hydrological Measurements Report of July 1981.

The Ndoup discharge data were adjusted for the simulation. While, the Nja discharge data were directly applied to the simulation. These data are shown in Table 1.9.

(3) Tank model calculation

A tank model is usually composed of 3 to 4 storage tanks, and 4 tanks model was adopted in this study.

Each tank has several runoff holes at different heights, and infiltration hole at a bottom. It is generally interpreted that the first tank corresponds to the surface runoff, the second tank to the inter flow and the lower two tanks give base flow and infiltration to the groundwater. Rainfall is put to the first tank and it outflows from the side holes and penetrates to the lower tanks.

The coefficients of tanks made by a trial and error method were given as follows:

1) Ndoup river basin

a) Catchment area : 19.8 km^2 (Ndoup No. 2 gauging station)

b) First storage height

First Tank : 0 mm

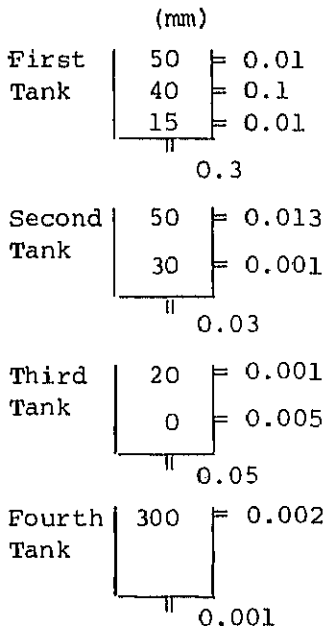
Second Tank : 0 mm

Third Tank : 0 mm

Fourth Tank : 1,000 mm

c) Evaporation

Month	Evaporation (mm/day)
Jan.	4.0
Feb.	5.6
Mar.	4.8
Apr.	4.0
May	3.1
Jun.	2.8
Jul.	2.3
Aug.	2.2
Sep.	2.3
Oct.	2.6
Nov.	2.3
Dec.	3.4



d) Rainfall station : Koundja Meteorological Station

2) Nja river basin

a) Catchment area : 17.1 km^2 (Nja gauging station)

b) First storage height

First Tank : 0 mm

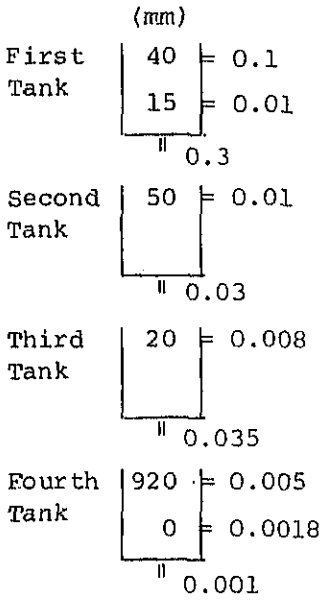
Second Tank : 0 mm

Third Tank : 0 mm

Fourth Tank : 1,000 mm

c) Evaporation

Month	Evaporation (mm/day)
Jan.	3.5
Feb.	4.9
Mar.	4.1
Apr.	3.4
May	2.8
Jun.	2.5
Jul.	2.0
Aug.	1.9
Sep.	2.0
Oct.	2.2
Nov.	2.3
Dec.	3.0



d) Rainfall station : Koundja Meteorological Station

Trial and error calculations were conducted by computer until obtaining the model to simulate the discharges similar to the observed discharge values applying rainfalls at the Koundja meteorological station. For evaluation of the models' accuracy, the simulated daily discharges and the observed ones were plotted in 10-day basis as shown in Fig. 1.9.

Applying these models, the daily discharges of the Ndoup and Nja rivers were generated for the drought year with a five-year return period. The calculation results are shown in Table 1.10 and Fig. 1.10.

The 10-day discharges of the both rivers are summarized in Table 1.11, and the monthly mean discharges are summarized as follows:

(Unit: m^3/sec)

Month	Ndoup No. 2 Gauging Station (C A = 19.8 km^2)	Nja Gauging Station (C A = 17.1 km^2)
Jan.	0.28	0.34
Feb.	0.20	0.27
Mar.	0.13	0.21
Apr.	0.12	0.19
May	0.22	0.28
Jun.	0.27	0.33
Jul.	0.52	0.51
Aug.	0.74	0.70
Sep.	0.92	0.82
Oct.	0.91	0.85
Nov.	0.59	0.63
Dec.	0.33	0.38
Average	0.44	0.46

CHAPTER 4 FLOOD DISCHARGE

4.1 General

The flood discharges analysis was made for the Ndoup and Nja rivers with a five-year return period. The rainfall data at the Koundja meteorological station and the runoff data measured by the JICA Study Team were applied to the analysis.

4.2 Evaluation of Rainfall

As shown in Fig. 1.5, the daily rainfall data are available for 9 years from 1976 to 1984, but the hourly rainfall data are only collected ones by the Study Team during the field survey period. So, the hourly rainfalls with a five-year return period for the flood discharge calculation are estimated as follows:

- Estimate of the maximum daily rainfall (73 mm) with a five-year return period from the daily rainfall data from 1976 to 1984.
- Estimate of hourly rainfalls by the conversion of the above daily rainfall to hourly ones based on the distribution pattern. The duration of the rainfall (4 hours) was estimated from the daily rainfall data. Further, the distribution pattern was made from the hourly rainfall data collected in the survey period.

The probable daily rainfalls of exceedance are shown in Table 1.12. The hourly rainfall data of the maximum daily rainfall with a five-year return period are shown in Table 1.13.

4.3 Evaluation of Flood Discharge

(1) Evaluation method

The Storage Function Method was selected as suitable to analyse especially flood discharge. The Storage Function was used to generate hourly flood discharges from hourly rainfalls. Coefficients of the function were determined through simulation until obtaining the nearest discharges with the observed discharges by trial and error. Accuracy of the function depends on the accuracy of flood discharge observation data.

The simulation was made based on the hourly rainfall data at Koundja meteorological station shown in Table 1.14, and the flood discharge data observed hourly by the Study Team in the field survey period.

(2) Analysis of discharge data

The flood discharge data for the simulation were selected from several flood models considering the flood discharge, the influence of other floods and the reliability of observation. Finally, the flood on 23 September 1985 was adopted for the simulation. Those data are shown in Table 1.15.

(3) Storage Function Calculation

The Storage Function is expressed as follows:

$$S = K \cdot q^p$$

where, S: Storage height (mm)
q: Direct runoff (mm/hr)
K: Coefficient
p: Coefficient

To obtain coefficients K and p in the above function, the trial and error calculations were executed changing the time-lag Te. Further, runoff coefficient f was obtained in the process to determine the function.

These coefficients of the function were given as follows:

1) Ndoup river basin

a) Catchment area : 19.8 km^2 (Ndoup No. 2 gauging station)

b) Te = 3.0 hours

f = 0.236

The basin is not saturated by the both rainfalls of model (28 mm) and design (73 mm), considering the basin characteristics. In general, 200 mm is the necessary depth of rainfall to saturate the such basin. So the coefficient f was given only one value (0.236) before saturation.

c) Storage function

$S = 22.87\ q^{1.896}$ $\quad q \leq \begin{matrix} 1.82\ m^3/sec \\ 0.33\ mm/hr \end{matrix}$

$S = 7.48\ q^{0.891}$ $\quad q > \begin{matrix} 1.82\ m^3/sec \\ 0.33\ mm/hr \end{matrix}$

d) Rainfall station : Koundja Meteorological Station

2) Nja river basin

a) Catchment area : 17.1 km^2 (Nja gauging station)

b) Te = 3.0 hours

f = 0.104

The coefficient f was given only one value (0.104) before saturation of the basin by the same reason as the Ndoup.

c) Storage function

$S = 47.19\ q^{1.821}$ $\quad q \leq$ 0.38 m^3/sec = 0.08 mm/hr

$S = 5.06\ q^{0.954}$ $\quad q >$ 0.38 m^3/sec 0.08 mm/hr

d) Rainfall station : Koundja Meteorological Station

Trial and error calculations were conducted by computer until obtaining the function to simulate the discharges similar to the observed discharge values applying rainfalls at the Koundja meteorological station. For evaluation of the functions' accuracy, the simulated hourly flood discharges and the observed ones were plotted in Fig. 1.11.

Applying these functions, the hourly flood discharges of the Ndoup and Nja rivers were generated for the flood with a five-year return period. The calculation results were shown in Table 1.16 and Fig. 1.12. The peak discharges of the both rivers are shown below.

- Ndoup No. 2 Gauging Station : 15.0 m3/sec
  (C A = 19.8 km^2)
- Nja Gauging Station : 8.0 m3/sec
  (C A = 17.1 km2)

CHAPTER 5 RECOMMENDATION

In order to get more reliable data, the following works are recommended.

1) Establishment of raingauge stations

At present, rainfall data in concerned basins with the Baigom plain are available only at the Koundja meteorological station, which is located in the Nja river basin. So, automatic raingauges would be installed in the following basins.

- Ndoup river basin
- Baigom plain

2) Installation of automatic water level recorders

To obtain the hourly discharge records especially for flood analysis, automatic water level recorders would be installed at the following stations.

- Ndoup No. 2 station
- Nja station
- Nkoup No. 1 station

3) Continuous discharge measurement

Not only to grasp the tendency in some years during long period but also to observe the runoff condition from a season to another season, the continuous discharge measurement would be made throughout the year for long period.

4) River cross section survey

As the river section is sometimes changed by large floods, etc., the cross section survey at the gauging station would be carried out at least once a year.

Table 1.1 SUMMARY OF CLIMATIC CONDITIONS

Koundja Station : Lat. 5°37'N, Long. 10°45'E, Altitude 1,208m, Record Period 1975 - 1984

Description		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total or Average
Temperature (°C)	Mean	21.3	23.1	23.0	22.4	21.4	20.4	19.6	19.6	19.7	20.4	20.7	20.5	21.0
	Mean Max.	29.3	30.6	29.7	28.2	26.7	25.7	24.8	24.8	25.1	26.1	27.4	28.5	27.2
	Mean Min.	14.5	16.1	17.4	17.8	17.2	16.5	16.3	16.5	16.1	16.3	15.3	13.9	16.2
Relative Humidity (%)	Mean	57	55	62	74	80	81	83	83	81	78	69	61	72
	Mean Max.	87	85	90	96	99	99	100	100	100	99	96	92	95
	Mean Min.	26	23	34	50	60	62	65	66	62	56	40	30	48
Pan Evaporation	Total (mm)	163.2	184.0	188.8	146.2	124.4	104.4	91.1	87.7	99.7	120.0	133.4	143.7	1,586.6
	Mean (mm/day)	5.2	6.5	6.1	4.9	4.0	3.5	2.9	2.8	3.3	3.9	4.4	4.6	4.3
Atmospheric Pressure	Mean (millbars/day)	879.7	879.0	879.0	879.3	880.3	881.5	881.4	881.2	881.0	880.4	880.2	879.8	880.2
Water Vapor Pressure	Mean (millbars/day)	13.9	14.4	17.2	20.4	21.0	20.5	20.1	20.2	20.0	19.9	17.4	14.9	18.3
Sunshine Duration	Total (hours)	268.9	239.9	219.3	205.5	208.3	195.4	135.7	125.3	139.0	187.3	244.1	268.8	2,437.5
	Mean (hours/day)	8.7	8.5	7.1	6.8	6.7	6.5	4.4	4.0	4.6	6.0	8.1	8.7	6.7
Wind Velocity (m/s)	Mean	1.2	1.6	1.6	1.4	1.2	1.1	1.0	1.1	1.1	1.4	1.2	1.0	1.2
	Max.	7.2	8.3	11.6	11.2	10.6	10.4	8.3	8.5	9.1	10.8	8.7	7.2	9.3

Table 1.2(1/5) MONTHLY RAINFALL AT KOUNDJA (Lat. 5°37'N, Long. 10°45'E, Alt. 1,208 m)

(Unit : mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1951	2.1	19.6	87.9	93.3	128.6	215.5	246.5	388.6	458.7	298.3	16.9	0	1,956.0
1952	3.3	112.1	43.7	252.2	184.9	143.0	385.1	442.5	379.0	303.6	67.0	2.3	2,318.7
1953	0	108.6	116.2	142.5	111.9	181.9	420.1	257.8	202.4	184.1	41.9	0	1,767.4
1954	0	50.2	168.3	165.0	377.9	281.8	247.2	369.7	543.8	324.9	25.6	7.6	2,562.0
1955	44.3	7.0	189.3	102.6	252.4	226.2	358.0	369.2	315.8	300.4	43.5	12.7	2,221.4
1956	0	144.7	179.5	156.4	85.4	164.3	427.1	225.4	353.5	247.1	70.8	27.2	2,081.4
1957	2.9	13.6	142.1	186.0	234.9	256.9	192.6	386.0	352.5	132.1	149.4	48.6	2,097.6
1958	0	25.4	86.7	96.4	267.8	257.2	114.7	275.2	277.4	164.3	111.6	17.1	1,693.8
1959	0	0	73.1	147.1	178.0	214.3	333.5	342.6	516.9	288.3	104.9	0	2,198.7
1960	1.0	13.3	132.2	174.0	200.8	234.9	338.9	231.7	462.0	193.3	33.3	85.7	2,101.1
1961	9.9	0	90.5	187.7	107.0	116.6	399.9	169.2	425.8	368.5	4.3	0	1,879.4
1962	0.3	0.2	179.8	120.7	269.4	191.5	331.9	366.9	508.5	332.2	151.7	0	2,453.1
1963	0	48.8	85.9	118.1	201.0	112.8	391.4	275.6	274.5	266.4	54.0	0	1,828.5
1964	0	0	123.1	223.4	186.8	127.0	311.5	249.6	552.7	234.3	78.8	0	2,087.2
1965	0	50.4	56.1	225.2	159.8	149.7	197.0	373.2	187.7	255.9	0	0	1,655.0
1966	0	0.2	75.1	270.9	289.6	230.9	352.8	250.4	255.6	211.4	54.6	0	1,991.5
1967	0.3	3.0	26.9	198.1	166.2	158.2	350.9	380.4	380.2	443.4	55.0	0	2,162.6
1968	16.6	8.8	145.2	144.8	117.9	340.6	336.6	324.7	237.7	249.8	70.3	8.1	2,001.1
1969	0	10.8	238.9	129.0	220.1	245.9	422.0	355.4	295.8	248.1	110.3	0	2,276.3
1970	0	0	39.5	215.0	215.9	208.7	374.3	262.1	403.0	336.0	0	0	2,054.5
1971	0	28.4	138.7	139.1	103.1	187.0	387.2	299.0	367.7	226.0	30.7	43.5	1,950.4
1972	0	13.5	113.3	194.9	132.1	164.0	214.0	281.8	382.3	219.3	11.4	0	1,726.6
1973	3.5	16.8	92.9	166.8	302.4	225.1	100.6	445.9	272.5	166.6	35.2	0.5	1,828.8
1974	0	14.6	137.6	251.8	203.3	185.0	316.6	320.5	340.2	341.8	71.0	0.3	2,182.7
1975	0	0	125.1	137.9	116.0	161.0	438.2	385.9	312.8	331.0	108.7	7.6	2,124.2
1976	0	97.8	82.0	249.4	110.3	174.2	350.9	352.0	322.9	214.1	171.3	0	2,124.9
1977	5.2	0.3	27.2	106.8	103.0	170.7	430.0	323.0	285.1	215.5	0	0	1,666.8
1978	15.6	24.3	138.3	154.1	152.4	243.0	162.7	468.0	366.8	202.4	88.4	0	2,016.0
1979	0	3.2	123.4	248.7	279.0	170.5	271.2	306.4	282.4	300.5	117.4	0	2,102.7
1980	0.5	3.0	129.3	98.2	165.2	199.8	409.8	331.7	360.8	338.0	58.8	0	2,095.1
1981	0.7	19.0	129.4	108.4	247.8	186.1	277.8	533.3	275.0	208.6	22.0	0	2,008.1
1982	55.1	8.5	95.4	124.9	177.8	247.8	353.6	373.3	391.4	278.2	42.1	0	2,148.1
1983	0	1.0	14.8	42.1	221.2	187.4	211.6	270.9	278.7	132.1	0	19.4	1,379.2
1984	0	0	136.0	141.6	141.6	174.1	396.9	274.4	320.3	212.0	19.7	0	1,816.6
Average	4.7	24.9	110.7	162.2	188.6	198.0	319.2	331.2	351.2	257.9	59.4	8.3	2,016.3

Table 1.2(2/5) MONTHLY RAINFALL AT KOUNDEN (Lat. 5°42'N, Long. 10°48'E, Alt. 1,290 m)

(Unit : mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1951	-	-	-	-	-	227.9	363.1	-	244.1	257.3	6.1	0	-
1952	3.0	93.8	30.2	191.7	203.4	180.8	276.6	272.5	213.7	225.9	46.8	2.0	1,740.4
1953	15.4	67.4	110.1	84.2	221.2	166.9	355.5	299.7	254.7	182.7	51.1	14.2	1,823.1
1954	0	56.0	224.4	201.9	297.2	274.4	189.7	368.1	463.0	-	56.2	-	-
1955	3.3	49.6	131.0	125.4	238.4	335.4	433.4	371.9	380.5	193.9	33.8	3.8	2,300.4
1956	3.1	101.6	138.4	177.2	224.6	189.6	337.0	135.2	348.7	250.0	89.9	99.0	2,094.3
1957	3.1	11.3	54.6	138.9	210.9	247.6	358.1	332.8	386.5	188.2	92.6	24.4	2,049.0
1958	3.1	15.7	35.4	132.2	262.6	330.8	204.5	216.5	181.6	126.4	74.7	27.4	1,610.9
1959	7.4	9.1	90.2	234.1	131.2	251.3	320.1	293.9	316.3	211.2	45.8	3.7	1,914.3
1960	4.1	12.3	121.6	106.7	176.6	159.4	458.1	227.3	684.9	463.4	58.6	80.7	2,553.7
1961	12.2	0	59.0	146.7	98.2	163.6	306.0	346.3	407.9	332.8	20.3	0	1,893.0
1962	21.4	0	151.4	92.9	161.2	249.6	497.8	472.8	450.1	519.1	140.8	8.7	2,765.8
1963	0	49.2	59.7	200.3	193.2	111.7	284.3	249.9	336.4	288.6	78.6	0	1,851.9
1964	0	0	204.7	214.0	198.6	215.6	282.9	225.4	445.8	-	75.8	0	-
1965	7.1	36.6	133.9	185.9	162.3	318.8	295.4	364.6	167.2	288.4	0	14.1	1,974.3
1966	0	0	87.6	205.7	269.0	170.8	397.3	259.8	259.4	156.5	43.7	9.7	1,859.5
1967	11.3	27.1	41.3	90.9	113.2	192.3	541.8	388.1	528.3	389.2	29.2	0	2,352.7
1968	28.1	13.8	153.5	186.7	126.3	295.3	416.8	337.6	304.4	259.3	107.6	6.4	2,235.8
1969	0	17.6	147.9	156.2	203.8	237.7	434.4	457.3	354.6	249.8	81.4	0	2,340.7
1970	0	0	83.7	260.7	280.4	144.6	309.4	415.4	294.6	368.6	0	0	2,157.4
1971	7.8	25.4	91.4	134.6	117.3	277.4	278.1	453.4	376.2	268.3	19.7	33.5	2,083.1
1972	0	62.3	82.5	154.8	118.6	179.2	341.9	302.8	390.4	191.2	17.8	0	1,841.5
1973	0	30.6	181.8	159.7	368.6	295.2	103.9	350.9	289.7	161.8	39.9	6.7	1,988.8
1974	0	11.7	126.2	205.3	143.9	193.3	194.0	492.7	397.8	342.9	73.6	0	2,181.4
1975	-	-	-	-	-	-	-	-	-	-	-	-	-
1976	3.5	91.3	53.7	183.9	584.4	-	-	-	-	-	-	0	-
1977	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	-	-	-	-	-	-	184.4	412.4	467.9	229.8	60.0	0	-
1979	0	9.0	105.8	136.1	253.4	152.0	264.8	296.9	296.9	299.3	115.1	0	1,929.3
1980	18.5	24.9	97.1	91.1	125.4	321.9	421.4	417.0	345.0	213.8	87.5	0	2,163.6
1981	0.3	9.1	103.7	113.1	155.1	155.6	336.9	369.8	281.8	155.5	33.1	0	1,714.0
1982	47.0	15.5	162.5	91.7	169.1	231.2	381.8	401.1	315.9	242.6	15.7	0	2,074.1
1983	0	0	51.6	187.2	256.8	117.9	261.4	287.3	273.2	85.8	0	28.9	1,550.1
1984	0	0	98.5	111.5	103.3	183.8	256.5	310.5	302.5	202.5	35.0	0	1,604.1
Average	6.7	28.0	107.1	156.7	205.6	219.1	325.4	337.7	347.1	253.3	52.6	11.7	2,051.0

Table 1.2(3/5) MONTHLY RAINFALL AT FOUMBAN (Lat. 5°44'N, Long. 10°54'E, Alt. 1,238 m)

(Unit : mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1955	0	1.6	171.8	139.0	240.8	176.1	248.8	369.5	324.1	171.0	33.0	6.3	1,882.0
1956	0	65.6	140.9	166.7	118.8	241.4	293.4	265.3	234.4	392.7	43.0	13.0	1,975.2
1957	2.4	0.2	163.9	203.4	368.3	231.1	263.9	267.9	338.6	294.0	114.7	40.5	2,288.9
1958	0	20.2	71.2	148.0	309.2	215.6	162.4	305.2	328.7	219.6	99.0	13.6	1,892.7
1959	0	0	104.3	193.0	142.2	190.5	270.3	327.1	443.9	321.3	75.6	0	2,068.2
1960	0	3.7	72.0	160.3	164.4	168.3	375.1	212.5	352.8	256.0	59.4	77.6	1,902.1
1961	4.2	0	41.7	210.9	78.4	166.4	350.3	193.2	316.2	317.5	7.5	0	1,686.3
1962	2.3	3.6	133.1	115.6	312.3	151.4	219.0	206.8	379.8	225.5	133.9	2.3	1,885.6
1963	0	66.6	85.2	151.4	217.8	89.3	323.4	245.1	204.4	197.6	53.5	0	1,634.3
1964	0	0	70.0	136.0	94.7	97.5	414.4	231.4	523.9	253.1	88.4	0	1,909.4
1965	13.8	74.4	30.9	277.9	162.4	142.8	152.1	413.7	251.6	265.0	0	0	1,784.6
1966	0	0.5	89.3	303.4	398.6	133.0	224.2	320.0	283.6	247.4	70.3	7.6	2,077.9
1967	1.8	2.9	14.8	118.5	129.6	158.2	307.3	424.1	363.5	378.9	54.4	0	1,954.0
1968	18.6	14.2	133.5	102.7	106.0	194.3	461.4	209.5	301.4	261.3	96.1	5.8	1,904.8
1969	0	6.9	172.6	124.9	198.5	180.6	280.9	298.3	369.6	244.2	97.3	0	1,973.8
1970	0	0	39.1	184.1	272.0	211.6	300.4	285.9	232.3	365.9	42.5	0	1,933.8
1971	0	69.9	129.9	166.6	69.2	167.4	454.7	272.5	323.1	199.4	21.3	34.0	1,908.0
1972	0	44.7	152.5	151.3	261.0	208.8	137.3	328.1	291.3	167.6	24.0	0	1,766.6
1973	0.5	24.9	97.5	205.0	205.4	202.5	116.7	370.1	310.8	182.6	15.7	0.7	1,777.4
1974	0	5.4	108.7	236.1	206.8	245.2	347.6	336.2	450.8	390.5	88.6	0	2,415.9
1975	0	2.1	136.0	170.1	158.3	151.9	276.3	259.8	399.0	305.0	147.4	30.8	2,036.7
1976	12.0	102.3	45.3	188.6	134.0	98.1	358.5	159.7	323.0	316.1	169.8	0	1,907.4
1977	0	12.5	18.7	120.2	122.7	233.8	249.7	410.0	292.6	162.6	0	0	1,622.8
1978	11.2	13.3	87.6	167.9	117.2	145.1	185.5	423.3	384.8	226.1	15.6	0	1,777.6
1979	0	0.2	72.2	174.5	244.4	117.9	397.9	152.5	170.2	251.3	62.5	0	1,643.6
1980	0	0	119.7	73.8	177.9	292.1	378.5	377.9	283.8	252.3	51.1	0	2,007.1
1981	24.5	29.6	82.5	97.2	247.0	186.1	402.4	405.3	228.9	185.3	30.9	0	1,919.7
1982	44.6	15.0	126.6	103.4	217.1	172.1	195.8	287.4	247.6	284.5	25.5	0	1,719.6
1983	0	0	2.5	49.6	227.6	122.7	152.7	268.1	293.8	62.2	-	0	-
1984	2.5	0	472.2	-	511.2	203.2	421.4	261.7	340.0	281.0	35.0	0	-
Average	4.6	19.3	106.2	160.0	208.6	176.5	290.7	296.3	319.6	255.9	60.6	7.7	1,906.0

Table 1.2(4/5) MONTHLY RAINFALL AT FOUMBOT (Lat. 5°31'N, Long. 10°48'E, Alt. 1,050 m)

(Unit : mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1951	0	16.4	108.0	62.8	171.4	-	336.4	295.4	377.6	337.7	24.7	0	-
1952	6.7	53.6	68.0	214.5	123.4	168.8	280.7	201.2	236.4	281.2	21.1	10.5	1,666.1
1953	-	-	-	-	107.7	139.5	269.2	194.9	-	124.6	27.3	9.5	-
1954	0	70.1	97.2	99.5	175.1	226.5	116.3	209.7	321.6	353.1	88.1	0	1,757.2
1955	39.5	15.6	129.8	127.5	310.4	289.8	300.7	215.4	361.3	220.9	33.1	0	2,044.0
1956	10.4	116.0	233.8	124.5	116.3	126.4	163.7	111.2	253.3	256.6	74.8	54.2	1,641.2
1957	7.6	0.4	97.7	147.9	195.6	242.8	323.0	151.7	316.6	231.1	107.0	63.2	1,884.6
1958	0	10.1	30.3	124.3	155.1	211.4	81.6	376.8	391.4	147.5	101.3	42.4	1,672.2
1959	7.8	0	112.6	141.5	153.4	138.9	174.1	215.5	459.8	285.8	106.9	0	1,796.3
1960	4.1	0	101.1	158.3	187.2	147.5	217.2	269.8	281.6	132.9	35.9	51.6	1,587.2
1961	8.8	0	41.7	200.8	58.6	137.7	188.9	212.8	258.7	306.8	12.4	0	1,427.2
1962	0	0	197.1	90.4	242.3	220.6	252.2	225.3	414.8	268.7	112.0	0	2,023.4
1963	0	56.1	85.7	122.9	131.8	104.2	205.1	177.8	222.5	244.1	58.8	0	1,409.0
1964	0	0	168.0	150.2	202.8	110.4	187.5	229.9	381.8	213.3	70.8	1.2	1,715.9
1965	1.7	34.7	25.5	233.1	-	84.9	159.6	275.6	270.1	354.3	0	0	-
1966	0	2.3	120.1	205.4	277.7	181.3	243.9	236.6	271.2	174.9	45.5	12.6	1,771.5
1967	0	25.5	45.1	151.1	134.7	197.2	452.6	399.9	309.8	363.7	38.3	0	2,117.9
1968	28.1	12.7	120.3	149.7	110.2	240.1	263.2	447.4	263.2	288.6	71.9	17.1	2,002.5
1969	0	34.0	141.7	111.6	219.8	198.5	297.0	324.1	302.3	222.1	122.1	0	1,973.2
1970	0	0	34.1	198.8	230.9	333.6	234.2	174.7	245.4	-	-	-	-
1971	-	-	-	-	-	-	-	-	-	-	-	-	-
1972	-	-	-	-	-	-	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-	-	-	-	-	-	-
1974	0	19.1	151.6	120.2	152.7	159.4	141.5	308.9	272.7	248.7	72.2	0	1,647.0
1975	9.5	2.0	117.0	127.6	86.1	62.9	198.0	193.6	221.2	234.4	63.0	7.9	1,323.2
1976	3.2	67.3	75.8	96.6	62.0	124.9	192.8	329.7	287.6	252.3	10.9	0	1,503.1
1977	19.4	0	6.7	152.2	96.7	128.6	268.6	166.4	242.6	151.9	0	0	1,232.5
1978	15.2	15.9	166.3	139.2	87.2	174.4	124.7	197.1	480.0	212.2	31.5	0	1,643.7
1979	0	9.3	65.3	105.9	125.5	87.4	283.8	248.1	186.7	202.1	97.1	0	1,411.2
1980	0	22.0	115.0	128.1	124.1	136.0	170.6	295.3	370.7	215.1	91.3	0	1,668.2
1981	0	20.7	-	56.1	191.3	171.9	227.6	248.6	194.5	232.2	24.9	0	-
1982	72.8	24.7	115.8	79.8	134.3	197.2	219.7	280.1	286.4	220.6	0	0	1,631.4
1983	0	0	10.3	106.6	131.9	111.4	140.7	-	-	-	-	-	-
1984	0	8.0	145.2	86.0	121.2	196.7	281.5	260.9	196.8	207.8	12.8	0	1,516.9
Average	7.8	21.2	100.9	133.8	153.9	168.3	225.7	249.1	299.3	240.9	53.6	9.3	1,663.8

Table 1.2(5/5) MONTHLY RAINFALL AT BAFOUSSAM (Lat. 5°28'N, Long. 10°26'E, Alt. 1,410 m)

(Unit : mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1951	0	3.5	87.1	138.0	151.4	161.8	194.8	197.4	275.6	326.8	49.9	0	1,586.3
1952	31.9	29.8	126.6	184.4	147.3	296.0	276.8	206.1	216.2	346.5	47.7	2.3	1,911.6
1953	13.2	124.7	97.7	180.4	124.0	227.7	281.1	120.5	327.0	267.8	112.1	15.0	1,891.2
1954	0	48.8	92.1	268.0	230.7	267.4	87.0	203.4	339.5	303.7	88.0	12.0	1,940.6
1955	9.4	86.0	138.6	141.6	188.3	226.8	251.5	282.8	275.3	254.2	44.6	8.0	1,907.1
1956	0	154.7	295.3	208.8	117.8	179.0	206.6	101.0	344.9	231.6	86.4	-	-
1957	3.9	9.1	95.8	196.5	167.8	227.5	242.4	295.2	247.1	229.5	81.0	40.6	1,836.4
1958	0	8.4	41.5	146.9	249.6	266.6	97.3	364.0	260.5	280.8	125.1	32.1	1,872.8
1959	0.4	0	105.6	199.7	163.3	229.7	223.5	267.7	292.4	270.4	84.5	-	-
1960	-	-	-	-	243.1	199.8	83.8	312.7	250.7	261.0	4.3	6.7	-
1961	13.2	0	65.8	190.0	88.9	238.8	251.8	102.5	365.2	201.1	2.5	0	1,519.8
1962	0	12.0	40.1	135.3	177.8	229.7	240.7	123.1	351.8	240.5	102.9	0	1,653.9
1963	5.2	44.5	74.5	137.4	224.9	53.4	237.3	201.4	241.7	259.9	60.6	0	1,540.8
1964	57.7	2.1	256.1	185.9	200.1	104.1	206.6	113.9	386.2	269.1	76.1	0	1,857.9
1965	2.1	14.6	36.2	276.2	156.0	201.1	311.5	189.4	255.8	240.7	0	0	1,683.6
1966	0	7.1	115.0	342.3	261.3	142.1	189.7	339.5	186.9	305.4	63.3	0	1,952.6
1967	1.9	8.2	68.5	123.2	117.1	162.1	369.7	326.4	233.4	257.4	46.2	0	1,714.1
1968	31.0	28.1	203.9	158.6	104.0	236.9	291.8	453.2	306.0	302.5	54.2	9.1	2,179.3
1969	0	14.8	183.2	113.7	203.3	225.4	275.2	298.9	231.7	212.8	145.3	0	1,904.3
1970	0	0	35.6	197.5	221.7	181.1	197.8	178.4	291.5	388.7	0	0	1,692.3
1971	0	58.8	88.0	126.9	171.2	150.8	381.6	258.8	216.1	369.1	54.3	25.2	1,900.8
1972	0	14.5	66.9	183.6	207.2	171.5	360.2	297.6	324.7	235.0	20.7	0	1,881.9
1973	5.8	26.1	108.0	159.6	291.8	191.5	108.1	179.9	263.8	237.2	47.5	20.1	1,639.4
1974	0	37.2	147.5	220.9	196.2	196.7	127.1	277.4	339.8	225.0	77.1	0	1,844.9
1975	19.8	18.9	115.3	159.3	126.4	194.2	253.7	137.8	332.7	379.0	111.8	12.9	1,861.8
1976	0	102.2	149.6	154.4	118.5	108.8	245.4	465.3	265.8	325.3	191.3	6.7	2,133.3
1977	13.3	6.9	42.9	186.5	152.6	231.4	360.9	182.1	331.1	177.4	0	0	1,685.1
1978	2.8	9.3	183.7	145.8	133.4	241.7	183.0	231.6	224.9	157.9	69.2	0	1,583.3
1979	8.8	54.8	72.2	190.4	144.3	162.5	226.5	301.2	266.9	260.4	75.7	0	1,763.7
1980	16.7	77.3	100.8	104.3	142.0	116.7	264.6	342.3	263.5	301.0	56.2	0	1,785.4
1981	4.4	27.1	153.2	149.0	129.1	215.3	193.1	235.9	303.0	187.8	45.8	0	1,643.7
1982	29.3	47.5	163.2	156.3	155.4	212.3	294.2	434.4	278.2	288.4	22.2	-	-
1983	0	0	89.2	145.3	180.6	193.8	140.0	235.1	234.3	80.2	0	38.4	1,336.9
1984	0	0	131.8	128.1	109.6	184.2	-	436.7	260.3	250.6	23.7	0	-
Average	8.2	32.6	114.3	173.8	170.5	195.0	232.0	255.7	281.9	262.5	60.9	7.4	1,794.8

Table 1.3(1/9) DAILY RAINFALL RECORD AT KOUNDJA (Lat. 5°37'N, Long. 10°45'E, Alt. 1,208 m)

(Long. 10°45'N, Lat. 5°39'E. Alt. 1,208m)

Year : 1976

Month / Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1	0	0	7.8	71.9	0.4	11.9	1.3	2.3	2.5	1.5	10.9	0	
2	0	32.0	0	0.3	0.6	9.4	0.6	34.9	52.9	31.2	3.0	0	
3	0	0.3	0	0.5	0	0	2.3	9.0	2.3	17.5	36.9	0	
4	0	7.9	0	0	0	2.6	33.0	0	9.7	1.7	1.5	0	
5	0	0	0	32.7	0	6.5	41.7	0.1	6.9	2.7	18.0	0	
6	0	0	0	5.5	2.9	0	8.8	8.2	1.5	0.5	27.9	0	
7	0	0	0	13.4	2.9	6.0	0.1	9.6	1.7	0.8	2.7	0	
8	0	11.2	0	1.3	0	0	5.2	0.3	5.2	5.5	12.3	0	
9	0	0.3	0	41.3	10.4	2.9	18.8	4.6	0.5	2.7	4.7	0	
10	0	7.2	19.4	10.6	0	5.4	38.3	3.0	12.0	26.6	0	0	
11	0	0	0.7	0	0	5.3	0	56.7	22.4	0.1	0	0	
12	0	1.6	0	1.1	0	18.1	0	13.4	48.3	0	0	0	
13	0	0	0	3.9	11.4	0	13.8	10.8	8.3	1.9	0.2	0	
14	0	0	0	28.2	0	0	19.2	0.4	0.2	0.3	0	0	
15	0	0	0	0	6.2	2.6	34.0	15.0	11.7	40.5	0	0	
16	0	0	0	0.2	6.8	0	9.3	21.2	0	6.8	0	0	
17	0	0	0	0	0	0.8	3.6	20.0	3.3	3.3	0	0	
18	0	1.6	0	0.8	12.1	0	5.1	13.9	3.6	9.4	47.6	0	
19	0	2.5	21.3	0	4.4	3.2	0.1	10.6	3.3	4.1	5.6	0	
20	0	1.2	23.0	12.9	19.2	0	9.6	20.0	4.6	15.9	0	0	
21	0	0	0	0	0.4	2.5	7.7	3.2	0	0	0	0	
22	0	6.0	0	0	3.3	0	14.5	16.0	9.9	18.6	0	0	
23	0	0	9.0	0	0	43.4	3.7	0	4.3	0	0	0	
24	0	0	0	10.8	1.3	0.7	4.7	5.0	4.5	1.7	0	0	
25	0	0	0	0	6.6	30.1	21.8	8.2	34.3	2.1	0	0	
26	0	9.8	0	7.7	0	0	0	5.2	33.5	0	0	0	
27	0	16.2	0	0	10.8	9.2	5.9	0.2	0	0	0	0	
28	0	0	0	6.3	0	0	1.2	10.1	28.6	0	0	0	
29	0	0	0	0	7.7	13.4	9.8	32.2	0	13.2	0	0	
30	0	-	0	0	2.9	0.2	9.6	4.0	6.9	5.5	0	0	
31	0	-	0.8	-	0	-	27.2	13.9	-	0	-	0	
Total	0	97.8	82.0	249.4	110.3	174.2	350.9	352.0	322.9	214.1	171.3	0.0	2,124.9
No. of rainy day	0	13	7	18	18	19	28	29	26	24	12	0	194
Max. within one record day	0	32.0	23.0	71.9	19.2	43.4	41.7	56.7	52.9	40.5	47.6	0	71.9
(Date)		(2)	(20)	(1)	(20)	(23)	(5)	(11)	(2)	(15)	(18)		(4/1)

Table 1.3(2/9) DAILY RAINFALL RECORD AT KOUNDJA (Lat. 5°37'N, Long. 10°45'E, Alt. 1,208 m)

(Long. 10°45'N, Lat. 5°39'E. Alt. 1,208m)

Year : 1977

Month / Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1	0	0	0	3.3	34.8	0	41.2	21.9	4.4	4.5	0	0	
2	0	0	0	0	0	0	25.7	1.6	16.2	0	0	0	
3	0	0.1	0	0	0	0.2	7.0	0	4.8	10.3	0	0	
4	0	0.2	0	0	0	45.0	52.9	17.8	0	0.5	0	0	
5	0	0	0	0	0	0	18.6	6.5	9.0	2.7	0	0	
6	0	0	0	0	0.4	18.5	0	3.2	8.3	10.9	0	0	
7	0	0	0	1.1	3.6	0	5.7	0	24.2	0.9	0	0	
8	0	0	0	7.3	0.3	11.5	36.4	0	9.4	3.2	0	0	
9	0	0	0	0	0	7.0	0.7	7.0	12.5	4.7	0	0	
10	0	0	0	0	10.7	0	8.0	9.9	1.2	29.6	0	0	
11	0	0	0	0	0.2	12.6	11.1	24.8	8.6	1.4	0	0	
12	0	0	0	9.8	0.2	12.6	4.2	11.2	2.8	14.4	0	0	
13	0	0	0	0	5.2	7.7	3.3	6.5	2.8	28.1	0	0	
14	0	0	0	14.2	0	0	33.5	14.1	10.9	3.5	0	0	
15	0	0	0	0	0	9.7	12.8	56.7	1.0	13.2	0	0	
16	0	0	0	0	1.3	5.5	3.8	0.7	0.8	10.8	0	0	
17	0	0	0	0	0	0.1	16.5	0	4.1	6.6	0	0	
18	0	0	0	0.3	5.9	8.9	0	0	21.4	8.9	0	0	
19	0	0	0	11.0	0.1	8.2	52.3	18.5	5.7	12.8	0	0	
20	0	0	0	0	2.3	0	10.5	22.3	33.7	19.6	0	0	
21	0	0	0	4.0	0	0	1.2	37.7	18.9	6.2	0	0	
22	0	0	0	0	0	0	13.9	1.4	0.1	21.9	0	0	
23	0	0	0	0	0.1	3.4	9.4	0.3	35.3	0	0	0	
24	0	0	0.3	11.8	0	4.1	16.1	15.3	2.0	0.8	0	0	
25	1.7	0	18.6	0	4.3	11.0	4.7	10.2	9.1	0	0	0	
26	3.5	0	0	10.8	13.3	0.5	0	10.7	0	0	0	0	
27	0	0	0	0	0	0.8	0.5	17.3	32.5	0	0	0	
28	0	0	0	28.6	3.5	0	15.1	0	1.6	0	0	0	
29	0	-	0	4.5	16.0	3.4	0	3.4	3.8	0	0	0	
30	0	-	0	0.1	0.8	0	0	0	0	0	0	0	
31	0	-	8.3	-	0	-	24.9	4.0	-		-	0	
Total	5.2	0.3	27.2	106.8	103.0	170.7	430.0	323.0	285.1	215.5	0.0	0.0	1,666.8
No. of rainy day	2	2	3	13	18	19	26	24	27	22	0	0	156
Max. within one record day	3.5	0.2	18.6	28.6	34.8	45.0	52.9	56.7	35.3	29.6	0	0	56.7
(Date)	(26)	(4)	(25)	(28)	(1)	(4)	(4)	(15)	(23)	(10)			(8/15)

Table 1.3(3/9) DAILY RAINFALL RECORD AT KOUNDJA (Lat. 5°37'N, Long. 10°45'E, Alt. 1,208 m)

(Long. 10°45'N, Lat. 5°39'E. Alt. 1,208m)

Year : 1978

Month / Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1	0	0	0	0	13.8	0	2.5	0	21.1	2.0	38.5	0	
2	0	0	4.3	1.5	0.4	10.1	4.2	0	3.0	8.0	16.2	0	
3	0	0	0.3	0	16.0	8.1	0	20.2	44.7	1.2	0	0	
4	0	0	0	17.7	0.2	0	7.3	12.9	3.8	0.6	5.6	0	
5	0	0	22.9	3.5	16.6	27.8	0	13.0	17.4	8.0	21.6	0	
6	0	0	14.7	2.0	0	20.6	0	0	8.3	37.1	6.5	0	
7	0	0	38.0	0	0	14.6	11.5	7.3	21.0	0	0	0	
8	0	0	9.8	5.9	23.6	18.8	2.0	2.5	14.0	3.5	0	0	
9	0	0	4.2	1.5	0	1.0	0.7	7.6	9.7	6.3	0	0	
10	0	0	0	26.6	5.7	0.1	0	9.7	1.7	8.6	0	0	
11	0	0	0	4.5	0.5	0	0	14.8	4.9	0	0	0	
12	0	0	25.6	1.5	19.9	4.2	1.2	28.2	0.6	1.4	0	0	
13	0	0	0	6.1	0	0	11.2	10.4	0.7	5.6	0	0	
14	0	0	0	0	11.7	14.7	1.6	28.1	6.7	1.5	0	0	
15	0	3.5	0	1.2	12.3	25.6	46.4	3.0	16.2	1.2	0	0	
16	0	20.8	0	0	0	8.0	25.9	0.1	8.2	1.2	0	0	
17	0	0	0	2.7	1.4	0	0	11.7	3.2	0	0	0	
18	0	0	0	0	1.1	28.5	14.4	1.6	0.9	9.1	0	0	
19	10.2	0	0	17.3	0.1	0.7	0	20.5	31.4	11.0	0	0	
20	5.4	0	0.4	6.9	7.4	0.3	1.5	25.2	9.7	1.0	0	0	
21	0	0	0	0	0	0	0.7	21.0	2.2	0.6	0	0	
22	0	0	5.0	21.7	5.8	14.1	0	30.5	29.7	3.0	0	0	
23	0	0	0	5.7	2.8	0.7	0	37.0	19.4	9.9	0	0	
24	0	0	0	8.1	0	8.5	0.1	17.6	1.1	2.3	0	0	
25	0	0	2.4	1.6	0	0	1.7	10.2	13.3	12.4	0	0	
26	0	0	9.2	0.3	0	16.9	0.5	28.6	37.4	5.2	0	0	
27	0	0	0	8.1	0.1	0	0	3.7	12.2	0	0	0	
28	0	0	0	0	13.0	15.6	0.2	7.9	13.5	21.3	0	0	
29	0	-	1.5	4.8	0	2.2	0	50.2	7.6	20.0	0	0	
30	0	-	0	4.9	0	1.9	0	1.6	3.2	3.5	0	0	
31	0	-	0	-	0	-	29.1	42.9	-	16.9	-	0	
Total	15.6	24.3	138.3	154.1	152.4	243.0	162.7	468.0	366.8	202.4	88.4	0.0	2,016.0
No. of rainy day	2	2	13	22	19	22	19	28	30	27	5	0	189
Max. within one record day	10.2	20.8	38.0	26.6	23.6	28.5	46.4	50.2	44.7	37.1	38.5	0	502
(Date)	(19)	(16)	(7)	(10)	(8)	(18)	(15)	(29)	(3)	(6)	(1)		(8/29)

Table 1.3(4/9) DAILY RAINFALL RECORD AT KOUNDJA (Lat. 5°37'N, Long. 10°45'E, Alt. 1,208 m)

(Long. 10°45'N, Lat. 5°39'E. Alt. 1,208m)

Year : 1979

Month / Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1	0	0	0	6.4	0	6.3	19.6	0	25.9	20.9	0	0	
2	0	0	0	0	16.2	0	0.4	3.9	16.2	34.9	4.5	0	
3	0	0	0	25.1	4.1	0	0	12.5	2.6	0	10.3	0	
4	0	0	14.2	2.4	2.7	3.5	0	11.8	0	1.8	0	0	
5	0	0	0	22.8	19.2	10.9	5.6	0.3	1.3	44.5	15.2	0	
6	0	0	23.7	0	93.8	0	14.5	3.8	39.1	12.8	0.6	0	
7	0	0	2.3	0	0	0.2	7.7	6.0	0	0	7.0	0	
8	0	0	0	21.9	22.1	20.4	0	41.9	16.6	0	20.4	0	
9	0	0	0	0	6.3	1.4	0	28.5	2.6	1.7	0	0	
10	0	0	0	0	29.5	29.1	0	10.5	20.9	7.8	0	0	
11	0	0	0	2.8	1.1	11.3	0.4	13.9	6.5	1.8	0.6	0	
12	0	0	0	1.0	3.3	4.8	4.0	27.8	15.1	11.9	6.2	0	
13	0	0	0	0	0	12.4	2.0	4.4	0	13.0	11.6	0	
14	0	0	0	0	1.0	0.5	0.4	10.9	1.5	20.5	0.8	0	
15	0	0	0	0.5	0	0	0	22.4	24.5	0	0	0	
16	0	0.7	0	58.2	0.4	7.0	11.0	0	1.4	11.5	0	0	
17	0	0	0	3.0	0.5	22.1	26.2	11.6	3.1	0	0	0	
18	0	2.3	0	0	4.6	0	2.7	8.4	6.5	12.4	0	0	
19	0	0	0	0	1.0	1.2	0	39.5	0	15.0	0	0	
20	0	0	0	0	0.8	0.9	1.4	1.0	2.2	14.3	0	0	
21	0	0	0	4.5	26.0	0.8	0.2	0	0.4	2.0	0	0	
22	0	0	1.8	11.4	0	16.5	52.9	0	0	22.5	0	0	
23	0	0.2	11.2	28.2	0.8	0.2	1.8	0.4	0.3	8.5	0	0	
24	0	0	5.7	5.0	28.7	0.8	0.6	15.1	0	24.9	39.0	0	
25	0	0	16.5	0	8.6	0	24.9	4.4	0	5.2	0.2	0	
26	0	0	0	6.1	0.2	0	25.5	4.5	16.7	9.0	1.0	0	
27	0	0	5.9	24.6	0	0.1	42.3	0	12.0	0	0	0	
28	0	0	10.5	0	0	6.8	0.1	4.8	43.0	0	0	0	
29	0	-	10.7	3.8	8.1	13.3	0	0	23.1	0	0	0	
30	0	-	0	21.0	0	0	26.1	0	0.9	2.8	0	0	
31	0	-	20.9	-	0	-	0.9	18.1	-	0.8	-	0	
Total	0.0	3.2	123.4	248.7	279.0	170.5	271.2	306.4	282.4	300.5	117.4	0.0	2,102.7
No. of rainy day	0	3	11	18	22	22	23	24	23	23	13	0	182
Max. within one record day	0	2.3	23.7	58.2	93.8	29.1	52.9	41.9	43.0	44.5	39.0	0	93.8
(Date)		(18)	(6)	(16)	(6)	(10)	(22)	(8)	(28)	(5)	(24)		(5/6)

Table 1.3(5/9) DAILY RAINFALL RECORD AT KOUNDJA (Lat. 5°37'N, Long. 10°45'E, Alt. 1,208 m)

(Long. 10°45'N, Lat. 5°39'E. Alt. 1,208m)

Year : 1980

Month / Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1	0	0	0	0	3.3	0	0	8.1	28.5	12.3	0	0	
2	0	0	0	2.7	0	9.3	10.0	2.7	9.5	38.8	9.7	0	
3	0	0	0	0	5.0	4.7	0	16.9	49.9	0	7.2	0	
4	0	0	0	0	0	0.3	3.4	6.0	46.5	15.5	0	0	
5	0	0	0	0.9	0	0	72.2	5.0	0.4	19.3	29.4	0	
6	0	0	0	0	0	0	12.0	1.5	1.7	15.9	0.3	0	
7	0	0	0	0	9.2	2.0	1.6	0	0	11.0	7.5	0	
8	0	0	0	13.6	43.1	0	3.1	14.8	34.4	0.9	1.2	0	
9	0	0	0	16.2	15.4	0	33.4	36.4	0.9	15.5	0	0	
10	0	0	0	35.6	0	0	19.0	0.6	24.3	4.4	0	0	
11	0	0	27.1	3.3	39.8	9.8	11.4	0	0.1	28.5	0	0	
12	0	0	0	0	0	9.7	0	2.8	12.3	9.9	0	0	
13	0	0	0	0	0	0	0	0	16.5	0.3	0	0	
14	0	0	1.5	0	8.7	0	0	0	7.0	0	1.7	0	
15	0	0	0	0	3.4	30.5	39.7	0.3	16.0	19.3	0	0	
16	0	0	0	0	0	0.8	21.1	42.3	6.4	22.3	0	0	
17	0	0	0	0	0	0	0.4	0.4	0	26.0	0	0	
18	0	0	0	0	0.2	2.5	3.7	12.6	15.7	6.9	0	0	
19	0	0	0	1.9	0	13.9	9.4	51.3	1.4	1.4	0	0	
20	0	0	0	0	0	39.4	0.3	1.0	2.8	26.4	1.8	0	
21	0	0	10.8	1.2	3.0	26.0	6.5	0.6	9.5	8.6	0	0	
22	0	0	38.2	4.1	1.9	0.4	61.8	0.5	7.0	5.0	0	0	
23	0	0	25.6	6.9	11.2	5.7	0	55.9	2.4	15.0	0	0	
24	0	0	9.0	0	0	0	0.9	1.3	4.1	15.2	0	0	
25	0.5	0	11.3	0	8.2	0	10.2	21.7	8.7	1.8	0	0	
26	0	0	3.5	4.0	2.2	13.1	25.1	6.8	4.6	1.6	0	0	
27	0	0	0.4	0	10.6	10.9	11.5	17.9	21.3	0	0	0	
28	0	1.8	1.9	1.0	0	12.4	27.9	0.4	13.4	0.2	0	0	
29	0	1.2	0	6.8	0	8.4	25.2	18.3	3.5	14.2	0	0	
30	0	-	0	0	0	0	0	4.6	12.0	0.2	0	0	
31	0	-	0	-	0	-	0	1.0	-	1.6	-	0	
Total	0.5	3.0	129.3	98.2	165.2	199.8	409.8	331.7	360.8	338.0	58.8	0.0	2,095.1
No. of rainy day	1	2	10	13	15	18	23	27	28	28	8	0	173
Max. within one record day	0.5	1.8	38.2	35.6	43.1	39.4	72.2	55.9	49.9	38.8	29.4	0	72.2
(Date)	(25)	(28)	(22)	(10)	(8)	(20)	(5)	(23)	(3)	(2)	(5)		(7/5)

Table 1.3(6/9) DAILY RAINFALL RECORD AT KOUNDJA (Lat. 5°37'N, Long. 10°45'E, Alt. 1,208 m)

(Long. 10°45'N, Lat. 5°39'E. Alt. 1,208m)

Year : 1981

Month / Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1	0	0	0	0	1.2	5.2	0	3.3	6.5	17.6	0.9	0	
2	0	0	0	0	0	0	8.9	58.6	10.6	0	0.2	0	
3	0	0	0	14.4	42.2	6.7	18.1	18.4	2.1	0	0.4	0	
4	0	0	0	11.7	0	10.5	17.9	22.1	21.4	0	0	0	
5	0	0	0	0	0	0	0	40.4	27.0	6.5	0.2	0	
6	0	0	0	15.6	50.2	0	0.5	0	0.2	0	20.3	0	
7	0	0	0	0	1.8	0	6.9	4.2	2.6	0.5	0	0	
8	0	0	0	0	40.7	22.3	30.8	22.7	10.9	0	0	0	
9	0	0	0	0.8	1.8	0	2.1	0	22.4	0.1	0	0	
10	0	0	20.6	0	3.5	0.6	14.3	5.1	4.7	0	0	0	
11	0	0	0	0	16.3	0	8.1	5.4	11.0	12.1	0	0	
12	0	0	0	0	0	7.2	20.4	0.2	0.2	0	0	0	
13	0	0	0	0	0	6.3	5.7	7.3	1.4	23.3	0	0	
14	0	0	0	0	5.9	9.4	2.4	43.8	0	7.5	0	0	
15	0	0	0	0	6.2	5.3	4.8	31.0	19.4	32.8	0	0	
16	0	0	0	0	0.2	0	20.3	12.4	0.2	5.6	0	0	
17	0	0	0	0	0	0	26.8	12.5	0	2.4	0	0	
18	0	0	0	0	0	0	0	15.9	2.3	1.6	0	0	
19	0	19.0	31.5	8.2	22.6	35.1	22.5	11.1	13.1	0.1	0	0	
20	0	0	9.7	1.5	1.7	0.5	15.3	0.2	6.5	0	0	0	
21	0	0	7.3	0	1.2	2.4	5.0	17.0	0.7	1.0	0	0	
22	0	0	0	11.6	0	0	0.1	64.8	20.3	3.9	0	0	
23	0	0	0	0.7	0.1	1.8	13.0	12.0	15.0	1.0	0	0	
24	0	0	8.9	14.7	0	6.7	0	43.5	46.5	36.7	0	0	
25	0.7	0	22.2	2.8	13.8	34.1	0	0.6	2.5	0.7	0	0	
26	0	0	0	11.2	12.7	5.1	0	8.9	0.6	2.2	0	0	
27	0	0	26.4	14.9	1.6	0	16.1	1.2	2.4	5.9	0	0	
28	0	0	0	0.3	0	0	0	2.4	9.6	1.3	0	0	
29	0	-	2.8	0	2.3	13.8	0.4	32.7	2.0	7.5	0	0	
30	0	-	0	0	20.2	13.1	17.3	28.1	12.9	31.3	0	0	
31	0	-	0	-	1.6	-	0.1	7.5	-	7.0	-	0	
Total	0.7	19.0	129.4	108.4	247.8	186.1	277.8	533.3	275.0	208.6	22.0	0.0	2,008.1
No. of rainy day	1	1	8	13	21	18	24	29	28	23	5	0	171
Max. within one record day	0.7	19.0	31.5	15.6	50.2	35.1	30.8	64.8	46.5	36.7	20.3	0	64.8
(Date)	(25)	(19)	(19)	(6)	(6)	(19)	(8)	(22)	(24)	(24)	(6)		(8/22)

Table 1.3(7/9) DAILY RAINFALL RECORD AT KOUNDJA (Lat. 5°37'N, Long. 10°45'E, Alt. 1,208 m)

(Long. 10°45'N, Lat. 5°39'E. Alt. 1,208m)

Year : 1982

Month / Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1	0	0	0.3	0	0	0.8	1.5	11.7	0	13.3	0.2	0	
2	0	0	0	0	3.9	10.0	13.0	47.9	35.4	6.5	41.7	0	
3	0	0	2.6	0	10.0	4.4	6.6	6.6	0.2	10.7	0.2	0	
4	0	0	0	0	0	6.5	0.7	27.8	36.7	2.2	0	0	
5	0	0	0	0	21.5	5.6	1.8	1.6	0	0	0	0	
6	15.5	0	0	0	0	4.0	0	5.9	0	0	0	0	
7	0.2	0	0	0	6.6	4.7	28.4	0	10.0	12.4	0	0	
8	0.7	0	0	0.1	3.6	0.9	2.9	12.3	1.9	40.2	0	0	
9	0	0	0	13.0	0	0	0	25.0	0	0	0	0	
10	0	0	0	0	19.5	0.4	5.5	16.4	0.2	1.1	0	0	
11	0	0	0.3	26.5	0	7.3	0	12.3	17.7	8.0	0	0	
12	0	0	10.7	33.0	11.5	0	0	0.2	20.0	1.5	0	0	
13	0	0	0.8	7.2	25.4	0	2.1	11.8	21.6	12.3	0	0	
14	0	0	0	0	0.6	6.6	0.7	0.6	5.3	11.4	0	0	
15	0	0	0	1.8	15.2	11.4	0.9	34.7	6.6	13.2	0	0	
16	0	0	5.0	0	5.5	0	21.9	0.1	0.6	15.0	0	0	
17	0	0	0.4	0	0	0	0.2	13.5	0	8.4	0	0	
18	0	0	6.4	4.6	0	33.5	9.8	11.9	0.4	10.0	0	0	
19	0	0	0	1.4	0	4.5	0	8.7	11.6	19.9	0	0	
20	0	0	0	0	0	0	33.5	11.4	21.4	1.4	0	0	
21	0	0	0.9	7.2	1.1	10.4	45.1	32.3	0	19.5	0	0	
22	15.3	0	0	0	0	40.6	7.8	0	20.0	7.2	0	0	
23	23.1	0	8.4	12.6	4.5	0	55.2	4.5	2.4	9.0	0	0	
24	0.1	0	12.6	1.8	14.7	9.1	1.1	2.0	40.8	7.8	0	0	
25	0.2	4.7	22.4	0	6.5	0	10.6	29.9	5.8	0.4	0	0	
26	0	0	0	0	0.7	37.1	20.4	0.4	41.1	22.2	0	0	
27	0	0	0	11.7	14.9	41.1	13.2	23.4	30.7	0	0	0	
28	0	3.8	5.3	0.1	0	0	18.0	1.8	8.2	8.3	0	0	
29	0	-	19.2	0	1.0	8.9	17.0	0	10.3	5.8	0	0	
30	0	-	0.1	3.9	0	0	27.2	14.8	42.5	8.0	0	0	
31	0	-	0	-	11.1	-	8.5	3.8	-	2.5	-	0	
Total	55.1	8.5	95.4	124.9	177.8	247.8	353.6	373.3	391.4	278.2	42.1	0.0	2,148.1
No. of rainy day	7	2	15	14	19	20	26	28	24	27	3	0	185
Max. within one record day	23.1	4.7	22.4	33.0	25.4	41.1	55.2	47.9	42.5	40.2	41.7	0	55.2
(Date)	(23)	(25)	(25)	(12)	(13)	(27)	(23)	(2)	(30)	(8)	(2)		(7/23)

Table 1.3(8/9) DAILY RAINFALL RECORD AT KOUNDJA (Lat. 5°37'N, Long. 10°45'E, Alt. 1,208 m)

(Long. 10°45'N, Lat. 5°39'E. Alt. 1,208m)

Year : 1983

Month / Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1	0	0	0	2.9	6.3	2.6	12.2	13.9	1.4	0	0	0	
2	0	0	0	1.5	4.2	0	0	2.3	12.9	15.6	0	16.4	
3	0	0	0	0	22.4	0	0.1	15.0	0.1	11.7	0	0	
4	0	0	0	0	1.6	0	33.5	9.1	8.5	4.3	0	0	
5	0	0	0	0	19.5	0	0.3	2.3	14.9	0	0	0	
6	0	0	0	0	24.4	14.9	10.4	30.3	8.4	0	0	0	
7	0	0	0	6.1	27.6	0.3	4.2	15.3	23.5	56.0	0	0	
8	0	0	0	3.0	0	29.1	1.9	7.4	8.4	10.5	0	0	
9	0	0	0	9.0	19.6	3.2	0	11.6	25.5	3.0	0	0	
10	0	0	0	0.3	0	0	0	3.7	0.3	1.1	0	0	
11	0	0	0	0	10.4	58.7	0	11.9	35.6	18.3	0	0	
12	0	0	0	0	0	0.2	5.5	1.1	3.2	0.8	0	0	
13	0	0	0	0	0	15.3	0	0	27.3	0	0	3.0	
14	0	0	0	0	3.6	5.0	0.8	0	18.0	0	0	0	
15	0	0	0	0	7.1	5.5	8.2	11.8	15.6	0	0	0	
16	0	0	0	0	28.9	0	13.2	0	18.5	0	0	0	
17	0	0	0	0	1.0	0	0.4	2.2	18.9	2.4	0	0	
18	0	0	0	0	0	0	6.8	21.1	4.4	0	0	0	
19	0	0	0	0	8.2	4.6	0.4	4.8	4.0	0	0	0	
20	0	1.0	0	6.2	7.3	5.9	0	0	0	0	0	0	
21	0	0	0	0	0.6	5.1	0	14.9	0	0.2	0	0	
22	0	0	0	0	0.5	0.8	1.2	11.8	2.1	0	0	0	
23	0	0	0	0	0	6.7	0.8	2.1	9.9	0	0	0	
24	0	0	0	2.8	0	0	0	40.2	0	0	0	0	
25	0	0	0	0.9	0	1.3	25.2	0	0.8	0	0	0	
26	0	0	0	9.4	7.8	0.3	23.8	12.5	0	0	0	0	
27	0	0	0	0	0	0	8.3	5.3	4.7	8.2	0	0	
28	0	0	4.8	0	7.0	0	0	14.0	8.2	0	0	0	
29	0	-	0	0	1.8	26.2	1.2	0.2	3.4	0	0	0	
30	0	-	7.2	0	11.4	1.7	43.0	1.4	0.2	0	0	0	
31	0	-	2.8	-	0	-	10.2	4.7	-	0	-	0	
Total	0.0	1.0	14.8	42.1	221.2	187.4	211.6	270.9	278.7	132.1	0.0	19.4	1,379.2
No. of rainy day	0	1	3	10	21	19	22	26	26	12	0	2	142
Max. within one record day	0	1.0	7.2	9.4	28.9	58.7	43.0	40.2	35.6	56.0	0	16.4	58.7
(Date)		(20)	(30)	(26)	(16)	(11)	(30)	(24)	(11)	(7)		(2)	(6/11)

Table 1.3(9/9) DAILY RAINFALL RECORD AT KOUNDJA (Lat. 5°37'N, Long. 10°45'E, Alt. 1,208 m)

(Long. 10°45'N, Lat. 5°39'E. Alt. 1,208m)

Year : 1984

Month / Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1	0	0	0	0	21.1	18.7	1.6	4.3	24.7	1.4	0	0	
2	0	0	0	2.1	3.3	1.9	8.8	14.0	1.0	6.4	0	0	
3	0	0	0	6.1	0	0.6	21.6	6.2	34.0	11.2	0	0	
4	0	0	0	0.1	0	0	0	2.0	5.4	2.9	0	0	
5	0	0	0	0	10.8	0.2	0.6	2.2	1.8	18.3	0	0	
6	0	0	5.0	8.3	0	0	21.0	22.4	7.1	15.5	0	0	
7	0	0	0	1.0	9.5	6.7	2.9	10.4	25.2	28.1	0	0	
8	0	0	7.3	0	0	5.5	38.0	17.2	3.7	1.4	0	0	
9	0	0	11.3	0	12.0	0	7.8	0.3	34.8	0	0	0	
10	0	0	1.7	0	5.5	0.6	4.0	0	0	0	0.1	0	
11	0	0	0.1	0	0	12.3	42.5	10.7	0	13.2	1.4	0	
12	0	0	0	11.1	6.7	2.6	5.0	10.2	18.4	0.9	11.4	0	
13	0	0	0	16.0	2.2	0	18.9	9.3	0	2.0	0	0	
14	0	0	0	29.0	0	2.8	31.9	5.0	10.4	6.5	0	0	
15	0	0	42.7	6.0	8.5	0	12.4	9.9	0	5.0	0	0	
16	0	0	0	0	0	0	30.1	1.4	6.7	8.4	4.6	0	
17	0	0	0	0	15.1	26.7	23.3	9.6	5.9	22.3	2.2	0	
18	0	0	3.8	0	0	0.5	25.9	18.3	44.5	22.1	0	0	
19	0	0	1.7	28.0	4.1	0.9	14.7	4.4	1.8	0	0	0	
20	0	0	0	0	0	0	4.1	1.8	12.5	2.0	0	0	
21	0	0	5.8	0	0.3	3.4	27.3	53.7	0	0.3	0	0	
22	0	0	3.0	0	0	0	12.3	20.0	4.4	2.6	0	0	
23	0	0	6.8	16.1	9.1	0	0.3	0	9.5	0.2	0	0	
24	0	0	19.8	0.3	8.0	0	17.1	0	0	0.6	0	0	
25	0	0	4.7	4.3	0.1	4.9	9.9	26.3	0.7	0	0	0	
26	0	0	0	8.0	8.8	13.0	3.5	4.6	35.7	7.2	0	0	
27	0	0	18.9	0	1.6	36.0	0	3.5	15.8	19.5	0	0	
28	0	0	0	0	0	0	0	4.0	1.5	10.8	0	0	
29	0	0	0.1	5.2	3.6	5.2	7.4	1.8	0	0	0	0	
30	0	-	0	0	11.2	31.6	3.6	0	14.8	3.2	0	0	
31	0	-	3.3	-	0.1	-	0.4	0.9	-	0	-	0	
Total	0.0	0.0	136.0	141.6	141.6	174.1	396.9	274.4	320.3	212.0	19.7	0.0	1,816.6
No. of rainy day	0	0	16	15	20	19	28	27	23	25	5	0	178
Max. within one record day (Date)	0	0	42.7 (15)	29.0 (14)	21.1 (1)	36.0 (27)	42.5 (11)	53.7 (21)	44.5 (18)	28.1 (7)	11.4 (12)	0	53.7 (8/21)

Table 1.4 (1/6) DISCHARGE RECORD BY SEDA

River Ndoup Year 1980

DATE	J	F	M	A	M	J	J	A	S	O	N	D
1			0.19	0.17	0.17	0.17	0.29	0.91	1.18	1.43	1.18	0.80
2			0.17	0.17	0.21	0.17	0.24	1.09	1.55	1.36	1.20	0.78
3			0.17	0.17	0.18	0.18	0.44	1.13	1.20	1.92	1.18	0.78
4			0.16	0.17	0.17	0.20	0.27	1.05	1.68	1.41	1.18	0.76
5			0,16	0,16	0.17	0,18	0,50	0,89	1.43	1.32	1.16	0.74
6			0.16	0.16	0.17	0.17	0.44	1.07	1.39	1.39	1.68	0.74
7			0.16	0.16	0.16	0.17	0.51	0.93	1.18	1.22	1.20	0.73
8			0.16	0.16	0.18	0.17	0.47	0.99	1.20	1.22	1.27	0.71
9			0.16	0.17	0.28	0.17	0.61	0.99	1.46	1.36	1.16	0.71
10			0.16	0.25	0.26	0.17	1.25	0.99	1.20	1.68	1.05	0.71
11			0.15	0.61	0.20	0.17	0.89	0.99	1.16	1.60	1.05	0.69
12			0.19	0.67	0.64	0.17	0.93	0.91	1.20	1.81	1.05	0.69
13			0.19	0.32	0.25	0.17	0.71	0.97	1.16	1.48	0.99	0.69
14			0.17	0.31	0.21	0.17	0.62	0.89	1.25	1.36	0.99	0.69
15			0.17	0.19	0.23	0.17	0.50	0.84	1.34	1.32	0.97	0.67
16			0.17	0.18	0.20	0.46	1.27	0.95	1.63	1.34	0.99	0.66
17			0.17	0.18	0.19	0.27	1.05	1.25	1.27	1.39	0.97	0.66
18			0.17	0.17	0.19	0.18	0.78	1.05	1.20	1.36	0.97	0.66
19			0.16	0.17	0.20	0.18	0.67	1.12	1.25	1.32	0.95	0.64
20			0.16	0.19	0.18	0.18	0.74	1.60	1.16	1.37	0.95	0.64
21			0.16	0.17	0.18	0.43	0.62	1.43	1.27	1.58	0.93	0.62
22			0.17	0.17	0.17	0.53	0.59	1.12	1.29	1.63	0.93	0.62
23			0.47	0.19	0.21	0.46	1.55	0.99	1.34	1.31	0.91	0.62
24			0.44	0.18	0.19	0.27	1.09	1.22	1.22	1.51	0.91	0.62
25		0.16	0.23	0.17	0.19	0.27	0.82	1.34	1.22	1.87	0.89	0.61
26		0.17	0.22	0.17	0.20	0.22	0.84	1.34	1.36	1.89	0.87	0.61
27		0.17	0.29	0.17	0.19	0.46	0.60	1.27	1.20	1.29	0.85	0.59
28		0.16	0.22	0.17	0.20	0.69	0.87	1.29	1.34	1.20	0.84	0.59
29		0.20	0.19	0.16	0.19	0.56	1.01	1.20	1.39	1.13	0.84	0.58
30		-	0.17	0.18	0.19	0.46	1.13	1.25	1.34	1.20	0.83	0.58
31		-	0.17	-	0.17	-	0.97	1.27	-	1.18	-	0.56
Ave.			0.20	0.21	0.21	0.27	0.76	1.06	1.30	1.43	1.03	0.67

Table 1.4 (2/6) DISCHARGE RECORD BY SEDA

River Ndoup Year 1981

DATE	J	F	M	A	M	J	J	A	S	O	N	D
1	0.56	0.40	0.34	0.31	0.29	0.24						
2	0.56	0.37	0.32	0.31	0.29	0.26						
3	0.55	0.37	0.32	0.31	0.29	0.26						
4	0.55	0.37	0.32	0.37	0.28	0.25						
5	0.53	0.37	0.32	0.37	0.29	0.27						
6	0.53	0.37	0.32	0.34	0.25	0.25						
7	0.51	0.37	0.32	0.49	1.01	0.25						
8	0.51	0.36	0.31	0.40	0.99	0.24						
9	0.51	0.36	0.31	0.32	1.07	0.27						
10	0.51	0.36	0.31	0.29	0.74							
11	0.51	0.36	0.71	0.29	0.53							
12	0.51	0.36	0.37	0.29	0.46							
13	0.51	0.36	0.34	0.28	0.41							
14	0.51	0.36	0.32	0.28	0.36							
15	0.50	0.35	0.31	0.28	0.35							
16	0.50	0.35	0.30	0.27	0.34							
17	0.49	0.35	0.30	0.27	0.32							
18	0.49	0.35	0.30	0.27	0.31							
19	0.47	0.35	0.29	0.27	0.31							
20	0.47	0.49	0.35	0.32	0.31							
21	0.46	0.43	0.58	0.29	0.29							
22	0.46	0.39	0.51	0.30	0.28							
23	0.44	0.36	0.44	0.29	0.29							
24	0.44	0.36	0.44	0.29	0.64							
25	0.44	0.36	0.35	0.30	0.30							
26	0.44	0.35	0.34	0.32	0.34							
27	0.44	0.34	0.34	0.35	0.34							
28	0.44	0.34	0.51	0.31	0.32							
29	0.43	-	0.49	0.29	0.32							
30	0.43	-	0.35	0.29	0.32							
31	0.40	-	0.34	-	0.31	-			-		-	
Ave.	0.49	0.37	0.37	0.31	0.42							

Table 1.4 (3/6) DISCHARGE RECORD BY SEDA

River Nja Year 1980

DATE	J	F	M	A	M	J	J	A	S	O	N	D
1			0.27	0.21	0.19	0.19	0.25	0.85	1.07	1.07	1.03	0.63
2			0.25	0.21	0.21	0.19	0.22	0.95	1.15	0.95	0.99	0.63
3			0.25	0.21	0.19	0.22	0.30	0.99	1.07	1.28	0.99	0.63
4			0.24	0.21	0.21	0.21	0.22	0.92	2.06	1.07	0.95	0.60
5			0.24	0.21	0.19	0.18	0.32	0.85	1.37	1.24	0.95	0.60
6			0.24	0.19	0.18	0.18	0.29	0.85	1.28	1.24	1.42	0.60
7			0.24	0.19	0.18	0.18	0.27	0.81	1.19	1.15	1.11	0.60
8			0.22	0.19	0.21	0.19	0.36	0.75	1.19	1.11	1.03	0.57
9			0.22	0.24	0.52	0.18	0.32	0.75	1.32	1.07	0.99	0.57
10			0.22	0.29	0.32	0.18	0.47	0.75	1.19	1.07	0.92	0.57
11			0.22	0.66	0.30	0.18	0.49	0.75	1.47	1.03	0.88	0.57
12			0.29	0.32	0.55	0.19	0.52	0.81	1.19	1.15	0.85	0.55
13			0.24	0.27	0.39	0.21	0.42	0.85	1.28	1.24	0.85	0.55
14			0.24	0.24	0.24	0.18	0.36	0.81	1.37	1.15	0.85	0.55
15			0.24	0.22	0.25	0.17	0.36	0.75	1.28	1.03	0.81	0.55
16			0.22	0.22	0.22	0.32	0.88	0.81	1.37	1.15	0.81	0.52
17			0.22	0.21	0.21	0.25	0.57	0.88	1.28	1.24	0.81	0.52
18			0.22	0.21	0.19	0.19	0.45	0.85	1.11	1.15	0.78	0.49
19			0.22	0.22	0.22	0.21	0.45	0.92	1.47	1.07	0.78	0.49
20			0.33	0.22	0.21	0.22	0.49	1.77	1.11	1.03	0.75	0.49
21			0.33	0.22	0.21	0.40	0.42	1.11	1.15	1.11	0.75	0.47
22			0.27	0.22	0.22	0.34	0.52	0.95	1.07	1.19	0.75	0.47
23			0.45	0.22	0.22	0.32	1.51	0.88	1.11	1.07	0.75	0.47
24			0.40	0.24	0.24	0.27	0.66	1.19	1.03	1.11	0.75	0.47
25		0.25	0.32	0.21	0.21	0.22	0.63	0.99	1.07	1.19	0.72	0.47
26		0.25	0.32	0.19	0.24	0.21	0.69	1.07	1.15	1.11	0.69	0.47
27		0.25	0.25	0.22	0.22	0.32	0.69	1.15	1.07	1.07	0.69	0.47
28		0.25	0.24	0.21	0.27	0.32	0.88	1.19	1.11	0.99	0.66	0.47
29		0.27	0.24	0.18	0.22	0.30	0.92	1.03	1.15	0.99	0.66	0.47
30		-	0.21	0.21	0.21	0.27	1.03	0.99	1.03	1.07	0.63	0.45
31		-	0.21	-	0.21	-	0.88	1.03	-	1.07	-	0.45
Ave.			0.23	0.23	0.24	0.23	0.54	0.94	1.23	1.11	0.85	0.53

Table 1.4 (4/6) DISCHARGE RECORD BY SEDA

River Nja Year 1981

DATE	J	F	M	A	M	J	J	A	S	O	N	D
1	0.45	0.30	0.24	0.22	0.18	0.21						
2	0.42	0.30	0.22	0.22	0.21	0.25						
3	0.42	0.30	0.22	0.21	0.18	0.25						
4	0.42	0.29	0.22	0.25	0.42	0.24						
5	0.40	0.29	0.21	0.24	0.24	0.27						
6	0.40	0.29	0.21	0.21	0.22	0.24						
7	0.40	0.29	0.21	0.30	0.72	0.22						
8	0.38	0.29	0.21	0.27	0.66	0.21						
9	0.38	0.29	0.21	0.21	0.72	0.29						
10	0.38	0.29	0.19	0.19	0.66							
11	0.38	0.29	0.25	0.18	0.60							
12	0.38	0.27	0.22	0.19	0.38							
13	0.38	0.25	0.21	0.19	0.30							
14	0.38	0.25	0.21	0.19	0.27							
15	0.36	0.25	0.21	0.19	0.25							
16	0.34	0.25	0.21	0.19	0.25							
17	0.34	0.25	0.19	0.18	0.24							
18	0.34	0.25	0.19	0.18	0.24							
19	0.34	0.25	0.19	0.18	0.24							
20	0.34	0.36	0.25	0.18	0.25							
21	0.34	0.32	0.37	0.18	0.25							
22	0.34	0.29	0.34	0.22	0.29							
23	0.34	0.25	0.21	0.21	0.32							
24	0.34	0.25	0.19	0.24	0.42							
25	0.32	0.25	0.25	0.22	0.24							
26	0.34	0.25	0.24	0.25	0.24							
27	0.34	0.24	0.21	0.25	0.24							
28	0.32	0.24	0.36	0.21	0.24							
29	0.32	-	0.30	0.19	0.22							
30	0.32	-	0.24	0.19	0.22							
31	0.32	-	0.22	-	0.22	-			-		-	
Ave.	0.36	0.27	0.23	0.21	0.33							

Table 1.4 (5/6) DISCHARGE RECORD BY SEDA

River Nkoup — Year 1980

DATE	J	F	M	A	M	J	J	A	S	O	N	D
1			0.15	0.49	0.35	0.72	2.29	8.22	8.74	14.9	5.11	1.94
2			0.15	0.49	0.35	0.27	2.29	8.74	7.97	13.8	4.92	1.94
3			0.12	0.34	0.27	0.24	2.05	7.49	8.48	+ 20	4.74	1.83
4			0.12	0.49	0.27	0.27	1.83	6.35	9.54	14.5	4.38	1.72
5			0.12	0.44	0.27	0.35	2.54	5.71	12.5	13.2	4.20	1.72
6			0.12	0.39	0.20	0.20	2.54	5.92	13.2	12.5	4.03	1.62
7			0.12	0.39	0.12	0.20	2.29	5.92	12.5	11.6	3.86	1.52
8			0.12	0.39	0.12	0.60	2.54	6.35	11.6	10.7	7.49	1.33
9			0.12	0.39	0.10	0.35	2.54	6.35	8.74	10.1	7.73	1.25
10			0.12	0.31	0.10	0.20	2.54	7.02	8.22	8.74	7.97	1.16
11			0.12	0.35	0.08	0.17	2.54	7.02	8.74	9.54	6.13	1.08
12			0.12	0.39	0.12	0.17	2.54	8.74	8.48	8.74	4.55	1.08
13			0.15	0.44	0.12	0.17	2.29	9.27	8.74	7.49	4.03	1.00
14			0.15	0.54	0.20	0.15	2.29	8.22	10.4	7.02	3.54	1.00
15			0.15	0.54	0.27	0.15	2.29	7.49	11.6	6.35	3.24	1.00
16			0.12	0.54	0.27	0.20	2.29	7.73	10.1	8.22	2.81	1.00
17			0.12	0.54	0.24	0.20	2.54	9.27	8.74	10.1	2.67	0.93
18			0.12	0.54	0.20	0.20	2.54	11.6	7.49	11.6	2.67	0.93
19			0.12	0.60	0.20	0.20	2.54	13.2	7.97	9.54	2.54	0.93
20			0.10	0.60	0.59	0.17	2.54	13.8	6.79	8.22	2.54	0.93
21			0.10	0.54	0.85	0.24	2.54	13.2	7.49	6.79	2.41	0.85
22			0.12	0.60	0.49	0.24	2.67	11.6	12.8	6.35	2.29	0.85
23			0.17	0.49	0.35	0.35	3.09	12.2	13.5	6.13	2.29	0.85
24			0.24	0.49	0.35	0.27	3.54	12.5	11.9	5.92	2.29	0.85
25		0.12	0.27	0.44	0.35	0.35	4.55	12.2	11.9	6.13	2.29	0.85
26		0.12	0.35	0.39	0.20	0.27	5.91	12.5	13.8	6.35	2.17	0.79
27		0.12	0.39	0.39	0.20	0.49	6.13	13.2	11.6	6.79	2.17	0.79
28		0.12	0.44	0.39	0.20	0.85	7.25	13.5	13.5	6.13	2.17	0.79
29		0.12	0.44	0.39	0.27	1.52	7.73	11.6	14.2	5.92	2.05	0.79
30		-	0.44	0.35	0.27	2.29	8.48	10.1	13.5	5.31	1.94	0.79
31		-	0.44	-	0.20	-	8.74	9.54	-	5.31	-	0.79
Ave.			0.19	0.46	0.26	0.40	3.49	9.57	10.5	9.16	3.71	1.13

Table 1.4 (6/6) DISCHARGE RECORD BY SEDA

River Nkoup Year 1981

DATE	J	F	M	A	M	J	J	A	S	O	N	D
1	0.78	0.49	0.24	0.35	0.39	0.78						
2	0.78	0.49	0.20	0.35	0.31	0.78						
3	0.78	0.49	0.20	0.31	0.31	0.72						
4	0.78	0.44	0.20	0.31	0.39	0.72						
5	0.78	0.39	0.17	0.35	0.49	0.78						
6	0.72	0.39	0.17	0.35	0.54	0.72						
7	0.72	0.39	0.17	0.39	0.66	0.66						
8	0.72	0.35	0.15	0.39	0.72	0.60						
9	0.72	0.31	0.15	0.39	0.85	0.66						
10	0.72	0.31	0.15	0.39	1.43							
11	0.66	0.31	0.15	0.35	1.52							
12	0.66	0.31	0.15	0.35	1.62							
13	0.66	0.27	0.15	0.35	1.83							
14	0.66	0.27	0.12	0.35	2.29							
15	0.66	0.27	0.12	0.35	2.05							
16	0.66	0.27	0.12	0.31	1.72							
17	0.60	0.27	0.12	0.31	1.52							
18	0.60	0.24	0.12	0.27	1.33							
19	0.60	0.24	0.10	0.27	1.43							
20	0.54	0.31	0.15	0.24	1.25							
21	0.54	0.31	0.27	0.24	1.16							
22	0.54	0.31	0.24	0.39	1.08							
23	0.54	0.31	0.20	0.31	1.00							
24	0.54	0.31	0.24	0.39	0.93							
25	0.54	0.27	0.31	0.39	0.85							
26	0.54	0.27	0.35	0.35	0.85							
27	0.54	0.24	0.44	0.39	0.85							
28	0.54	0.24	0.35	0.44	0.78							
29	0.54	-	0.35	0.39	0.78							
30	0.49	-	0.35	0.39	0.78							
31	0.49	-	0.35	-	0.78	-			-		-	
Ave.	0.63	0.32	0.21	0.35	1.05							

Table 1.5 (1/5) DISCHARGE MEASUREMENT

STATION: Ndoup No.1

DRAINAGE AREA: 10.0 Km^2 RIVER : Ndoup

No.	Date	Water Level on Gauge (m)	Water Depth (m)	Discharge (m^3/s)
1	'85 Sep. 14	1.010	1.450	1.036
2	'85 Sep. 19	0.920	1.360	0.716
3	'85 Sep. 23	0.855	1.295	0.495
4	'85 Sep. 25	0.945	1.385	0.784
5	'85 Sep. 26	0.905	1.345	0.697
6	'85 Oct. 1	0.960	1.400	0.890
7	'85 Oct. 30	0.805	1.245	0.44

Ekuation of zero point of water gauge 1196.07 m

Elevation of river bed 1195.63 m

Table 1.5 (2/5) DISCHARGE MEASUREMENT

STATION: Ndoup No.2

DRAINAGE AREA: 19.8 Km^2 RIVER : Ndoup

No.	Date	Water Level on Gauge (m)	Water Depth (m)	Discharge (m^3/s)
1	'85 Sep. 12	7.650	1.980	1.581
2	'85 Sep. 19	7.585	1.915	1.103
3	'85 Sep. 23	7.550	1.880	0.930
4	'85 Sep. 24	7.670	2.000	1.761
5	'85 Oct. 1	7.640	1.970	1.418
6	'85 Oct. 11	7.650	1.980	1.506
7	'85 Oct. 13	7.910	2.240	3.878
8	'85 Oct. 13	7.855	2.185	3.362
9	'85 Oct. 13	7.850	2.180	3.271
10	'85 Oct. 15	7.745	2.075	1.87
11	'85 Oct. 25	7.585	1.915	0.82
12	'85 Oct. 30	7.570	1.900	0.801
13	'85 Nov. 2	7.545	1.875	0.725
14	'85 Nov. 4	7.530	1.860	0.68
15	'85 Nov. 6	7.555	1.885	0.845

Ekuation of zero point of water gauge 1120.40 m

Elevation of river bed 1126.07 m

Table 1.5 (3/5) DISCHARGE MEASUREMENT

STATION: Nja

DRAINAGE AREA: 17.1 Km^2 RIVER : Nja

No.	Date	Water Level on Gauge (m)	Water Depth (m)	Discharge (m^3/s)
1	'85 Sep. 14	0.675	0.865	0.738
2	'85 Sep. 19	0.695	0.885	0.804
3	'85 Sep. 23	0.670	0.860	0.803
4	'85 Sep. 24	0.795	0.985	1.076
5	'85 Sep. 24	0.735	0.925	1.029
6	'85 Oct. 1	0.715	0.905	0.889
7	'85 Oct. 11	0.775	0.965	1.015
8	'85 Oct. 11	0.780	0.970	1.049
9	'85 Oct. 14	0.835	1.025	1.167
10	'85 Oct. 14	0.830	1.020	1.157
11	'85 Oct. 15	0.815	1.005	1.162
12	'85 Oct. 15	0.800	0.990	1.153
13	'85 Oct. 25	0.665	0.855	0.711
14	'85 Oct. 30	0.645	0.835	0.635
15	'85 Nov. 4	0.625	0.815	0.536
16	'85 Nov. 6	0.650	0.840	0.670

Ekuation of zero point of water gauge 1129.27 m

Elevation of river bed 1129.08 m

Table 1.5 (4/5) DISCHARGE MEASUREMENT

STATION: Nkoup No.1

DRAINAGE AREA: 88.4 Km^2 RIVER : Nkoup

No.	Date	Water Level on Gauge (m)	Water Depth (m)	Discharge (m^3/s)
1	'85 Sep. 17	1.250	1.370	7.305
2	'85 Sep. 19	1.085	1.205	5.473
3	'85 Sep. 23	0.795	0.915	3.877
4	'85 Oct. 1	1.245	1.365	7.486
5	'85 Oct. 15	1.340	1.460	8.243
6	'85 Oct. 16	1.310	1.430	7.197
7	'85 Oct. 23	0.750	0.870	3.668
8	'85 Oct. 30	0.590	0.710	2.46
9	'85 Nov. 2	0.580	0.700	2.514
10	'85 Nov. 4	0.550	0.670	2.375
11	'85 Nov. 6	0.540	0.660	2.356

Ekuation of zero point of water gauge 1108.17 m

Elevation of river bed 1108.05 m

Table 1.5 (5/5) DISCHARGE MEASUREMENT

STATION: Nkoup No.2

DRAINAGE AREA: 141.7 Km^2 RIVER : Nkoup

No.	Date	Water Level on Gauge (m)	Water Depth (m)	Discharge (m^3/s)
1	'85 Sep. 19	0.635	1.325	6.751
2	'85 Sep. 26	0.535	1.225	6.406
3	'85 Oct. 1	0.690	1.380	7.347
4	'85 Oct. 15	0.780	1.470	7.899
5	'85 Oct. 16	0.800	1.490	8.557
6	'85 Oct. 23	0.345	1.035	4.168
7	'85 Oct. 30	0.235	0.925	3.183

Ekuation of zero point of water gauge 1049.51 m

Elevation of river bed 1048.82 m

Table 1.6 PROBABLE ANNUAL RAINFALL OF NON-EXCEEDANCE

Station Koundja

Probability of Occurence (1/T)	Probable Annual Rainfall X (mm)
1/2	2,016.4
1/5	1,817.6
1/10	1,713.6
1/20	1,627.8
1/30	1,583.1
1/50	1,531.2
1/100	1,466.8
1/200	1,407.9
1/500	1,336.5

Table 1.7 DAILY RAINFALL IN 1/5 DROUGHT YEAR AT KOUNDJA

Year	1981						1980						
Month / Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1	-	-	-	-	20	2	3	-	5	22	-	-	
2	-	-	-	16	4	-	29	3	19	7	18	7	
3	-	-	-	-	8	5	-	6	34	-	7	-	
4	-	8	-	10	-	16	7	12	2	14	-	-	
5	-	-	-	-	-	-	13	27	9	3	4	-	
6	-	-	11	4	-	-	-	2	4	-	12	-	
7	-	-	-	-	32	7	27	-	-	27	-	-	
8	-	-	-	20	8	15	7	5	25	9	-	-	
9	-	-	-	7	-	-	2	9	7	4	-	-	
10	-	-	13	-	15	3	4	23	15	2	-	-	
11	-	-	12	-	3	4	-	7	4	22	-	-	
12	-	-	-	13	-	21	2	13	23	6	-	-	
13	-	-	-	-	-	-	5	-	2	11	-	-	
14	-	-	-	-	7	2	9	3	7	-	-	-	
15	-	-	-	11	16	8	27	30	15	3	-	-	
16	-	-	-	-	2	-	27	2	10	15	-	-	
17	-	-	-	-	-	-	6	3	-	8	-	-	
18	-	-	-	-	-	1	3	6	21	15	10	-	
19	-	8	12	16	12	23	-	25	5	-	-	-	
20	-	-	-	3	3	3	13	12	2	4	-	-	
21	-	-	-	3	3	5	5	7	-	17	-	-	
22	-	-	-	-	-	-	10	2	13	7	-	-	
23	-	-	5	6	5	22	1	3	24	2	-	-	
24	-	-	11	14	-	3	2	14	-	3	-	-	
25	4	-	17	-	11	-	31	39	7	1	4	-	
26	-	-	-	12	6	10	-	12	4	16	-	-	
27	-	-	2	-	3	5	18	3	18	-	-	-	
28	-	6	-	4	-	-	-	6	30	-	-	-	
29	-		5	8	12	20	9	1	2	-	-	-	
30	-		-	-	1	3	-	-	9	15	-	-	
31	-		12		-		27	23		-		-	
Total	4	22	100	147	171	178	287	298	316	233	55	7	1,818
No. of rainy day	1	3	10	15	19	20	24	27	26	23	6	1	175

Table 1.8 RAINFALL DATA FOR TANK MODEL ANALYSIS AT KOUNDJA

Year	1981						1980						
Month / Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1	0	0	0	0	3.3	0	0	8.1	28.5	12.3	0	0	
2	0	0	0	2.7	0	9.3	10.0	2.7	9.5	38.8	9.7	0	
3	0	0	0	0	5.0	4.7	0	16.9	49.9	0	7.2	0	
4	0	0	0	0	0	0.3	3.4	6.0	46.5	15.5	0	0	
5	0	0	0	0.9	0	0	72.2	5.0	0.4	19.3	29.4	0	
6	0	0	0	0	0	0	12.0	1.5	1.7	15.9	0.3	0	
7	0	0	0	0	9.2	2.0	1.6	0	0	11.0	7.5	0	
8	0	0	0	13.6	43.1	0	3.1	14.8	34.4	0.9	1.2	0	
9	0	0	0	16.2	15.4	0	33.4	36.4	0.9	15.5	0	0	
10	0	0	0	35.6	0	0	19.0	0.6	24.3	4.4	0	0	
11	0	0	27.1	3.3	39.8	9.8	11.4	0	0.1	28.5	0	0	
12	0	0	0	0	0	9.7	0	2.8	12.3	9.9	0	0	
13	0	0	0	0	0	0	0	0	16.5	0.3	0	0	
14	0	0	1.5	0	8.7	0	0	0	7.0	0	1.7	0	
15	0	0	0	0	3.4	30.5	39.7	0.3	16.0	19.3	0	0	
16	0	0	0	0	0	0.8	21.1	42.3	6.4	22.3	0	0	
17	0	0	0	0	0	0	0.4	0.4	0	26.0	0	0	
18	0	0	0	0	0.2	2.5	3.7	12.6	15.7	6.9	0	0	
19	0	19.0	0	1.9	0	13.9	9.4	51.3	1.4	1.4	0	0	
20	0	0	0	0	0	39.4	0.3	1.0	2.8	26.4	1.8	0	
21	0	0	10.8	1.2	3.0	26.0	6.5	0.6	9.5	8.6	0	0	
22	0	0	38.2	4.1	1.9	0.4	61.8	0.5	7.0	5.0	0	0	
23	0	0	25.6	6.9	11.2	5.7	0	55.9	2.4	15.0	0	0	
24	0	0	9.0	0	0	0	0.9	1.3	4.1	15.2	0	0	
25	0.7	0	11.3	0	8.2	0	10.2	21.7	8.7	1.8	0	0	
26	0	0	3.5	4.0	2.2	13.1	25.1	6.8	4.6	1.6	0	0	
27	0	0	0.4	0	10.6	10.9	11.5	17.9	21.3	0	0	0	
28	0	0	1.9	1.0	0	12.4	27.9	0.4	13.4	0.2	0	0	
29	0	-	0	6.8	0	8.4	25.2	18.3	3.5	14.2	0	0	
30	0	-	0	0	0	0	0	4.6	12.0	0.2	0	0	
31	0	-	0	-	0	-	0	1.0	-	1.6	-	0	
Total	0.7	19.0	129.3	98.2	165.2	199.8	409.8	331.7	360.8	338.0	58.8	0.0	2,111.3
No. of rainy day	1	1	10	13	15	18	23	27	29	28	8	0	173

Table 1.9(1/2) DISCHARGE DATA FOR TANK MODEL ANALYSIS

River Dnoup

Year	1981						1980						
Month / Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1	0.31	0.22	0.19	0.17	0.17	0.17	0.29	0.91	1.18	1.36	0.67	0.46	
2	0.31	0.20	0.17	0.17	0.21	0.17	0.24	1.09	1.55	1.29	0.68	0.45	
3	0.30	0.20	0.17	0.17	0.18	0.18	0.44	1.13	1.20	1.83	0.67	0.45	
4	0.30	0.20	0.16	0.17	0.17	0.20	0.27	1.05	1.68	1.34	0.67	0.44	
5	0.29	0.20	0.16	0.16	0.17	0.18	0.50	0.89	1.43	1.25	0.66	0.43	
6	0.29	0.20	0.16	0.16	0.17	0.17	0.44	1.07	1.39	1.32	0.96	0.43	
7	0.28	0.20	0.16	0.16	0.16	0.17	0.51	0.93	1.18	1.16	0.68	0.42	
8	0.28	0.19	0.16	0.16	0.18	0.17	0.47	0.99	1.20	1.16	0.72	0.41	
9	0.28	0.19	0.16	0.17	0.28	0.17	0.61	0.99	1.46	1.29	0.66	0.41	
10	0.28	0.19	0.16	0.25	0.26	0.17	1.25	0.99	1.20	1.60	0.60	0.41	
11	0.28	0.19	0.15	0.61	0.20	0.17	0.89	0.99	1.16	1.52	0.60	0.40	
12	0.28	0.19	0.19	0.67	0.64	0.17	0.93	0.91	1.20	1.72	0.60	0.40	
13	0.28	0.19	0.19	0.32	0.25	0.17	0.71	0.97	1.16	1.41	0.56	0.40	
14	0.28	0.19	0.17	0.31	0.21	0.17	0.62	0.89	1.25	1.29	0.56	0.40	
15	0.28	0.19	0.17	0.19	0.23	0.17	0.50	0.84	1.34	1.25	0.55	0.39	
16	0.28	0.19	0.17	0.18	0.20	0.46	1.27	0.95	1.63	1.14	0.56	0.38	
17	0.27	0.19	0.17	0.18	0.19	0.27	1.05	1.25	1.27	1.18	0.55	0.38	
18	0.27	0.19	0.17	0.17	0.19	0.18	0.78	1.05	1.20	1.16	0.55	0.38	
19	0.26	0.19	0.16	0.17	0.20	0.18	0.67	1.12	1.25	1.12	0.54	0.37	
20	0.26	0.26	0.16	0.19	0.18	0.18	0.74	1.60	1.16	1.08	0.54	0.37	
21	0.25	0.23	0.16	0.17	0.18	0.43	0.62	1.43	1.27	1.19	0.53	0.37	
22	0.25	0.21	0.17	0.17	0.17	0.53	0.59	1.12	1.23	1.22	0.53	0.36	
23	0.24	0.21	0.47	0.19	0.21	0.46	1.55	0.99	1.27	1.13	0.52	0.36	
24	0.24	0.21	0.44	0.18	0.19	0.27	1.09	1.22	1.16	1.13	0.52	0.36	
25	0.24	0.21	0.23	0.17	0.19	0.27	0.82	1.34	1.16	1.40	0.51	0.36	
26	0.24	0.20	0.22	0.17	0.20	0.22	0.84	1.34	1.29	1.23	0.50	0.35	
27	0.24	0.18	0.29	0.17	0.19	0.46	0.60	1.27	1.14	0.84	0.48	0.35	
28	0.24	0.18	0.22	0.17	0.20	0.69	0.87	1.29	1.27	0.78	0.48	0.34	
29	0.24	-	0.19	0.16	0.19	0.56	1.01	1.20	1.32	0.73	0.48	0.34	
30	0.24	-	0.17	0.18	0.19	0.46	1.13	1.25	1.27	0.78	0.47	0.34	
31	0.22	-	0.17	-	0.17	-	0.97	1.27	-	0.77	-	0.32	
Average	0.27	0.21	0.20	0.21	0.21	0.27	0.76	1.06	1.30	1.22	0.59	0.39	

Table 1.9(2/2) DISCHARGE DATA FOR TANK MODEL ANALYSIS

River Nja

Year	1981						1980						
Month / Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1	0.45	0.30	0.24	0.21	0.19	0.19	0.25	0.85	1.07	1.07	1.03	0.63	
2	0.42	0.30	0.25	0.21	0.21	0.19	0.22	0.95	1.15	0.95	0.99	0.63	
3	0.42	0.30	0.25	0.21	0.19	0.22	0.30	0.99	1.07	1.28	0.99	0.63	
4	0.42	0.29	0.24	0.21	0.21	0.21	0.22	0.92	2.06	1.07	0.95	0.60	
5	0.40	0.29	0.24	0.21	0.19	0.18	0.32	0.85	1.37	1.24	0.95	0.60	
6	0.40	0.29	0.24	0.19	0.18	0.18	0.29	0.85	1.28	1.24	1.42	0.60	
7	0.40	0.29	0.24	0.19	0.18	0.18	0.27	0.81	1.19	1.15	1.11	0.60	
8	0.38	0.29	0.22	0.19	0.21	0.19	0.36	0.75	1.19	1.11	1.03	0.57	
9	0.38	0.29	0.22	0.24	0.52	0.18	0.32	0.75	1.32	1.07	0.99	0.57	
10	0.38	0.29	0.22	0.29	0.32	0.18	0.47	0.75	1.19	1.07	0.92	0.57	
11	0.38	0.29	0.22	0.66	0.30	0.18	0.49	0.75	1.47	1.03	0.88	0.57	
12	0.38	0.27	0.29	0.32	0.55	0.19	0.52	0.81	1.19	1.15	0.85	0.55	
13	0.38	0.25	0.26	0.27	0.39	0.21	0.42	0.85	1.28	1.24	0.85	0.55	
14	0.38	0.25	0.24	0.24	0.24	0.18	0.36	0.81	1.37	1.15	0.85	0.55	
15	0.36	0.25	0.24	0.22	0.25	0.17	0.36	0.75	1.28	1.03	0.81	0.55	
16	0.34	0.25	0.22	0.22	0.22	0.32	0.88	0.81	1.37	1.15	0.81	0.59	
17	0.34	0.25	0.22	0.21	0.21	0.25	0.57	0.88	1.28	1.24	0.81	0.52	
18	0.34	0.25	0.22	0.21	0.19	0.19	0.45	0.85	1.11	1.15	0.78	0.49	
19	0.34	0.25	0.22	0.22	0.22	0.21	0.45	0.92	1.47	1.07	0.78	0.49	
20	0.34	0.36	0.33	0.22	0.21	0.22	0.49	1.77	1.11	1.03	0.75	0.49	
21	0.34	0.32	0.33	0.22	0.21	0.40	0.42	1.11	1.15	1.11	0.75	0.47	
22	0.34	0.29	0.27	0.22	0.22	0.34	0.58	0.95	1.07	1.19	0.75	0.47	
23	0.34	0.25	0.45	0.22	0.22	0.32	1.51	0.88	1.11	1.07	0.75	0.47	
24	0.34	0.25	0.40	0.24	0.24	0.27	0.66	1.19	1.03	1.11	0.75	0.47	
25	0.32	0.25	0.32	0.21	0.21	0.22	0.63	0.99	1.07	1.19	0.72	0.47	
26	0.34	0.25	0.32	0.19	0.24	0.21	0.69	1.07	1.15	1.11	0.69	0.47	
27	0.34	0.24	0.25	0.22	0.22	0.32	0.69	1.15	1.07	1.07	0.69	0.47	
28	0.32	0.24	0.24	0.21	0.27	0.32	0.88	1.19	1.11	0.99	0.66	0.47	
29	0.32	-	0.24	0.18	0.22	0.30	0.98	1.03	1.15	0.99	0.66	0.47	
30	0.32	-	0.21	0.21	0.21	0.27	1.03	0.99	1.03	1.07	0.63	0.45	
31	0.32	-	0.21	-	0.21	-	0.88	1.03	-	1.07	-	0.45	
Average	0.36	0.25	0.23	0.23	0.24	0.23	0.54	0.94	1.23	1.11	0.83	0.45	

Table 1.10(1/2) DAILY DISCHARGE IN 1/5 DROUGHT YEAR

River Ndoup

Year	1981						1980						
Month / Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1	0.32	0.23	0.15	0.12	0.13	0.24	0.35	0.66	0.83	0.94	0.78	0.38	
2	0.32	0.23	0.15	0.12	0.15	0.24	0.35	0.63	0.82	1.03	0.76	0.38	
3	0.31	0.23	0.15	0.12	0.16	0.23	0.43	0.62	0.85	0.97	0.77	0.38	
4	0.31	0.22	0.14	0.12	0.17	0.22	0.41	0.62	1.34	0.94	0.77	0.38	
5	0.31	0.22	0.14	0.12	0.17	0.24	0.41	0.63	0.90	0.95	0.75	0.37	
6	0.30	0.22	0.14	0.12	0.17	0.23	0.44	0.74	0.90	0.93	0.74	0.37	
7	0.30	0.22	0.14	0.12	0.16	0.23	0.42	0.68	0.89	0.90	0.75	0.37	
8	0.30	0.22	0.14	0.12	0.22	0.23	0.49	0.65	0.85	0.95	0.73	0.36	
9	0.30	0.21	0.14	0.13	0.23	0.25	0.50	0.64	0.90	0.95	0.72	0.36	
10	0.29	0.21	0.13	0.13	0.22	0.24	0.48	0.65	0.90	0.93	0.70	0.36	
11	0.29	0.21	0.13	0.12	0.25	0.24	0.48	0.70	0.92	0.91	0.68	0.36	
12	0.29	0.20	0.14	0.12	0.25	0.25	0.47	0.70	0.90	0.95	0.65	0.35	
13	0.28	0.20	0.13	0.12	0.24	0.29	0.46	0.72	0.96	0.94	0.63	0.35	
14	0.28	0.20	0.13	0.12	0.24	0.27	0.45	0.69	0.92	0.95	0.61	0.34	
15	0.28	0.19	0.13	0.12	0.24	0.27	0.45	0.68	0.91	0.91	0.58	0.33	
16	0.28	0.19	0.13	0.12	0.26	0.28	0.52	0.76	0.93	0.90	0.56	0.33	
17	0.27	0.19	0.13	0.12	0.26	0.28	0.85	0.73	0.93	0.91	0.54	0.32	
18	0.27	0.18	0.13	0.12	0.26	0.27	0.59	0.72	0.90	0.91	0.52	0.32	
19	0.27	0.18	0.12	0.12	0.25	0.26	0.58	0.71	0.94	0.93	0.52	0.31	
20	0.26	0.18	0.12	0.12	0.25	0.29	0.55	0.77	0.92	0.89	0.51	0.31	
21	0.26	0.18	0.12	0.12	0.25	0.29	0.57	0.80	0.90	0.88	0.50	0.30	
22	0.26	0.17	0.12	0.12	0.25	0.29	0.57	0.80	0.88	0.91	0.48	0.30	
23	0.26	0.17	0.12	0.13	0.25	0.29	0.60	0.76	0.88	0.90	0.47	0.30	
24	0.25	0.17	0.12	0.13	0.25	0.33	0.56	0.74	0.93	0.88	0.45	0.30	
25	0.25	0.16	0.12	0.13	0.24	0.33	0.55	0.76	0.89	0.86	0.43	0.29	
26	0.25	0.16	0.13	0.13	0.24	0.32	0.63	1.23	0.89	0.85	0.43	0.29	
27	0.25	0.16	0.12	0.13	0.24	0.33	0.60	1.04	0.87	0.86	0.42	0.29	
28	0.25	0.16	0.12	0.13	0.24	0.33	0.64	0.85	0.90	0.83	0.40	0.29	
29	0.24	0.15	0.12	0.13	0.24	0.32	0.61	0.84	1.18	0.82	0.39	0.28	
30	0.24	-	0.12	0.13	0.24	0.36	0.62	0.81	0.94	0.80	0.39	0.28	
31	0.24	-	0.12	-	0.25	-	0.60	0.79	-	0.79	-	0.28	
Average	0.28	0.20	0.13	0.12	0.22	0.27	0.52	0.75	0.92	0.91	0.59	0.33	

Table 1.10(2/2) DAILY DISCHARGE IN 1/5 DROUGHT YEAR

River Nja

Year	1981						1980						
Month / Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1	0.43	0.29	0.23	0.20	0.21	0.30	0.39	0.62	0.76	0.87	0.77	0.45	
2	0.42	0.29	0.23	0.20	0.23	0.30	0.38	0.60	0.75	0.96	0.75	0.44	
3	0.41	0.28	0.22	0.20	0.23	0.30	0.44	0.59	0.78	0.89	0.76	0.44	
4	0.40	0.28	0.22	0.20	0.24	0.29	0.43	0.59	1.19	0.86	0.76	0.43	
5	0.40	0.28	0.22	0.20	0.24	0.30	0.43	0.60	0.82	0.88	0.74	0.43	
6	0.39	0.28	0.22	0.20	0.24	0.30	0.45	0.70	0.82	0.86	0.74	0.43	
7	0.38	0.28	0.22	0.20	0.24	0.30	0.43	0.64	0.81	0.84	0.74	0.42	
8	0.37	0.28	0.22	0.19	0.28	0.30	0.49	0.62	0.78	0.88	0.73	0.42	
9	0.36	0.27	0.22	0.20	0.29	0.31	0.49	0.61	0.83	0.88	0.72	0.41	
10	0.35	0.27	0.21	0.20	0.28	0.31	0.48	0.62	0.82	0.87	0.71	0.41	
11	0.34	0.27	0.21	0.19	0.30	0.31	0.47	0.66	0.84	0.85	0.69	0.41	
12	0.34	0.27	0.22	0.19	0.30	0.31	0.46	0.66	0.82	0.88	0.68	0.40	
13	0.33	0.26	0.21	0.19	0.29	0.34	0.46	0.67	0.88	0.87	0.66	0.40	
14	0.33	0.26	0.21	0.19	0.29	0.33	0.46	0.65	0.84	0.80	0.65	0.40	
15	0.32	0.26	0.21	0.19	0.29	0.33	0.46	0.64	0.83	0.85	0.63	0.39	
16	0.32	0.26	0.21	0.19	0.31	0.30	0.52	0.72	0.85	0.84	0.62	0.39	
17	0.32	0.25	0.21	0.19	0.31	0.30	0.80	0.68	0.85	0.86	0.60	0.38	
18	0.32	0.25	0.21	0.19	0.31	0.32	0.56	0.67	0.82	0.85	0.59	0.38	
19	0.31	0.25	0.21	0.19	0.30	0.32	0.55	0.67	0.86	0.87	0.58	0.37	
20	0.31	0.25	0.21	0.19	0.30	0.35	0.53	0.71	0.85	0.84	0.57	0.36	
21	0.31	0.25	0.20	0.19	0.31	0.34	0.55	0.72	0.83	0.83	0.57	0.35	
22	0.31	0.24	0.20	0.19	0.31	0.34	0.54	0.72	0.81	0.85	0.55	0.34	
23	0.31	0.24	0.20	0.19	0.30	0.34	0.55	0.70	0.82	0.85	0.54	0.34	
24	0.30	0.24	0.20	0.19	0.30	0.37	0.54	0.69	0.86	0.83	0.53	0.33	
25	0.30	0.24	0.20	0.19	0.30	0.37	0.53	0.71	0.83	0.82	0.51	0.32	
26	0.30	0.23	0.22	0.19	0.30	0.36	0.60	1.10	0.83	0.81	0.51	0.32	
27	0.30	0.23	0.20	0.20	0.30	0.37	0.57	0.95	0.81	0.82	0.50	0.32	
28	0.30	0.23	0.20	0.20	0.30	0.37	0.60	0.77	0.84	0.80	0.49	0.32	
29	0.30	0.23	0.20	0.20	0.30	0.36	0.58	0.76	1.09	0.79	0.48	0.32	
30	0.29	-	0.20	0.21	0.31	0.39	0.59	0.74	0.87	0.78	0.47	0.32	
31	0.29	-	0.20	-	0.31	-	0.57	0.73	-	0.78	-	0.32	
Average	0.34	0.26	0.21	0.19	0.28	0.33	0.51	0.69	0.85	0.88	0.63	0.38	

Table 1.11 10-DAY DISCHARGE IN 1/5 DROUGHT YEAR

Month	10-day	Ndoup	Nja
		(m^3/s)	(m^3/s)
Jan.	1st	0.306	0.391
	2nd	0.277	0.324
	3rd	0.274	0.301
Feb.	1st	0.221	0.279
	2nd	0.190	0.256
	3rd	0.166	0.237
Mar.	1st	0.142	0.220
	2nd	0.130	0.210
	3rd	0.121	0.202
Apr.	1st	0.120	0.197
	2nd	0.123	0.191
	3rd	0.127	0.195
May	1st	0.176	0.248
	2nd	0.250	0.301
	3rd	0.245	0.303
Jun.	1st	0.234	0.300
	2nd	0.269	0.325
	3rd	0.318	0.360
Jul.	1st	0.428	0.440
	2nd	0.539	0.526
	3rd	0.593	0.566
Aug.	1st	0.651	0.620
	2nd	0.716	0.674
	3rd	0.779	0.782
Sep.	1st	0.918	0.836
	2nd	0.922	0.843
	3rd	0.925	0.858
Oct.	1st	0.950	0.878
	2nd	0.920	0.860
	3rd	0.851	0.815
Nov.	1st	0.745	0.742
	2nd	0.581	0.629
	3rd	0.436	0.514
Dec.	1st	0.371	0.428
	2nd	0.332	0.386
	3rd	0.290	0.326

Table I.12 PROBABLE DAILY RAINFALL OF EXCEEDANCE

Station Koundja

Probability of Occurence (1/T)	Probable Daily Rainfall X (mm)
1/5	72.88
1/10	81.50
1/20	90.37
1/30	95.73
1/50	102.69
1/100	112.57
1/200	123.00
1/500	137.70

Table 1.13 HOURLY RAINFALL FOR 1/5 FLOOD

Station Koundja

Hour	Rainfall (mm/hr)
1	13.3
2	55.1
3	2.7
4	1.9
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	0
21	0
22	0
23	0
24	0

Table 1.14 RAINFALL DATA FOR STORAGE FUNCTION ANALYSIS

Station Koundja

Date	Hour	Rainfall (mm/hr)
23 Sep.	12	0
	13	0
	14	0
	15	0
	16	21.0
	17	2.5
	18	1.0
	19	3.0
	20	0.5
	21	0
	22	0
	23	0
	24	0

Table 1.15 DISCHARGE DATA FOR STORAGE FUNCTION ANALYSIS

Date	Hour	Discharge (m^3/s)	
		Ndoup	Nja
23 Sep.	12	0.71	0.73
	13	0.71	0.73
	14	0.71	0.73
	15	0.71	0.74
	16	1.27	1.07
	17	1.92	1.49
	18	2.59	2.10
	19	3.04	1.39
	20	3.60	2.10
	21	3.39	2.05
	22	2.75	2.03
	23	2.75	1.84
	24	2.99	1.59
24 Sep.	1	3.04	1.39
	2	2.70	1.29
	3	2.59	1.17
	4	2.33	1.10
	5	2.15	1.00
	6	1.91	1.00
	7	1.82	0.98
	8	1.73	0.94
	9	1.64	0.91
	10	1.54	0.88
	11	1.45	0.85
	12	1.36	0.83
	13	1.26	0.80
	14	1.17	0.77
	15	1.07	0.75
	16	0.98	0.73

Table 1.16 HOURLY DISCHARGE IN 1/5 FLOOD

Hour	Discharge (m^3/s)	
	Ndoup	Nja
1	0	0
2	0	0
3	0	0
4	3.12	1.93
5	14.59	7.22
6	12.79	6.14
7	11.14	5.21
8	9.39	4.29
9	7.95	3.57
10	6.78	2.99
11	5.82	2.53
12	5.03	2.17
13	4.38	1.88
14	3.82	1.65
15	3.38	1.47
16	2.99	1.32
17	2.68	1.20
18	2.40	1.11
19	2.18	1.04
20	2.00	0.97
21	1.83	0.92
22	1.69	0.88
23	1.59	0.85
24	1.48	0.82

Fig.1.1 RIVER BASINS

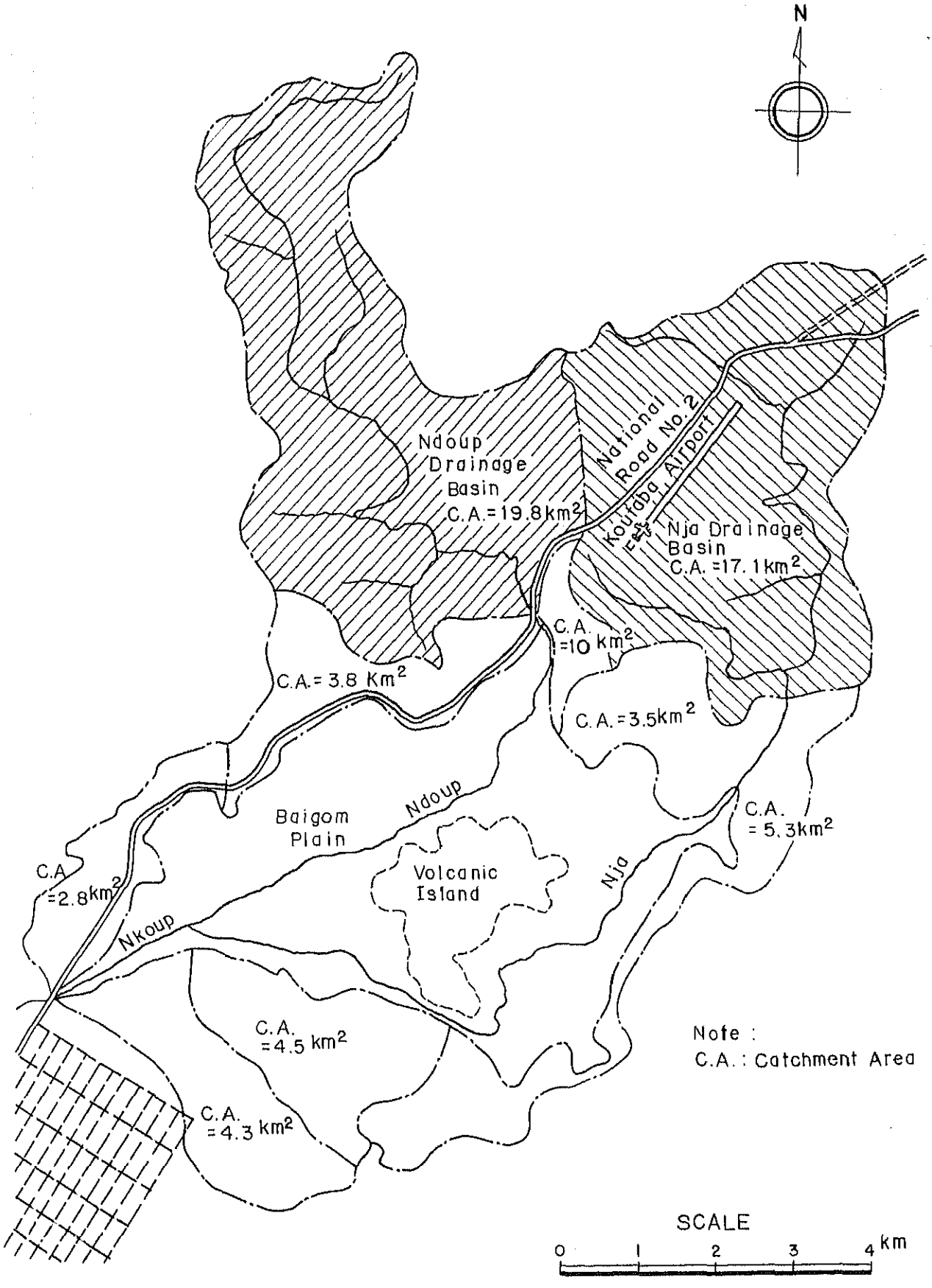


Fig.1.2 LOCATION OF METEOROLOGICAL STATIONS

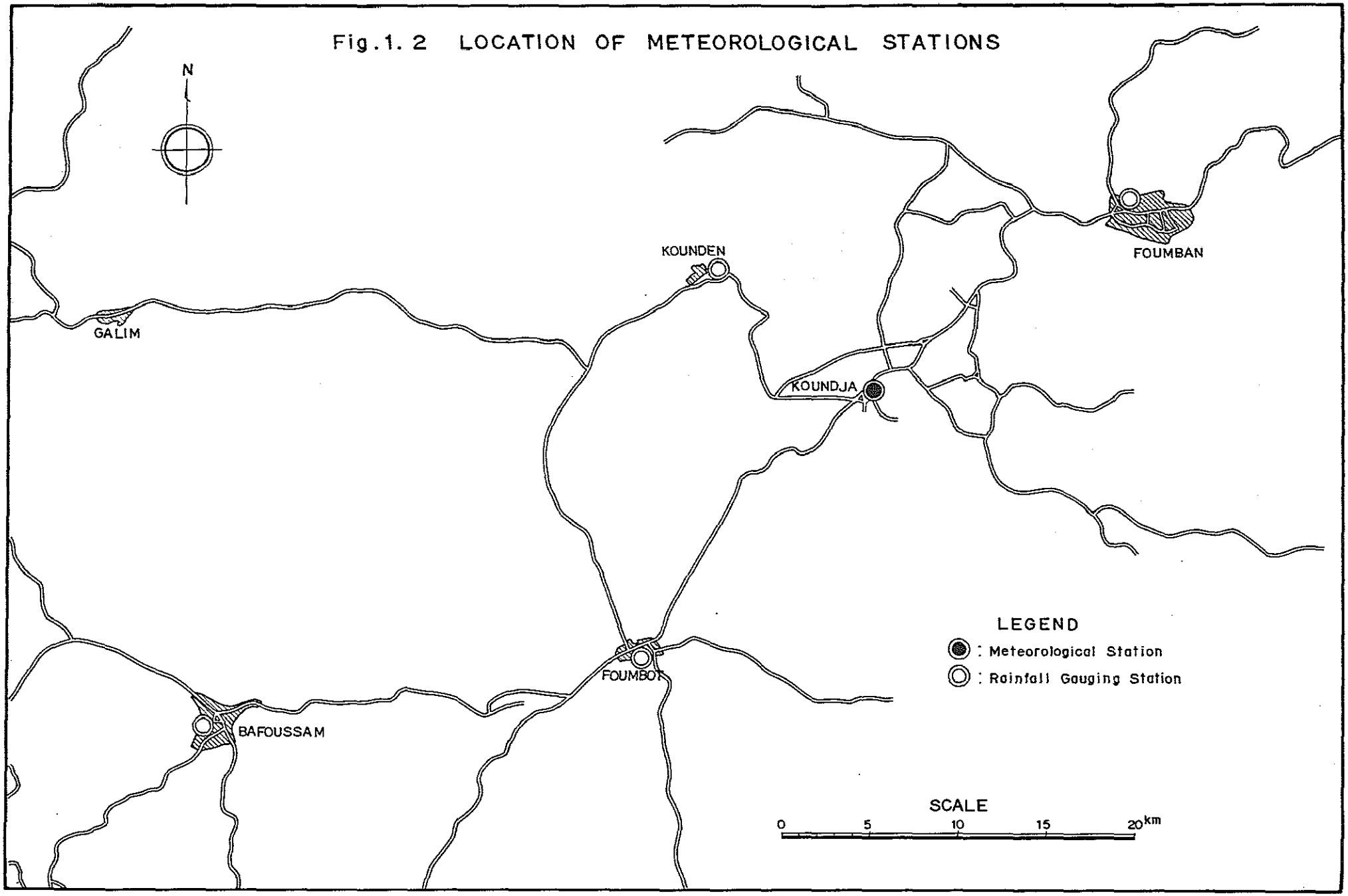


Fig. 1.3 METEOROLOGICAL FEATURES AT KOUNDJA STATION

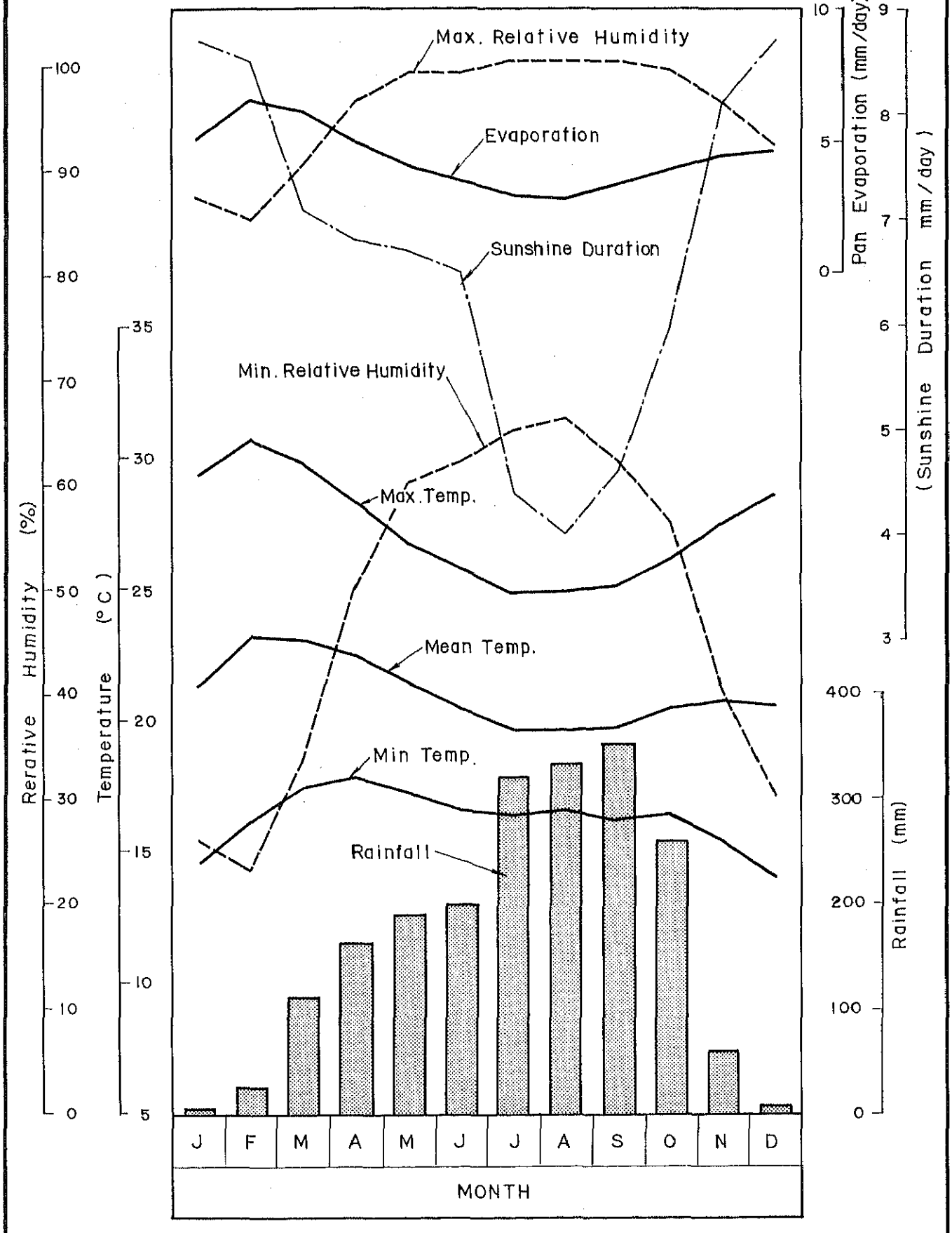


Fig. 1.4 AVAILABLE RECORDS OF RAINFALL

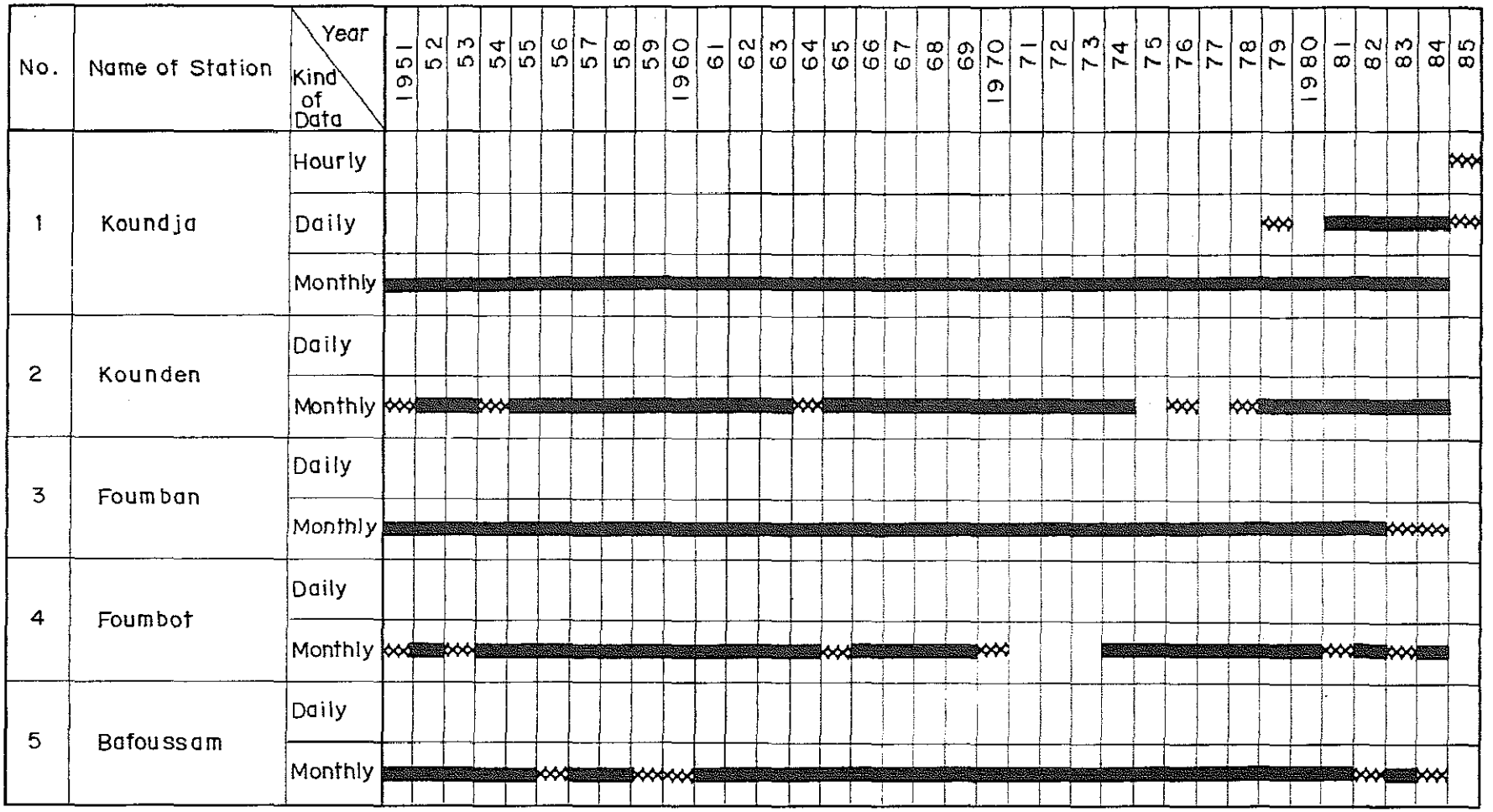
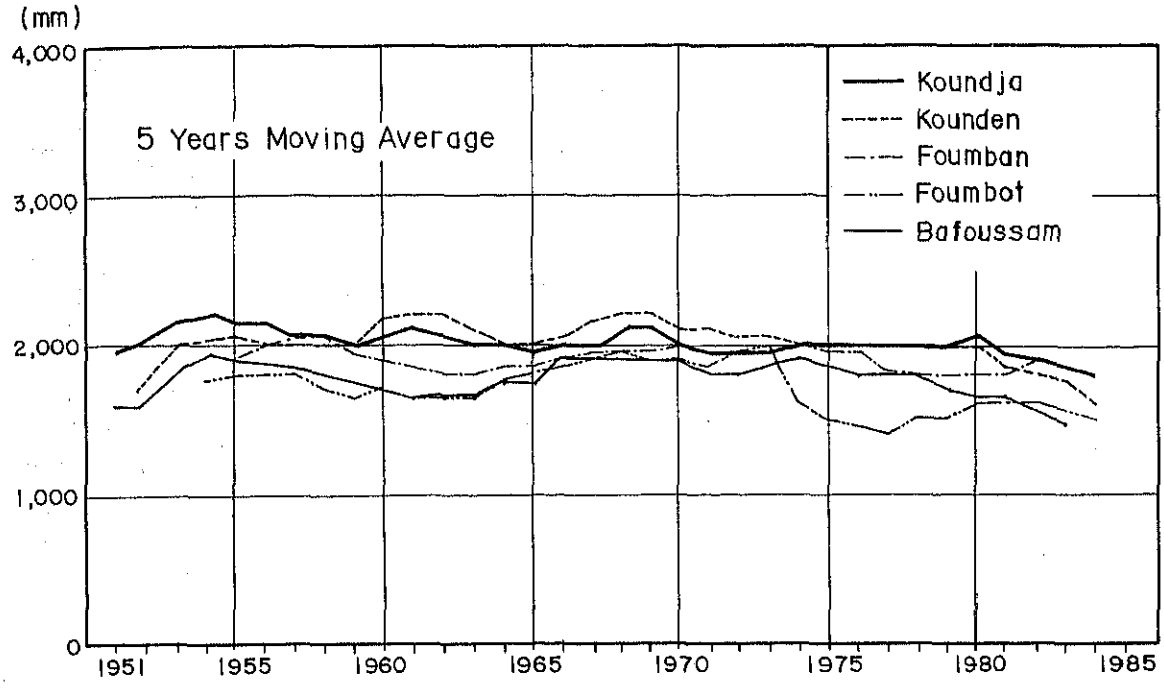


Fig. 1.5 FLUCTUATION OF ANNUAL RAINFALL



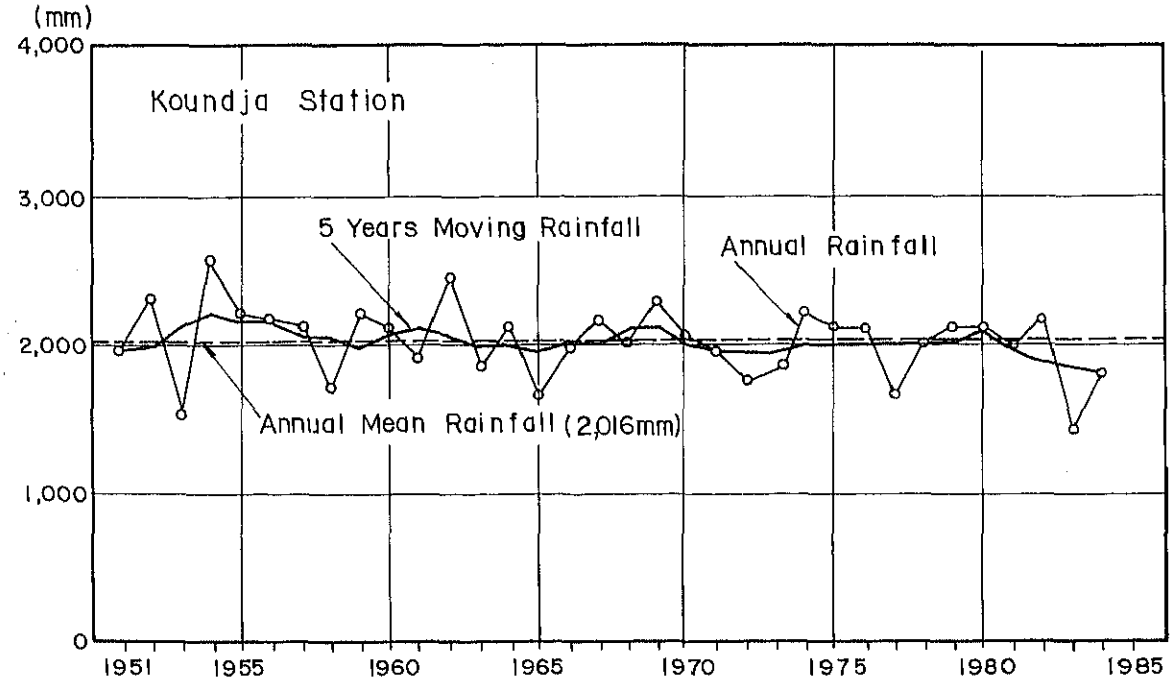


Fig. 1.6 LOCATION OF WATER LEVEL STAFF GAUGES

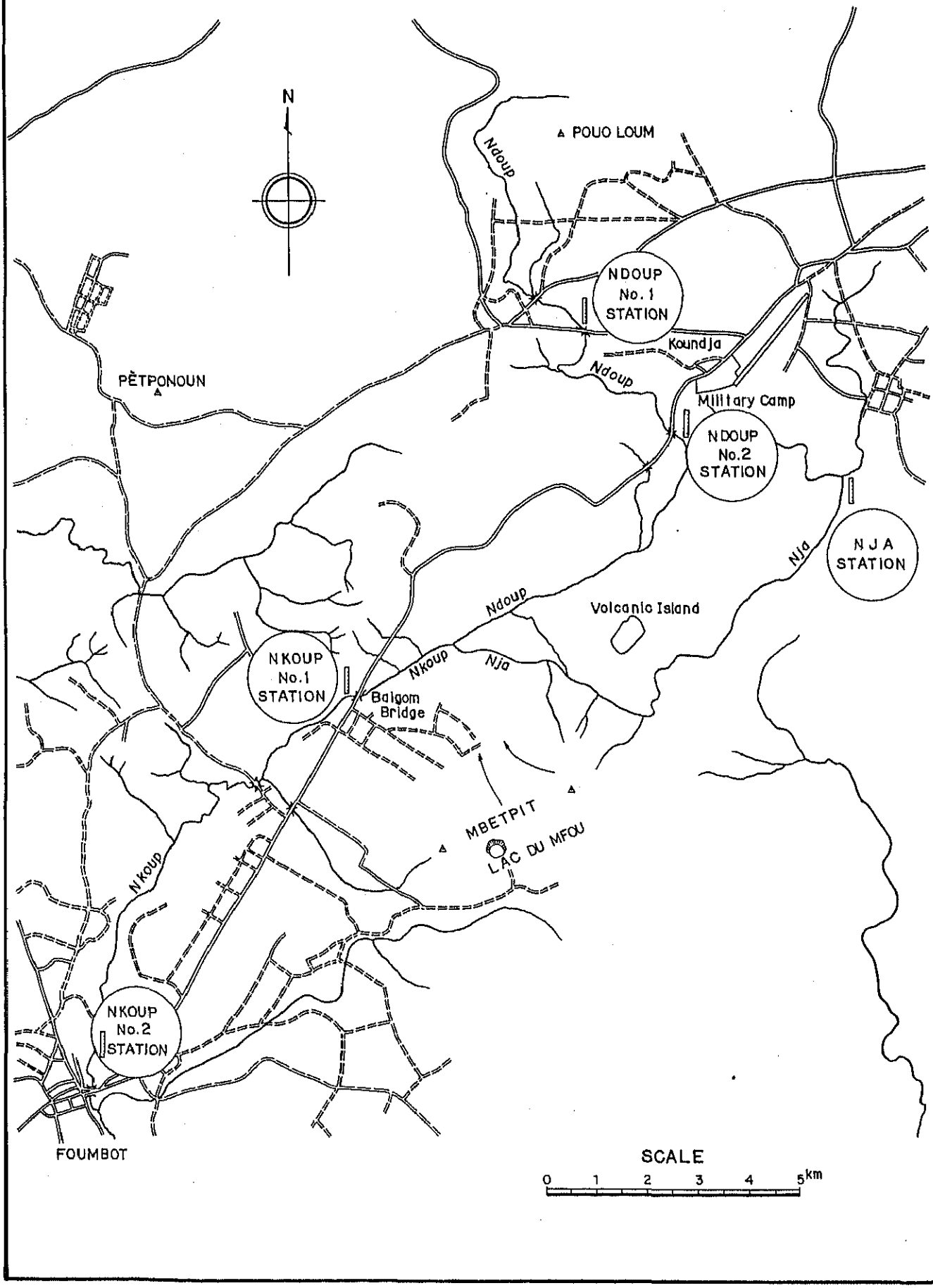


Fig. 1.7 (1/5) RIVER CROSS SECTION

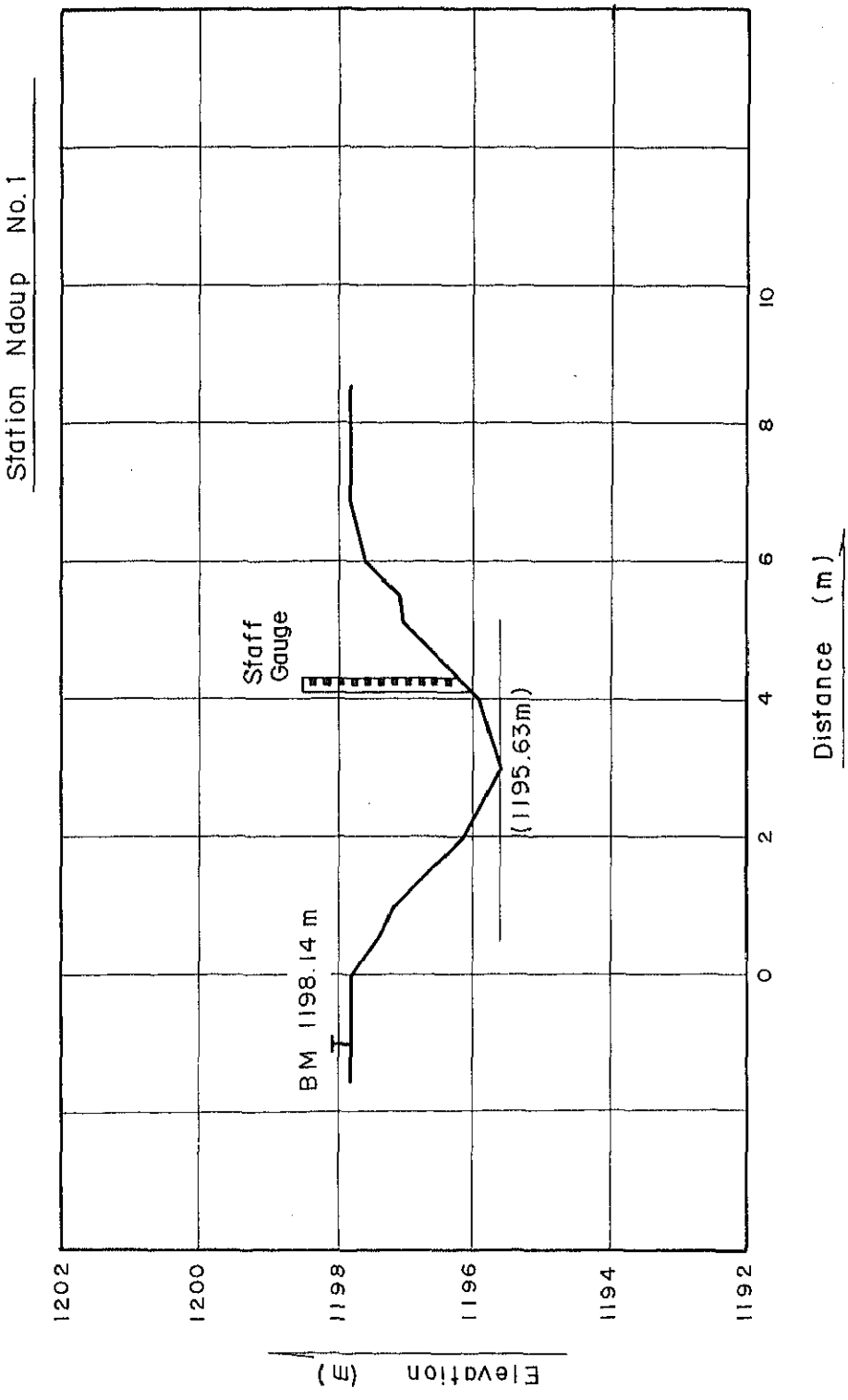


Fig. 1.7 (2/5) RIVER CROSS SECTION

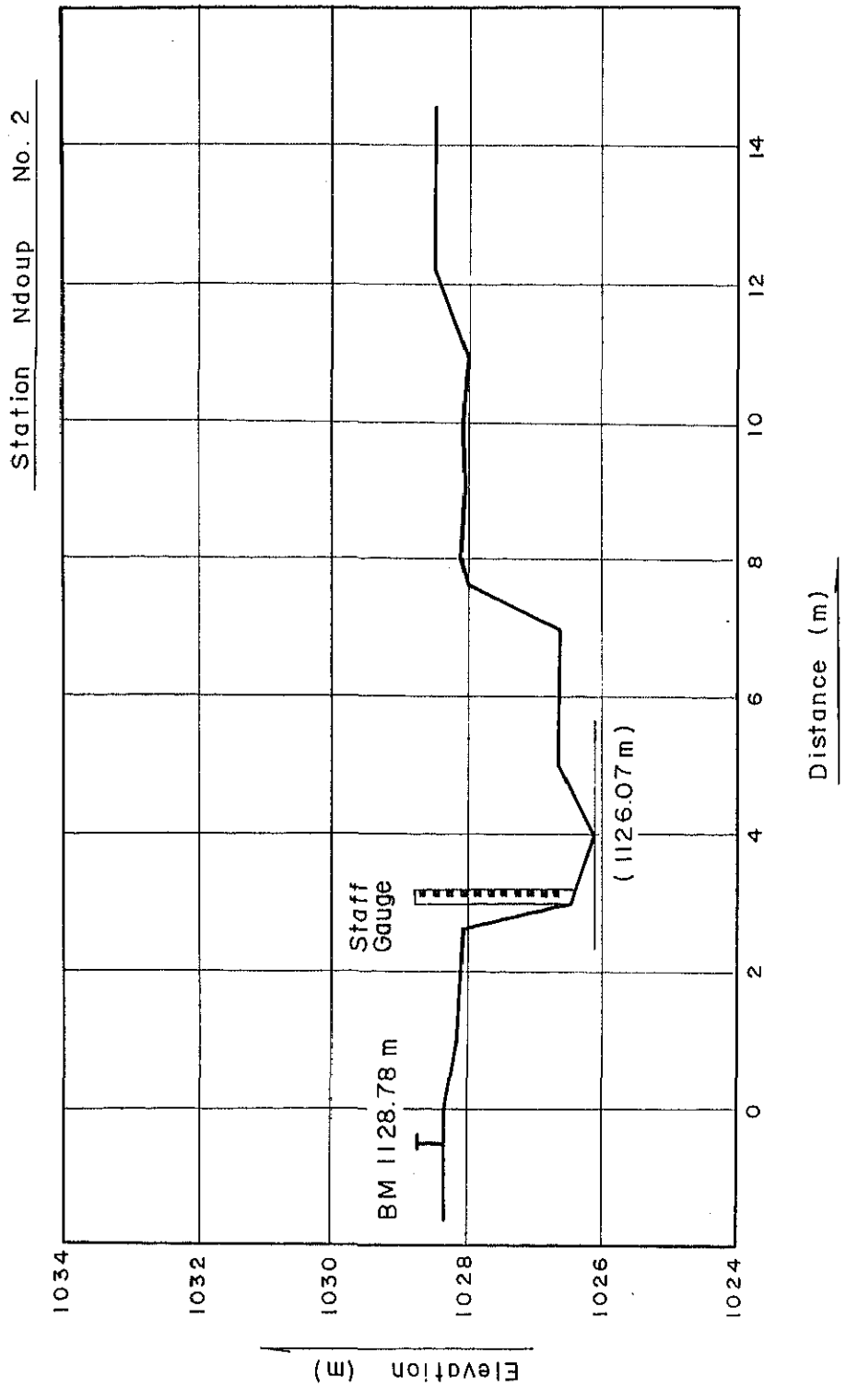


Fig. 1.7 (3/5) RIVER CROSS SECTION

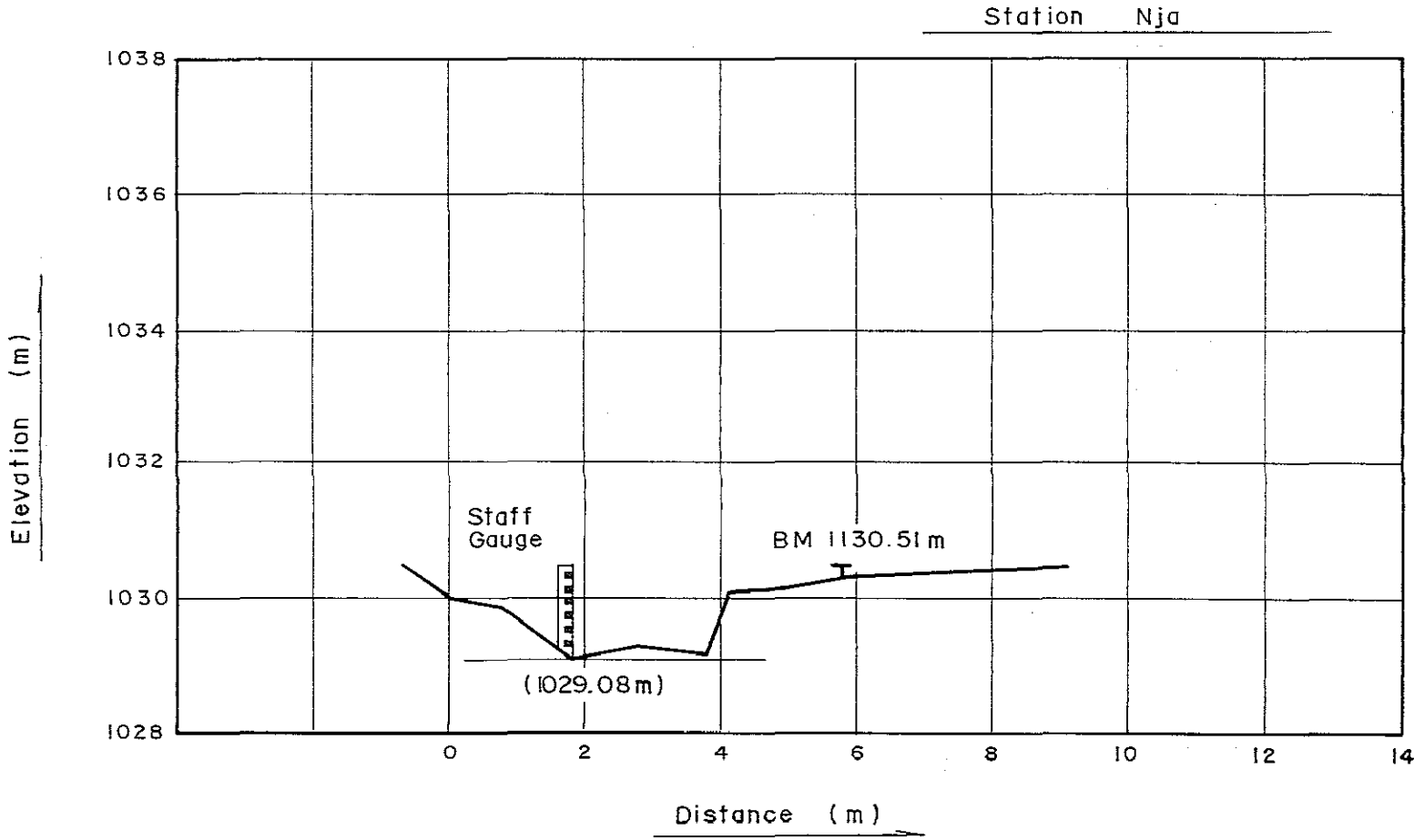


Fig. 1.7 (4/5) RIVER CROSS SECTION

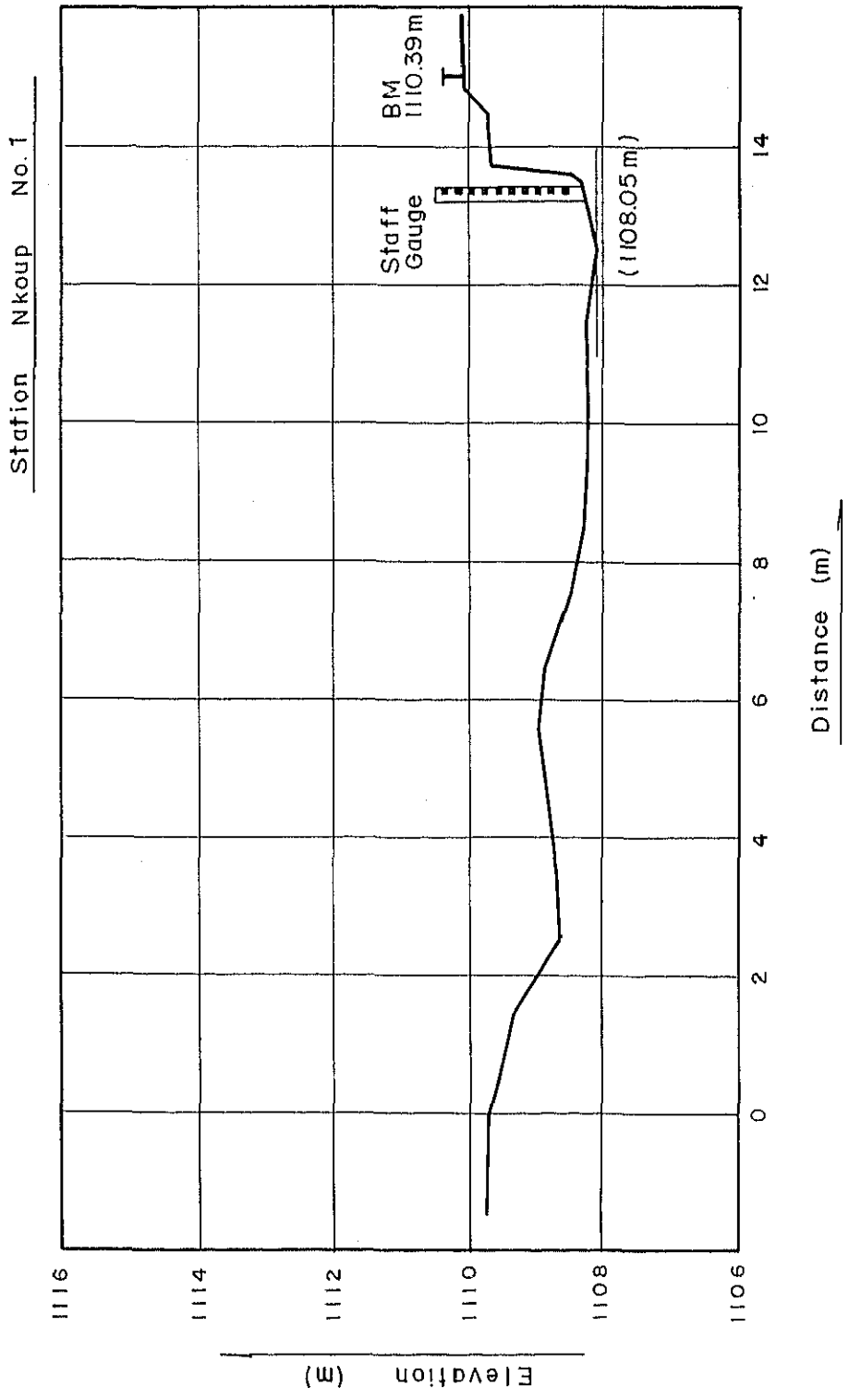


Fig 1.7 (5/5) RIVER CROSS SECTION

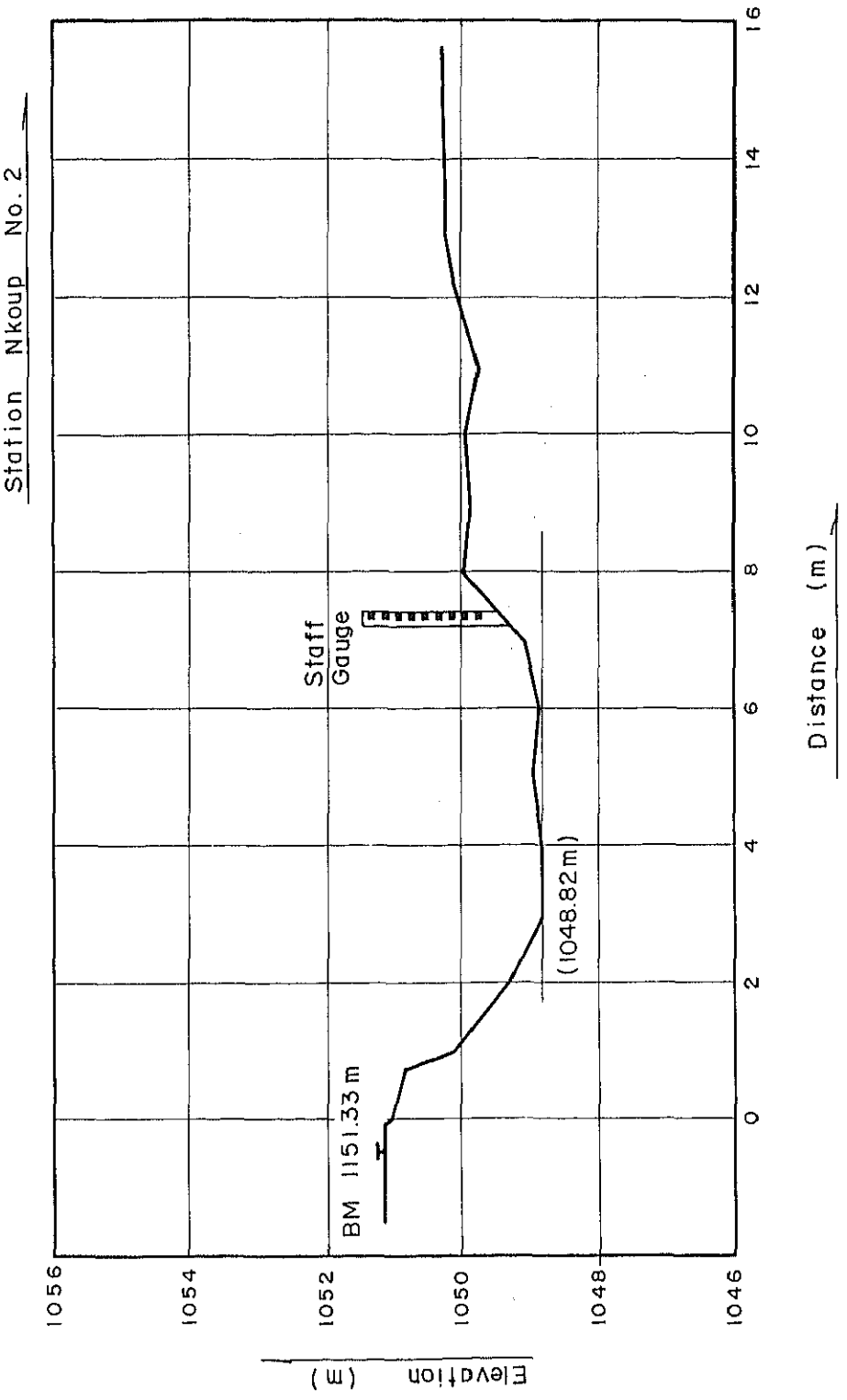


Fig. 1.8 (1/5) RATING CURVE AT NDOUP No.1 STATION

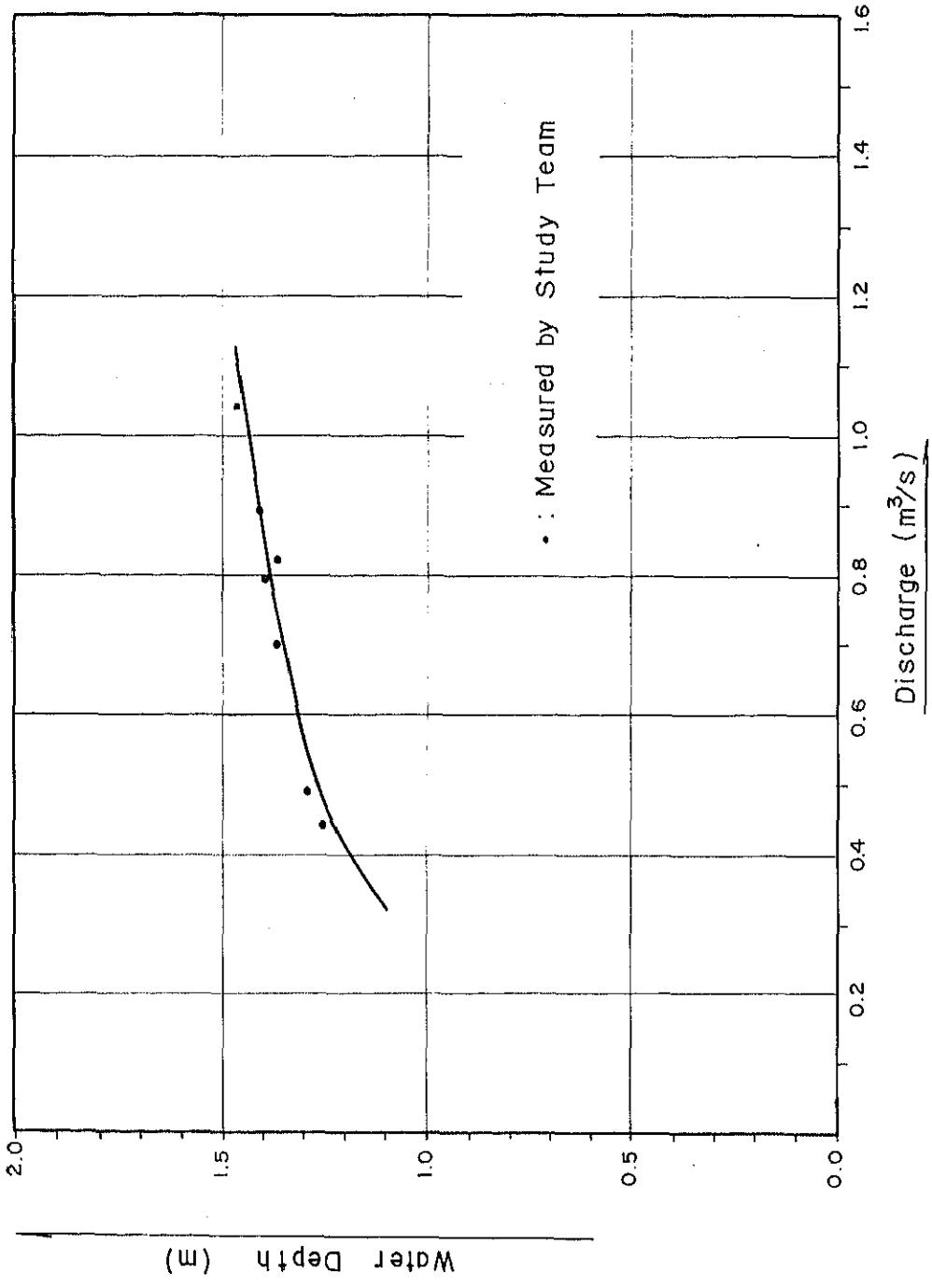


Fig. 1.8 (2/5) RATING CURVE AT NDOUP NO.2 STATION

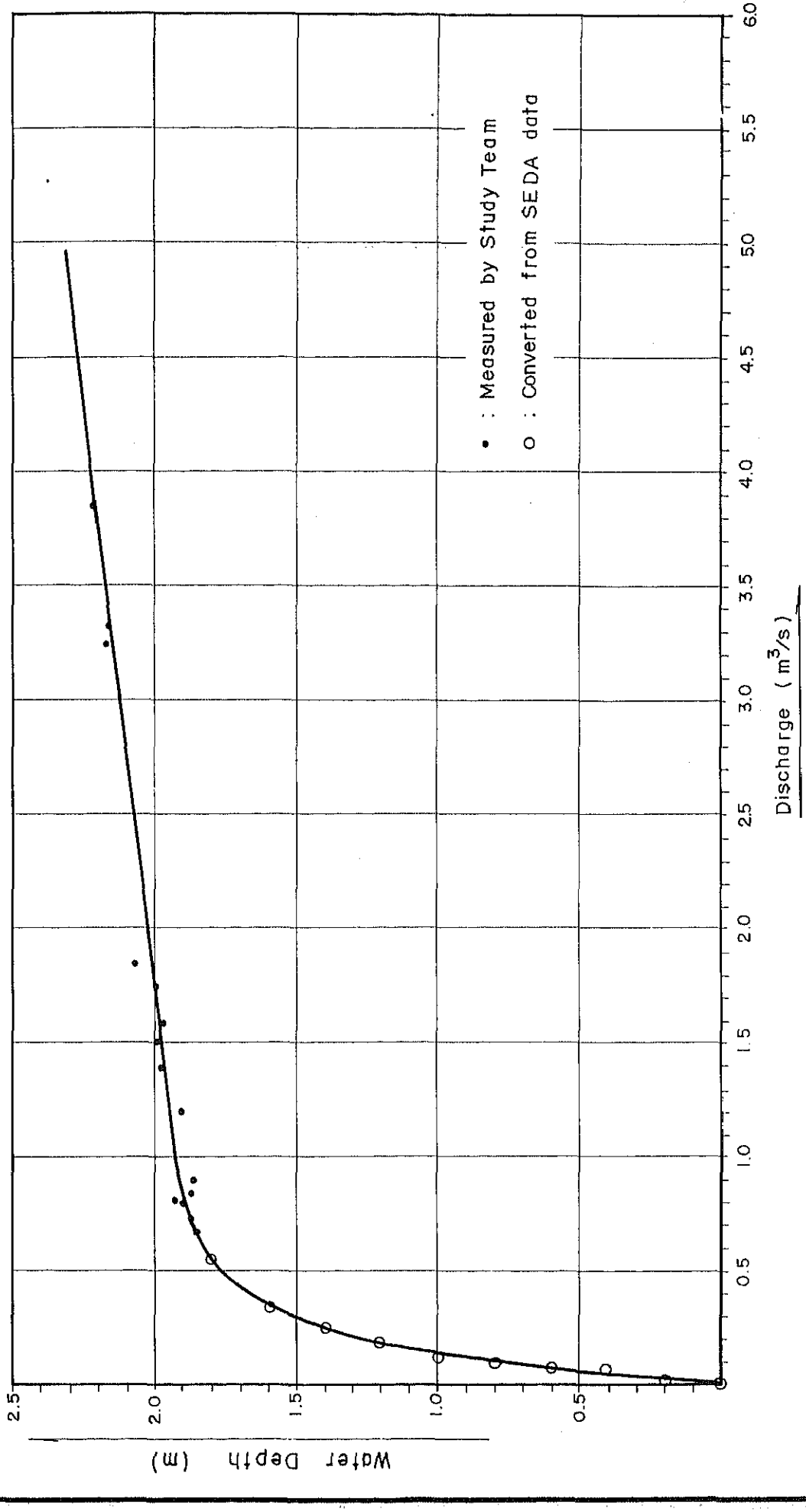


Fig.1.8 (3/5) RATING CURVE AT NJA STATION

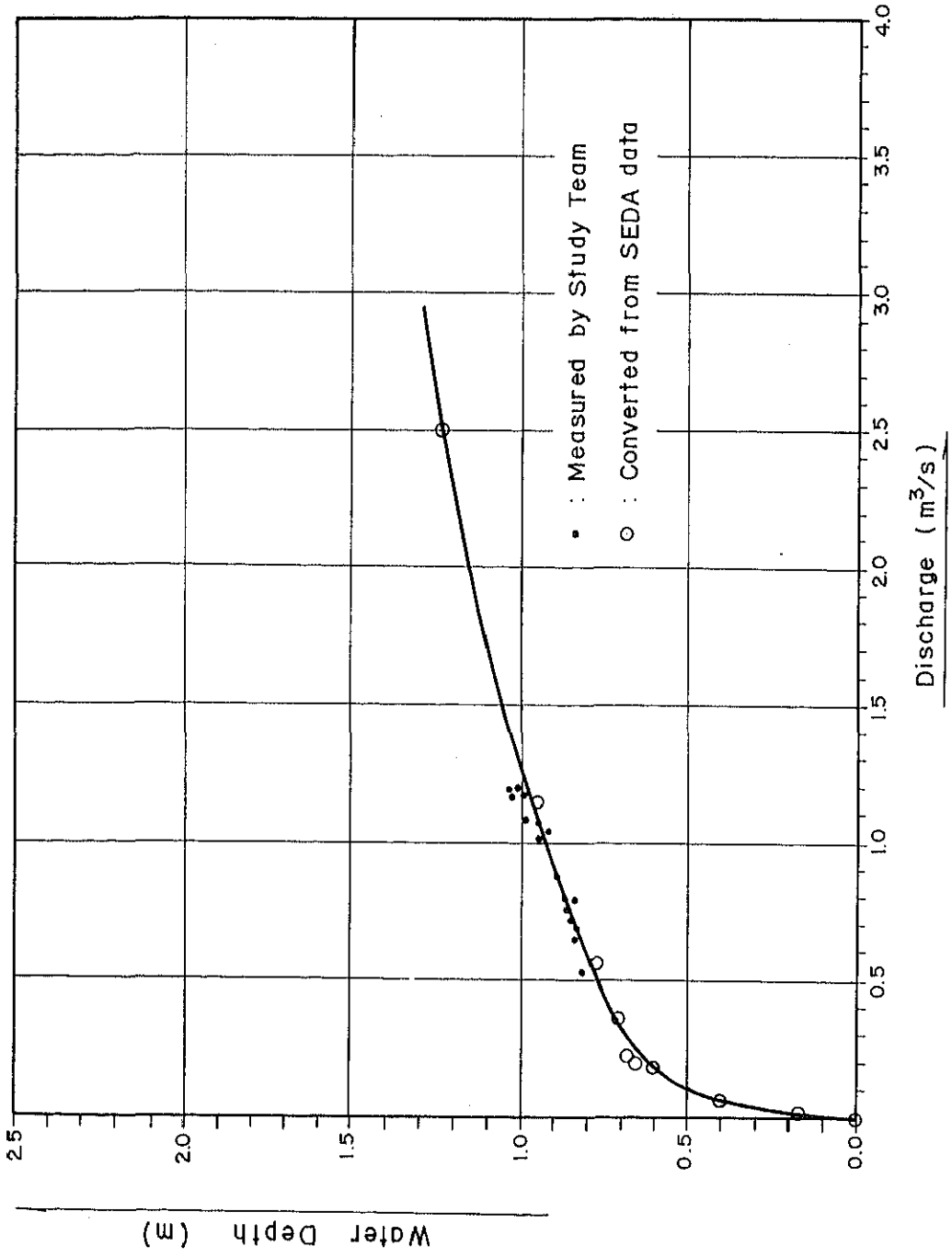


Fig. 1.8 (4/5) RATING CURVE AT NKOUP NO.1

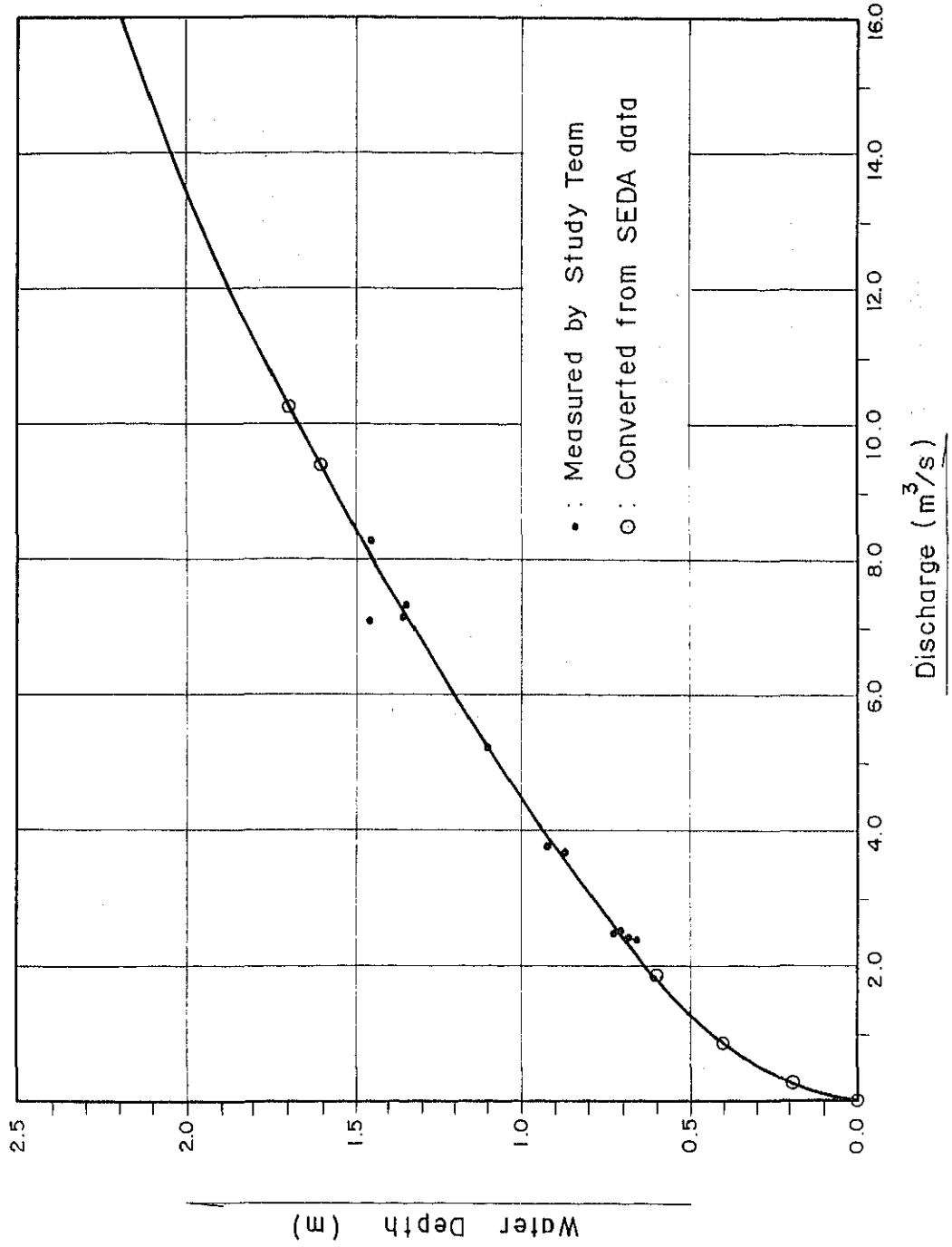


Fig. 1.8 (5/5) RATING CURVE AT NKOUP NO.2

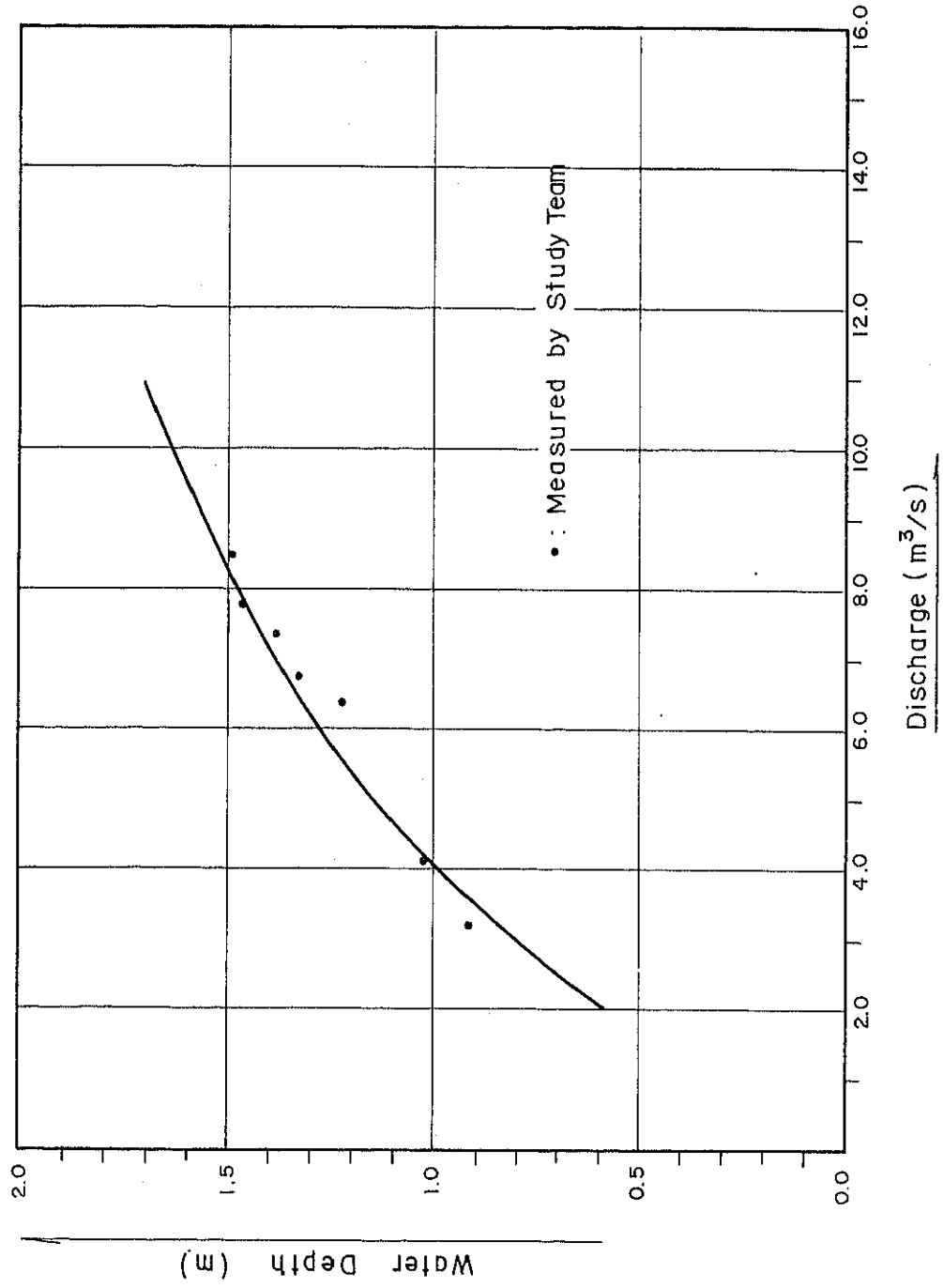


Fig.1.9 (1/2) COMPARISON OF SIMULATED AND OBSERVED 10-DAY DISCHARGES

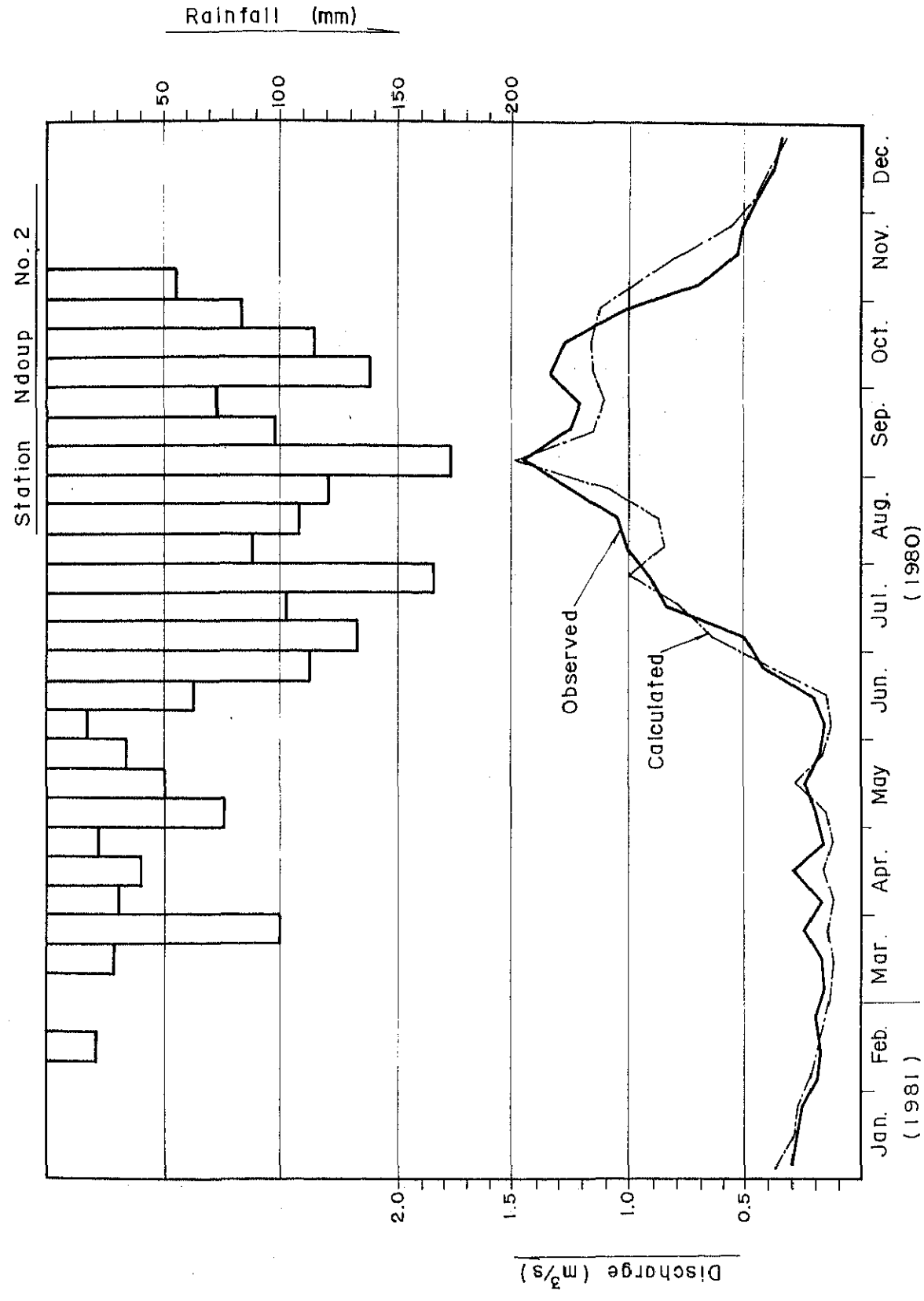


Fig. 1.9 (2/2) COMPARISON OF SIMULATED AND OBSERVED 10-DAY DISCHARGES

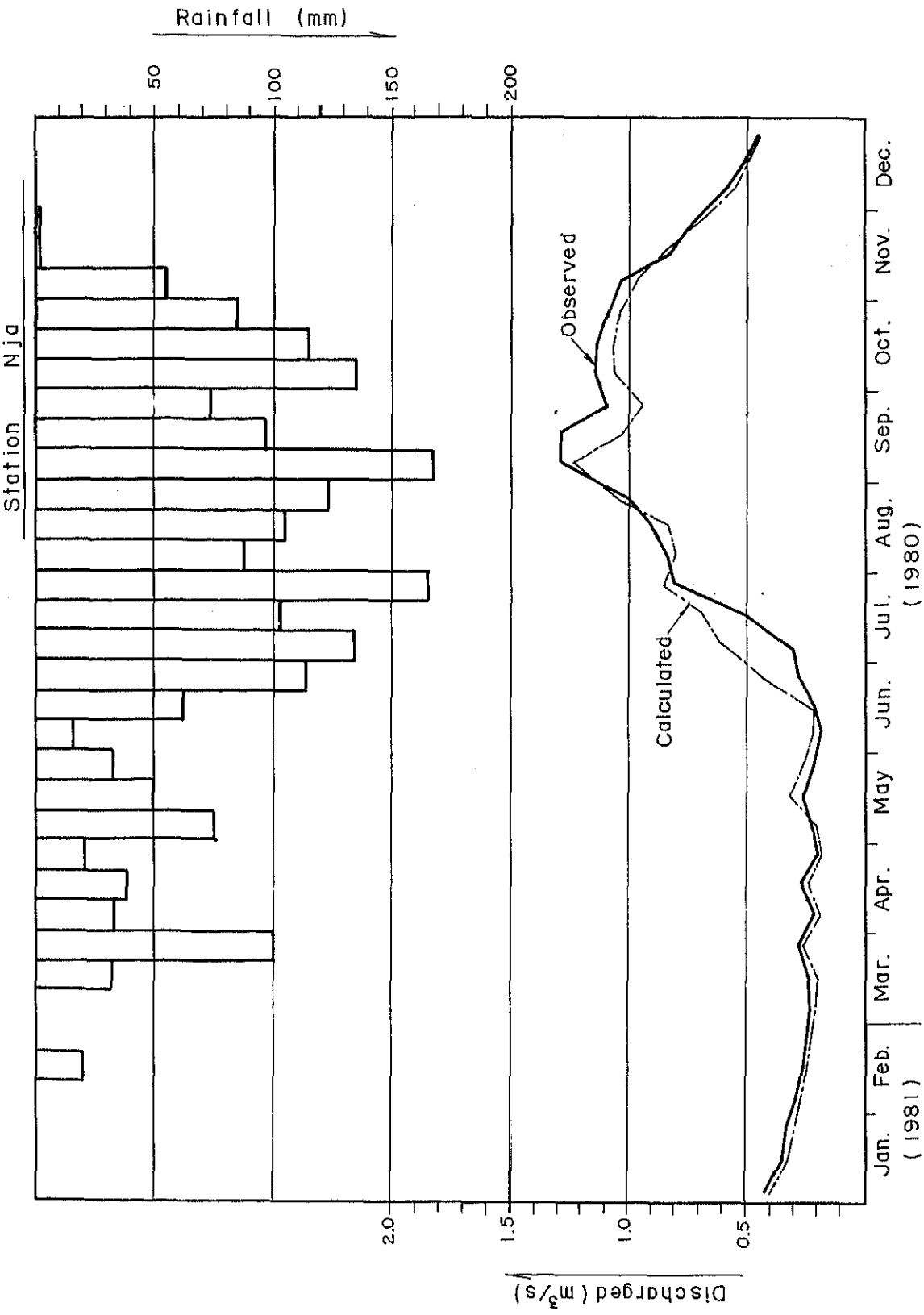


Fig. 1.10 10-DAY DISCHARGE IN 1/5 DROUGHT YEAR

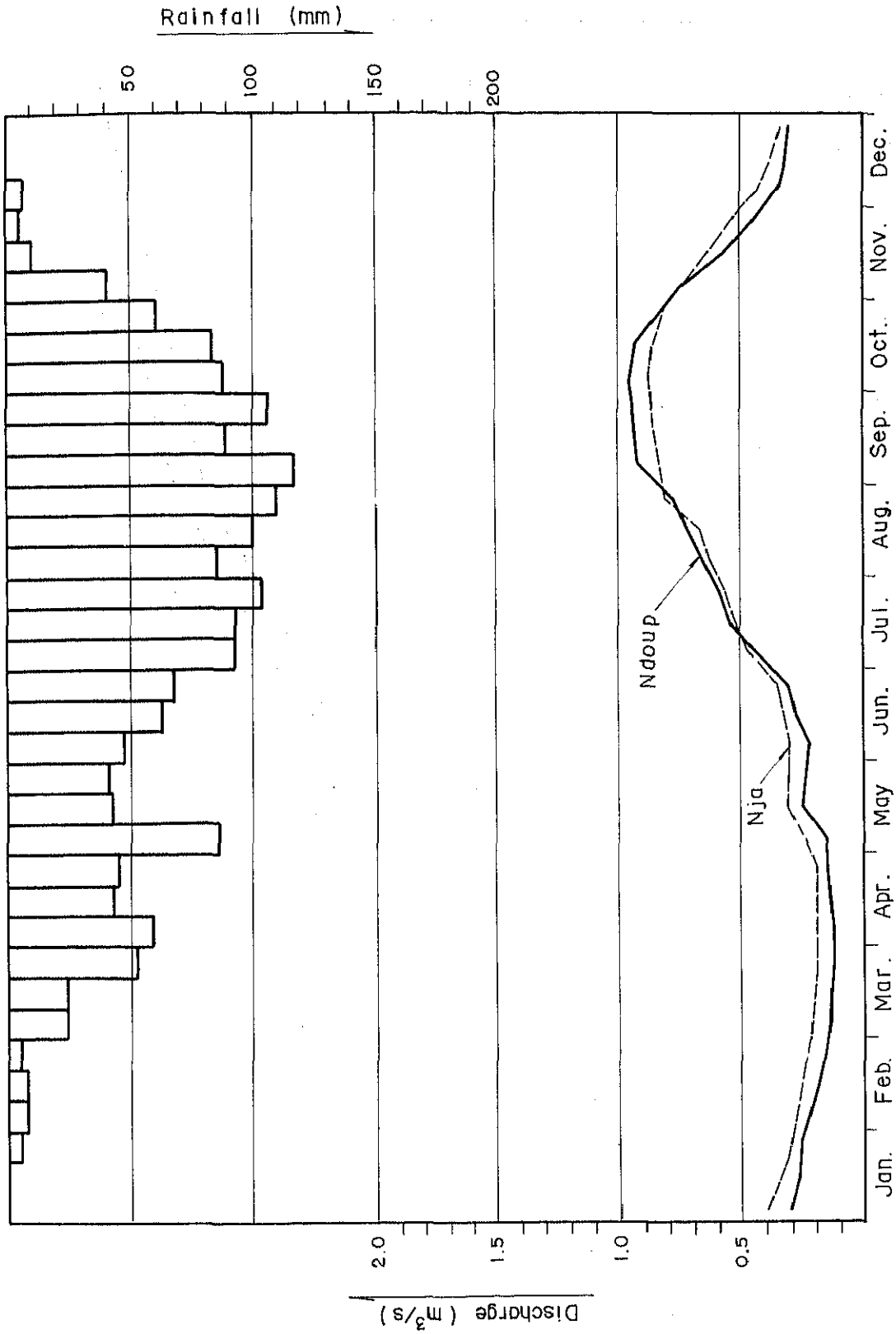


Fig.1.11 (1/2) COMPARISON OF SIMULATED AND OBSERVED HOURLY DISCHARGES

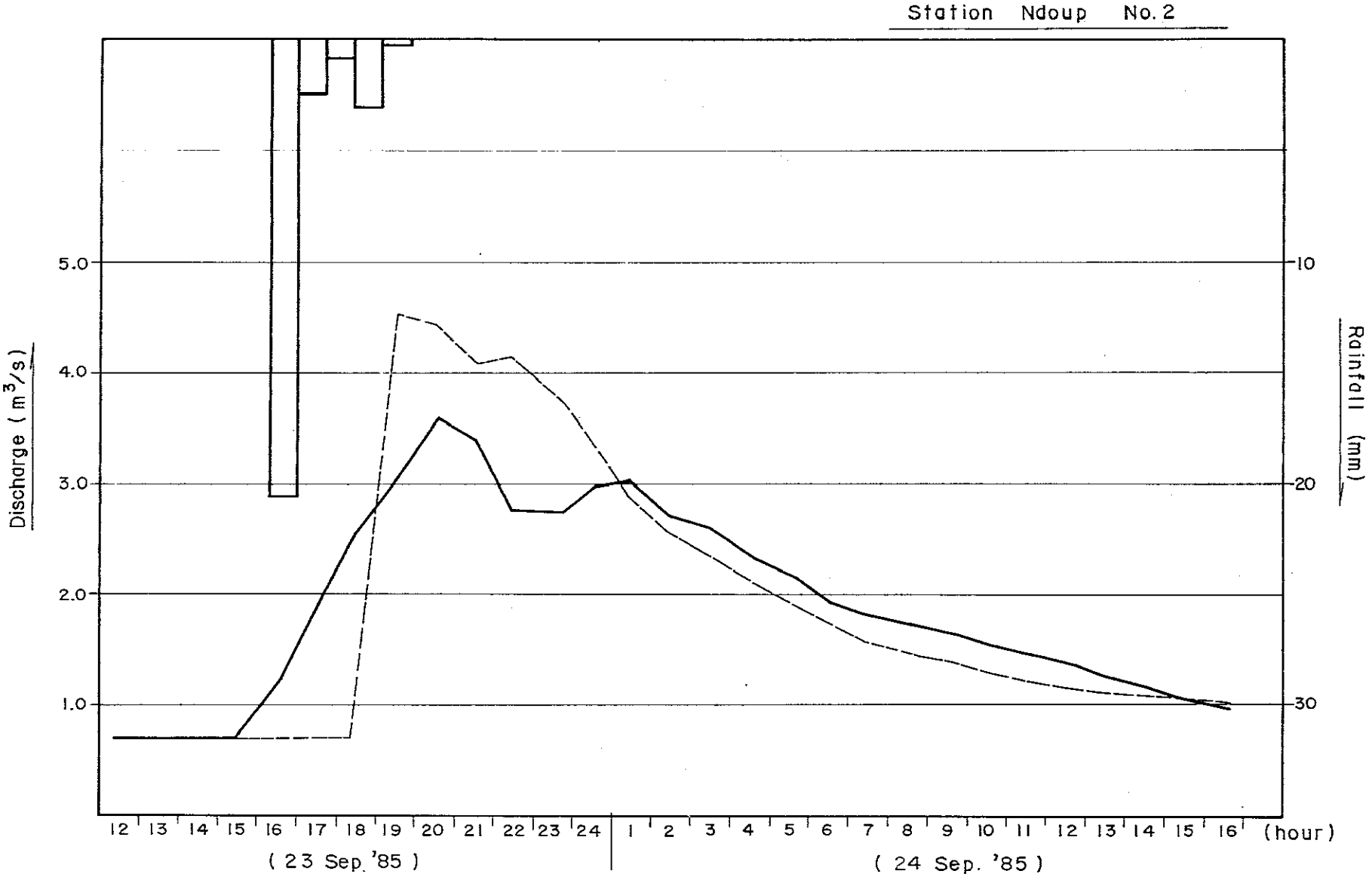


Fig. 1.11 (2/2) COMPARISON OF SIMULATED AND OBSERVED HOURLY DISCHARGES

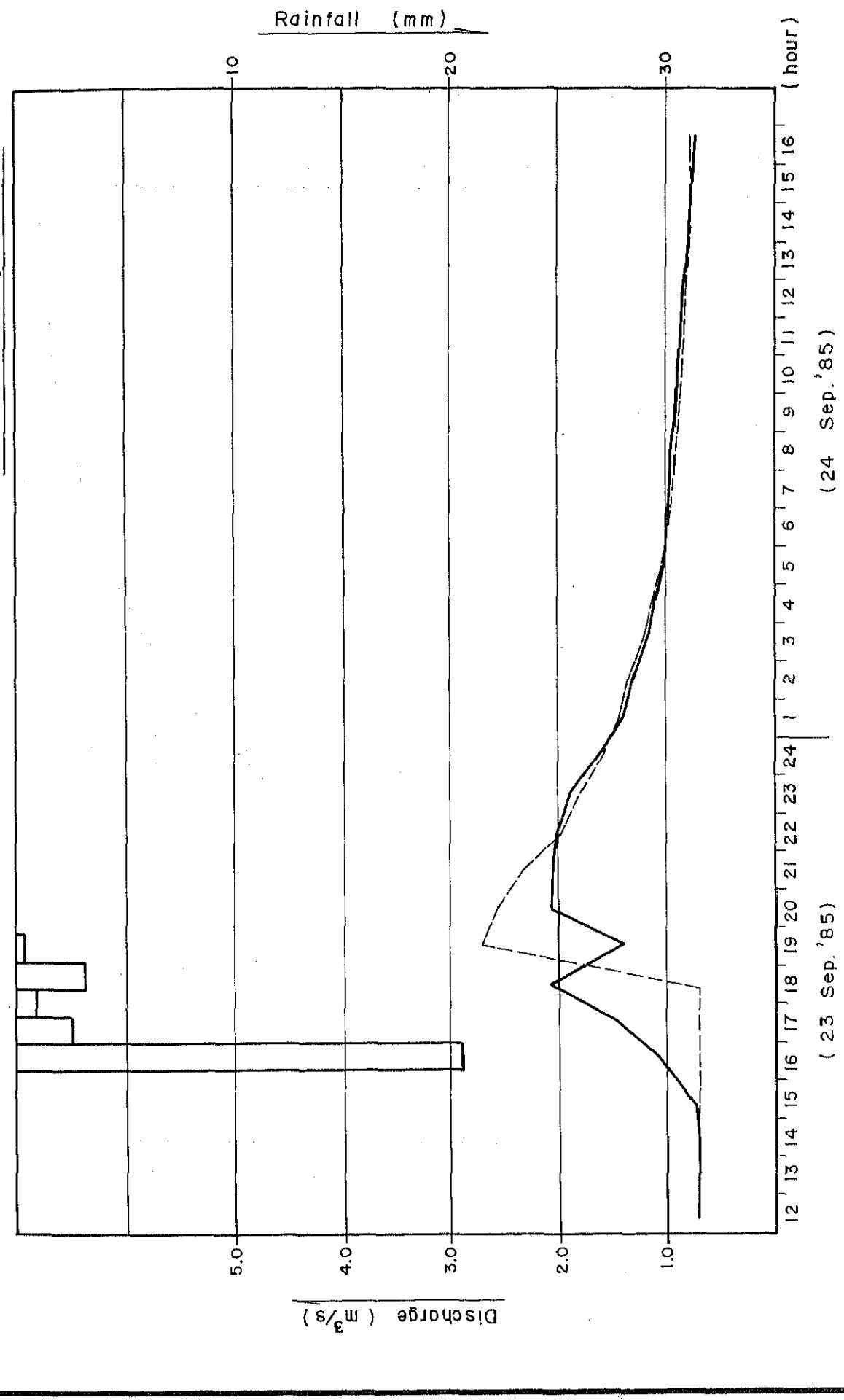
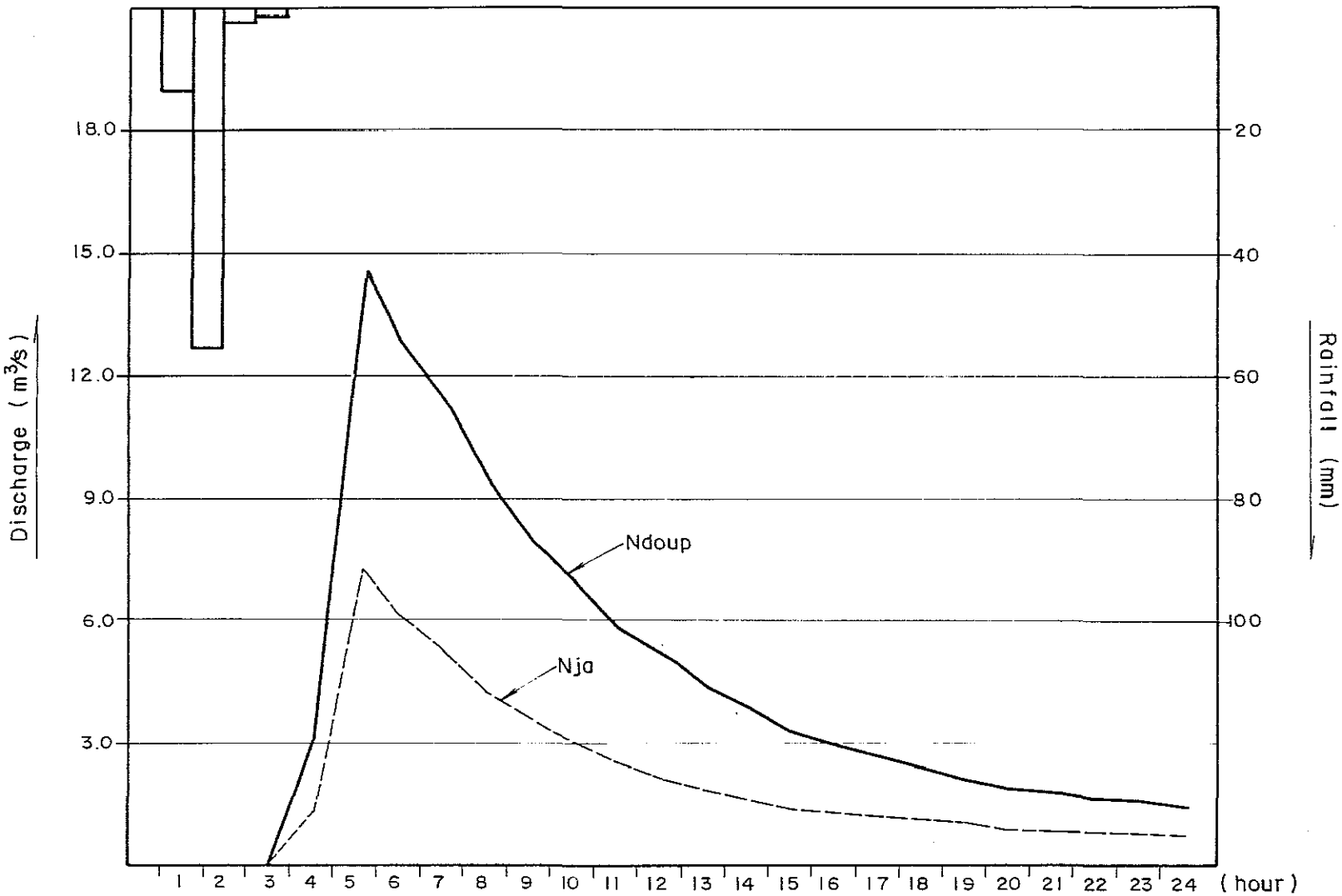


Fig. 1. 12 HOURLY DISCHARGE IN 1/5 FLOOD



ANNEX II

GEOLOGY AND SOIL MECHANICS

ANNEX II

GEOLOGY AND SOIL MECHANICS

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CHAPTER 1 GENERAL

The studies on geology and soil mechanics were made by means of the following ways:

- Review of the previous studies
- Field reconnaissance
- Field investigation using hand auger and cone penetrometer

Since the field investigation was carried out during the rainy season, August- November in 1985, sampling was limited in the accessible areas in and around the Baigom plain.

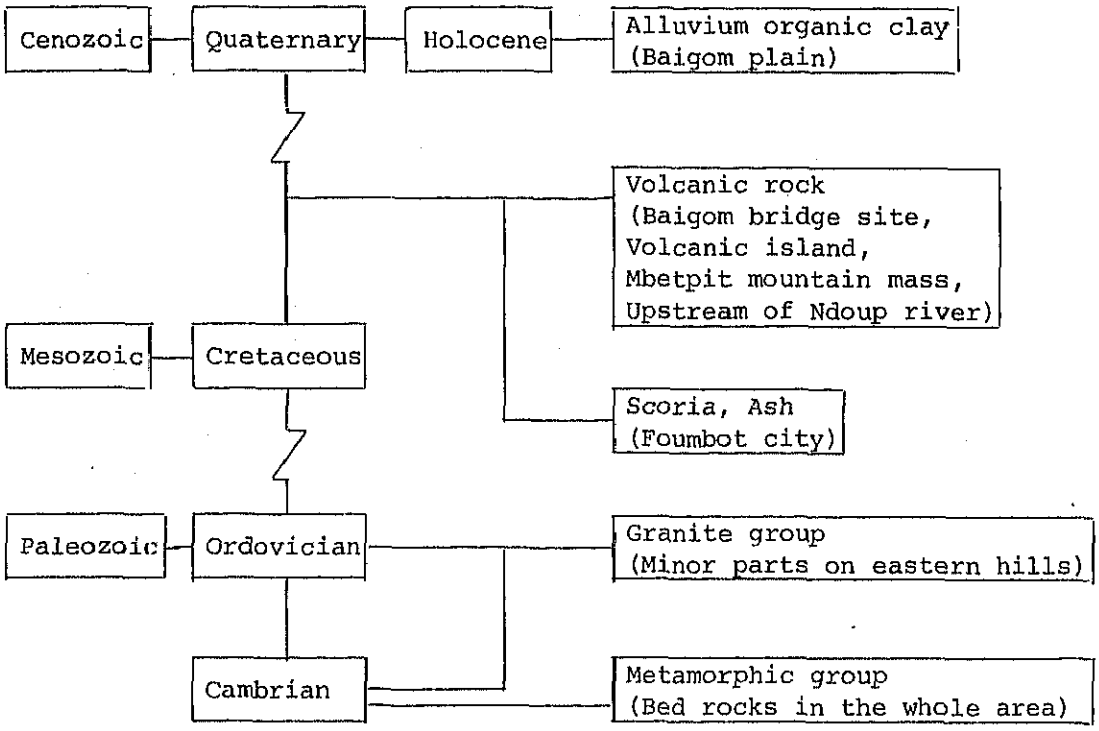
The Baigom plain is located in a particularly hilly area of the Bamoun plateau. The Bamoun plateau is a vast peneplain with some undulation, and highly rejuvenated by recent volcanic eruptions. On the north and south of the Baigom plain, two mountain masses - the Nkogam (2,263 m) on the north and the Mbetpit (1,988 m) on the south - break into the landscape. The Nkogam mountain mass is located about 6 km on the north of the plain and outlines the form of a horseshoe opened toward the west and enclosing the Kounden plain. This mountain mass is formed by complexed horsts, and covered with rhyolites and partially with basalt.

Between the Baigom plain and Nkogam mountain mass, hills of metamorphic rocks that dominate above the plain by about 100 m are capped with fluiditic basaltic lava issued from several Hawaiian volcanic eruption, and shows very unique landscape in the area. These hills and basaltic lava flows continue on the north-east of the plain and extend beyond the Koutaba airport. The Mbetpit mountain mass rises up abruptly on the immediate south of the Baigom plain. A peak of rhyolite dominates the landscape of more than 600 m. The Mbetpit mountain mass also forms a horseshoe open toward the west, but less markedly than in the Nkogam mountain mass. This mountain mass consists of rhyolites and partially basalt. On the west of the Mbetpit mountain mass, there is a lake created by the Mfou crater, which explains the presence of a large amount of ashes and lava observed in the plain.

The existence of the Baigom plain as a flooded and swampy plain was formulated by a recent flow of basaltic lava probably from the Mfou crater, and this lava flow has formed a barrier on the Nkoup river a little upstream from the Baigom bridge on the National Road No. 2. At the center of the plain, a small recent volcano had discharged basaltic ashes and lava which had constituted an island above the swampy plain. The plain is filled up with alluvial deposits from the parent rocks and surrounding volcanic rocks. This filling process is almost completed.

CHAPTER 2 GEOLOGY

The geology in and around the Baigom plain is chronologically classified in the following chart:



The typical rocks in and around the plain are summarized as follows:

(1) Metamorphic rock group

This rock group consists of mainly schist, gneiss, migmatite, etc., which appears in the whole area as the parent rocks of the plain. Most of these rocks are weathered and are in an advanced stage of lateritization except for quartzite dikes which are observed partly in the area.

- Schist

  Outcropping schist occurs rarely, but it can be observed in the hills on the south-east of Ngoundoup. These schists are deeply weathered with yellowish gray colour. These weathered schists are observed on the trench of the National Road No. 2 between Mfa Checkwet on the south and Ngoundoup on the north. The weathered schist lies directly on very developed gneiss, and are passed through by a large number of quartzite dikes, which are well preserved and have resisted to weathering. These quartzites sometimes outcrop in the form of real small masses as observed near Mfa Chekwet.

- Gneiss and Migmatite

  These rocks are found on the foot of the Mbetpit mountain mass and Ngoundoup hills in the north of the Baigom plain. In the vicinity of the Baigom bridge, banded gneiss are encountered. On the further north on the trench of the Road and Ngoundoup hill, eyed gneiss (gneiss with eyed structure) are outcropping.

(2) Volcanic rocks

Volcanic rocks are composed of basic (basalt), neutral (trachyte, andesite) and acid (rhyolite).

- Basalt

  Basalt appeared in the area is the form of volcanic effusions such as fine volcanic ashes, scoria, bombs and large sized boulders with very frequently vesicular texture. It is an olivine-pyroxene basalt which is very little weathered.

- Rhyolite

  Rhyolite is observed in outcrop over the whole Mbetpit mountain. The Mfo lake is an ancient explosion crater, and the pyroclastic effushins have flooded on the south-western part of the plain.

  The effusions and mainly volcanic ashes at the foot of Mbetpit are of gray or brown colour.

- Trachyte and Andesite

  At the foot of Mbetpit, especially in the torrent river bed, some volcanic bombs and andesite blocks are observed. Sanidine trachyte in the form of colluvium packed in transported soils are found on the Ngoundoup hill and along the trench of the National Road No. 2.

(3) Granite group

Granite group mainly composed of highly weathered granites is observed at minor parts on the eastern hills. Such a weathered granite also appears at the right side hills of the Nja river near the proposed dam site, and its outcrop is observed at the left side hill of the river.

The geological feature of the area can be summarized as follows:

- Basaltic outcrop is located on the Nkoup river a little upstream from the Baigom bridge, which forms barrier for drainage of the plain.
- Metamorphic rocks are parent rocks of the area.
- On the north of the plain, schists and quartzite are side by side with fairly migmatized gneiss.
- On the south-east of the plain, highly weathered granites are observed.
- The volcanic island in the plain is well constituted of a recent basaltic materials.

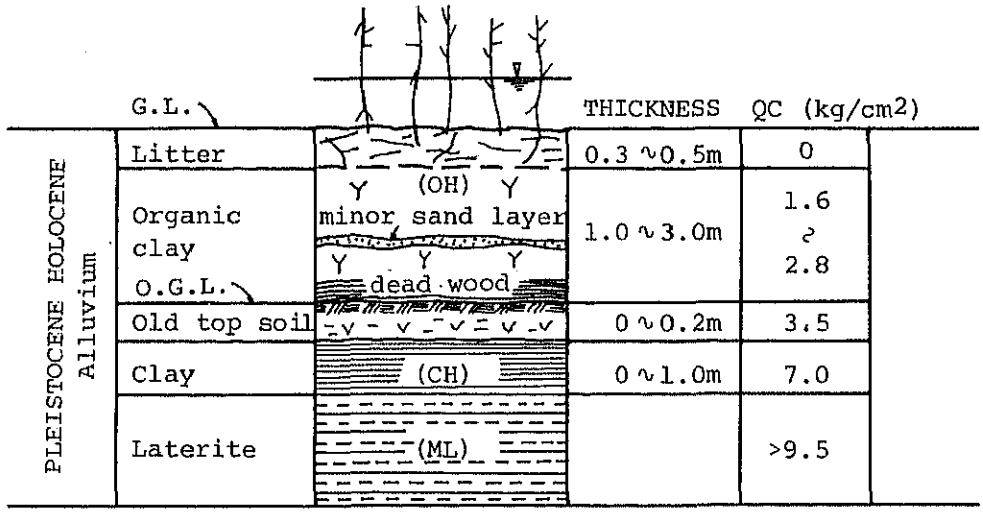
CHAPTER 3 SOIL MECHANICS

Soil mechanical investigations on the soil layers in the Baigom plain were made by hand auger drillings and penetration tests using the cone penetrometer.

The investigated points are shown in Fig. 2.1 and results on each point are shown in Table 2.1.

The following sketch shows the standard layer system in the Baigom plain.

STANDARD LAYER SYSTEM OF BAIGOM PLAIN



qc: Cone Bearing Capacity

G.S: Ground Surface

O.G.S: Old Ground Surface

Generally speaking, the area along the Nja river from the entrance into the plain to the eastern edge of the volcanic island is covered with a thick layer of organic clay. On the other side, a rather thin organic clay layer is found along the Ndoup river from the entrance into the plain to the northern edge of the island.

Descriptions for each soil layer are summarized as follows:

a) Little layer

This layer consists of undercomposed materials such as reeds, aquatic plants, fallen trees and roots, and rotted matters of the above. This soil layer is found all over the plain.

b) Organic clay layer

This layer is formed of volcanic ashes and sedimented clay which are transported from the external drainage basins. This soil layer contains organic matter perfectly decomposed, and sand layer is found partly. This organic clay has high shrinkage ratio by drying, high sensitivity ratio, high dry density and high dry strength. This means that this clay layer would have enough bearing capacity when the soil is dried after completion of the drainage works in the plain.

c) Old ground surface

On the old ground surface under the above organic clay layer, pieces of fallen trees are found in same places. These places are covered with rotten woods and not yet mineralized.

d) Old top soil layer

This layer is composed of volcanic ashes with mostly black colour, and is found all over the plain except for the circumferencial area of the area.

e) Clay layer

This layer is composed of weathered laterite with high density. It is considered that this soil was made through chemical weathering, and has a colour of grayish white. This layer is found mainly in the surrounding areas of the volcanic island.

f) Laterite layer

This layer is the bed soil layer of the plain and it shows red colour. The laterite is considered to be formed from metamorphic rocks through weathering with high temperature and high humidity which peculiar to the tropical region. It seems that this layer has been formed before the plain because swampy and lateritization is still proceeding at present. This laterite is judged to be ML (low consistency silty clay) according to the unified soil classification system.

From the results of the field investigation on soil mechanics, the isobathes of the bearing capacities in the plain are shown in the Figs. 2.2 and 2.3.

The lines on the map show the depth of layer which have qc values of 3.0 kg/cm^2 and 9.5 kg/cm^2, and qc means the value of cone bearing capacity.

qc: 3.0 kg/cm^2 line shows the boundary of organic clay layer and clay layer.

qc: 9.5 kg/cm^2 line shows the depth of laterite which is the bed soil layer of the plain.

Swamp bulldozer is workable on the lands which have qc value of more than 3.0 kg/cm^2

The results of cone penetration tests at the proposed dam sites are shown in Table 2.2 and the locations of tests are shown in the drawings of proposed Ndoup and Nja dams (see Annex XII).