F I G U R E S

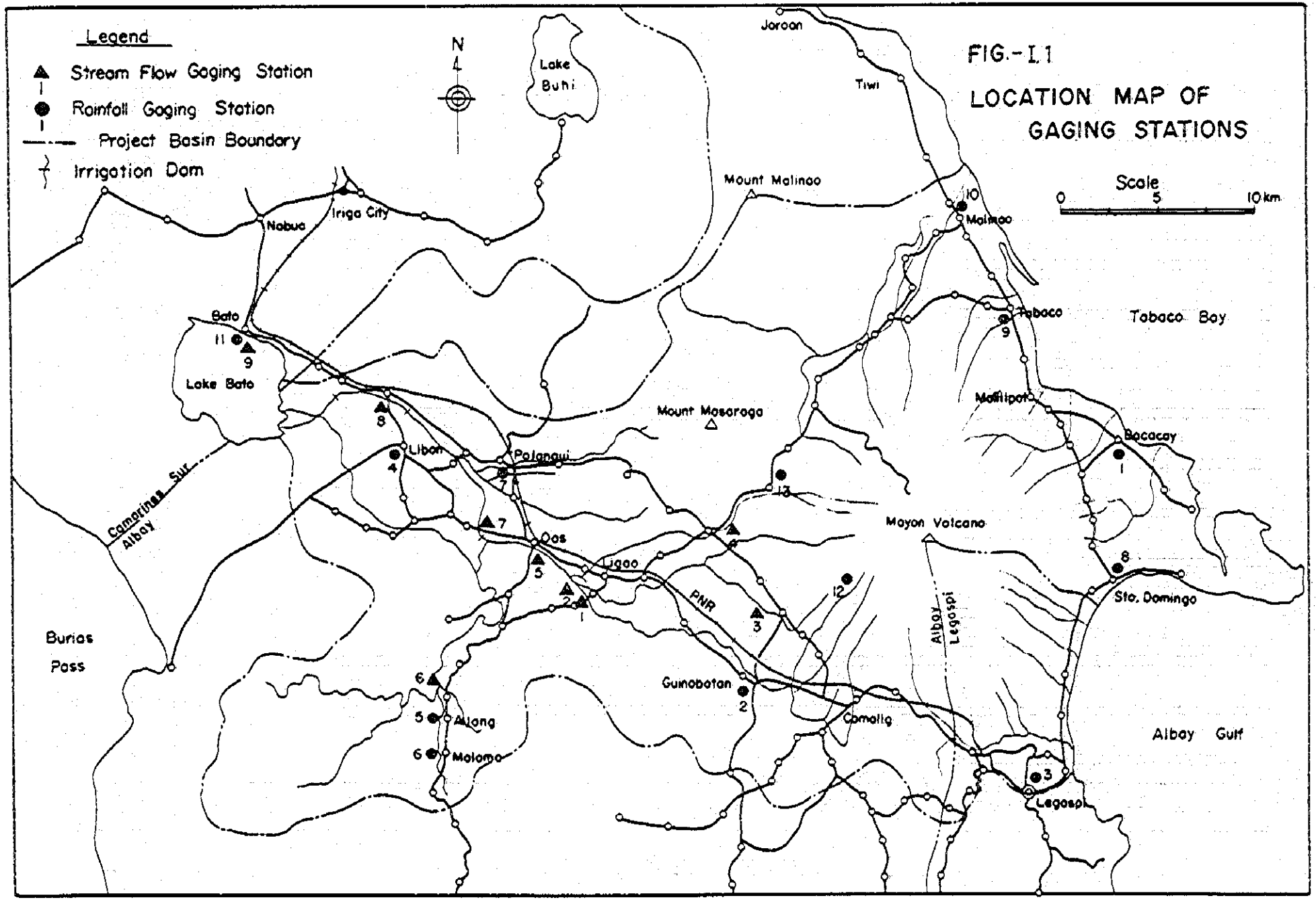
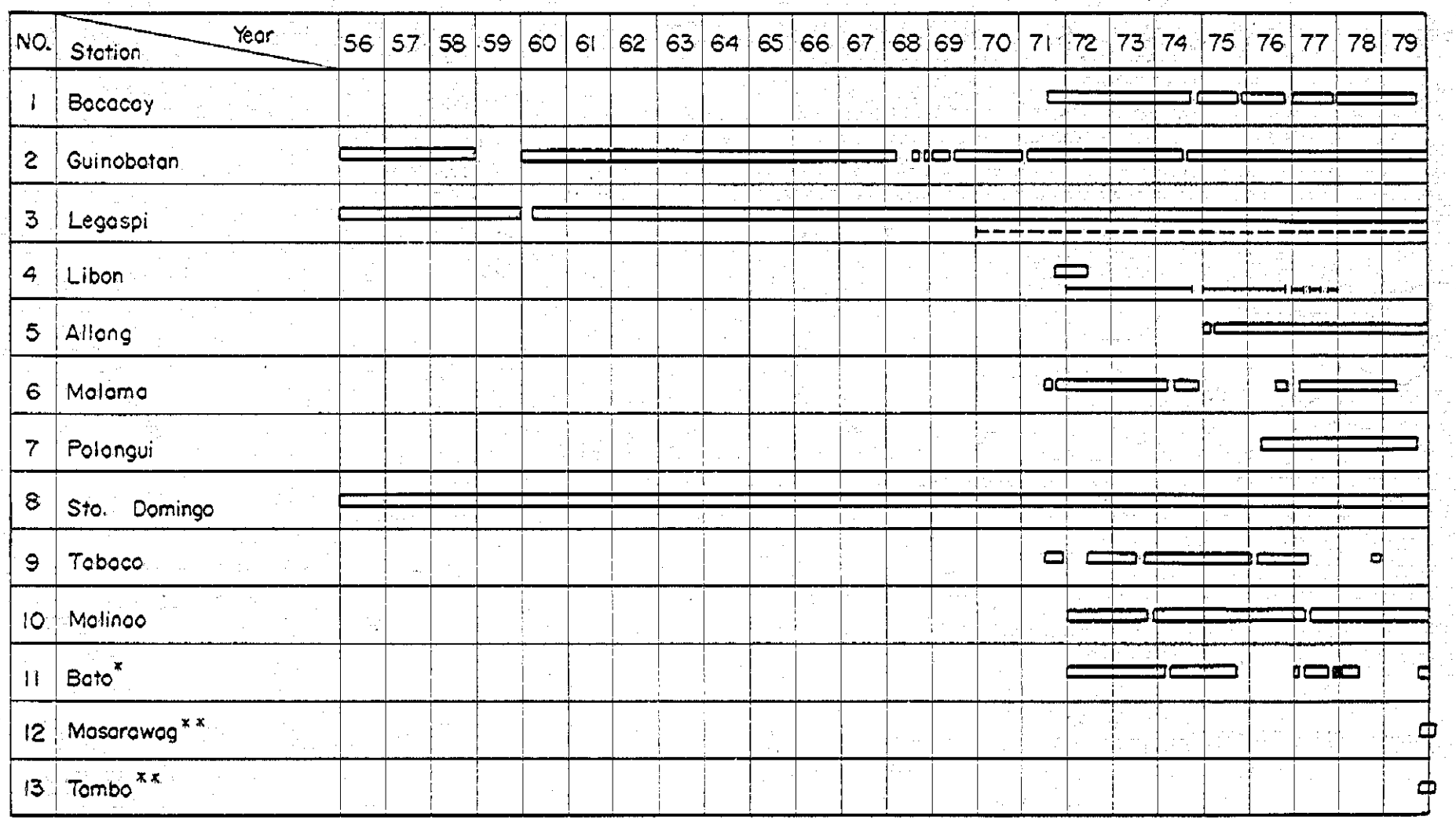

Legend
Stream Flow Gaging Station
Rainfall Gaging Station
Project Basin Boundary
Irrigation Dam
N
FIG.-I.1
LOCATION MAP OF
GAGING STATIONS
Scale
0 5 10 km
Joroan
Tiwi
Lake Buhi
Mount Malinao
Malinao
Nabua
Iriga City
Bato
Lake Bato
Tabaco
Tabaco Bay
Malilipot
Mount Masaraga
Libon
Polangui
Bacacay
Camarines Sur
Albay
Mayon Volcano
Oas
Ligao
PNR
Sto. Domingo
Albay Legaspi
Burias Pass
Guinobatan
Camalig
Albay Gulf
Legaspi
Malong
Molomo

FIG.-I.2 LIST OF RAINFALL RECORD LENGTH

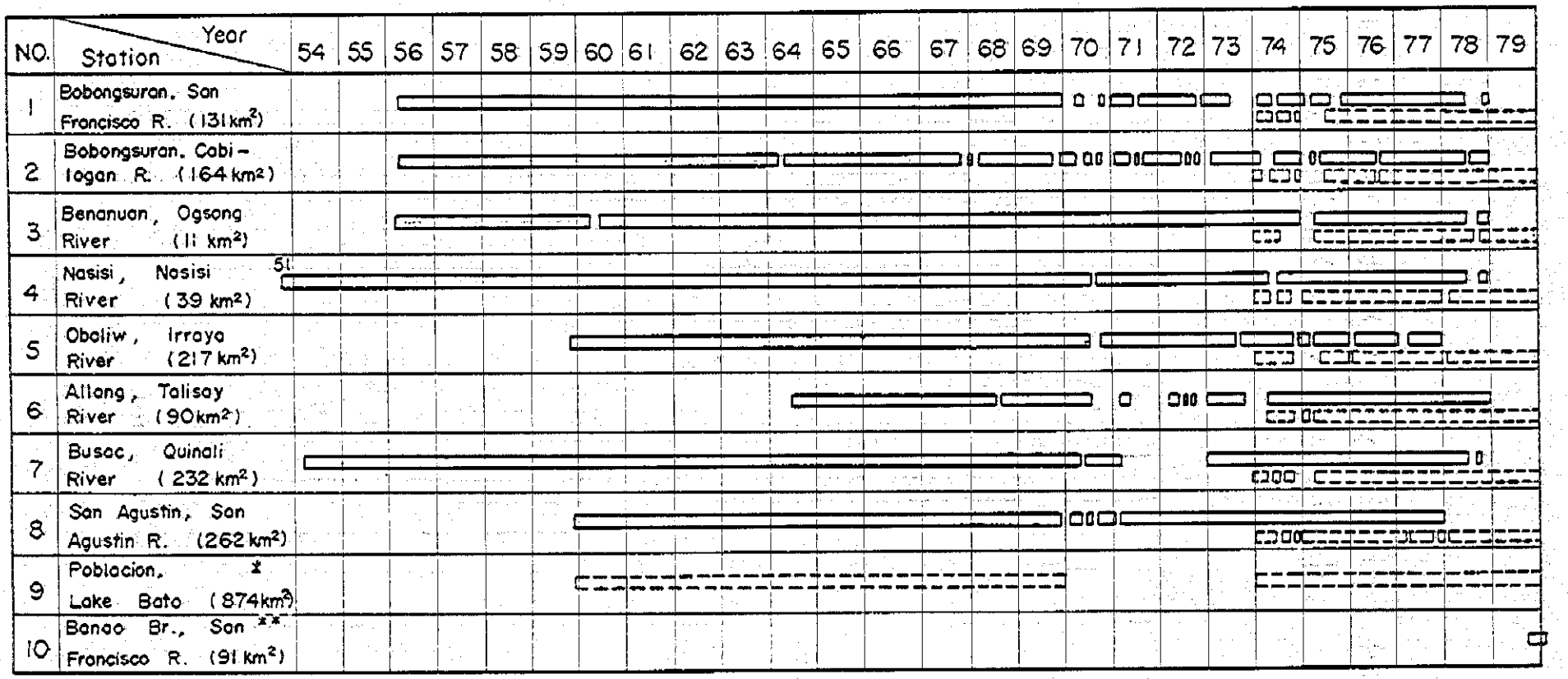


* Station outside the project area

** Stations installed by the study team (no longer operational)

Legend ; daily record
6-hour record
monthly record
hourly record

FIG.-I.3 LIST OF STREAM FLOW RECORD LENGTH



* Station outside the project area

** Stations established by the study team.

All station are located in the Quinali (A) River basin.

Legend ; daily discharge record

daily gage height record

hourly gage height record

FIG-1.4 FREQUENCY CURVES FOR ANNUAL MAXIMUM RAINFALL AT BACACAY (1971-79)

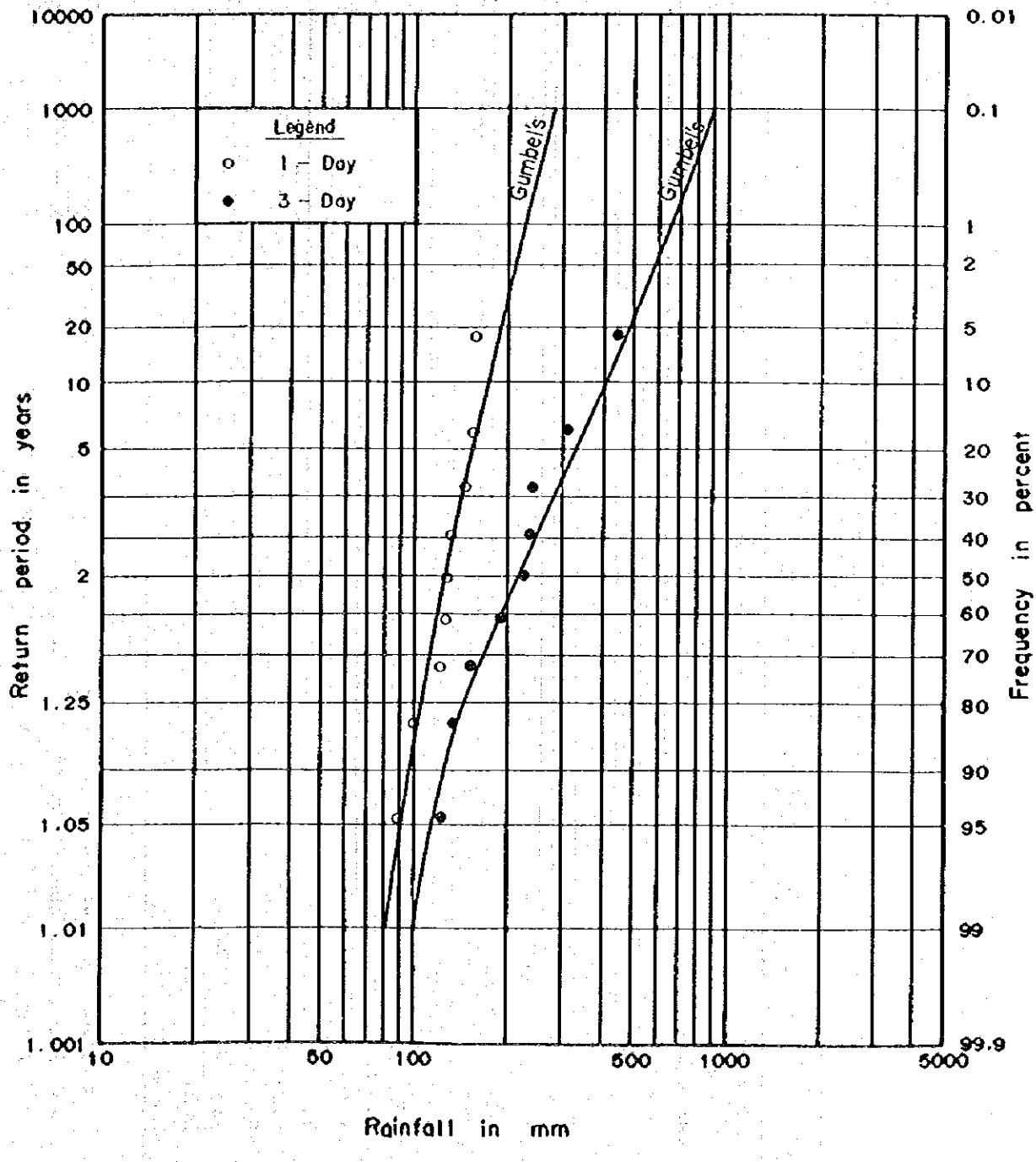


FIG-I.5 FREQUENCY CURVES FOR ANNUAL MAXIMUM RAINFALL AT GUINOBATAN (1956-79)

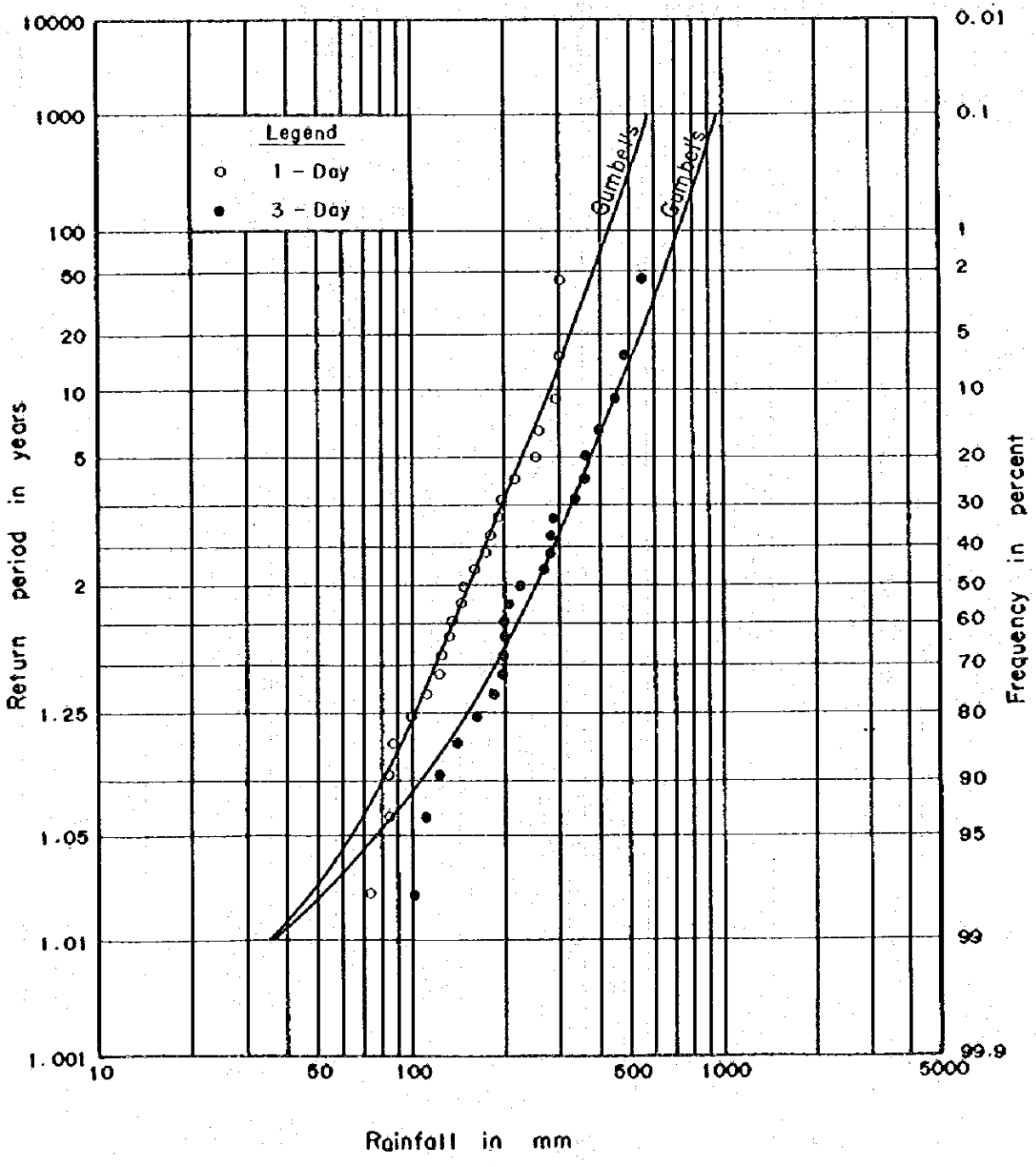


FIG-I.6 FREQUENCY CURVES FOR ANNUAL MAXIMUM RAINFALL AT LEGASPI (1956 - 79)

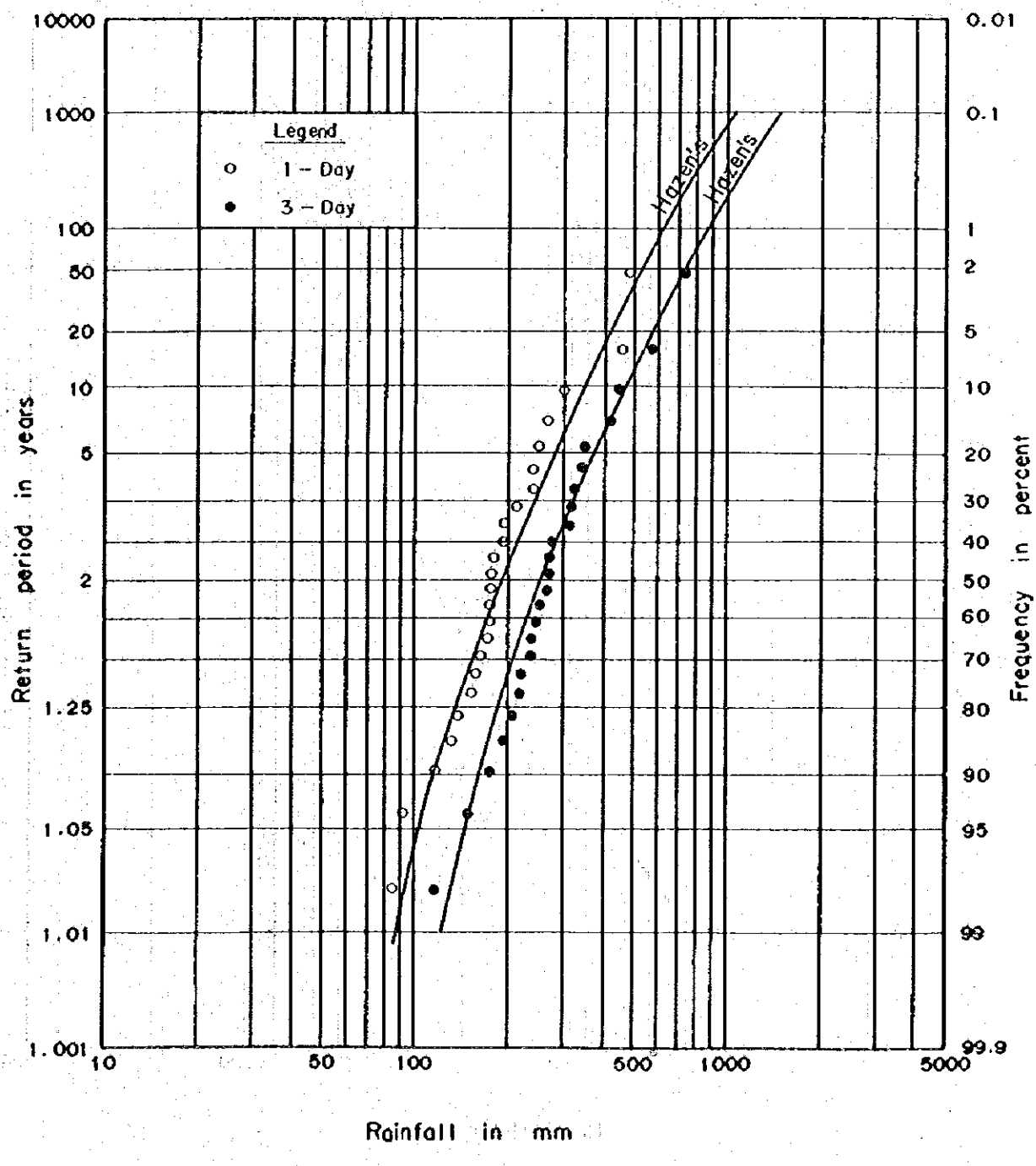


FIG-1.7 FREQUENCY CURVES FOR ANNUAL MAXIMUM RAINFALL AT LEGASPI (1970-79)

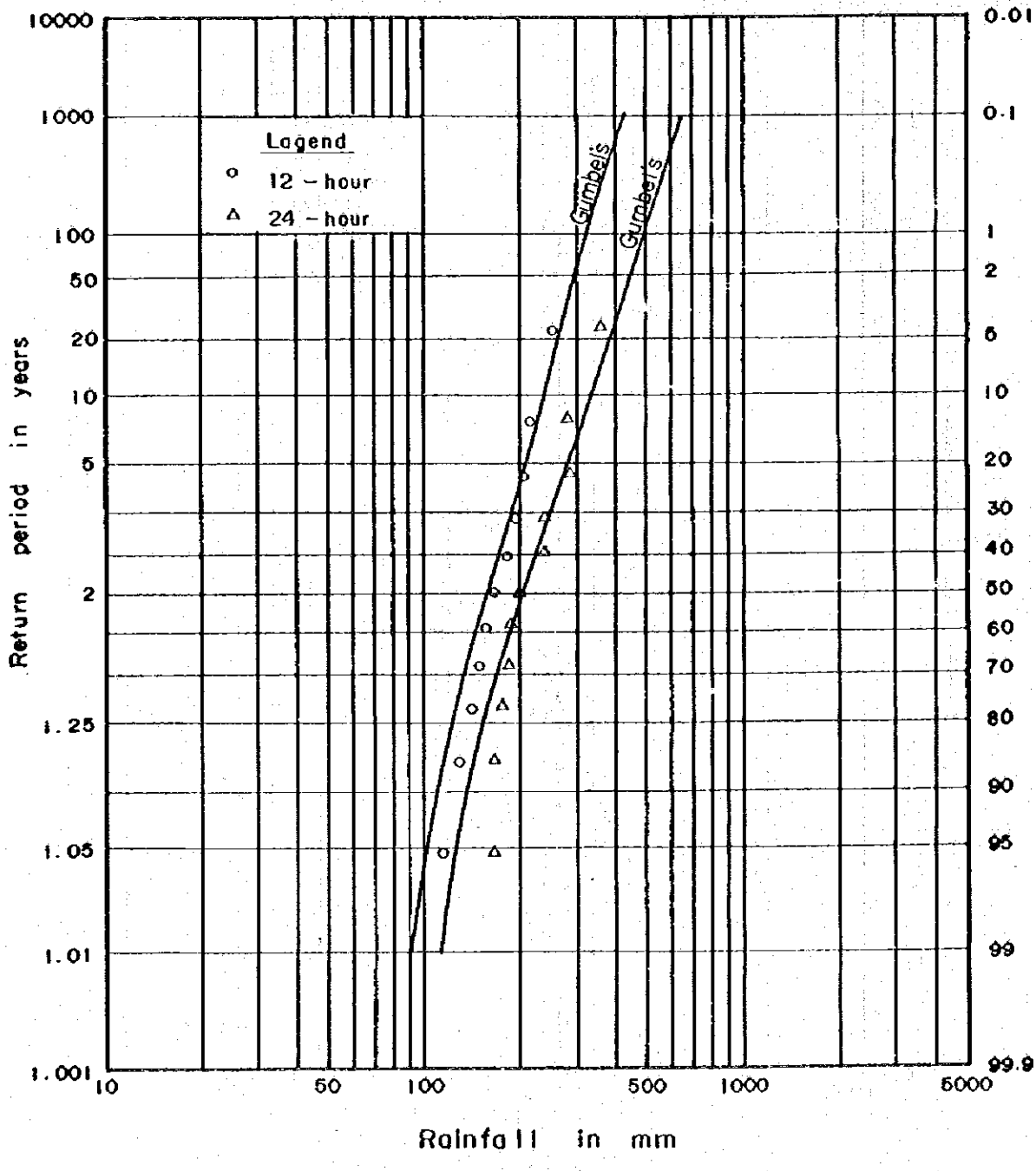


FIG-1.8 FREQUENCY CURVES FOR ANNUAL MAXIMUM RAINFALL AT LEGASPI (1970-79)

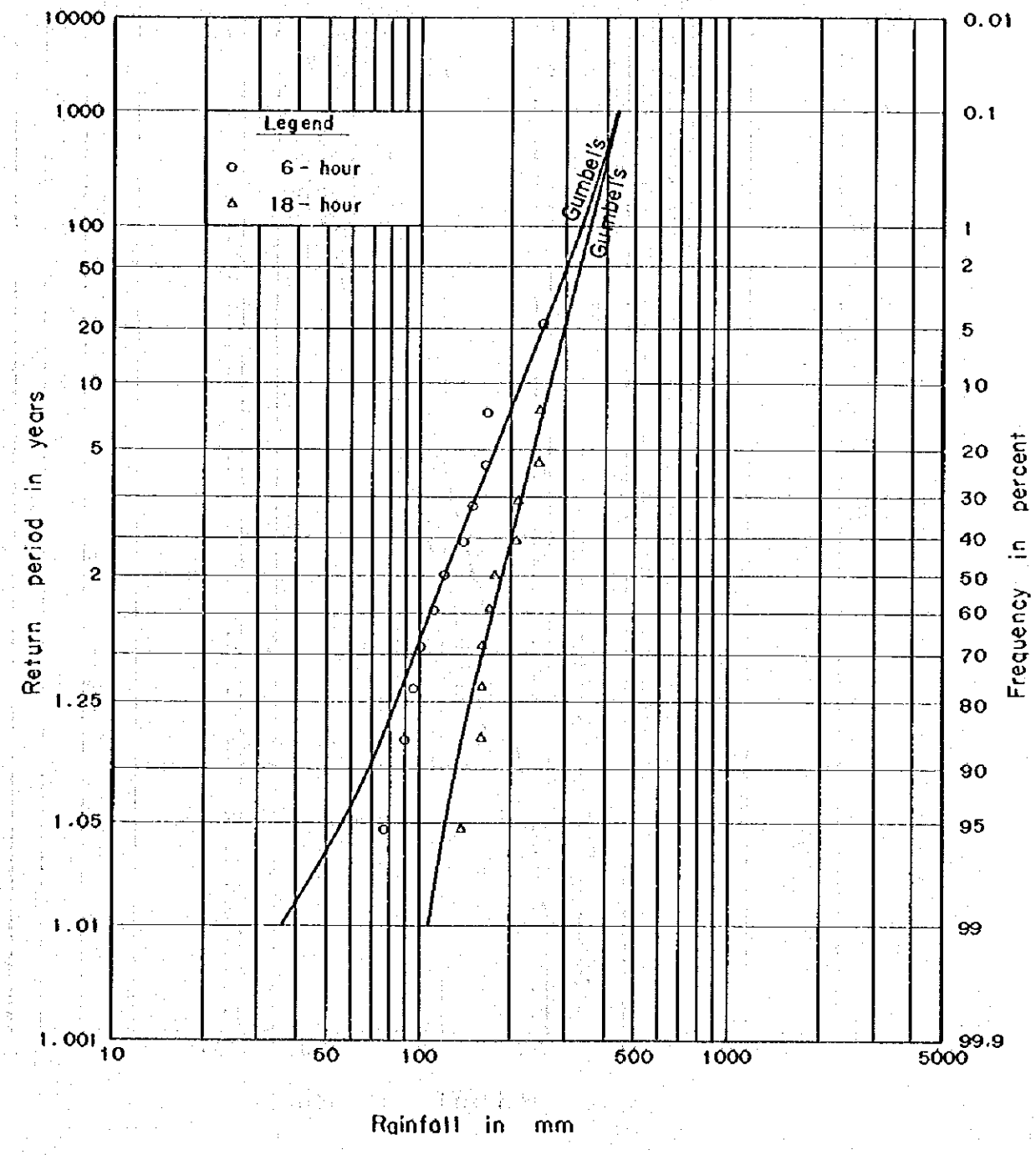


FIG-1.9 FREQUENCY CURVES FOR ANNUAL MAXIMUM RAINFALL AT ALLANG (1975 - 79)

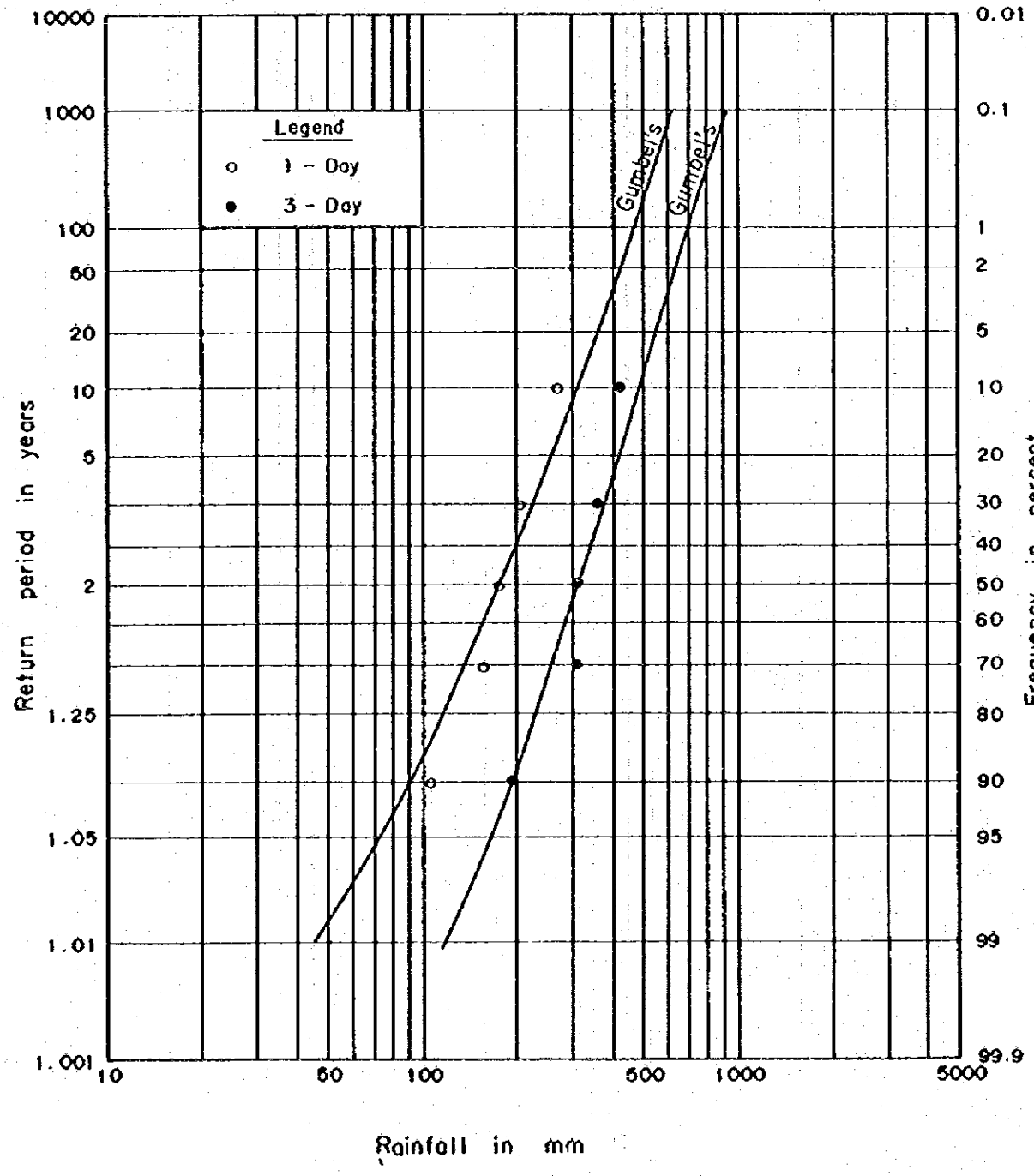


FIG-1.10 FREQUENCY CURVES FOR ANNUAL MAXIMUM RAINFALL AT MALAMA (1971 - 79)

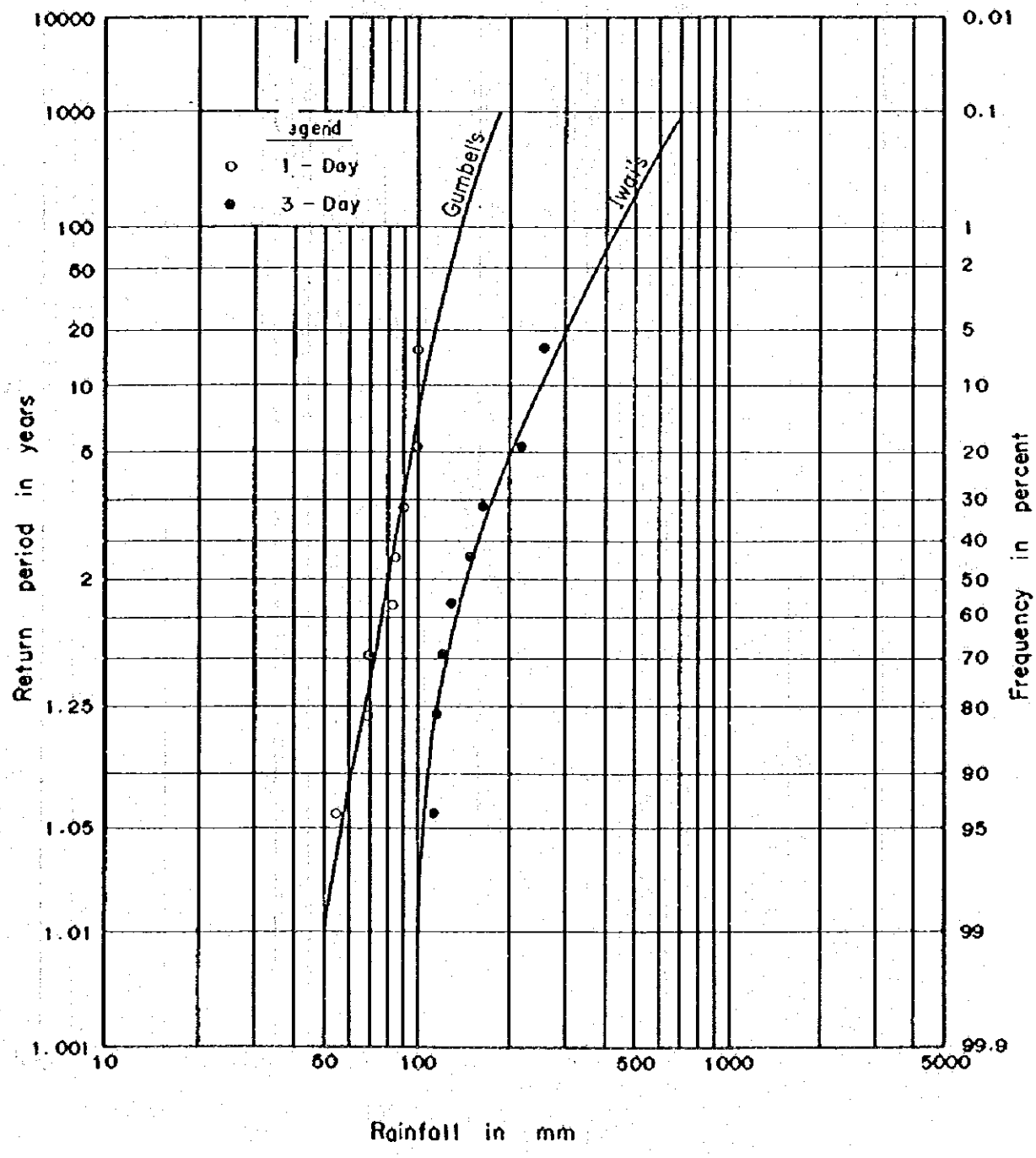


FIG-I.11 FREQUENCY CURVES FOR ANNUAL MAXIMUM RAINFALL AT STO. DOMINGO (1956-79)

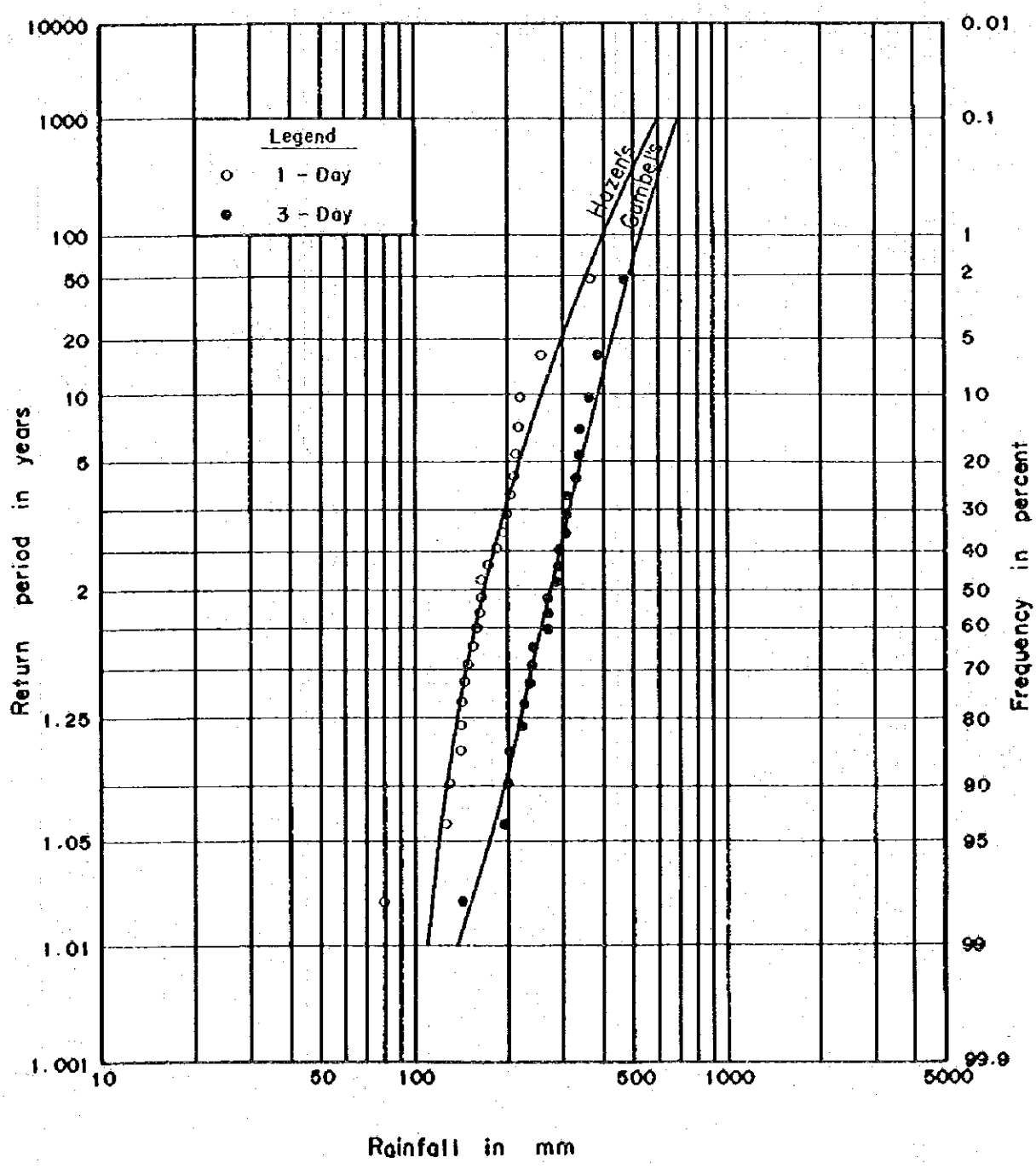


FIG-1.12 FREQUENCY CURVES FOR ANNUAL MAXIMUM RAINFALL AT TABACO (1971 - 78)

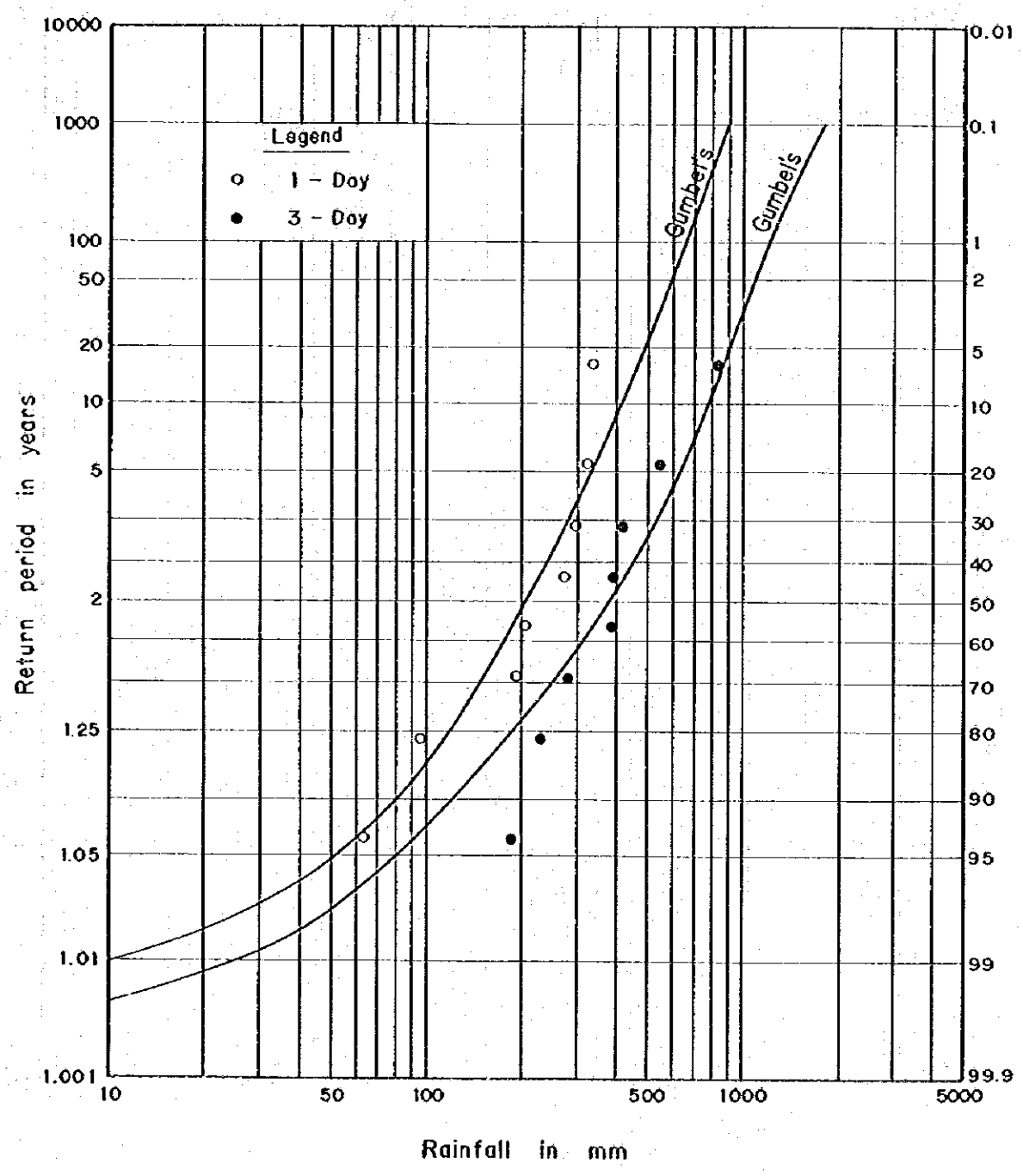


FIG-1.13 FREQUENCY CURVES FOR ANNUAL MAXIMUM RAINFALL AT MALINAO (1972 - 79)

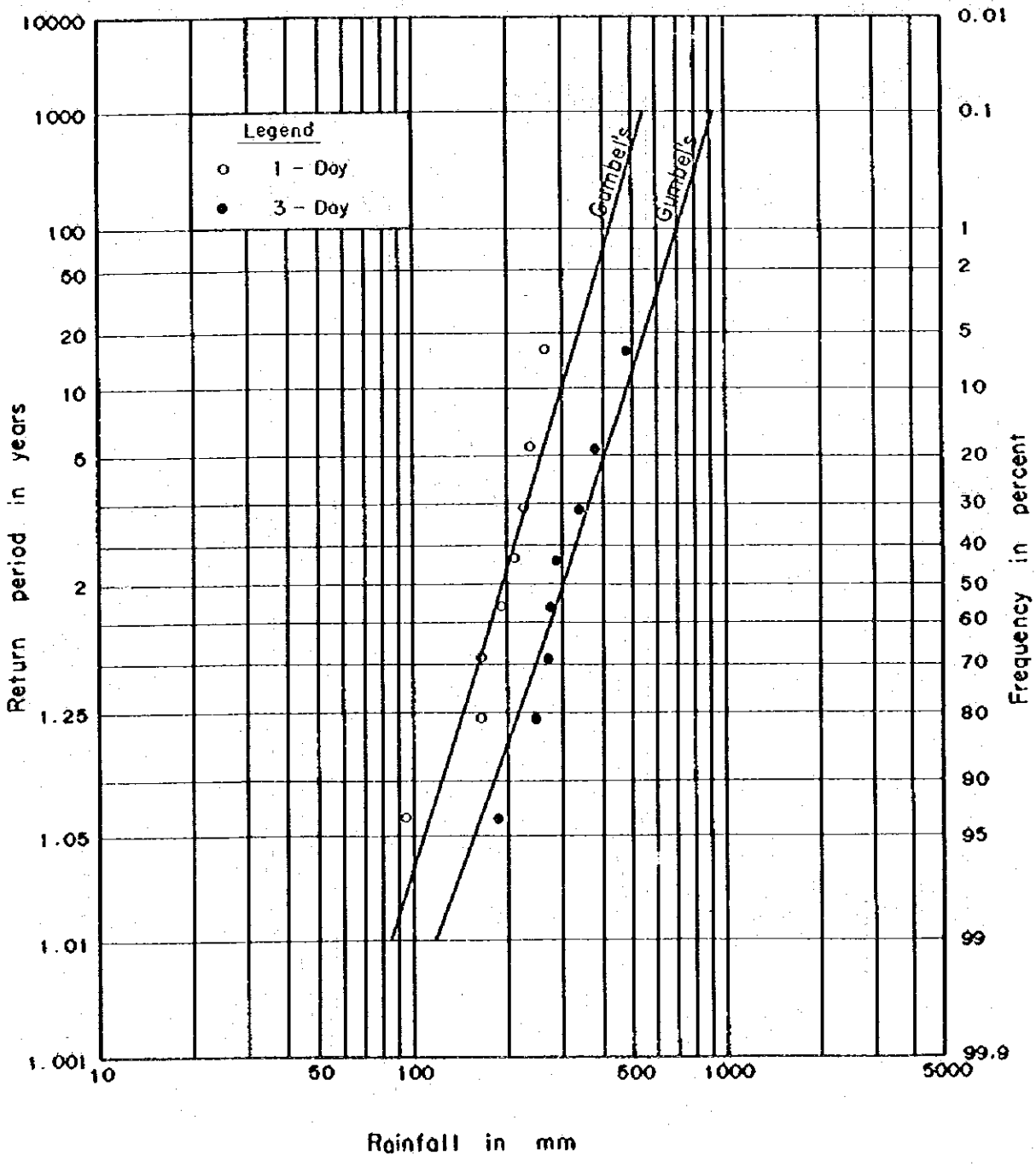


FIG.-I.14 FREQUENCY CURVE FOR ANNUAL MAXIMUM BASIN AVERAGE 1-DAY RAINFALL IN THE QUINALI (A) RIVER BASIN (1972-79)

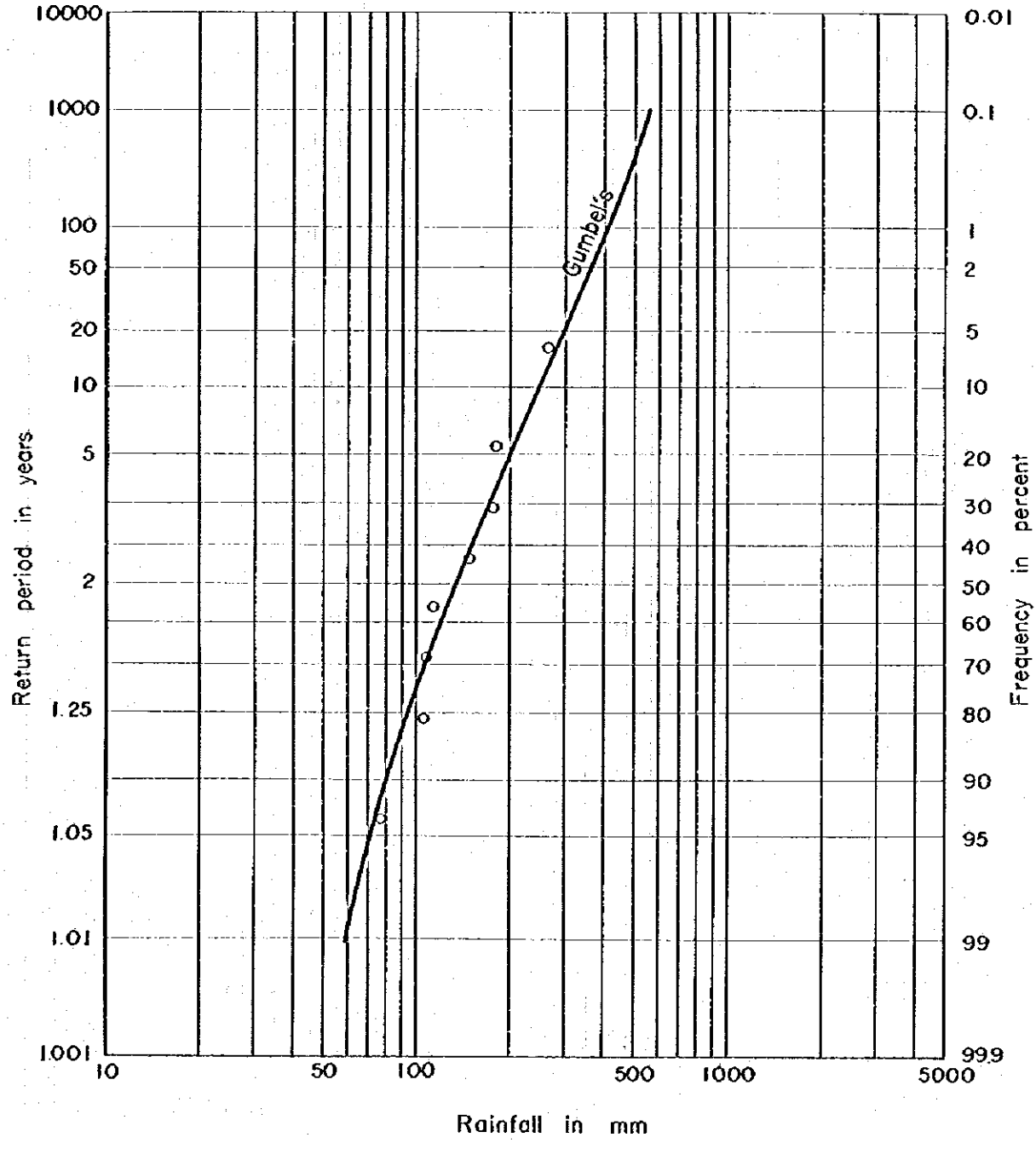
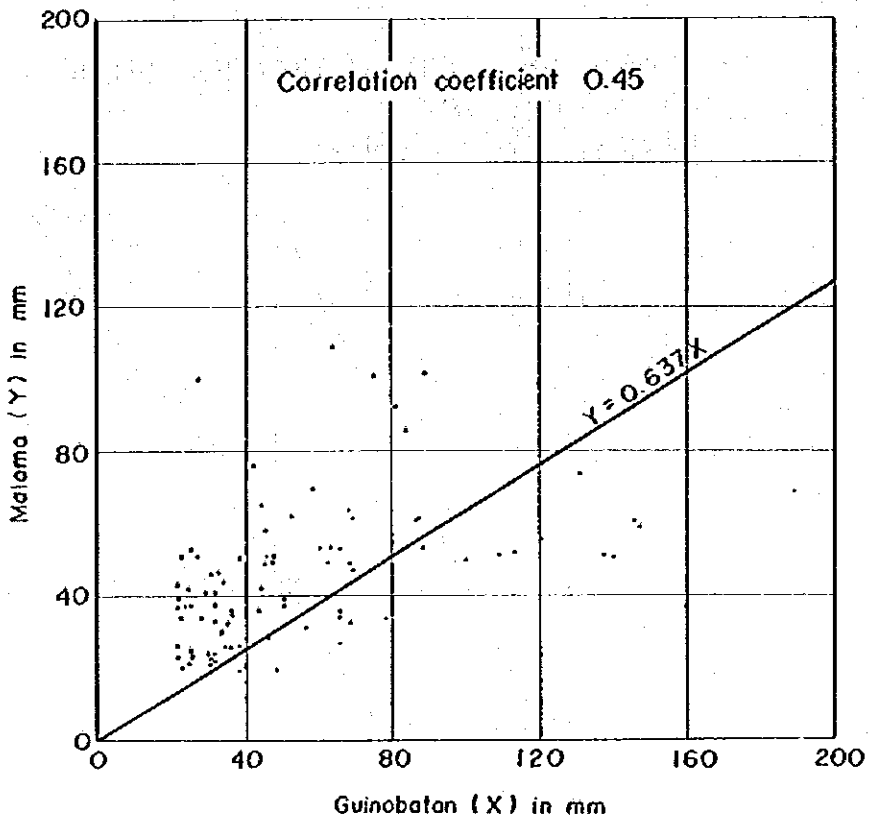


FIG.- I. 15 RAINFALL CORRELATION AMONG GUINOBATAN, MALAMA AND BATO



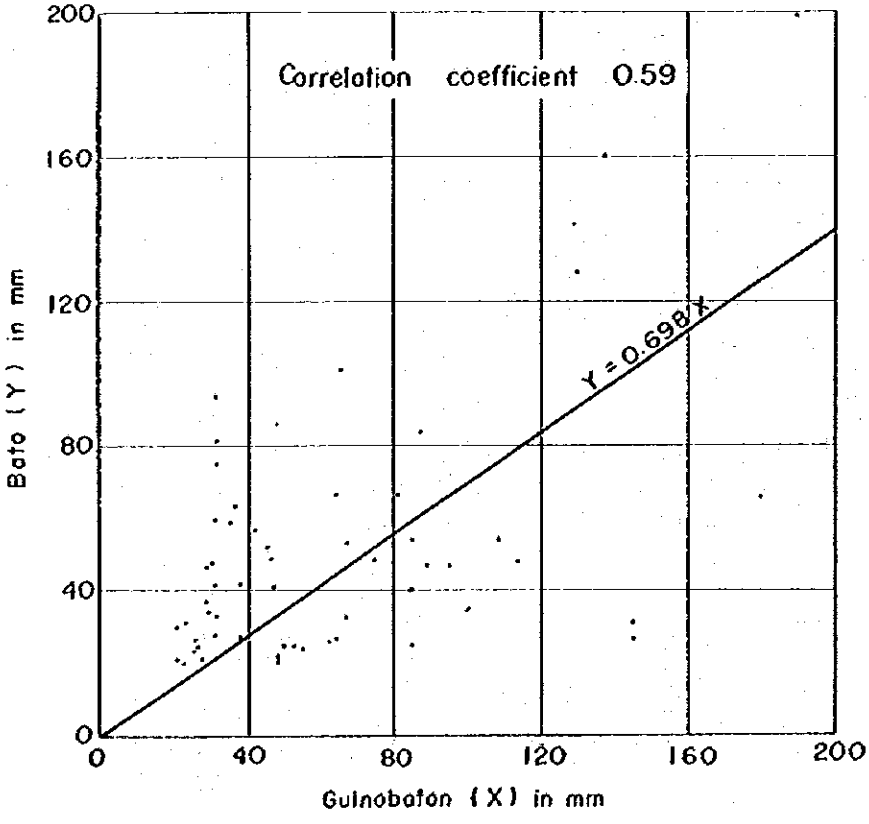
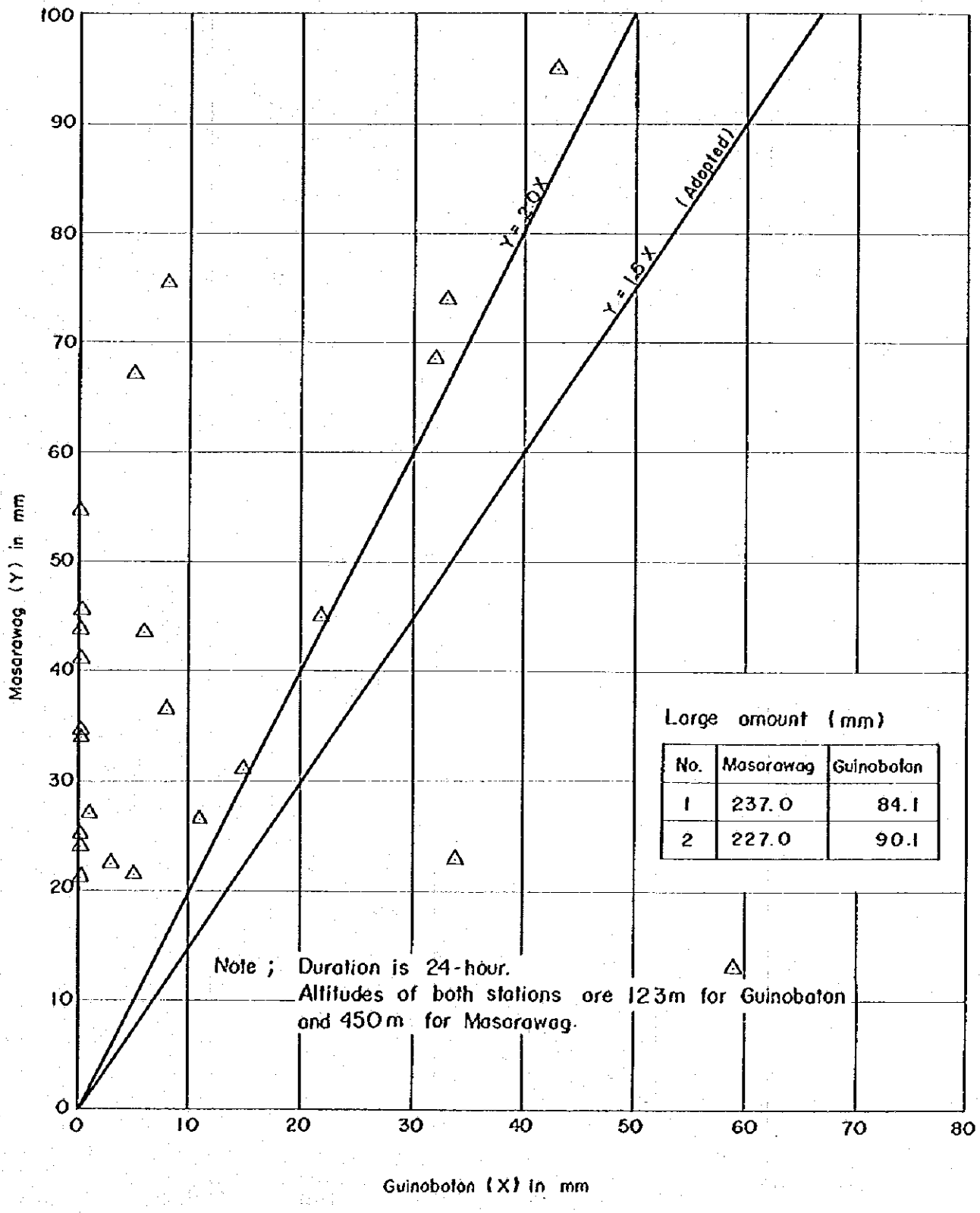


FIG.-I.16 RAINFALL RELATION BETWEEN GUINOBATAN AND MASARAWAG

(Difference due to altitude)



Large amount (mm)

No.	Masarawag	Guinobatan
1	237.0	84.1
2	227.0	90.1

Note ; Duration is 24-hour.
Altitudes of both stations are 123m for Guinobatan and 450m for Masarawag.

FIG.-1.17 RAINFALL RELATION BETWEEN LEGASPI AND MASARAWAG

(Difference due to altitude)

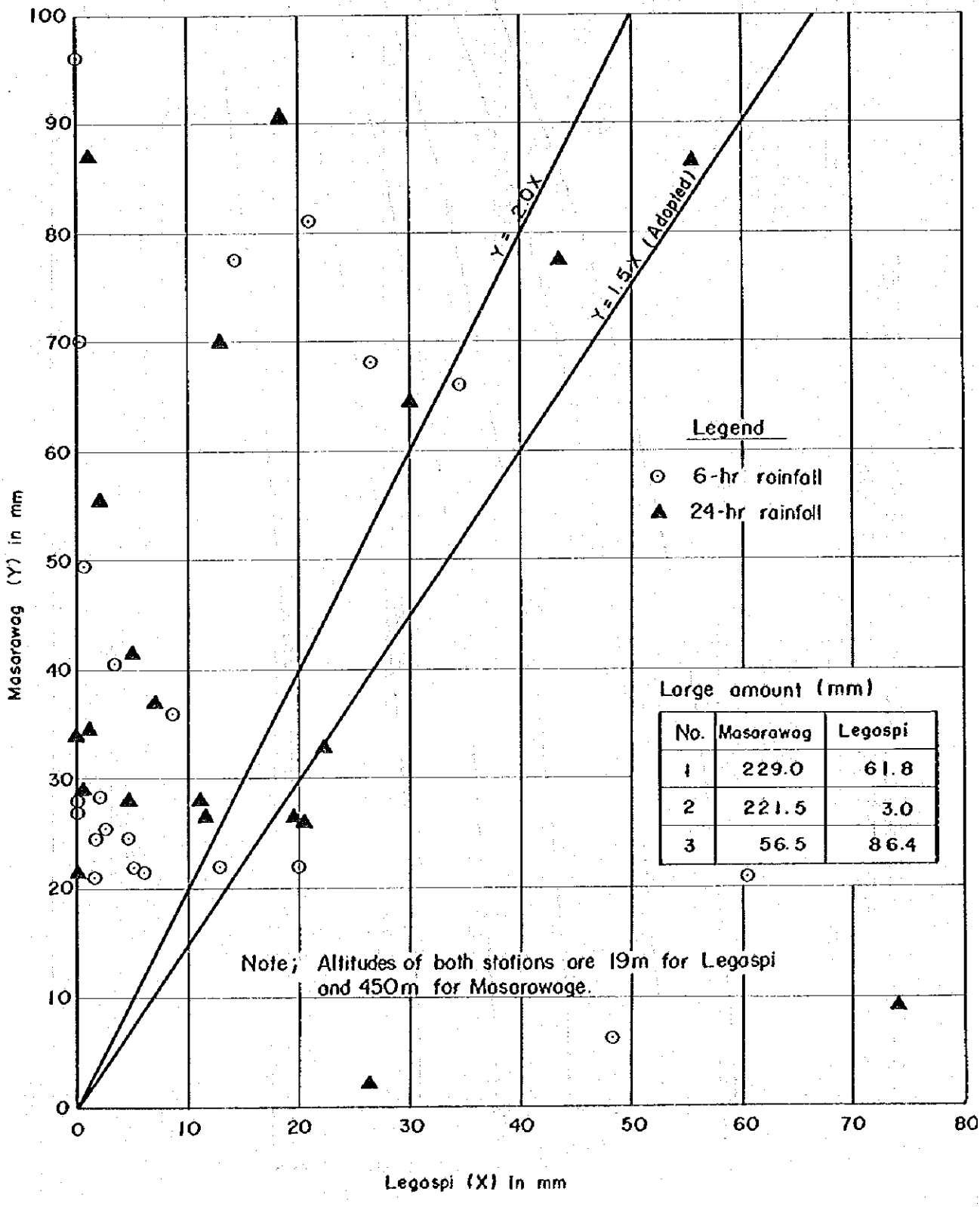


FIG.-I.18 PROBABLE DAILY RAINFALL DEPTH-AREA CURVES FOR THE QUINALI (A) RIVER BASIN

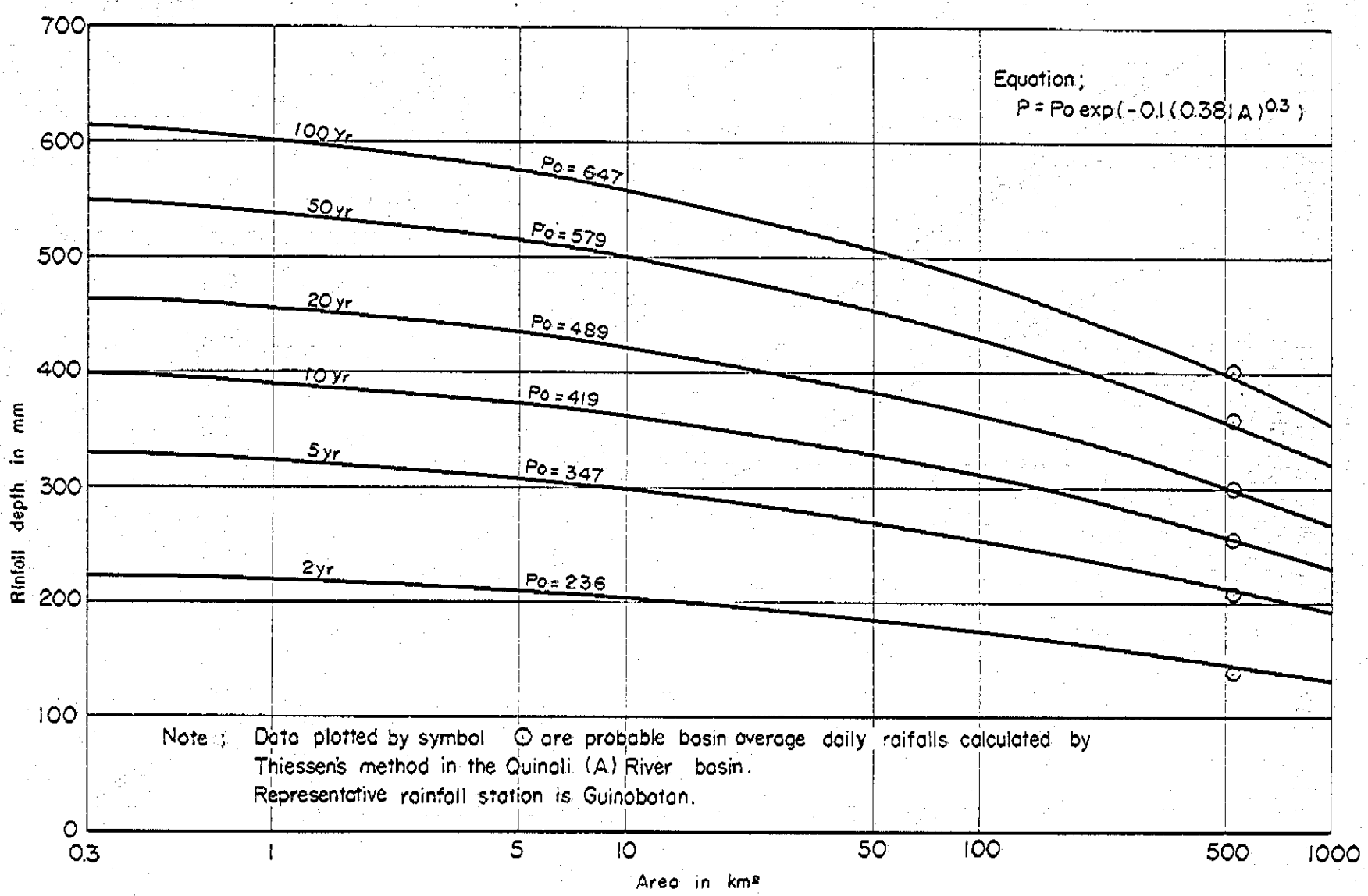


FIG. - I.19 DAILY RAINFALL DEPTH - AREA RELATION AFTER HORTON

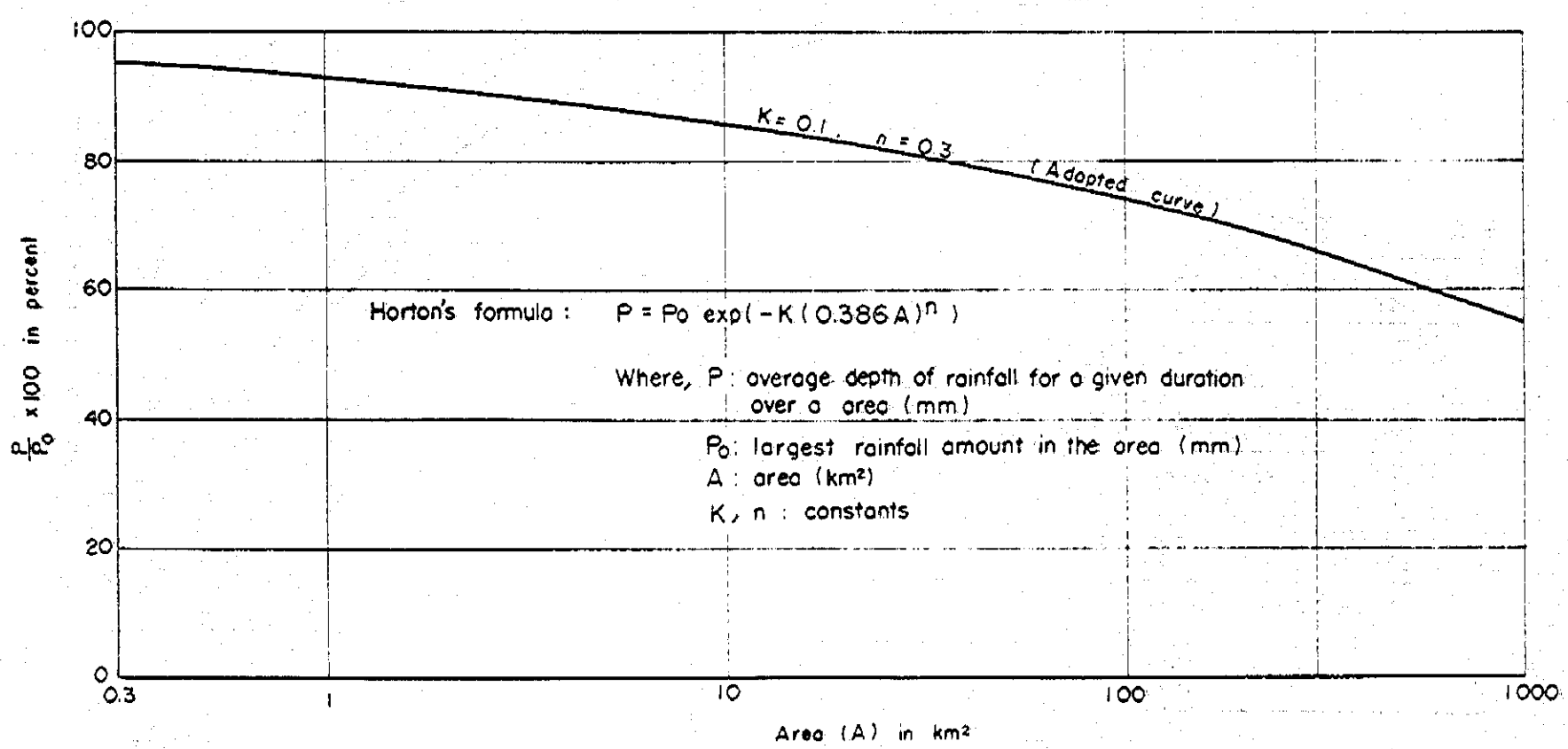
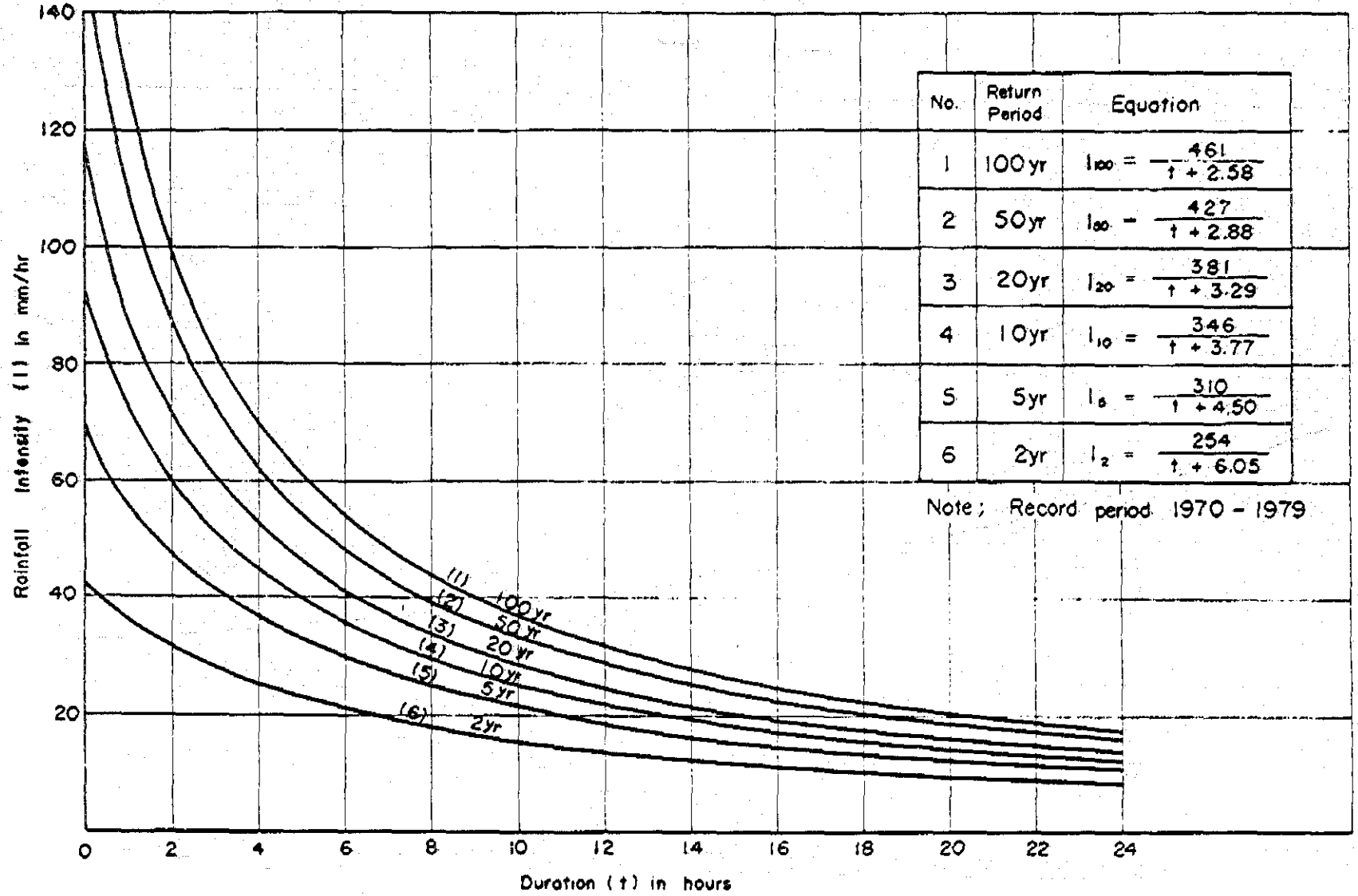


FIG. - I.20 PROBABLE RAINFALL INTENSITY - DURATION CURVES FOR LEGASPI



No.	Return Period	Equation
1	100 yr	$I_{100} = \frac{461}{t + 2.58}$
2	50 yr	$I_{50} = \frac{427}{t + 2.88}$
3	20 yr	$I_{20} = \frac{381}{t + 3.29}$
4	10 yr	$I_{10} = \frac{346}{t + 3.77}$
5	5 yr	$I_5 = \frac{310}{t + 4.50}$
6	2 yr	$I_2 = \frac{254}{t + 6.05}$

Note; Record period 1970 - 1979

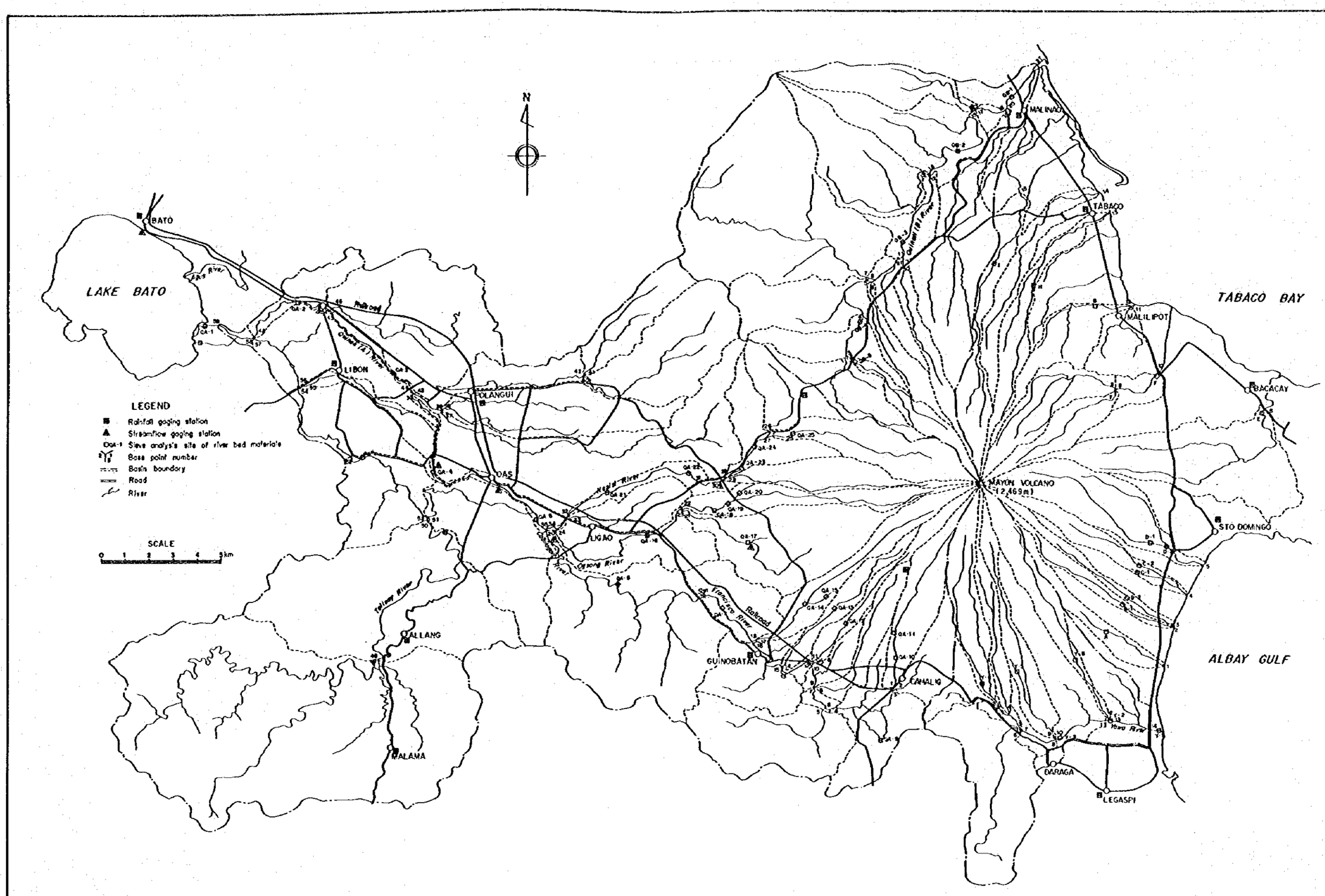


FIG.- 1.21 BASIN MAP

FIG. - I. 22 SPECIFIC FLOOD DISCHARGE DIAGRAM FOR RIVERS IN THE PHILIPPINS

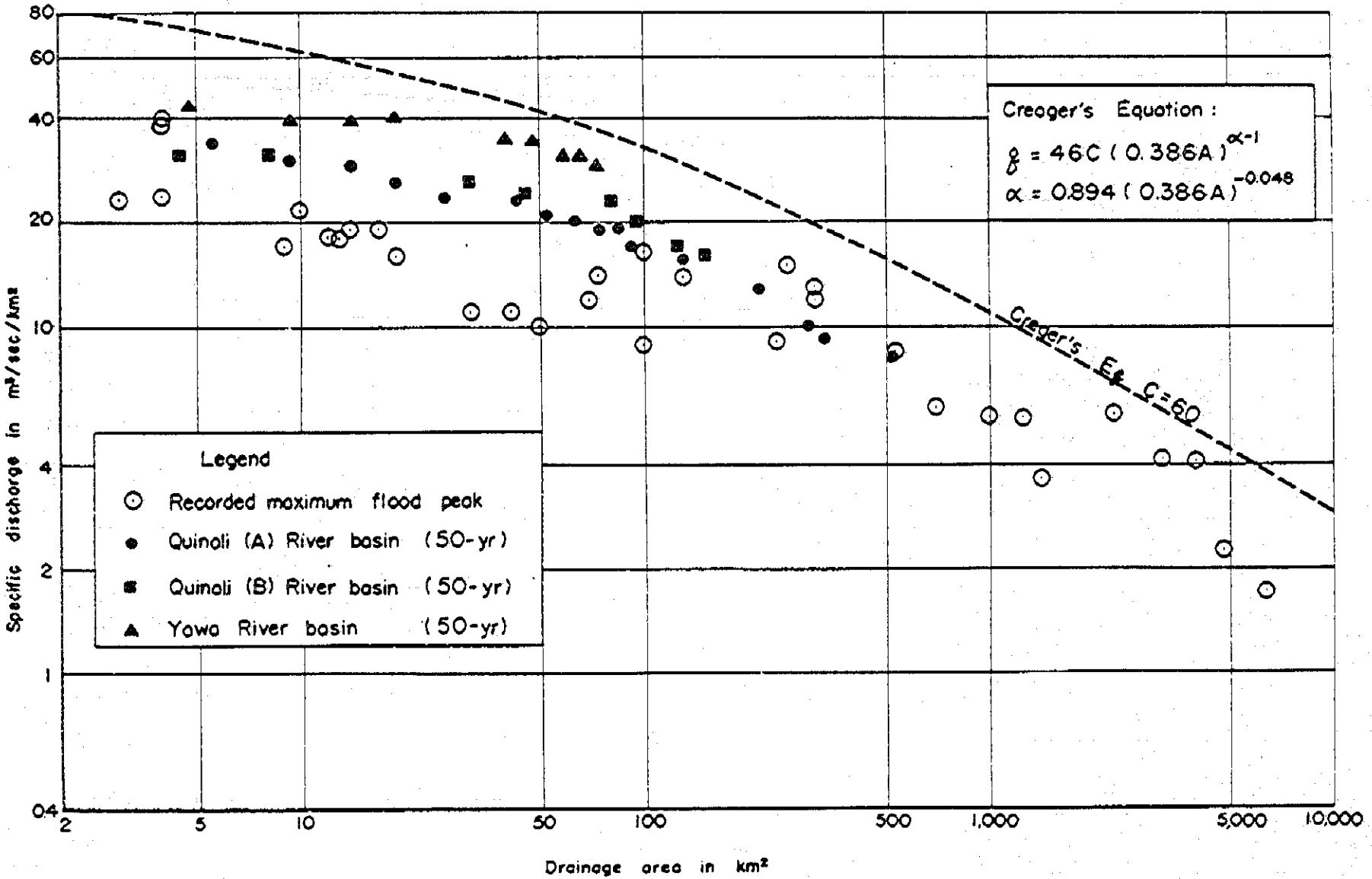


FIG.- I.23 PROBABLE HYETOGRAPH BY CRITICAL ARRANGEMENT METHOD

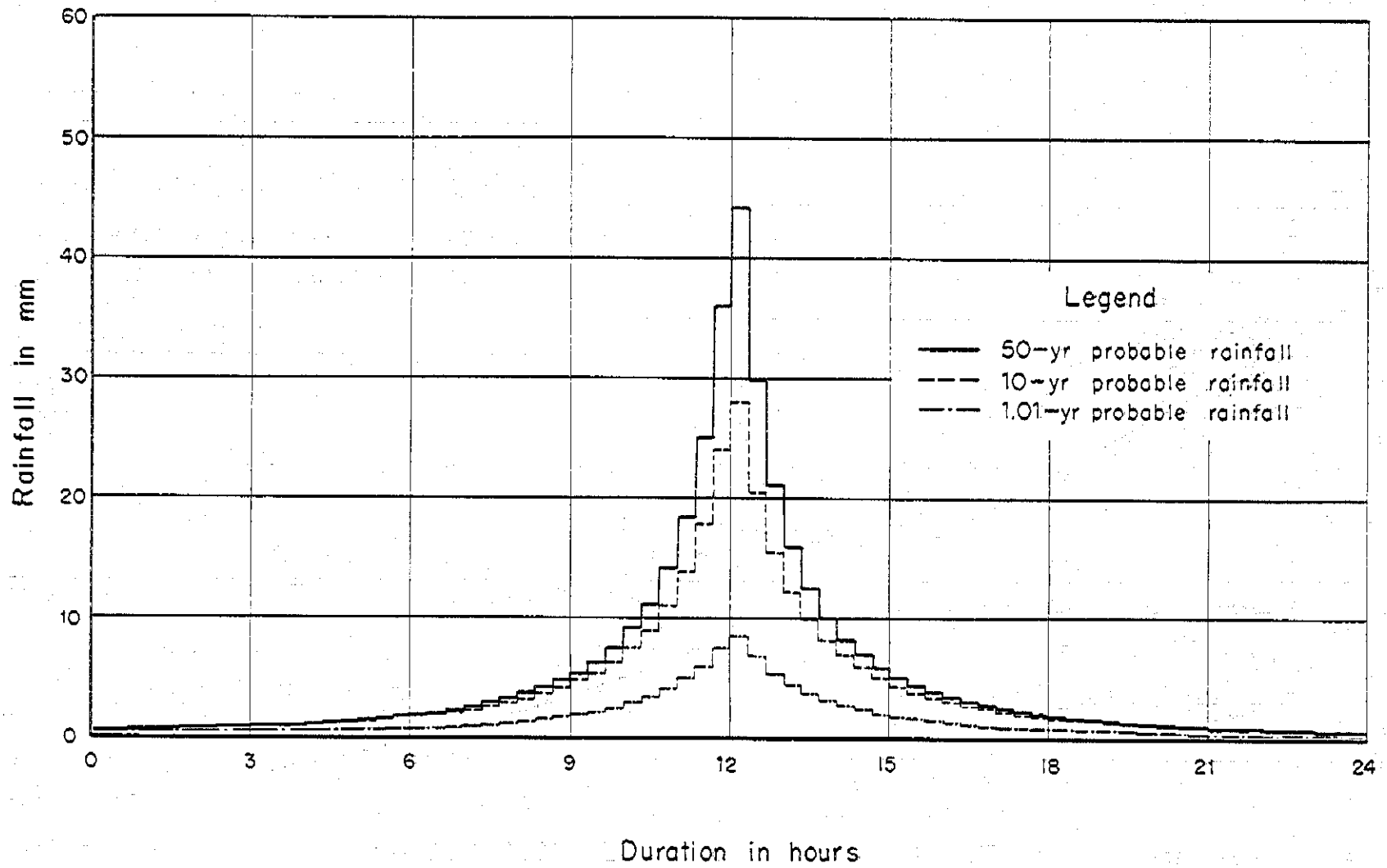


FIG-I.24 FREQUENCY CURVES FOR DRAUGHT ANNUAL RAINFALL BY WEIBULL'S METHOD

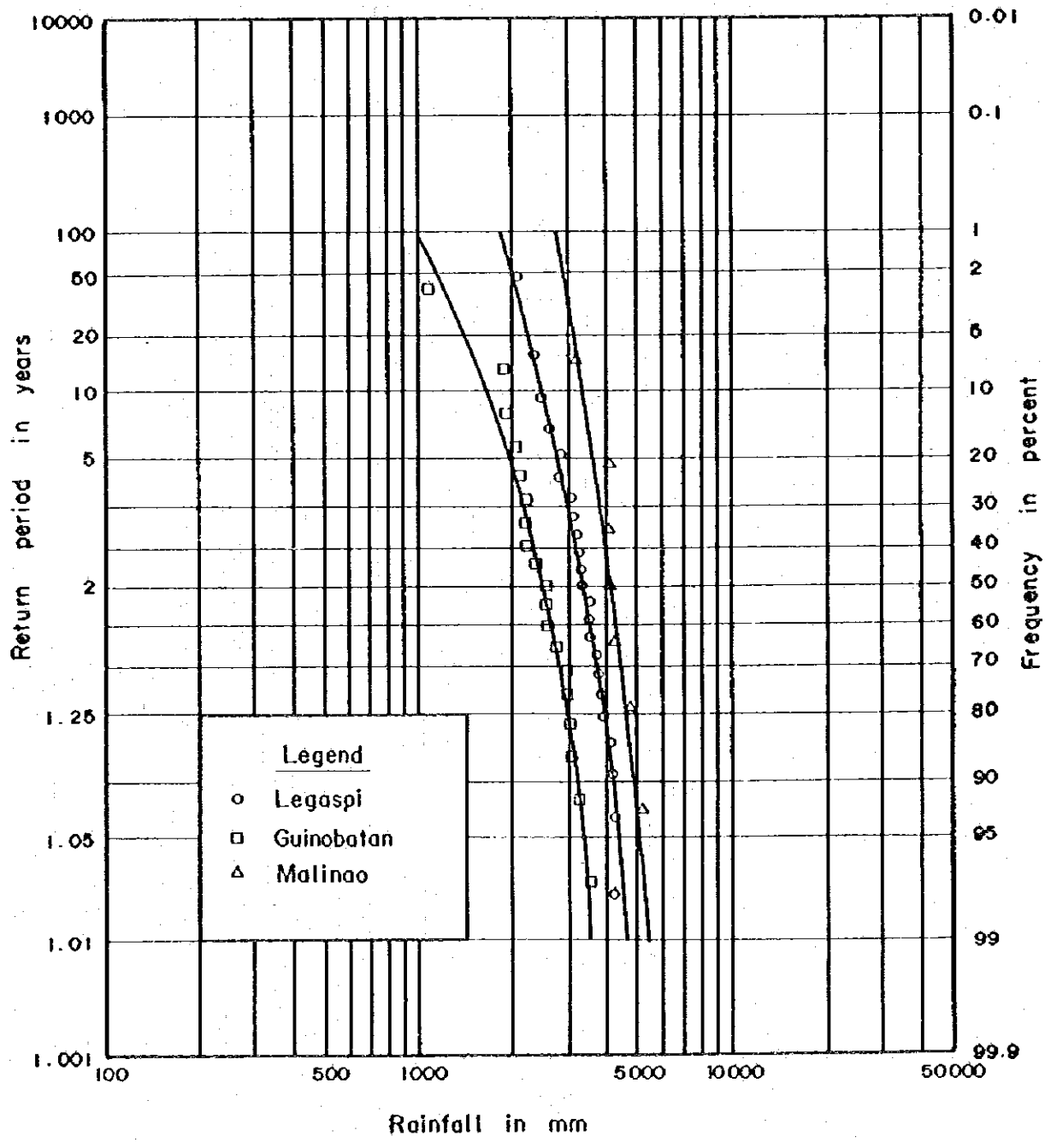


FIG-1.25 FREQUENCY CURVES FOR ANNUAL MINIMUM MONTHLY RAINFALL BY WEIBULL'S METHOD

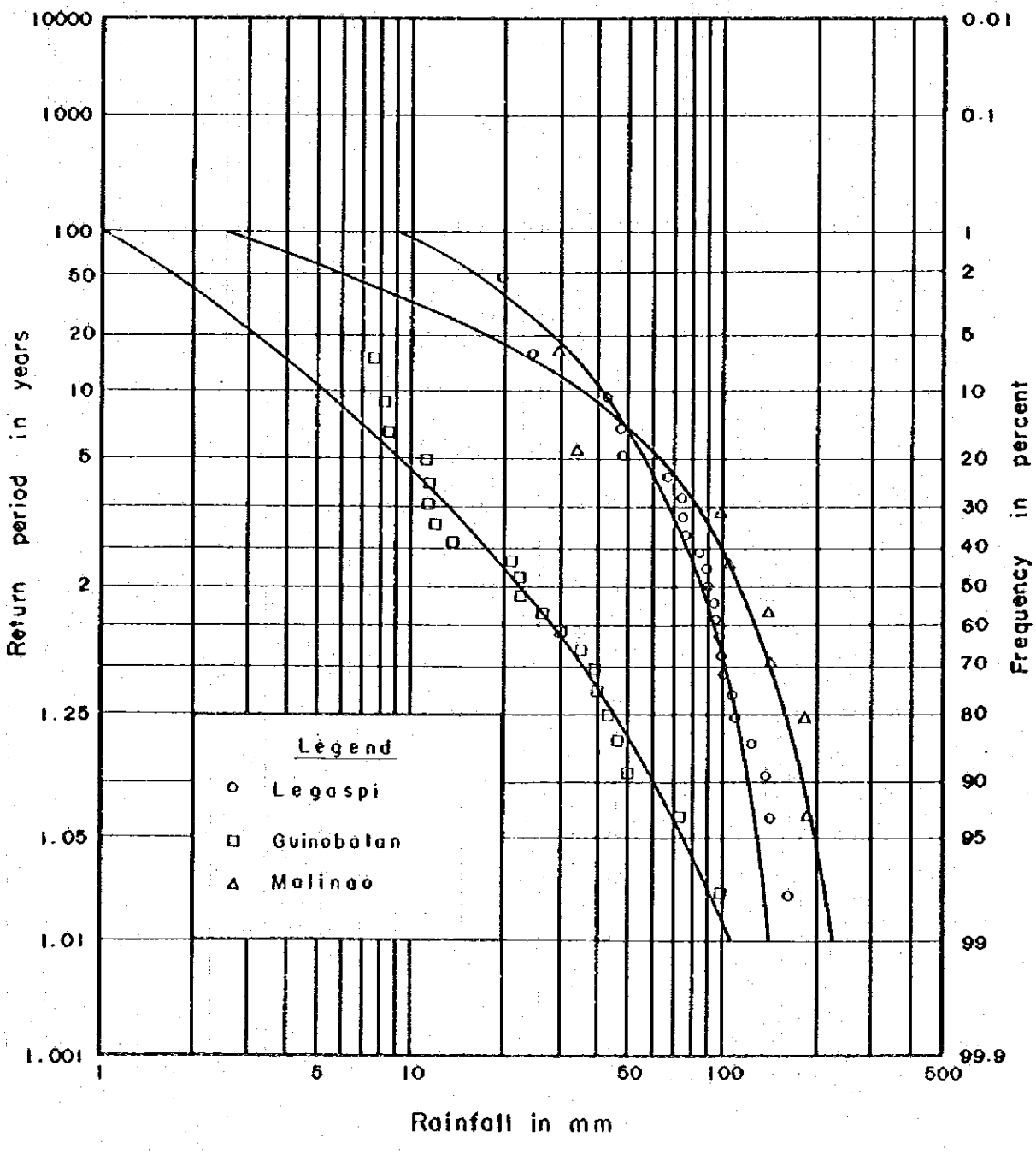


FIG-I.26 FREQUENCY CURVES FOR ANNUAL MINIMUM MONTHLY MEAN RUNOFF BY WEIBULL'S METHOD

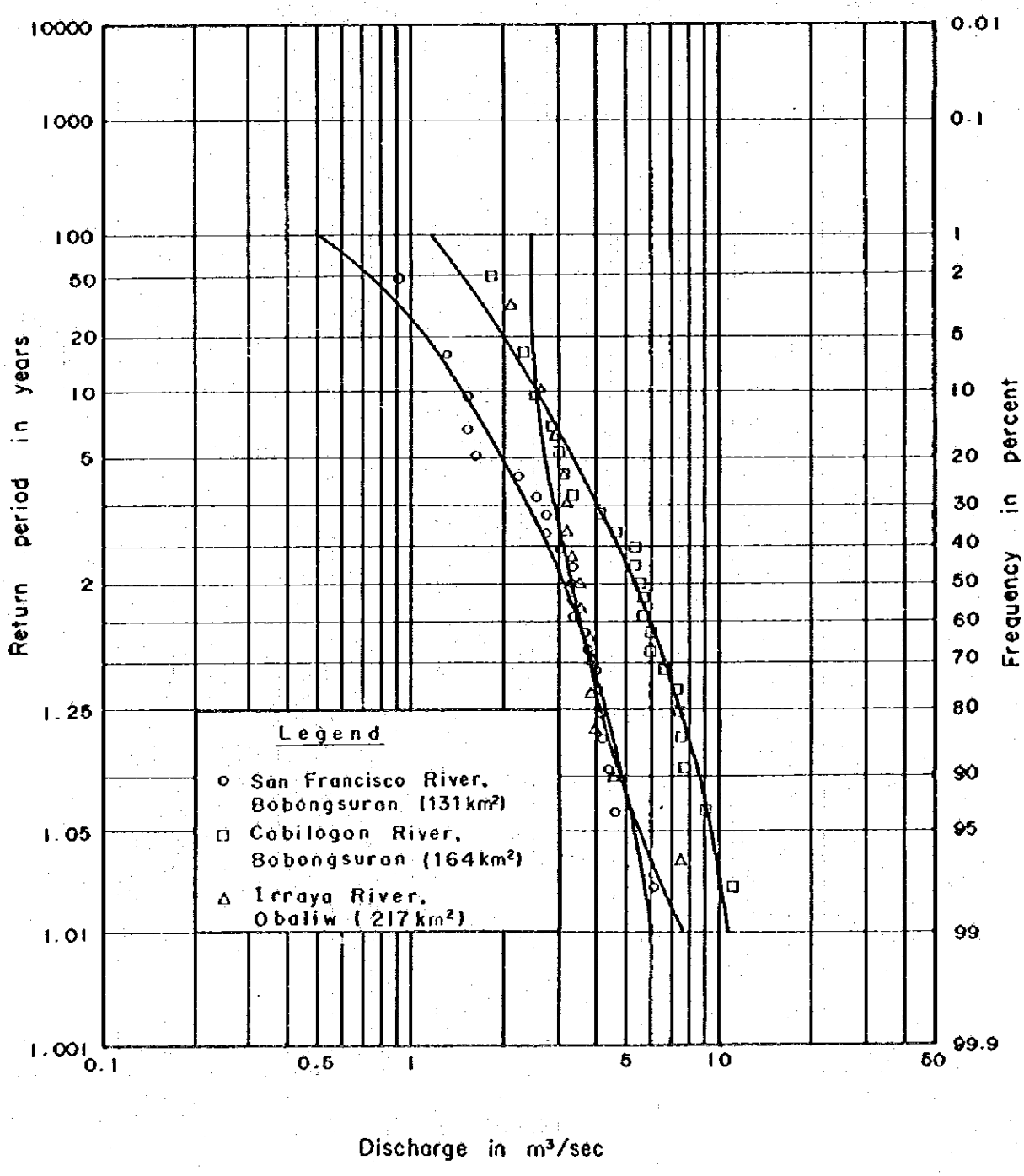


FIG-I.27 FREQUENCY CURVES FOR ANNUAL MINIMUM MONTHLY MEAN RUNOFF BY WEIBULL'S METHOD

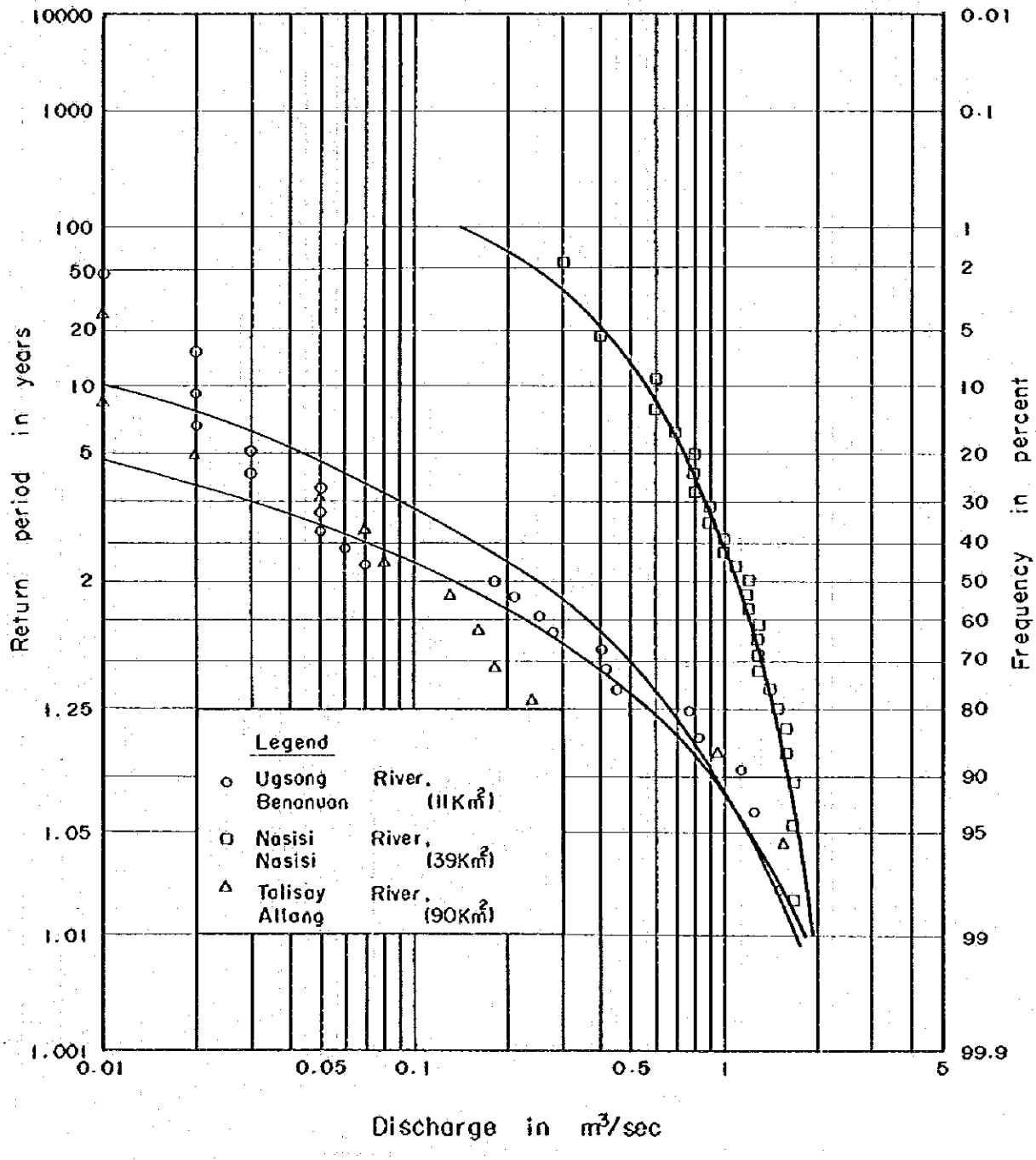


FIG-I.28 FREQUENCY CURVES FOR ANNUAL MINIMUM MONTHLY MEAN RUNOFF BY WEIBULL'S METHOD

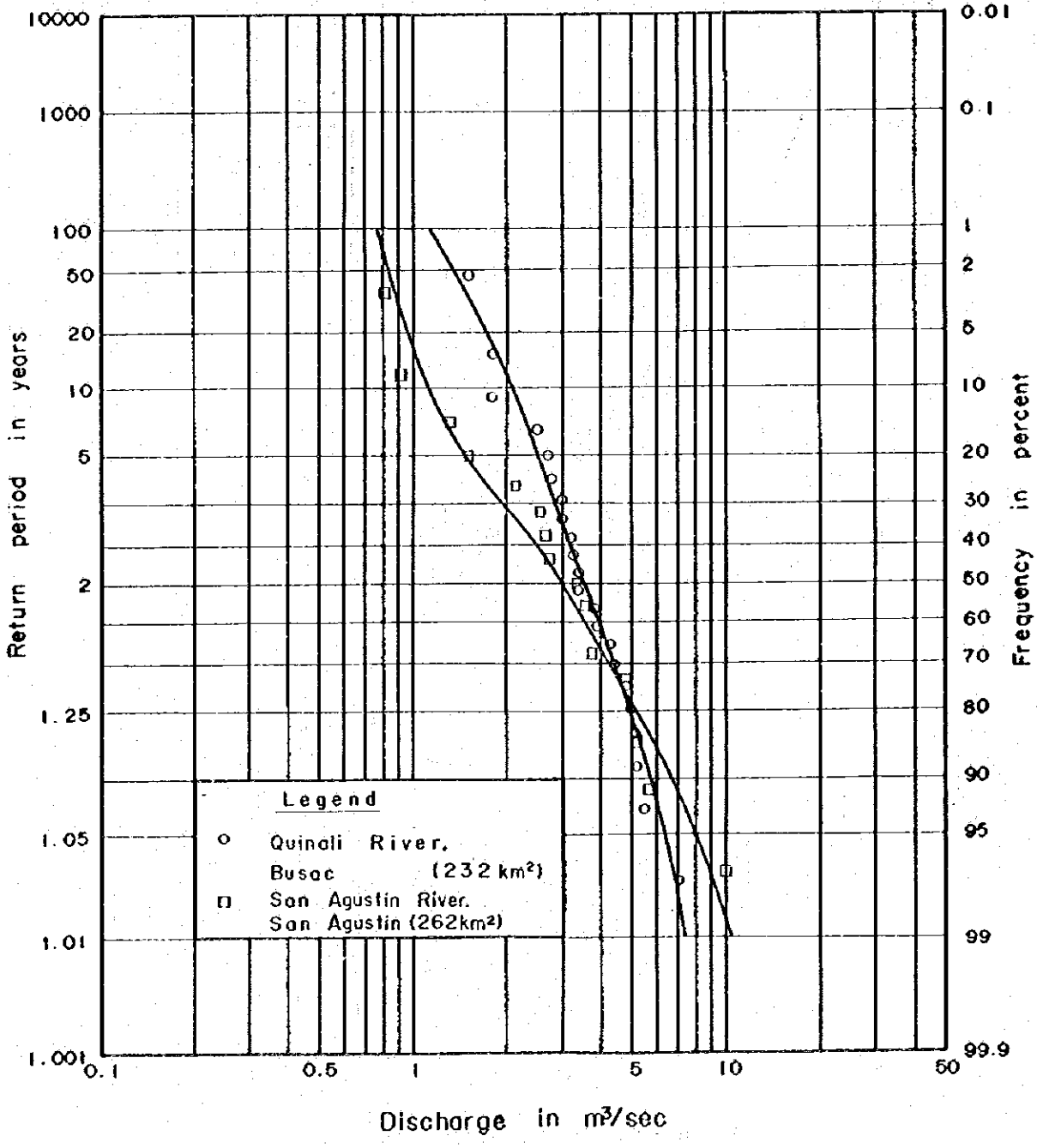


FIG.- I. 29

REGIONAL DRAUGHT FREQUENCY CURVE FOR SELECTED STATIONS IN THE QUINALI (A) RIVER BASIN

(Annual minimum monthly mean runoff)

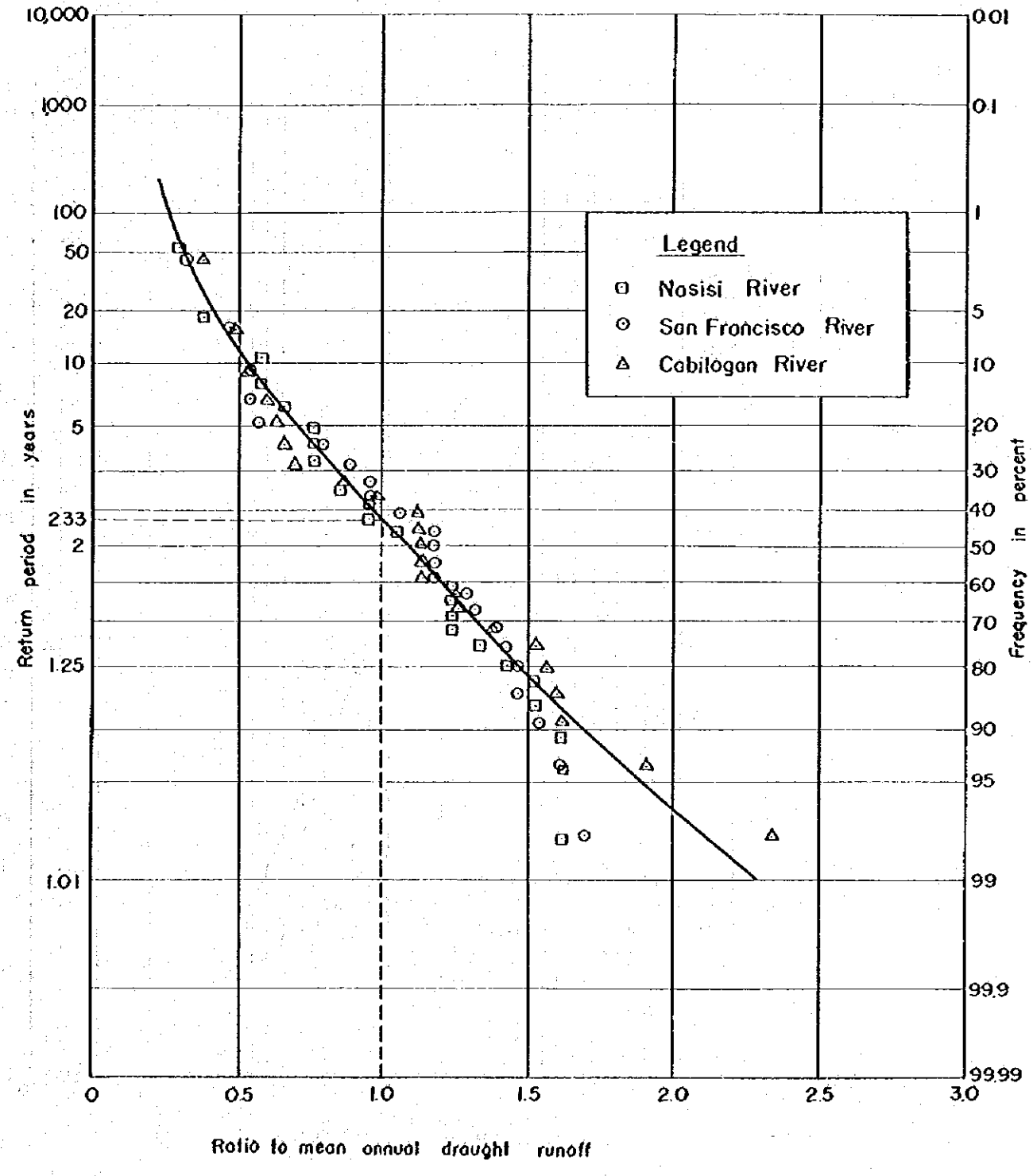


FIG.- I. 30 VARIATION OF MEAN ANNUAL DRAUGHT RUNOFF (2.33-yr) WITH DRAINAGE AREA

(Annual minimum monthly mean runoff)

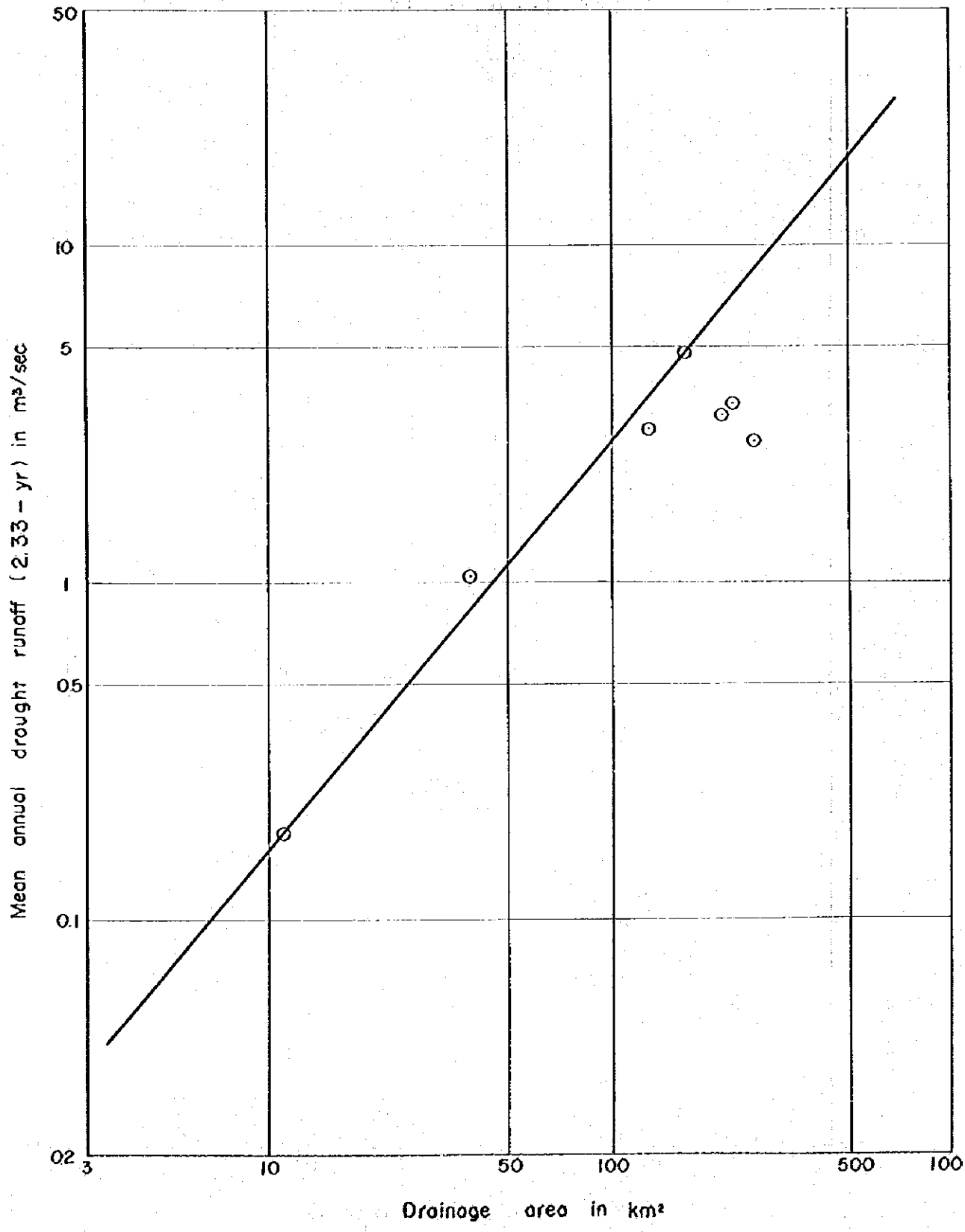


FIG. - 1.31 RELATIONSHIP BETWEEN DRAINAGE AREA AND ANNUAL MEAN RUNOFF IN THE QUINALI (A) RIVER BASIN

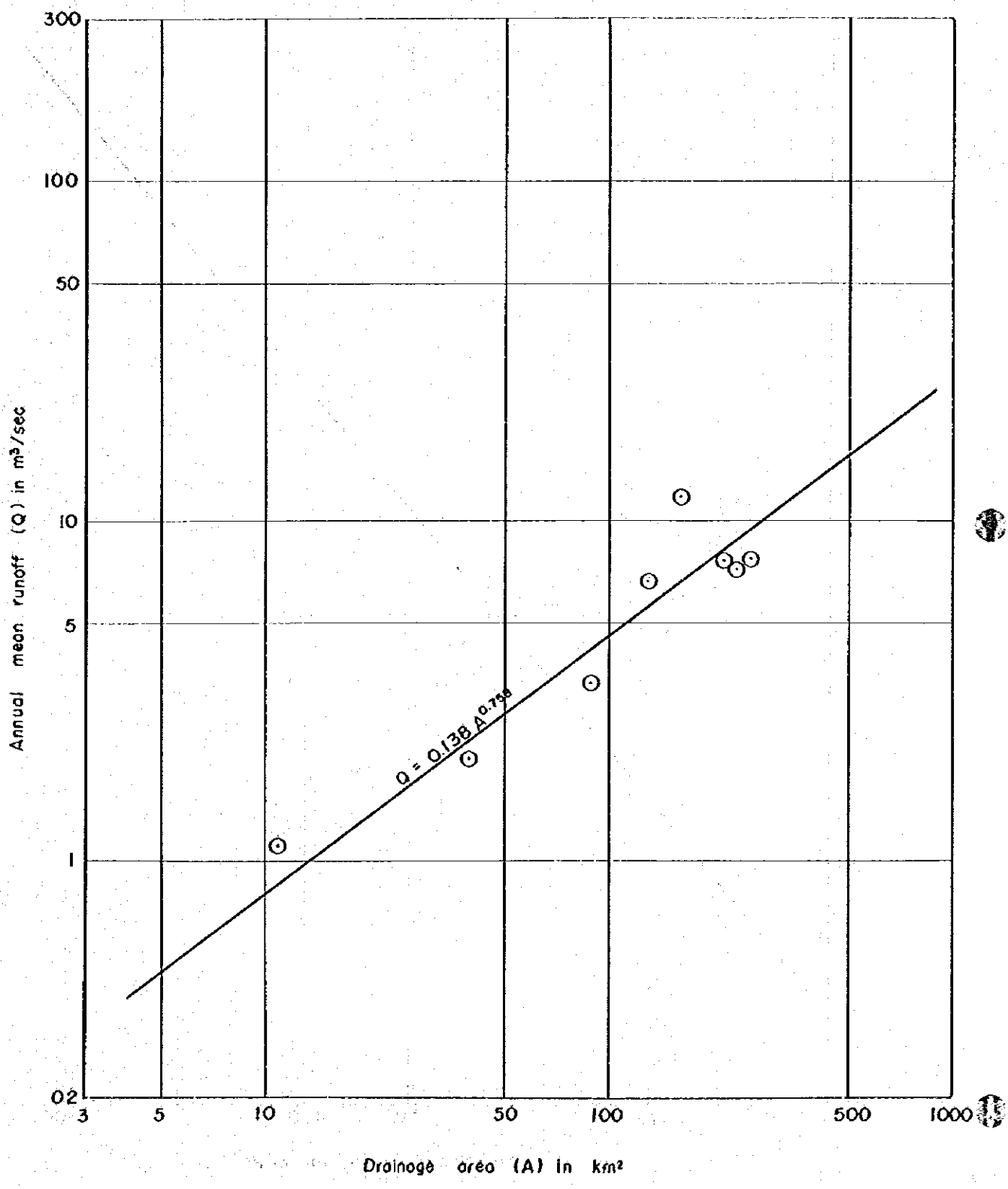


FIG.-I.32 SUSPENDED LOAD RATING CURVE FOR THE QUINALI (A) RIVER AT BUSAC

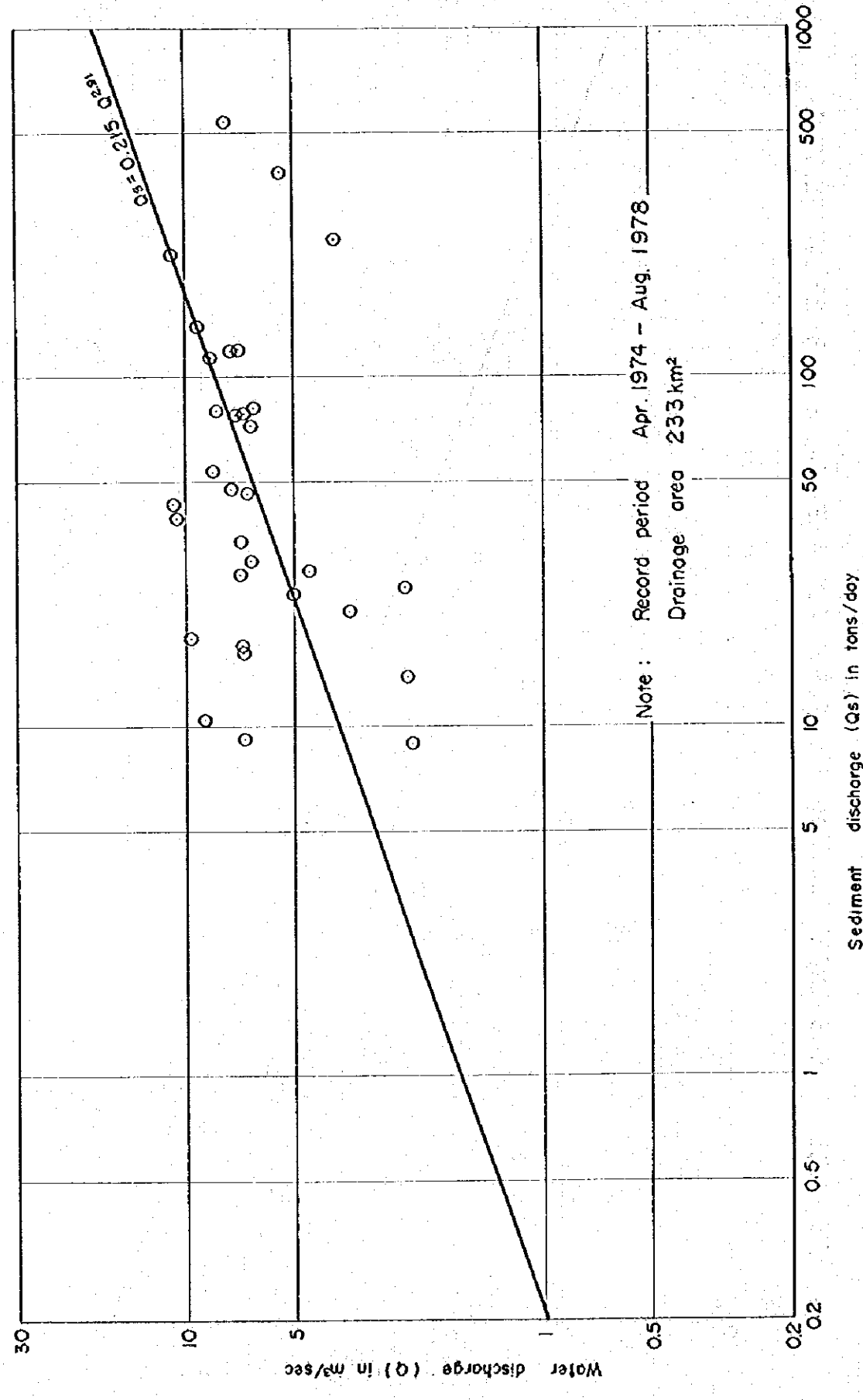


FIG.-I.33 SUSPENDED LOAD RATING CURVE FOR THE TALISAY RIVER AT ALLANG

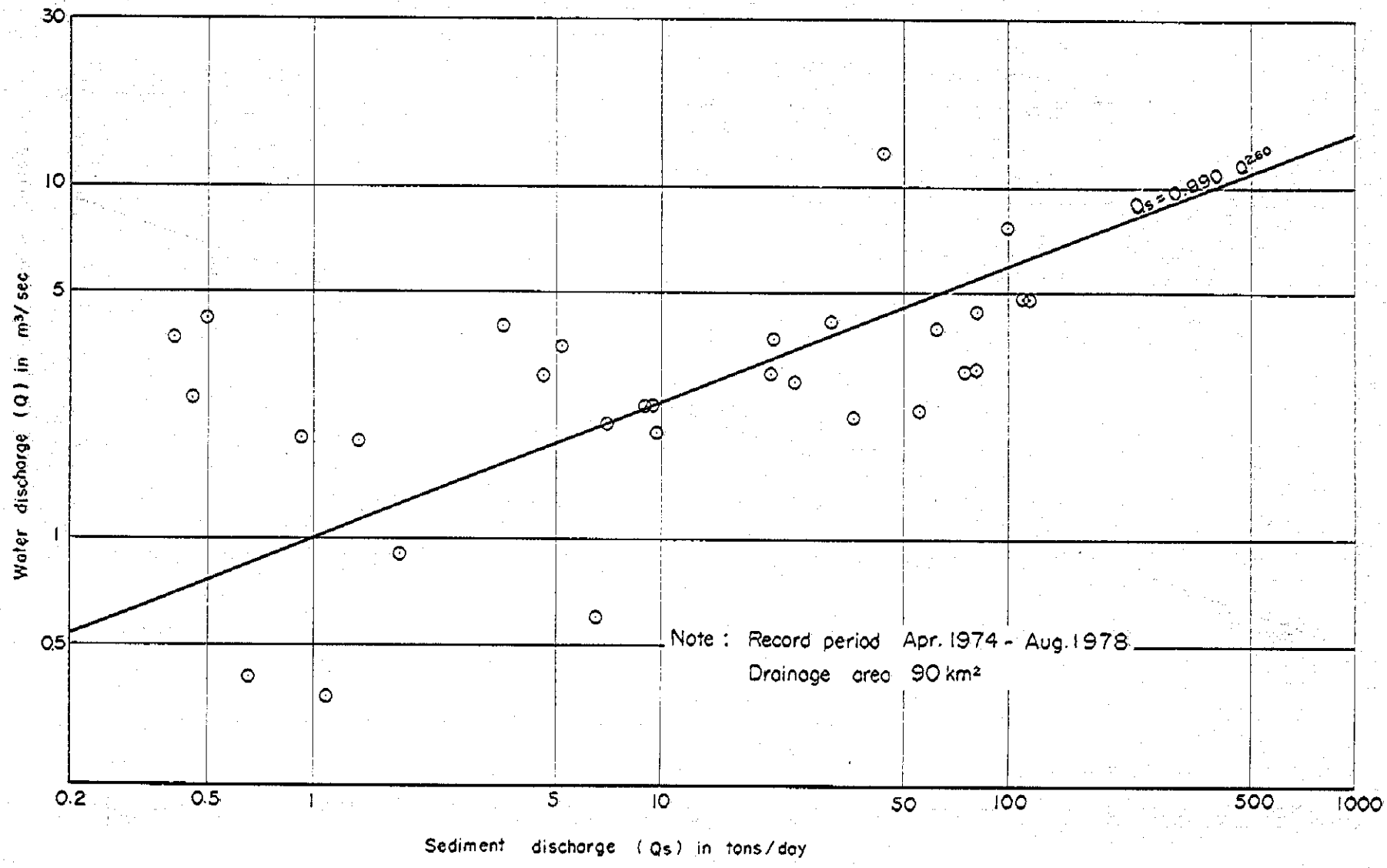


FIG.- I.34 BED LOAD RATING CURVES UNDER PRESENT RIVER CONDITIONS

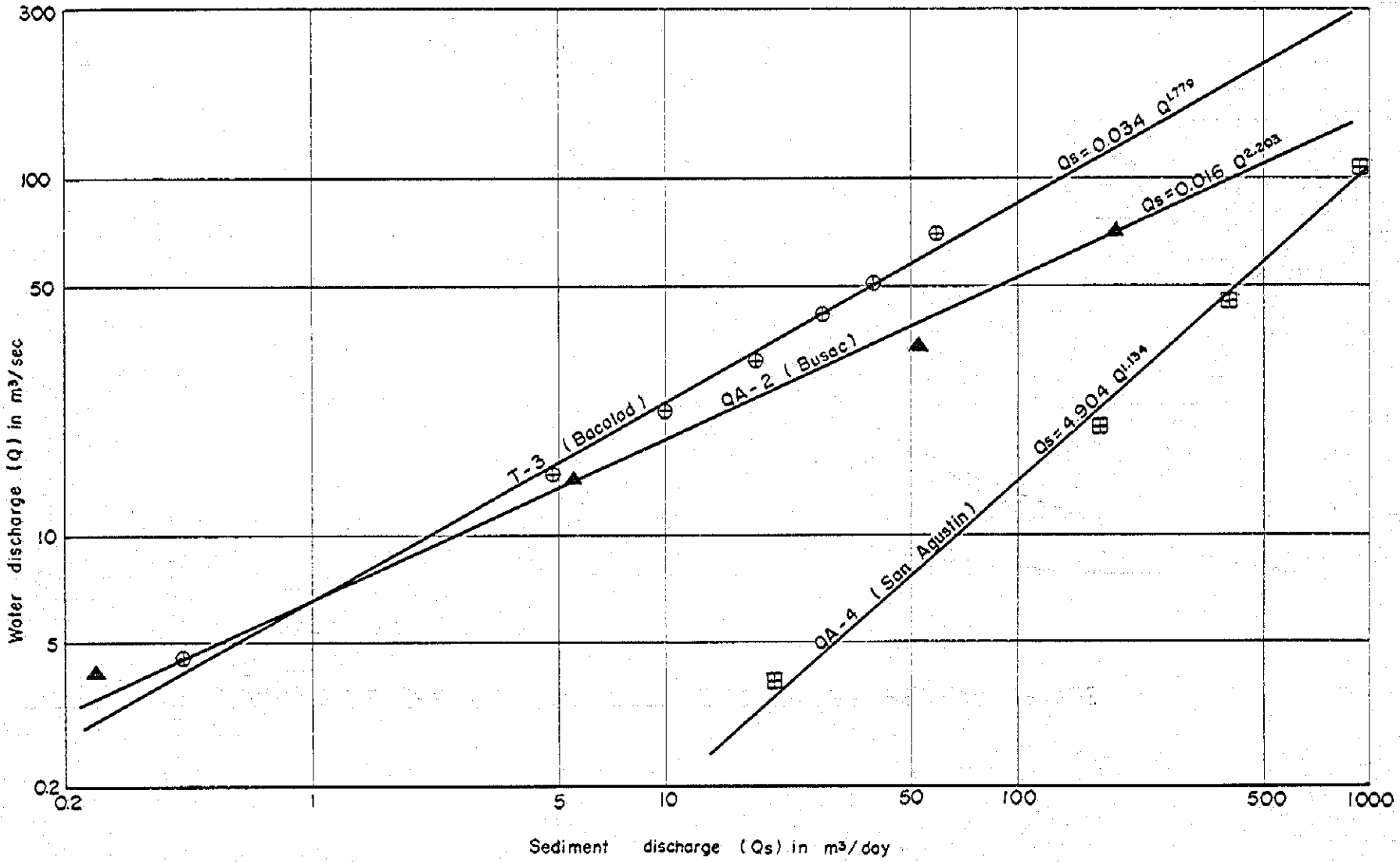


FIG.-I.35 GRAIN SIZE DISTRIBUTION CURVES OF RIVER BED MATERIALS

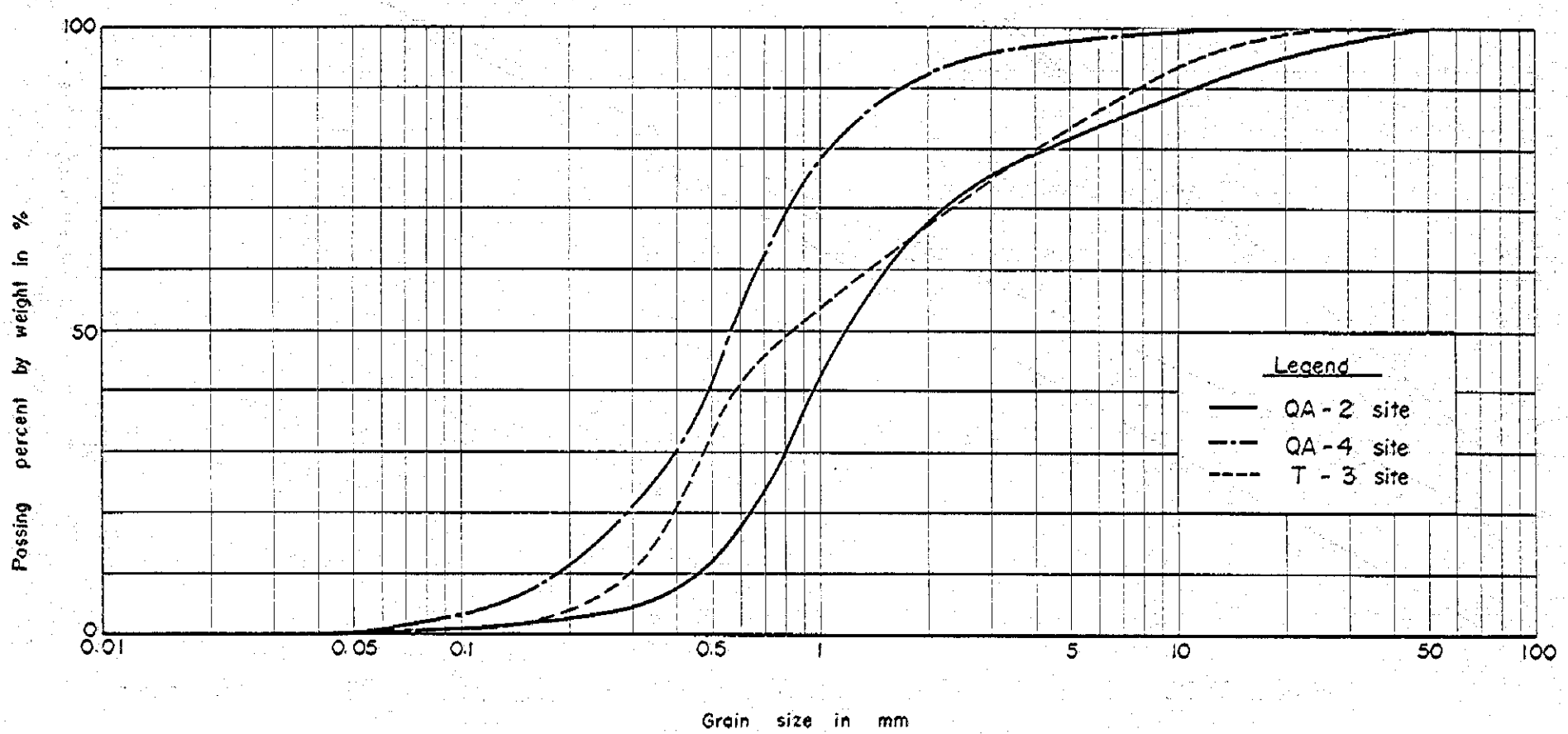


FIG.- I.36 MEAN ANNUAL RAINFALL IN THE PROJECT AREA

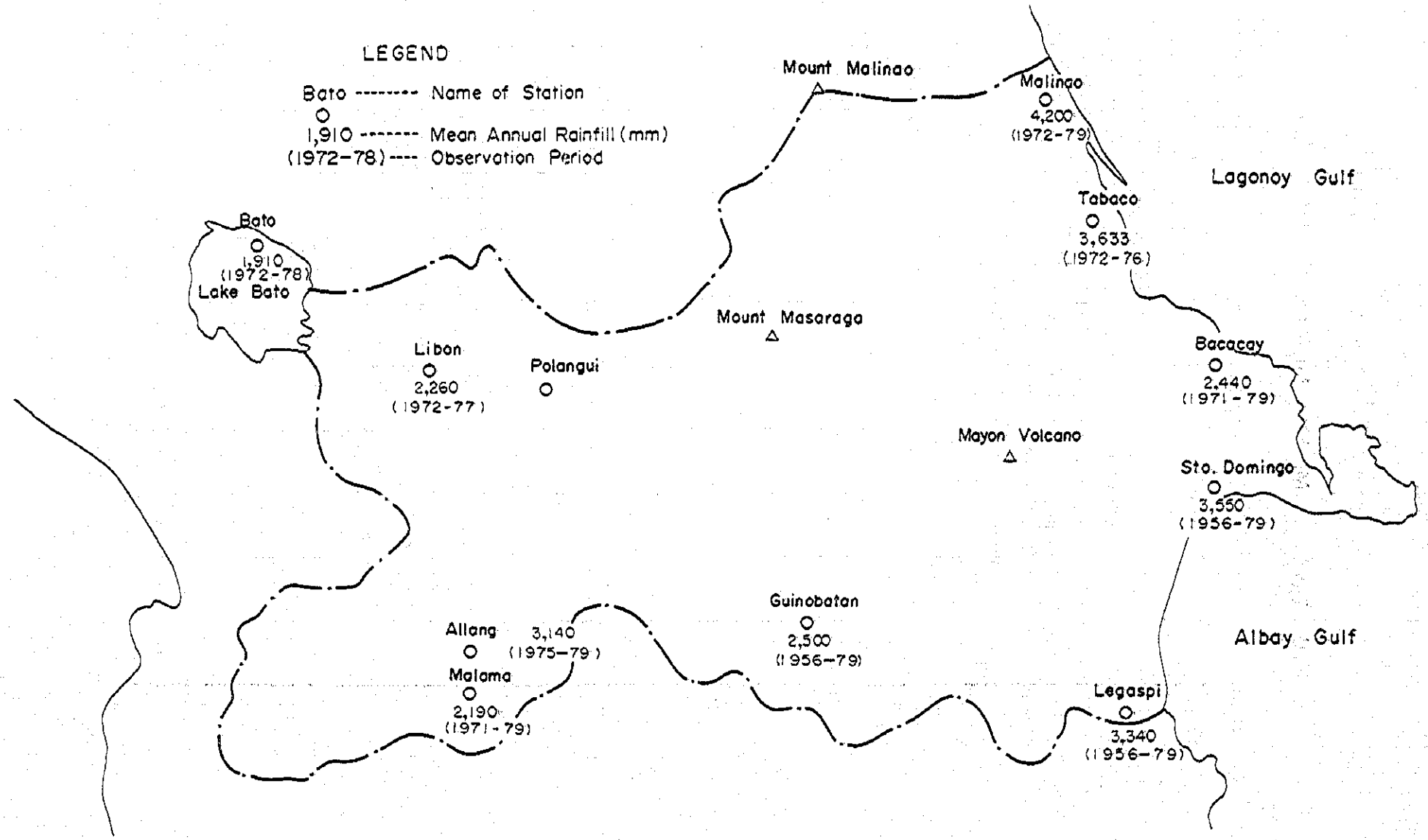


FIG.-1.37 MEAN MONTHLY RAINFALL

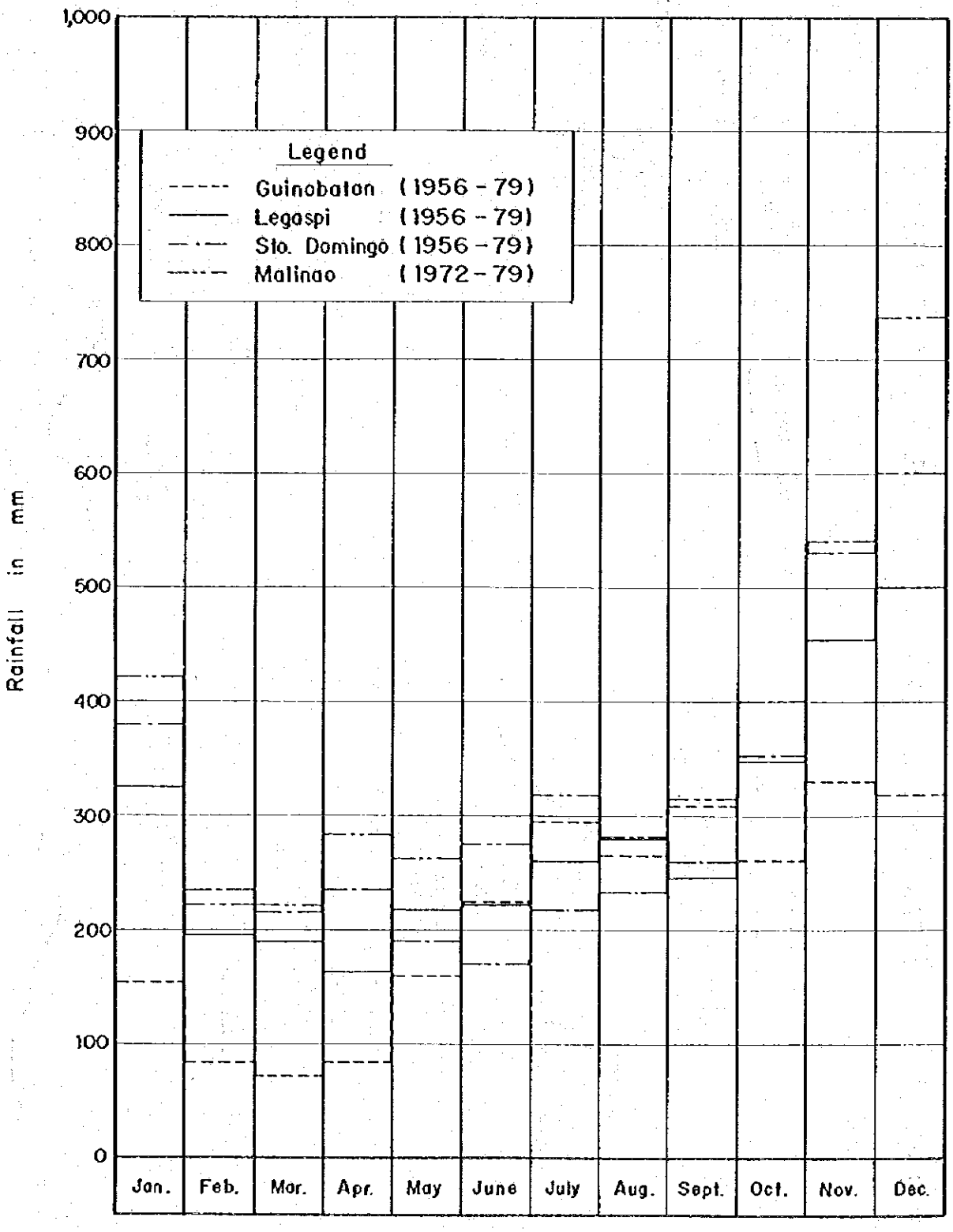


FIG.-I.38 MONTHLY TEMPERATURE RECORD

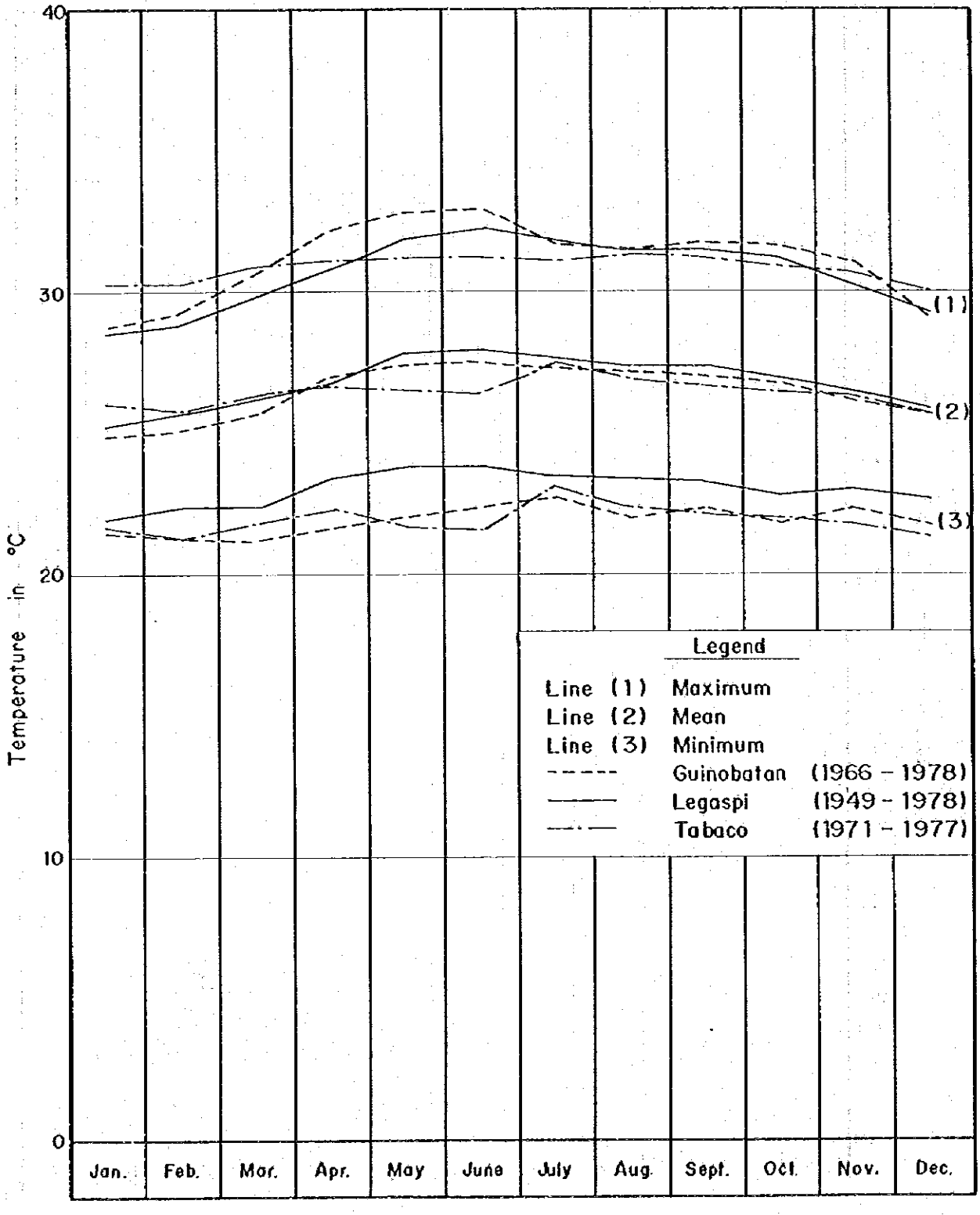


FIG.-I.39 MONTHLY RELATIVE HUMIDITY AT LEGASPI

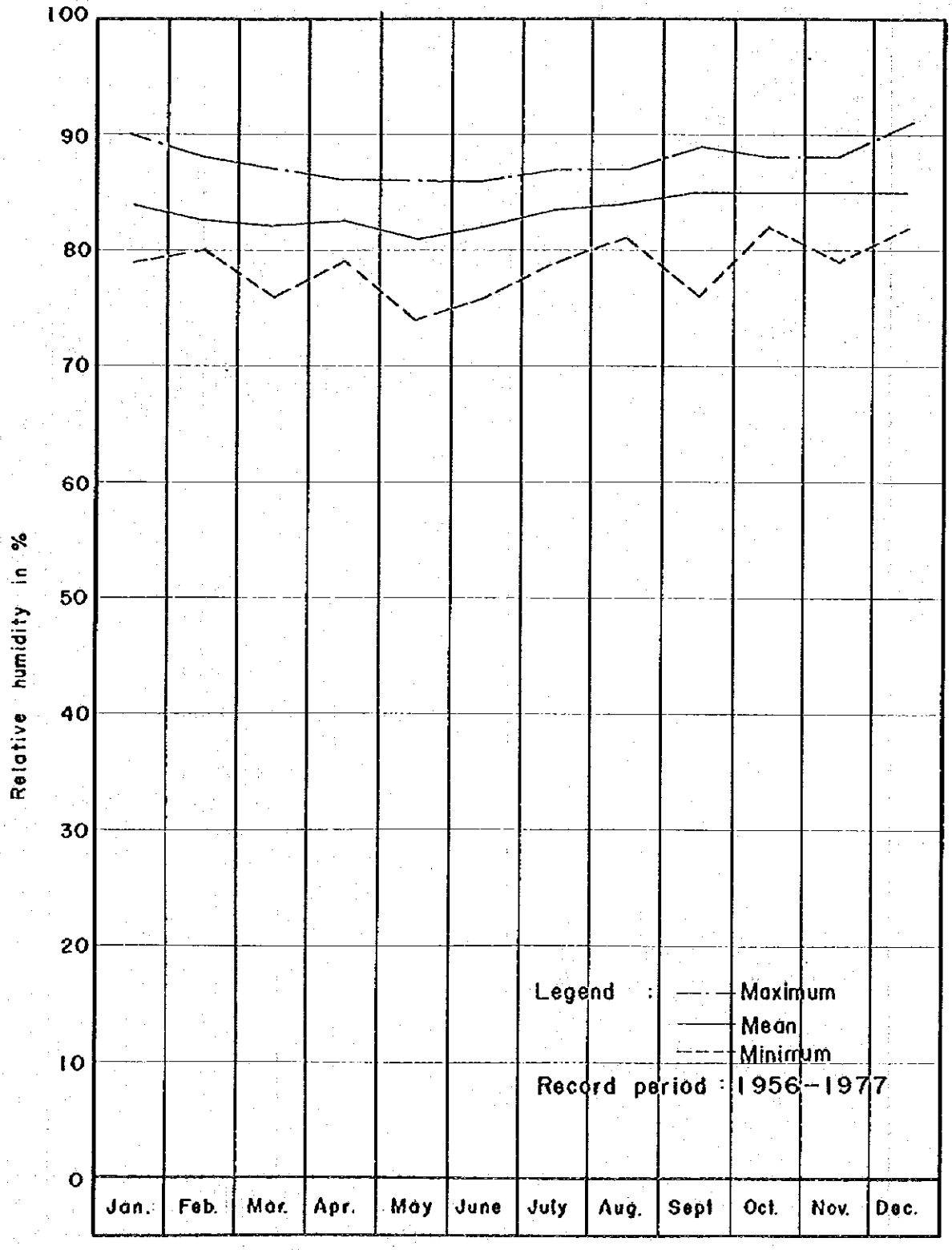
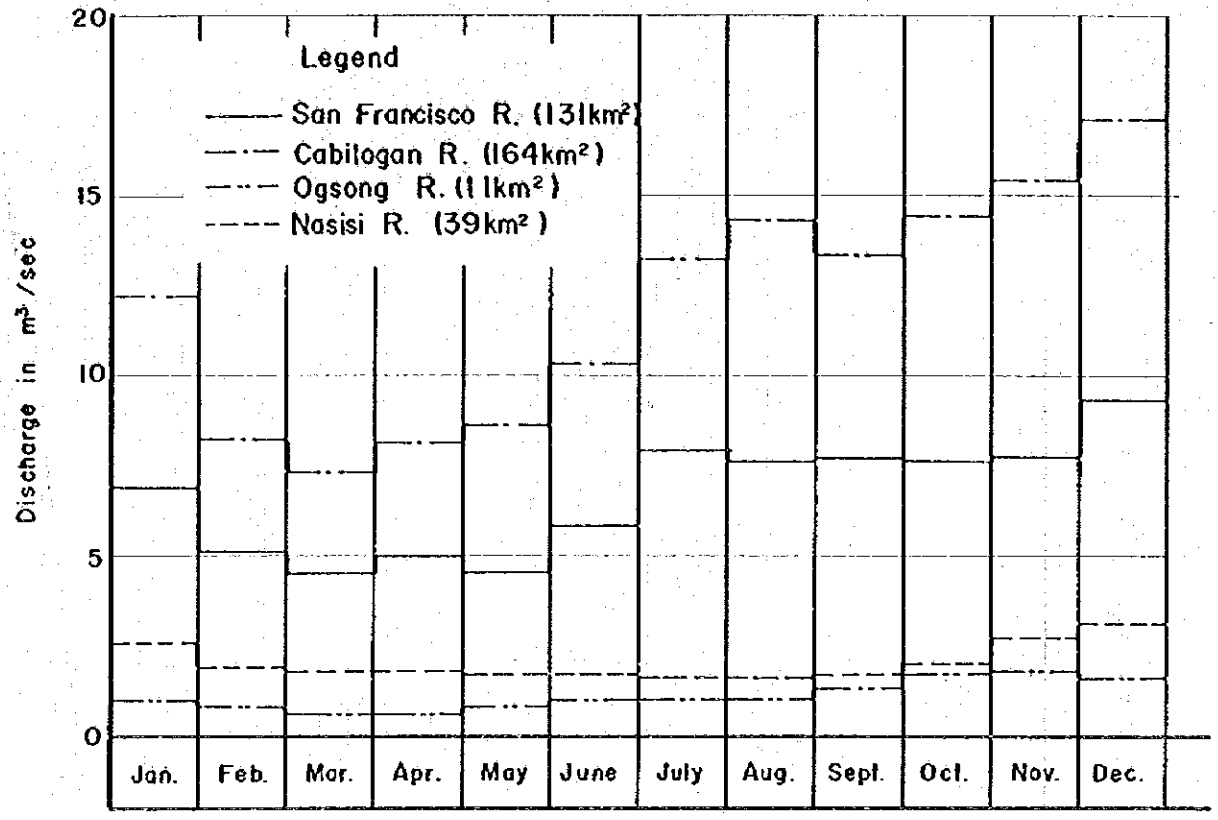


FIG.-I.40 MONTHLY MEAN RUNOFF IN THE QUINALI (A) RIVER BASIN



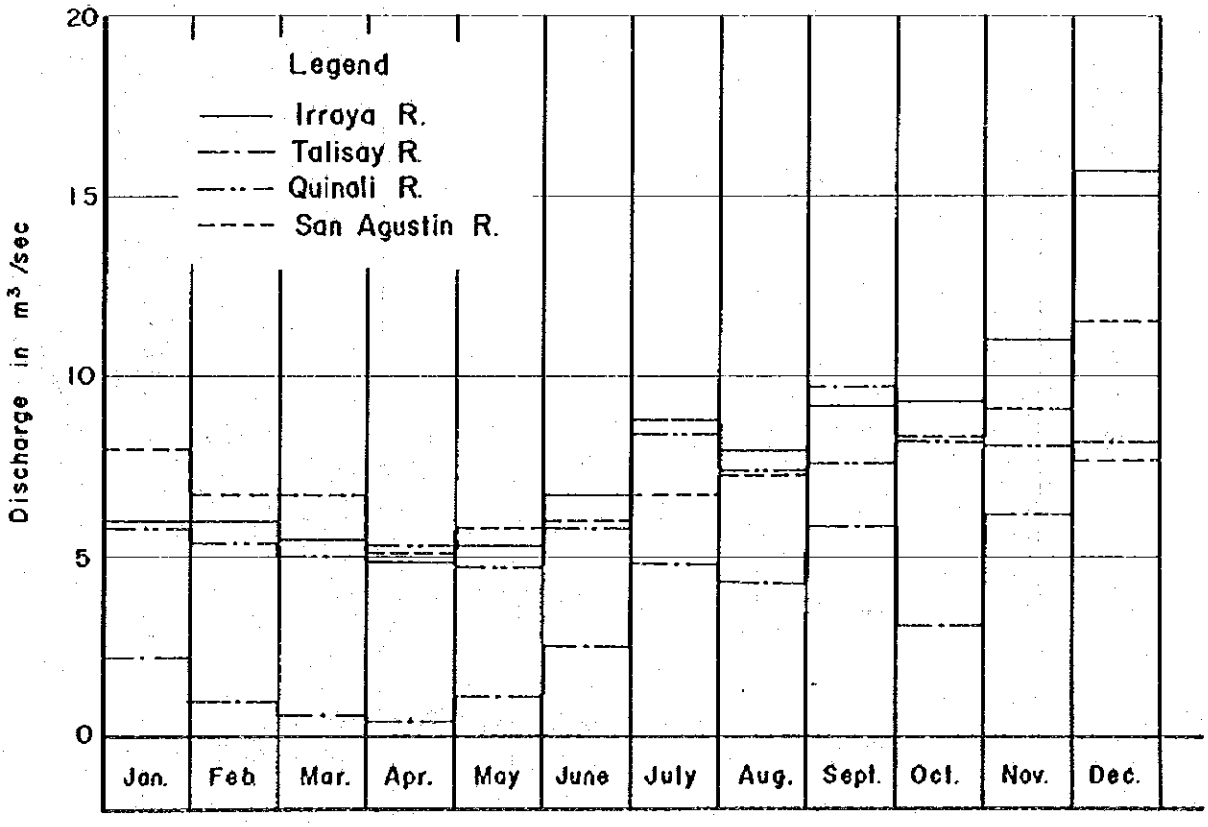


FIG.- I.41 DAILY RUNOFF DURATION CURVES

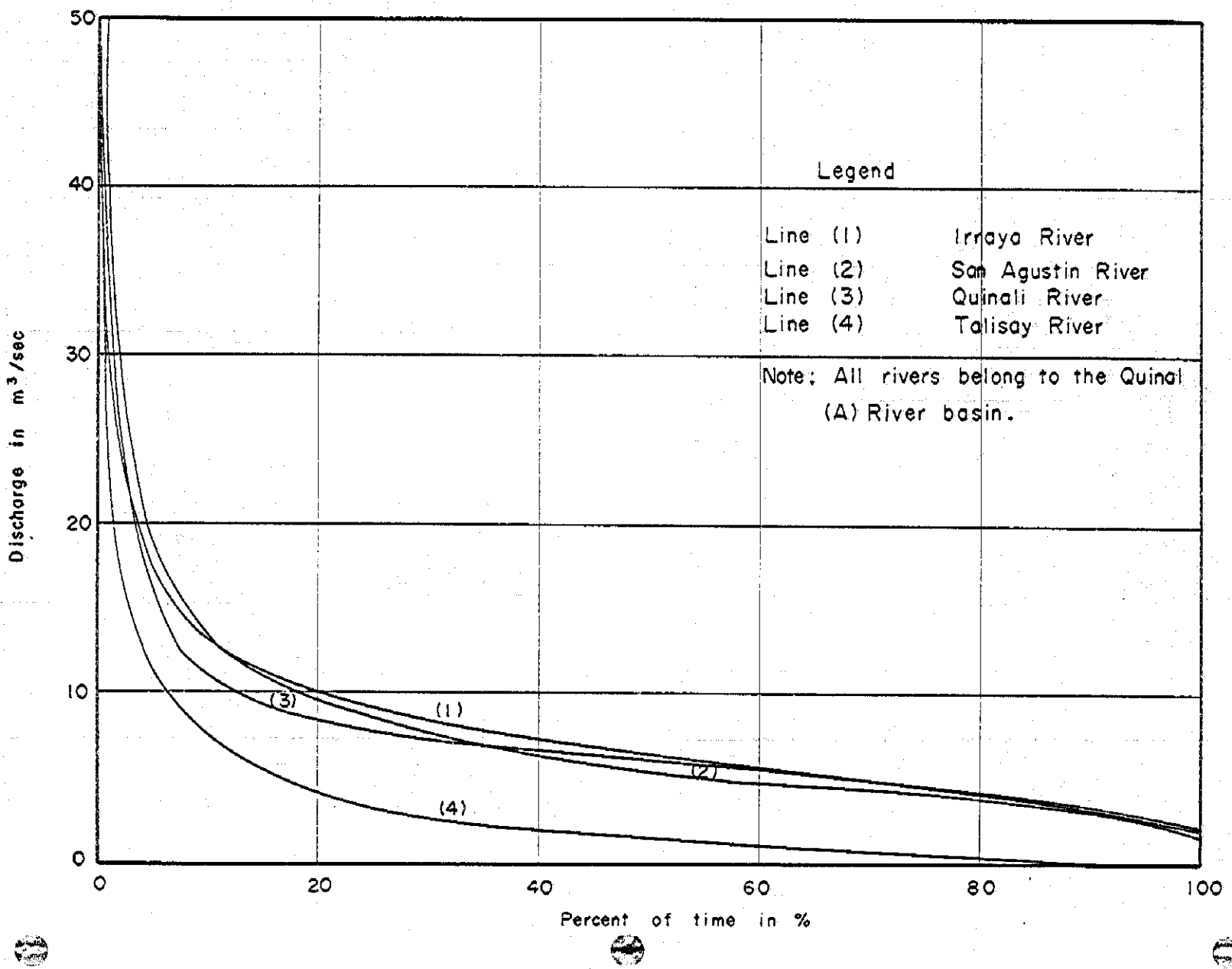


FIG.-I.42 DAILY RUNOFF DURATION CURVES

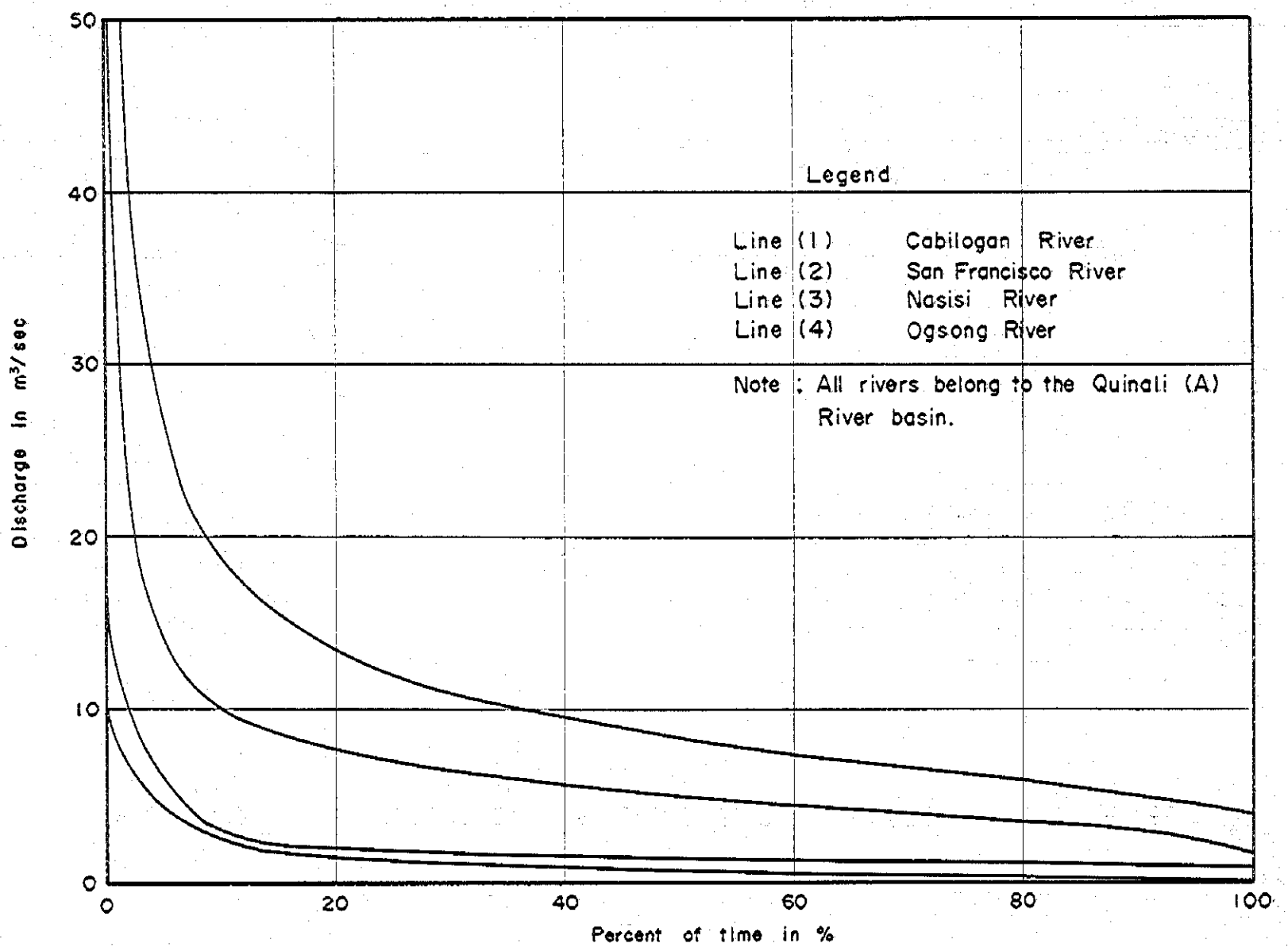


FIG.- I.43 FLUCTUATION OF LAKE BATO SURFACE WATER LEVEL

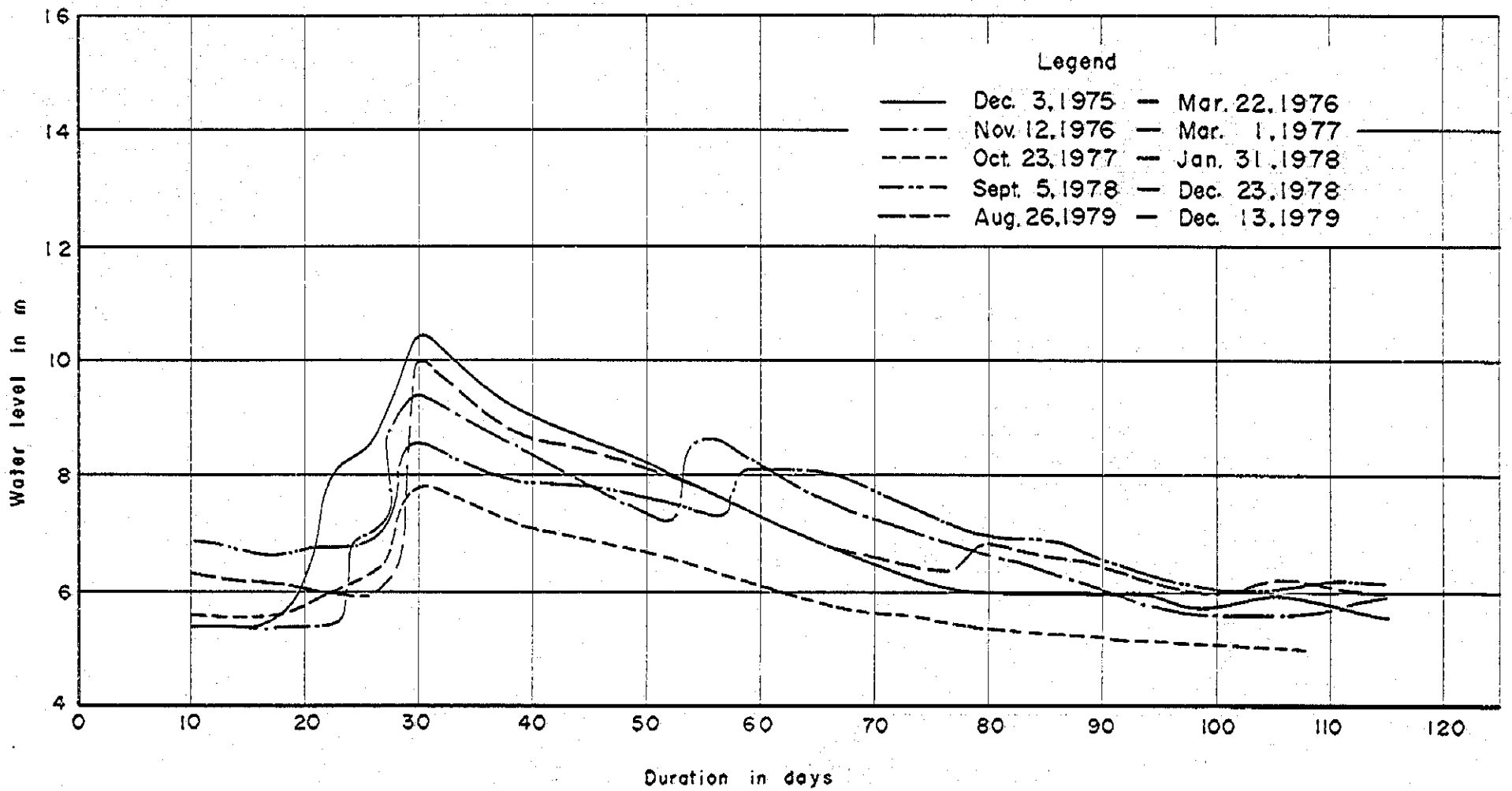


FIG-144 FREQUENCY CURVE FOR WATER LEVEL OF LAKE BATO (1960 – 1979)

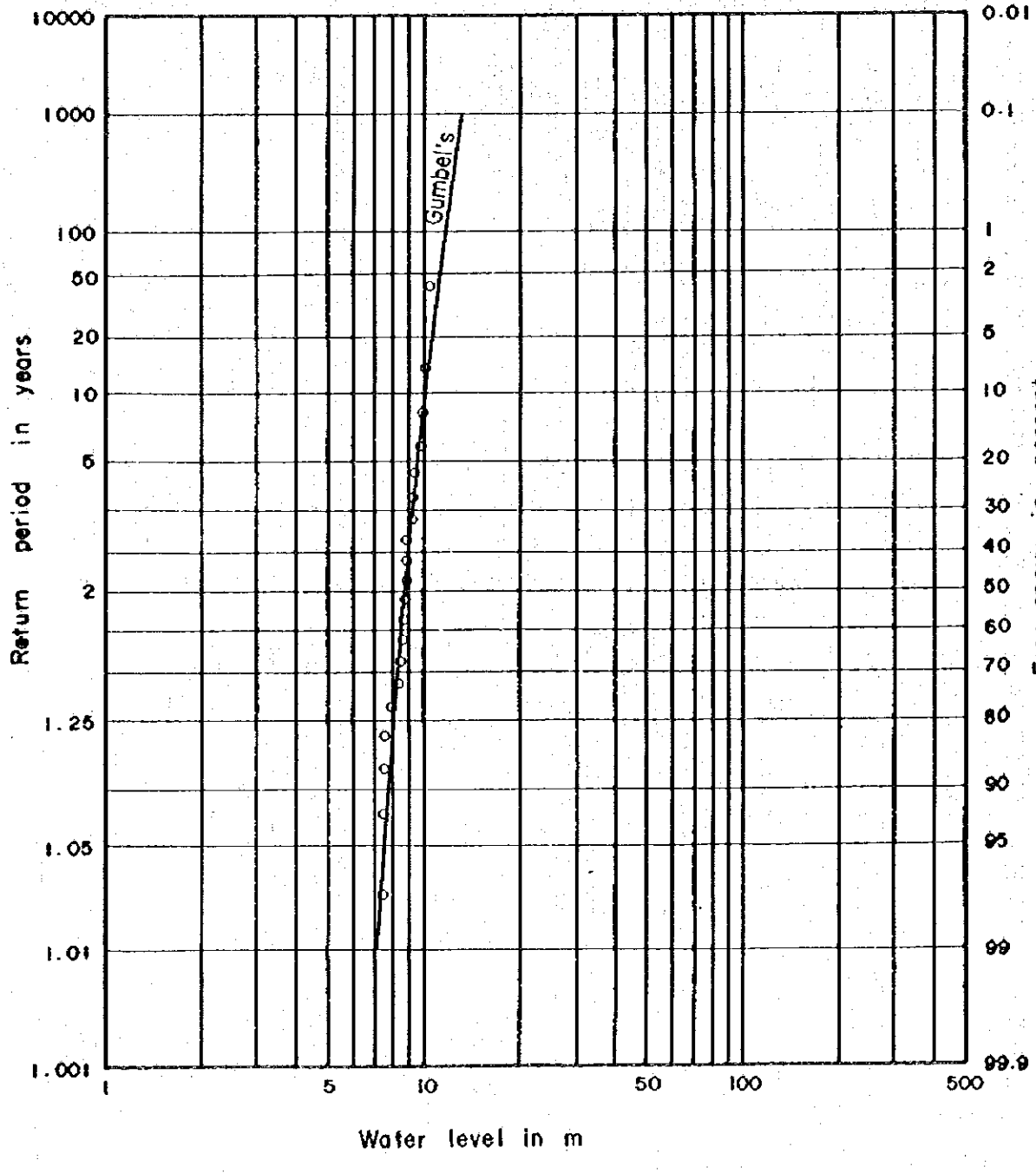


FIG-IV-1 LOCATION MAP OF BASE POINTS AND SUB-BASE POINTS IN THE QUINALI (A) RIVER BASIN

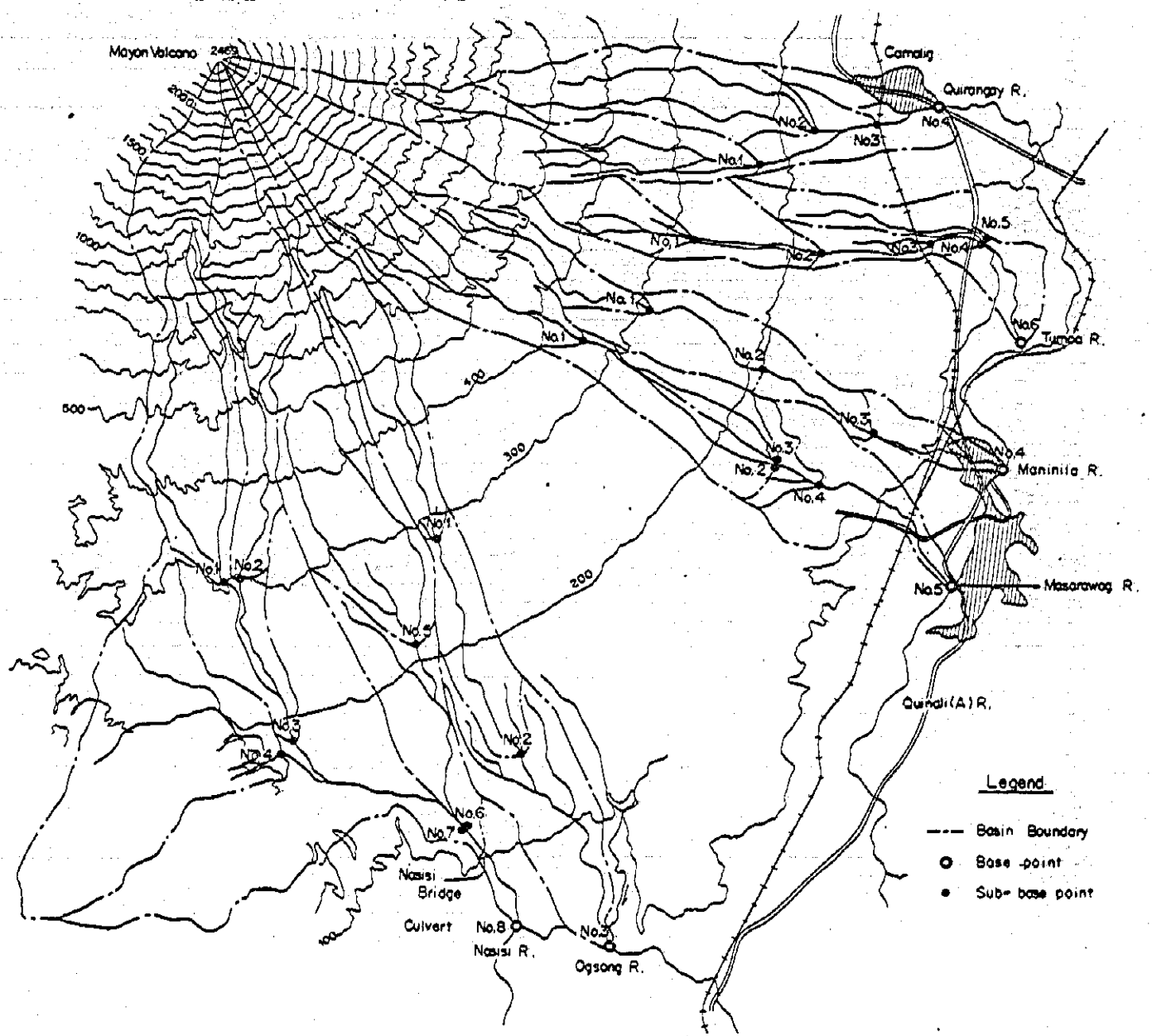


FIG. – IV·2 LOCATION MAP OF BASE POINT AND SUB BASE POINTS IN THE QUINALI (B) RIVER BASIN

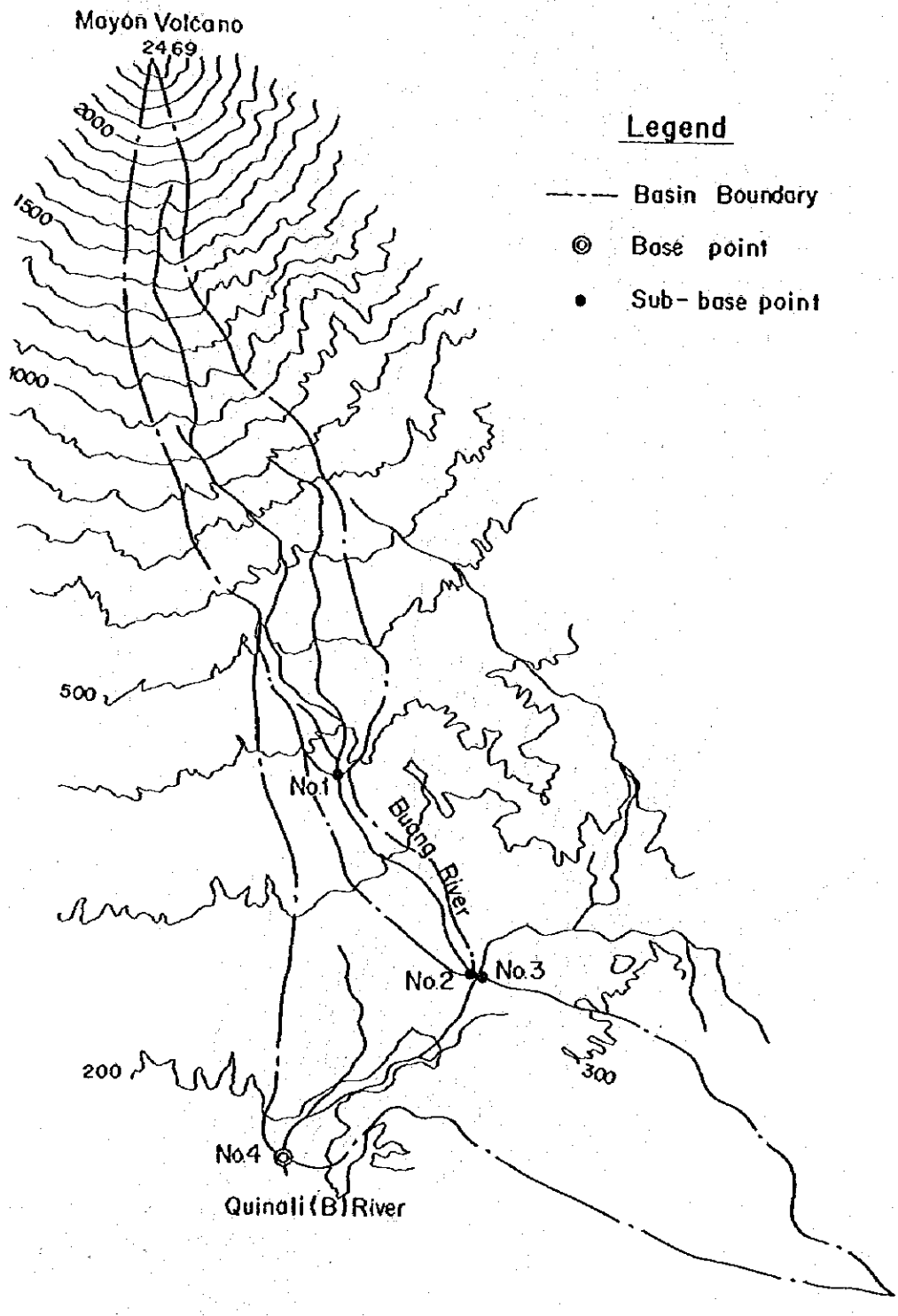


FIG.-IV-3 LOCATION MAP OF BASE POINT AND SUB BASE POINTS IN THE YAWA RIVER BASIN

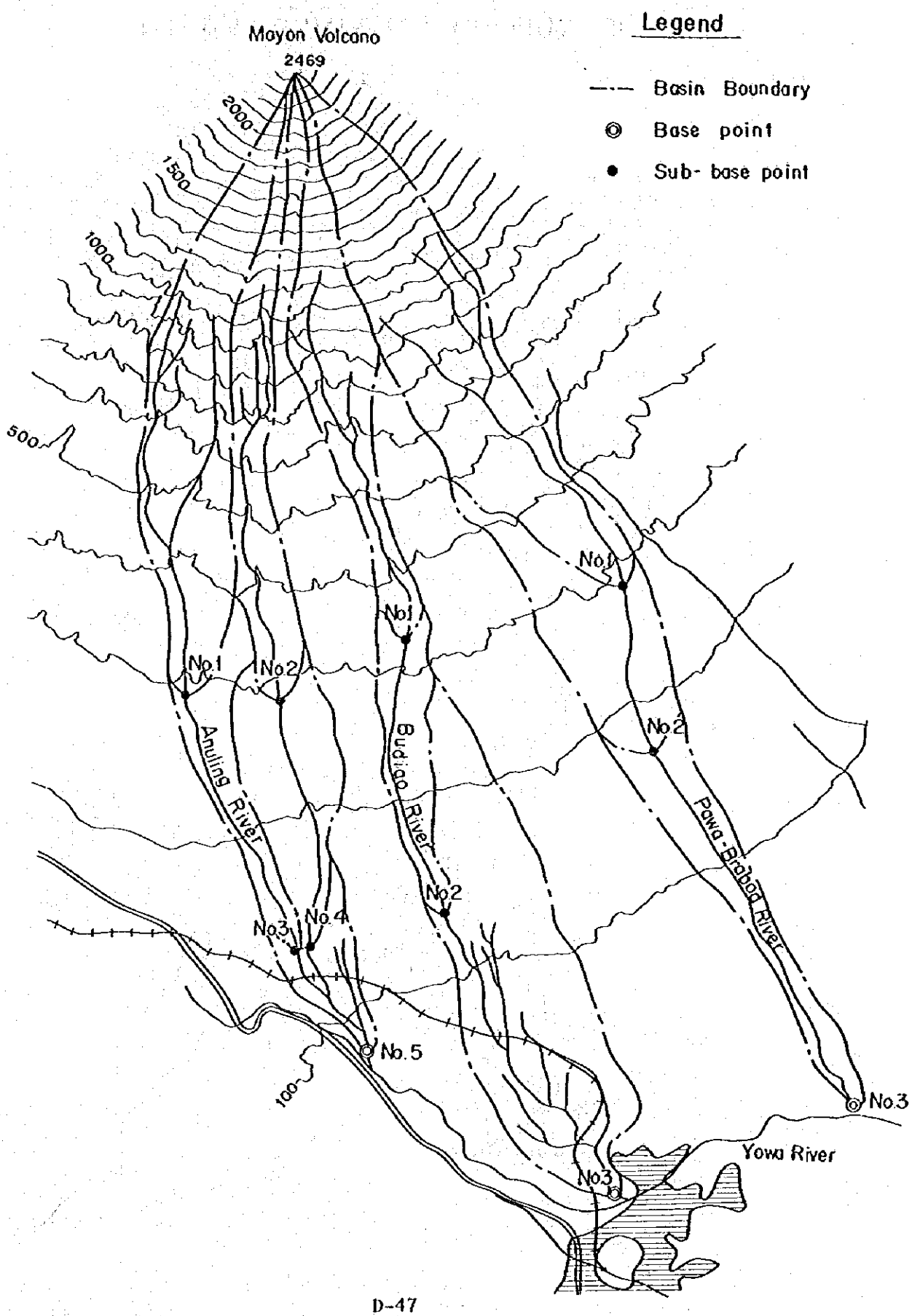


FIG-IV.4 SEDIMENT BALANCE DIAGRAM IN THE QUINALI (A) RIVER BASIN

(Present River Condition)

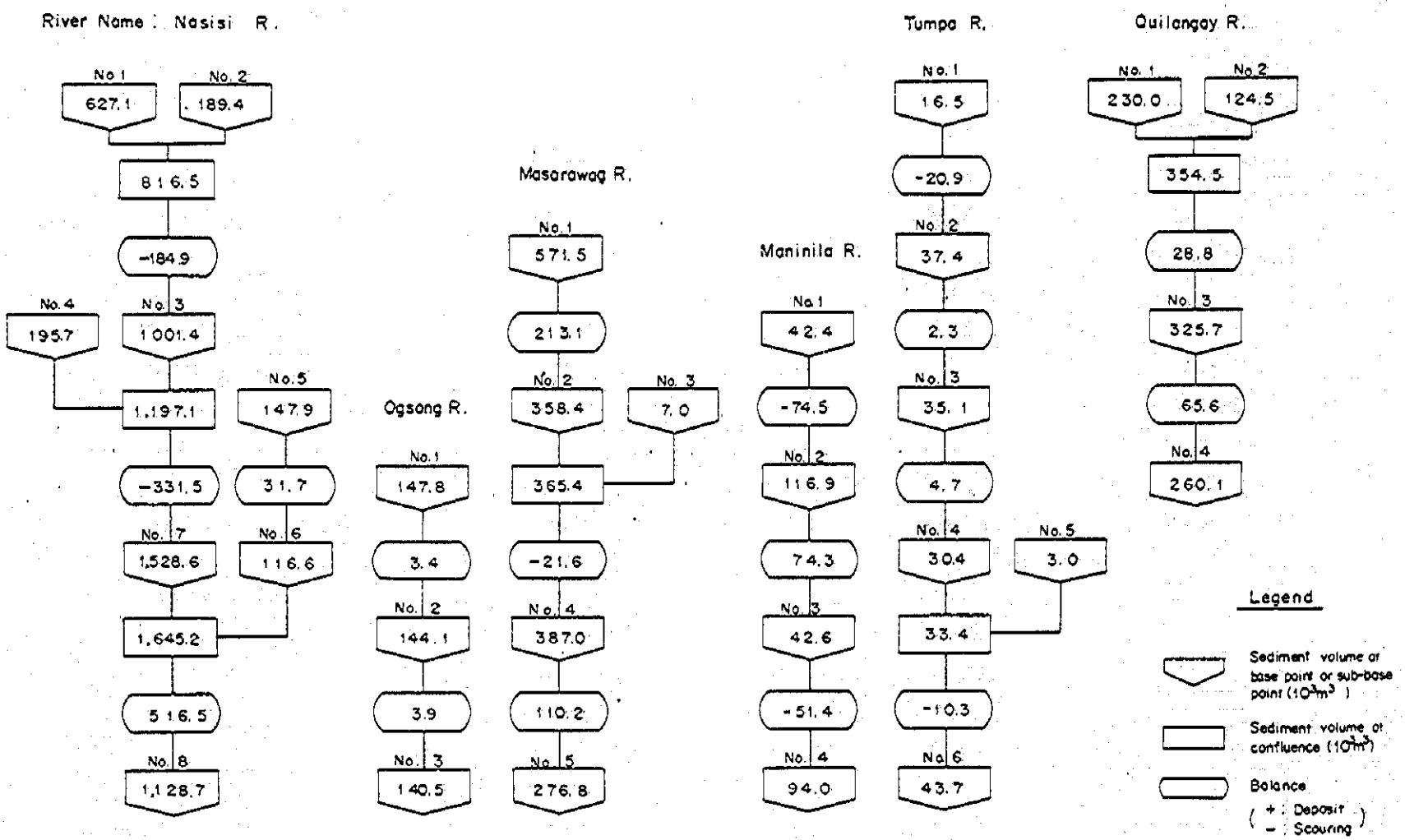


FIG-IV.5 SEDIMENT BALANCE DIAGRAM IN THE QUINALI (A) RIVER BASIN
(With Project)

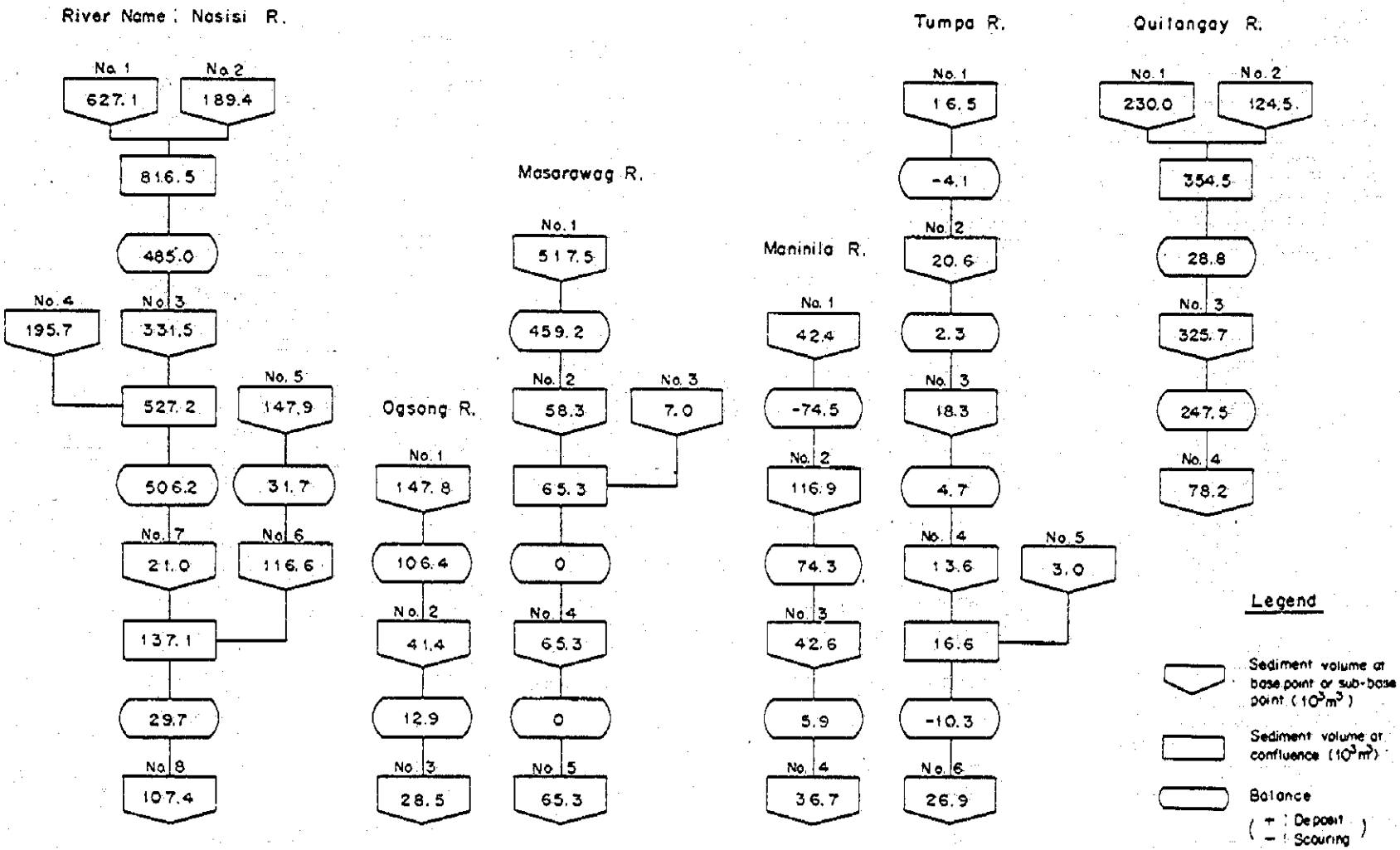


FIG-IV.6 SEDIMENT BALANCE DIAGRAM OF THE BUANG RIVER IN THE QUINALI (B) RIVER BASIN

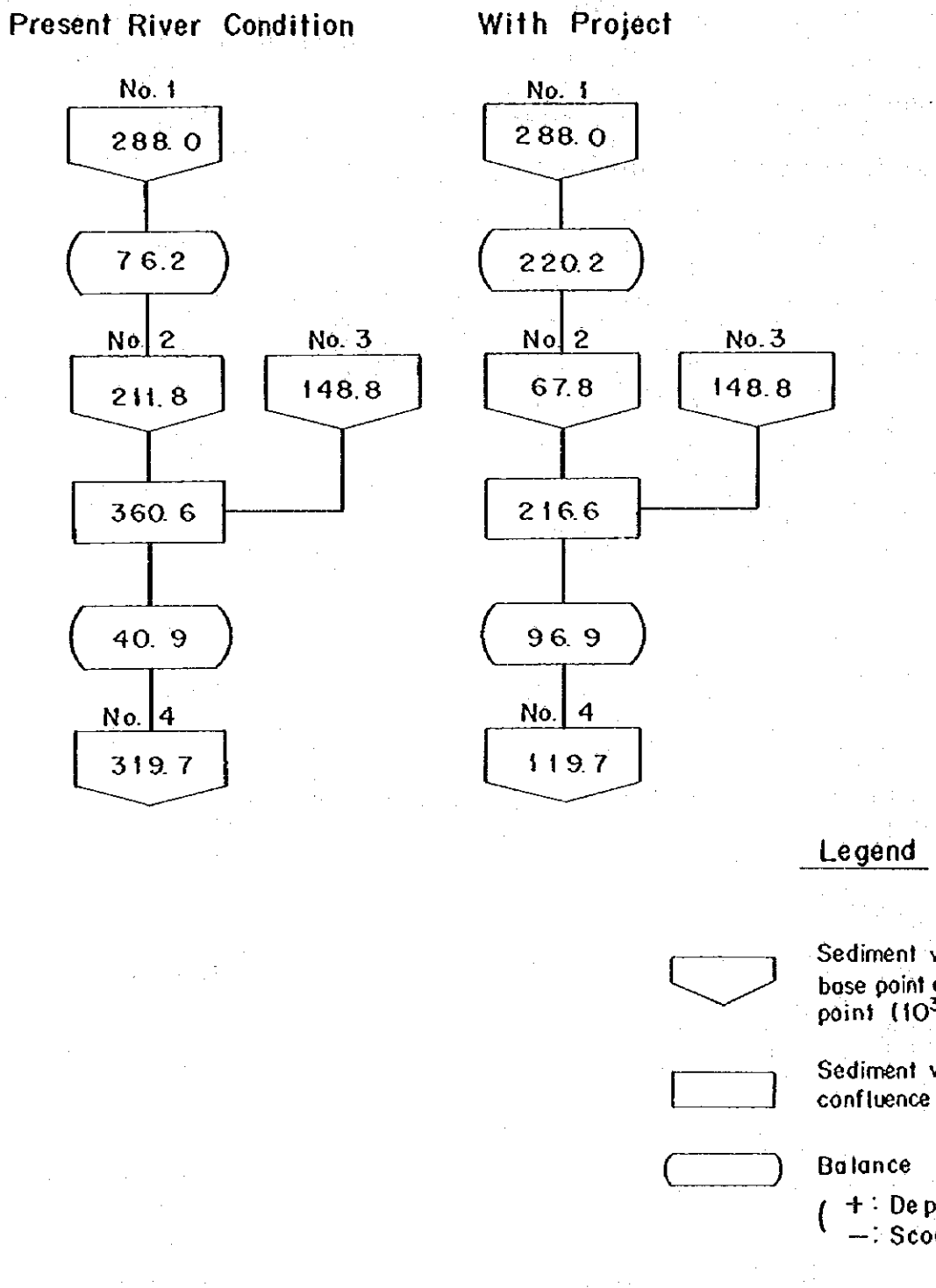


FIG-IV.7 SEDIMENT BALANCE DIAGRAM IN THE YAWA RIVER BASIN

(Present River Condition)

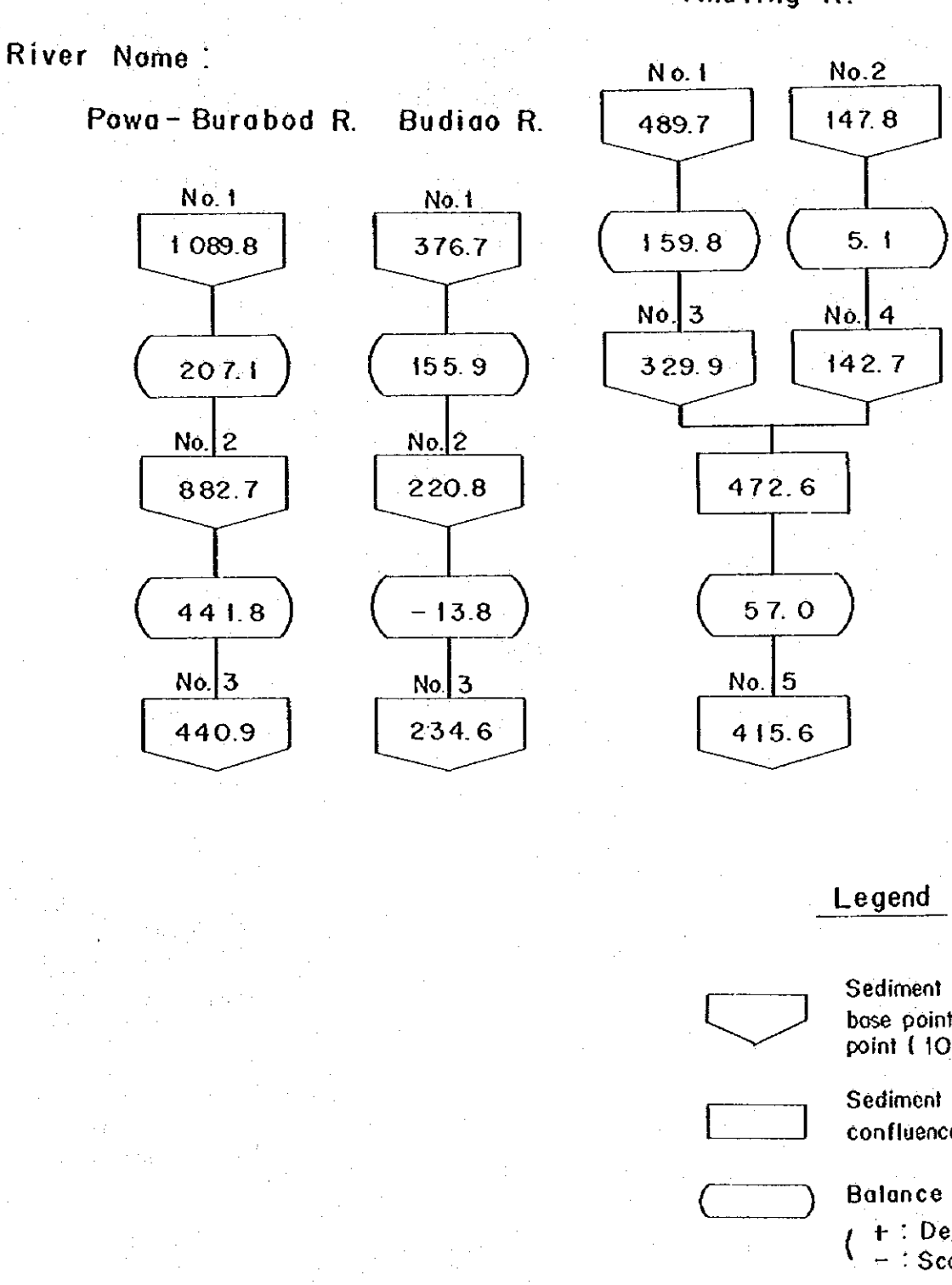


FIG – IV.8 SEDIMENT BALANCE DIAGRAM IN THE YAWA RIVER BASIN
(With project)

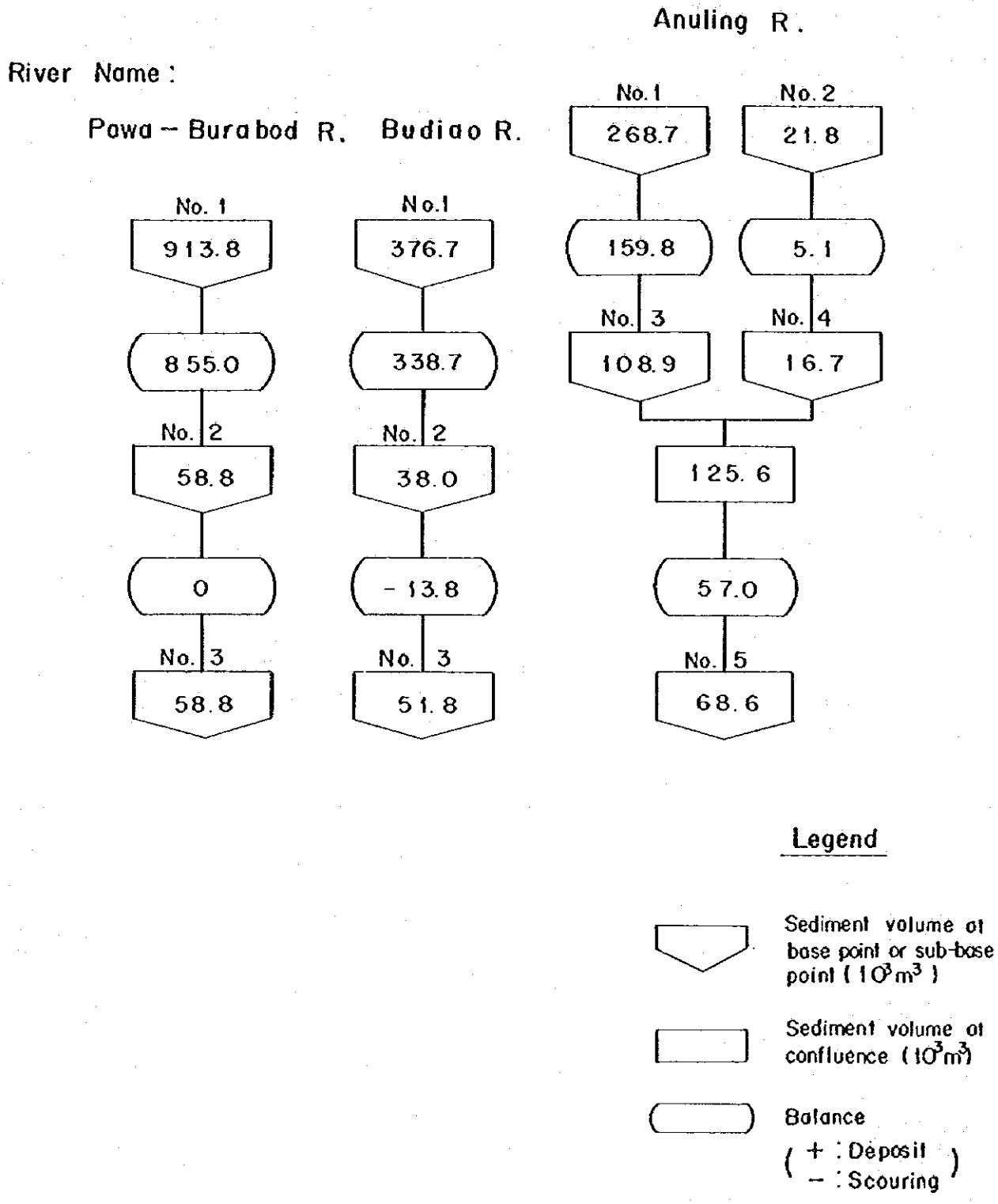


FIG.- V.1 INUNDATION AREA IN THE QUINALI (A) RIVER BASIN

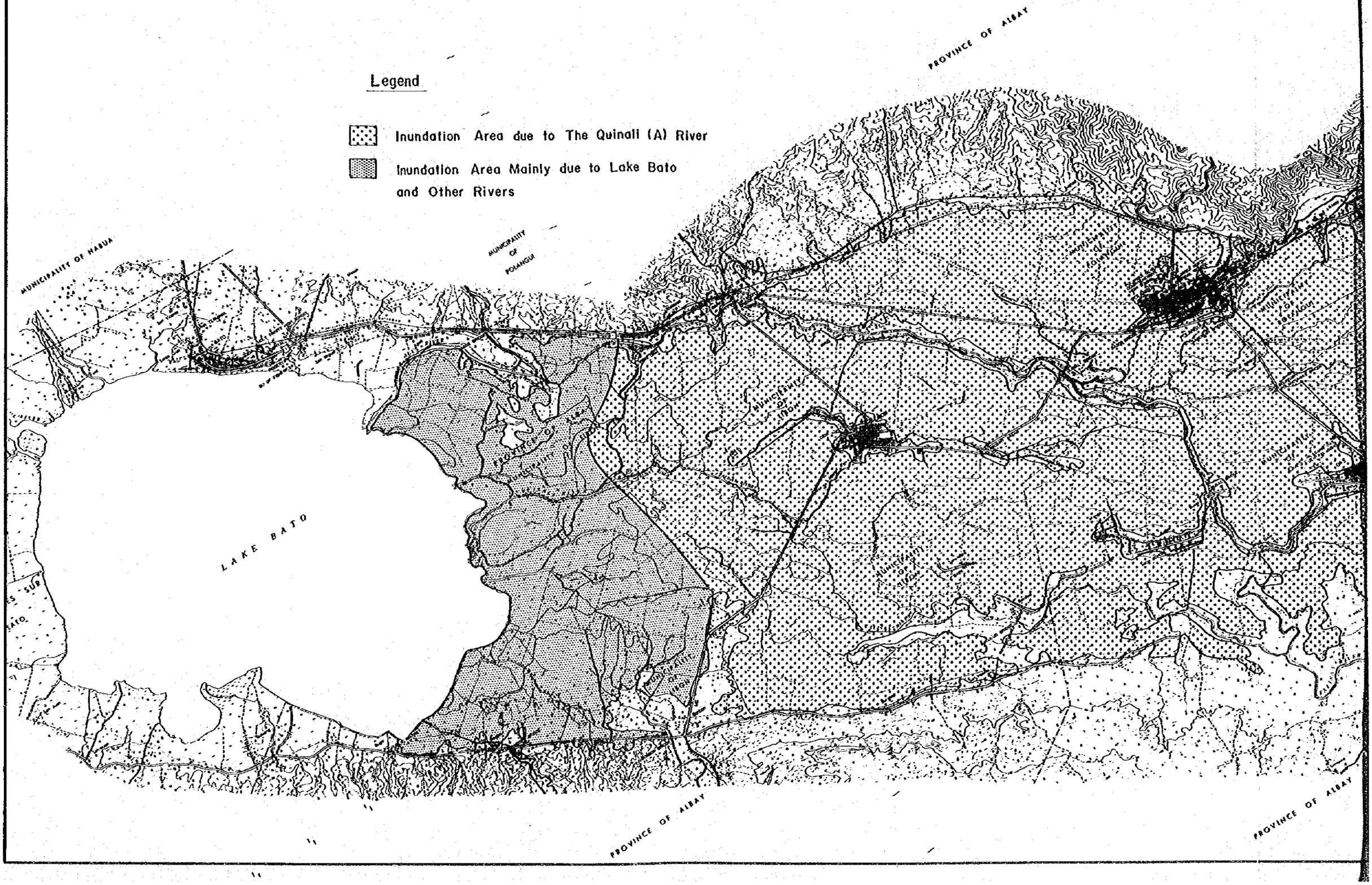


FIG.- V.1 INUNDATION AREA IN THE QUINALI (A) RIVER BASIN

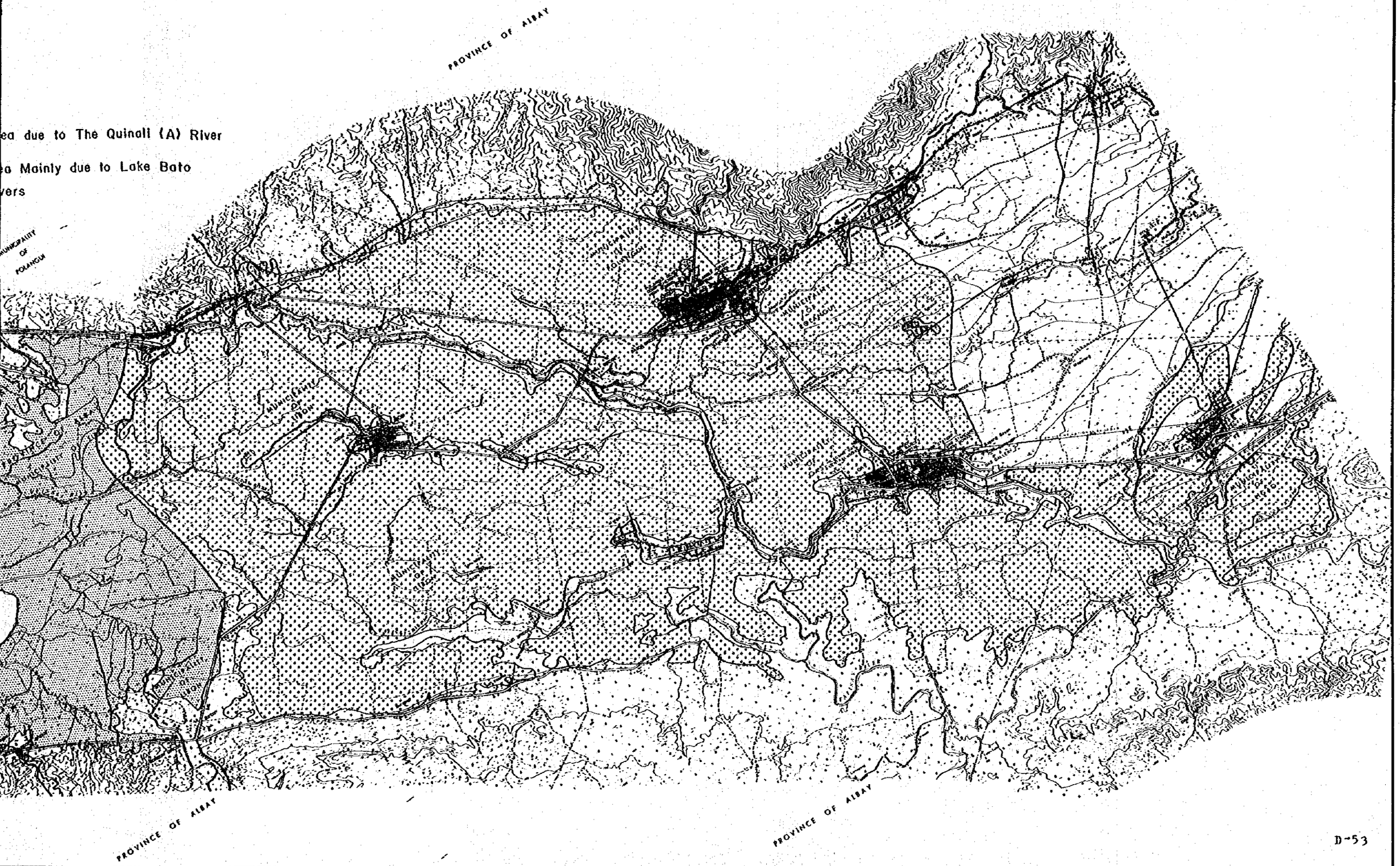


FIG. - V.2 INUNDATION AND FLOODING AREA IN THE QUINALI (B) RIVER BASIN

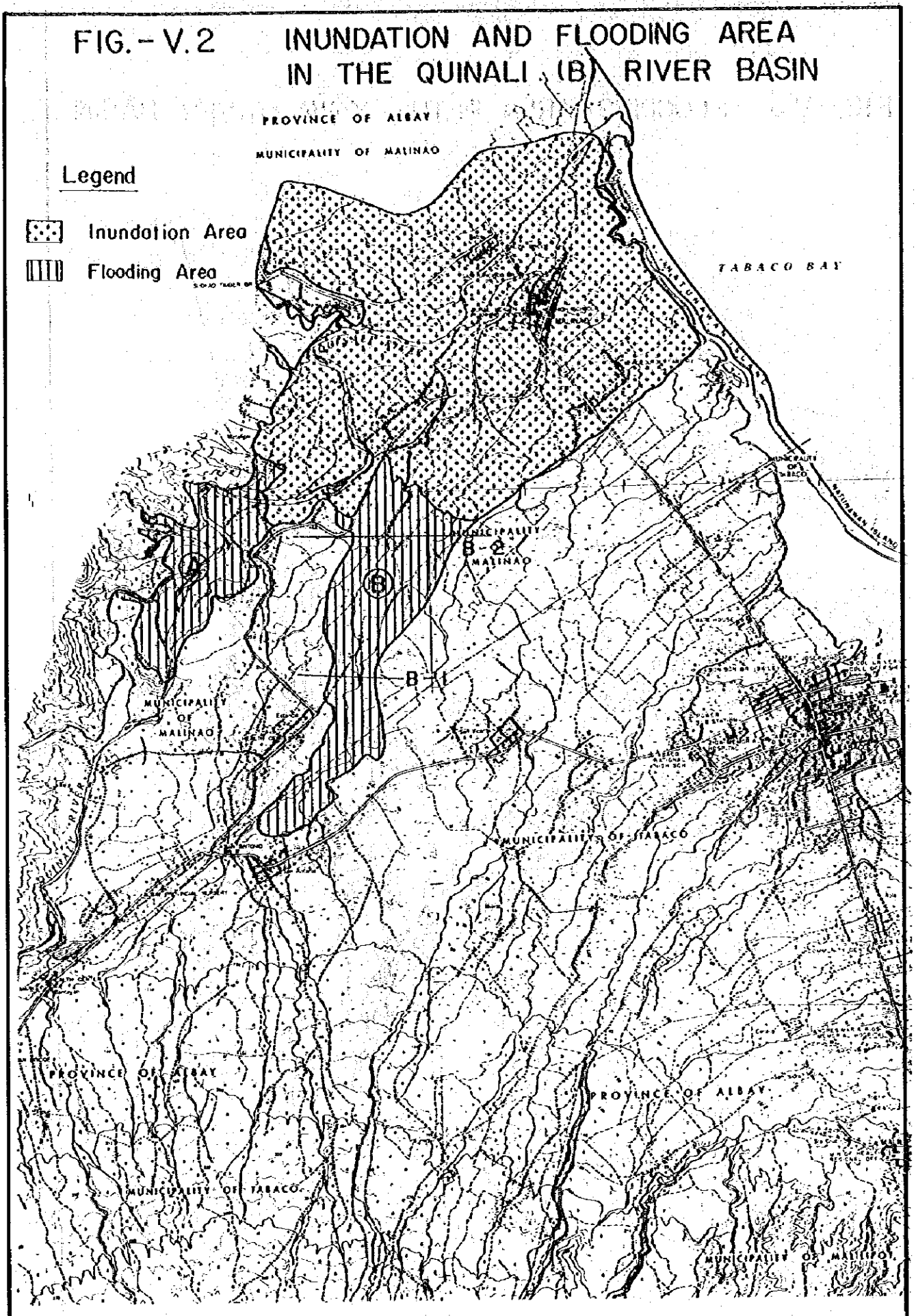
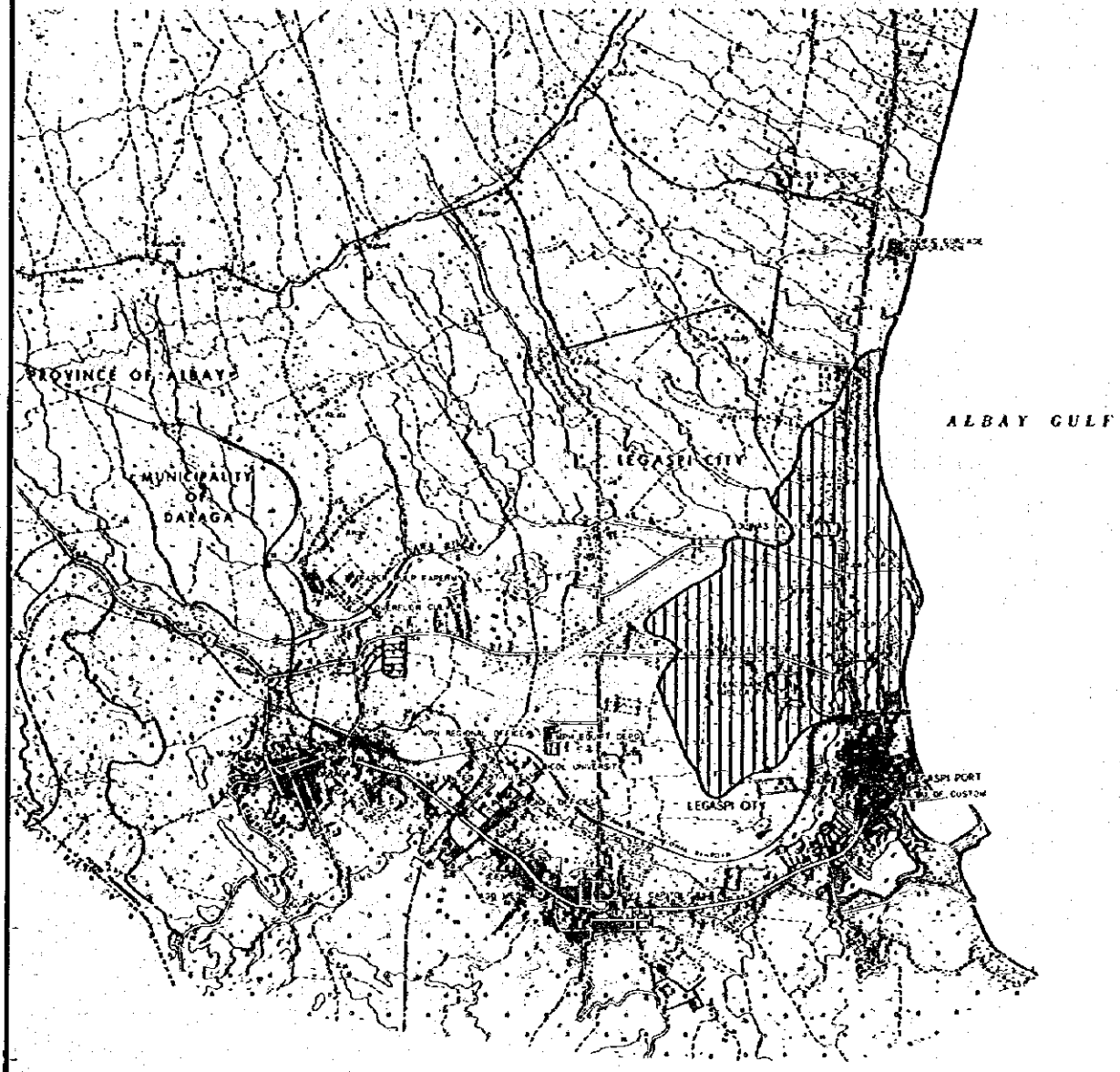


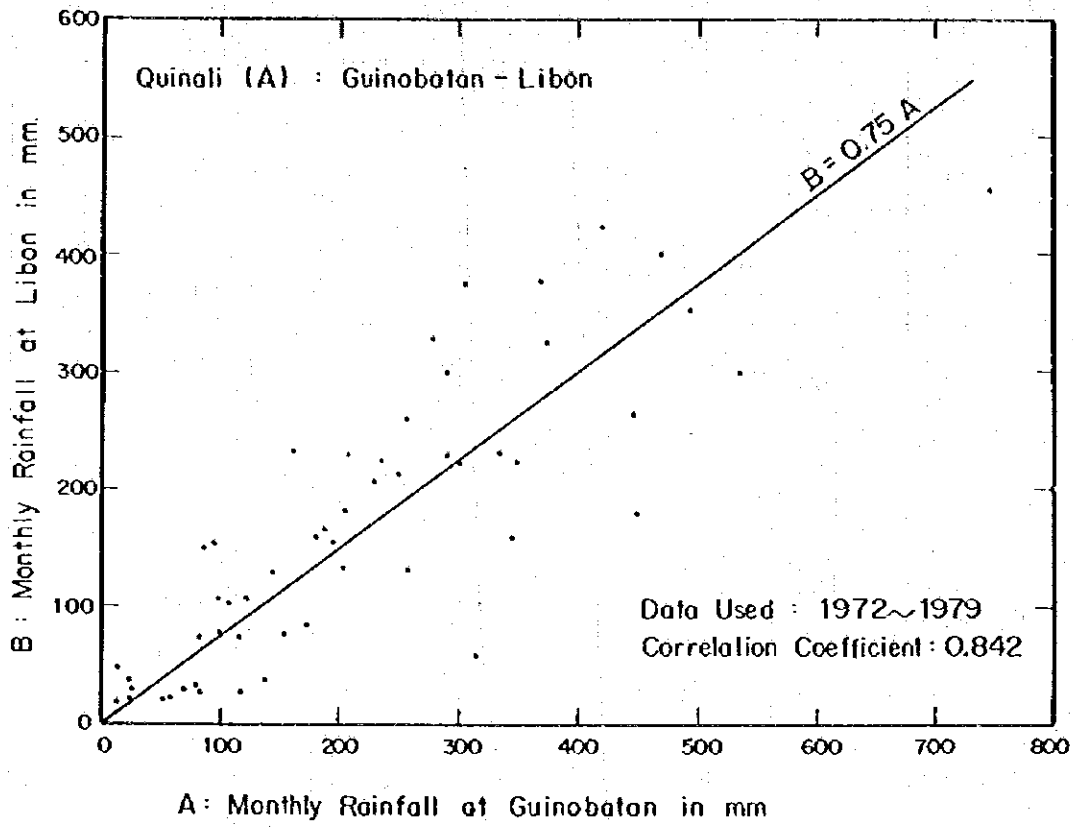
FIG.- V.3 FLOODING AREA IN THE YAWA RIVER BASIN



Legend

Flooding Area

Fig. VII - 1 CORRELATION OF MONTHLY RAINFALL



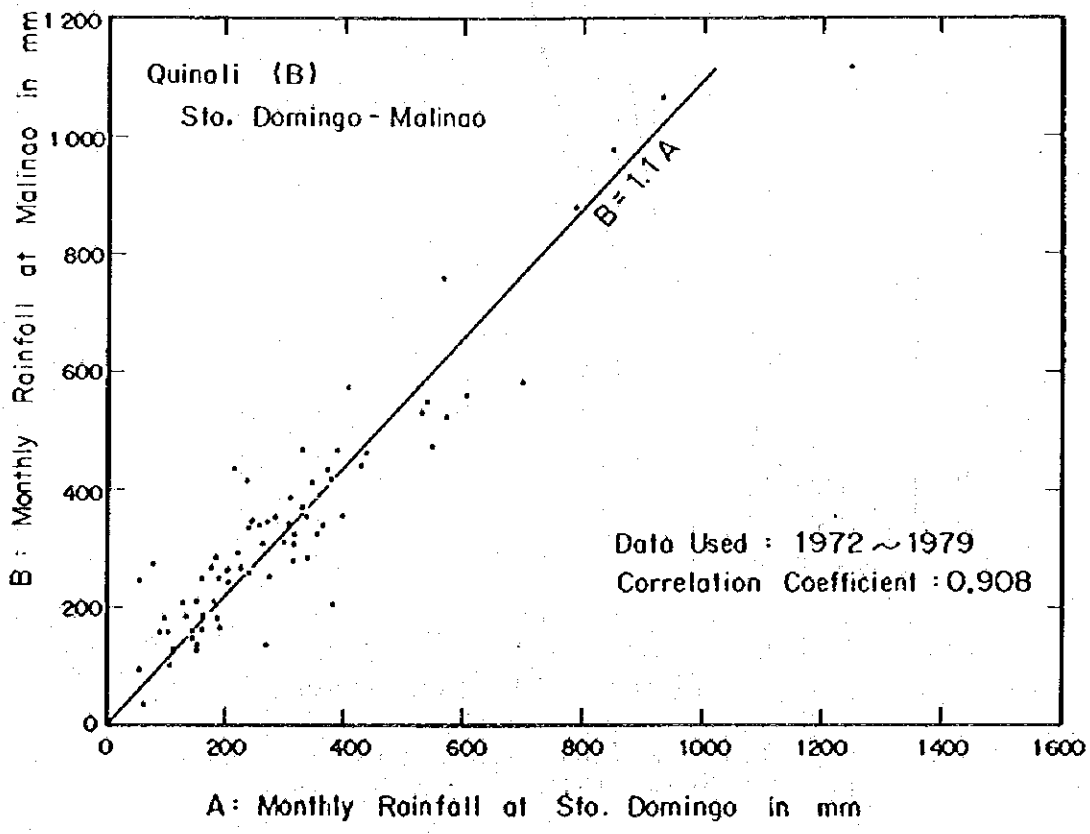
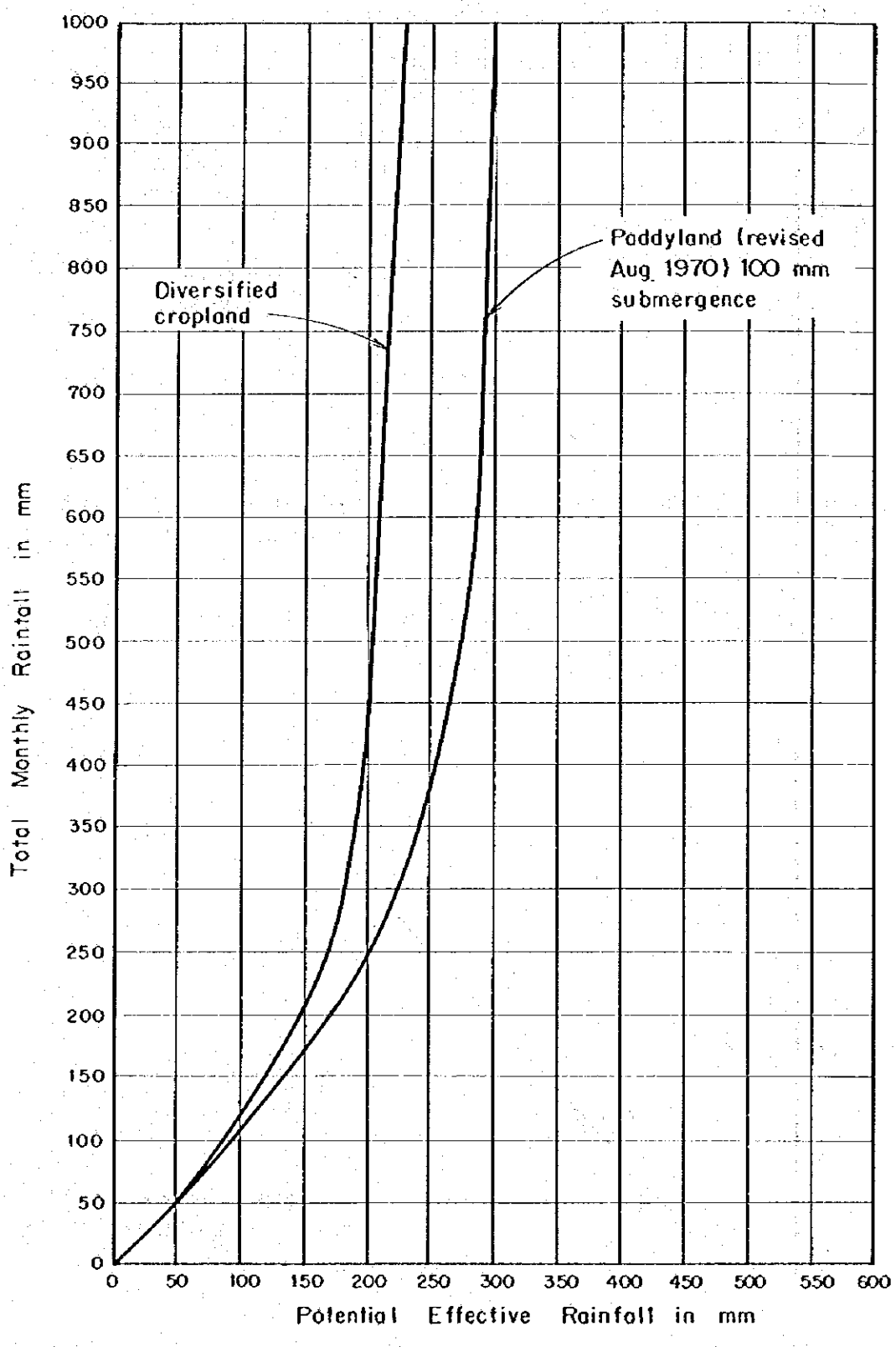


Fig. Ⅶ-2 POTENTIAL EFFECTIVE RAINFALL CURVES



Source = Upper Pampanga River Project, Irrigation - Agriculture Study by ECI - EDCOP, 1975

Fig · VII - 3 MONTHLY WATER BALANCE AT CABILOGAN HEADWORKS (1/2)

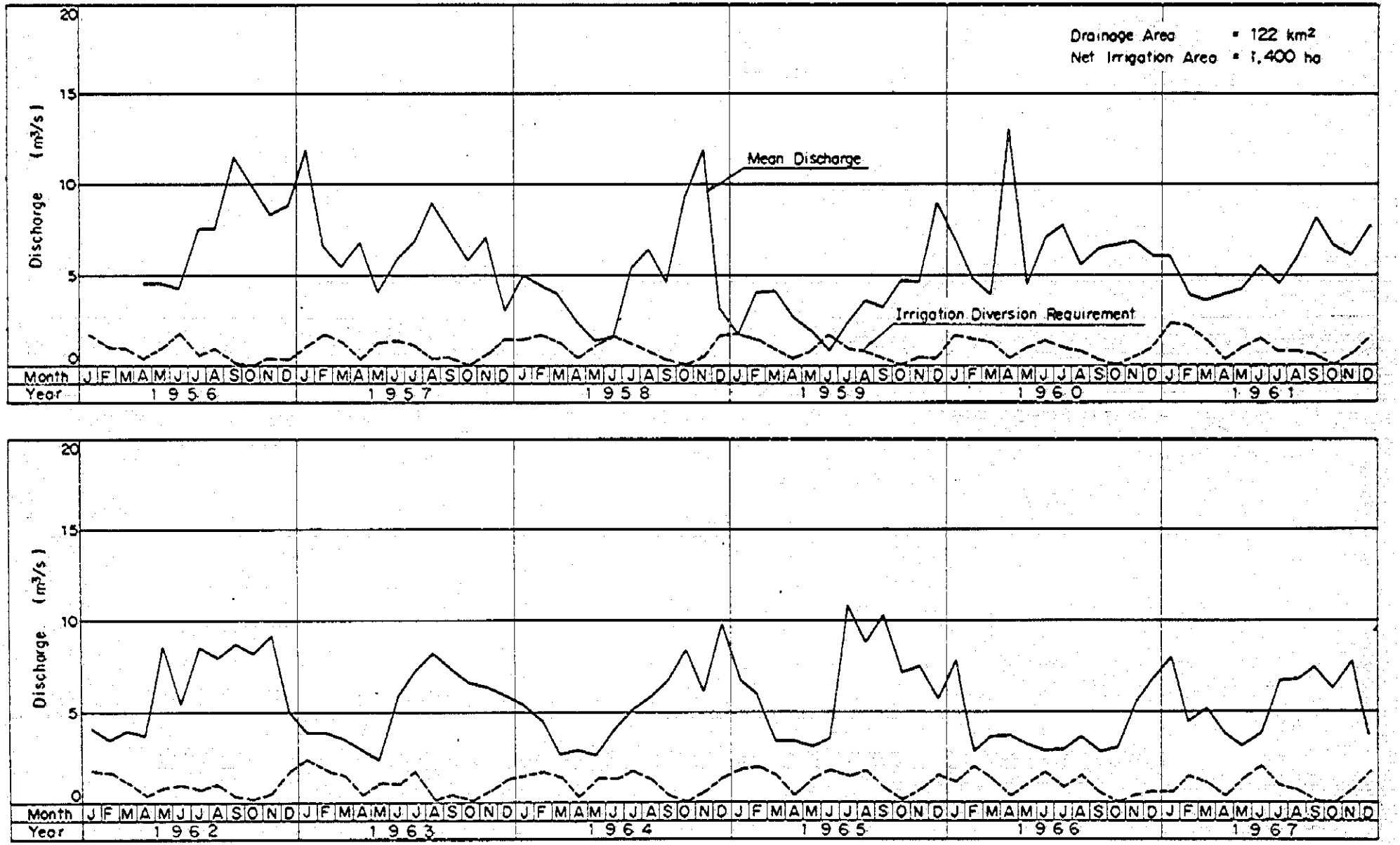


Fig · VI - 4 MONTHLY WATER BALANCE AT CABILOGAN HEADWORKS (2/2)

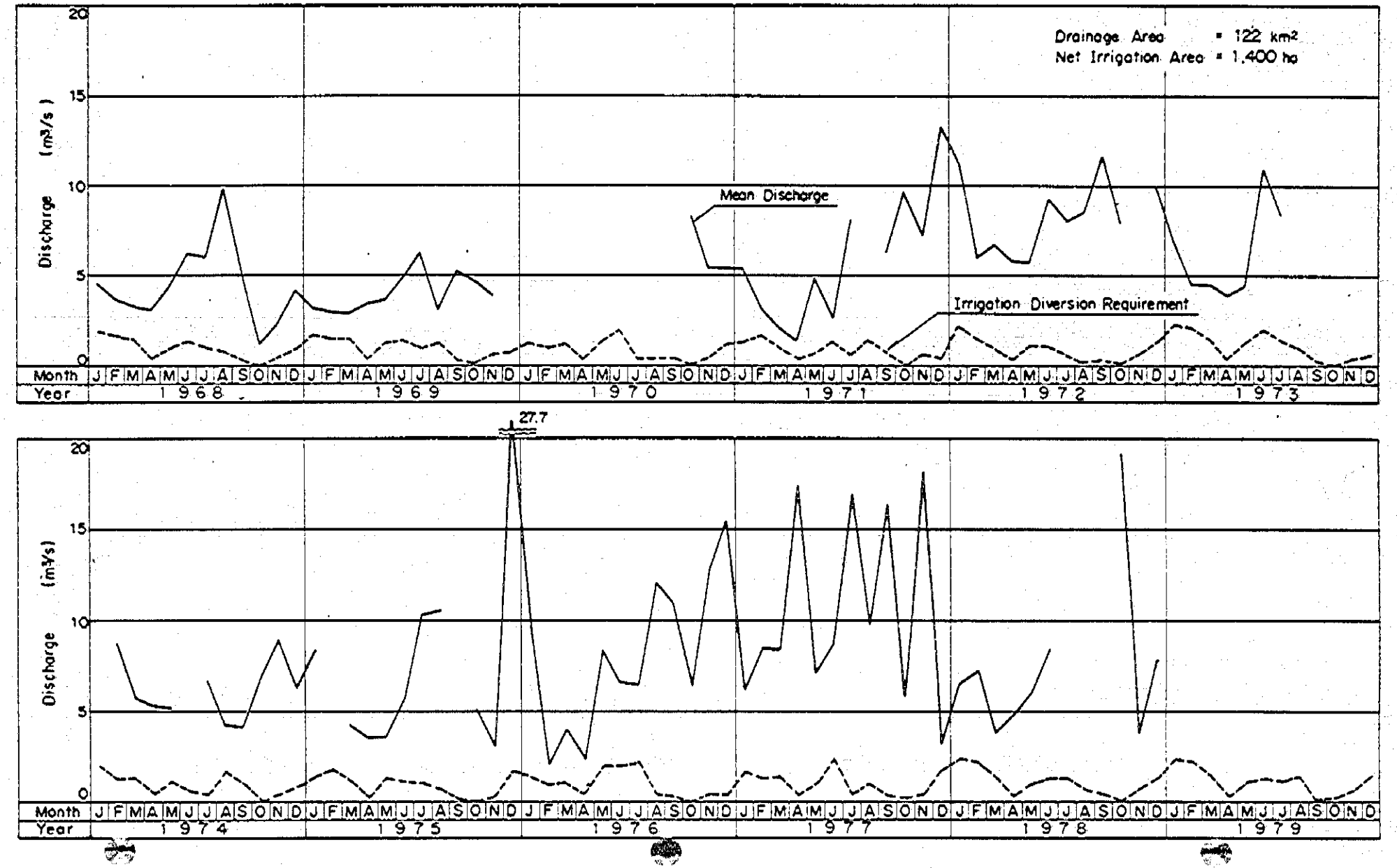


Fig · Ⅶ - 5 MONTHLY WATER BALANCE AT SOUTH QUINALI HEADWORKS (1/2)

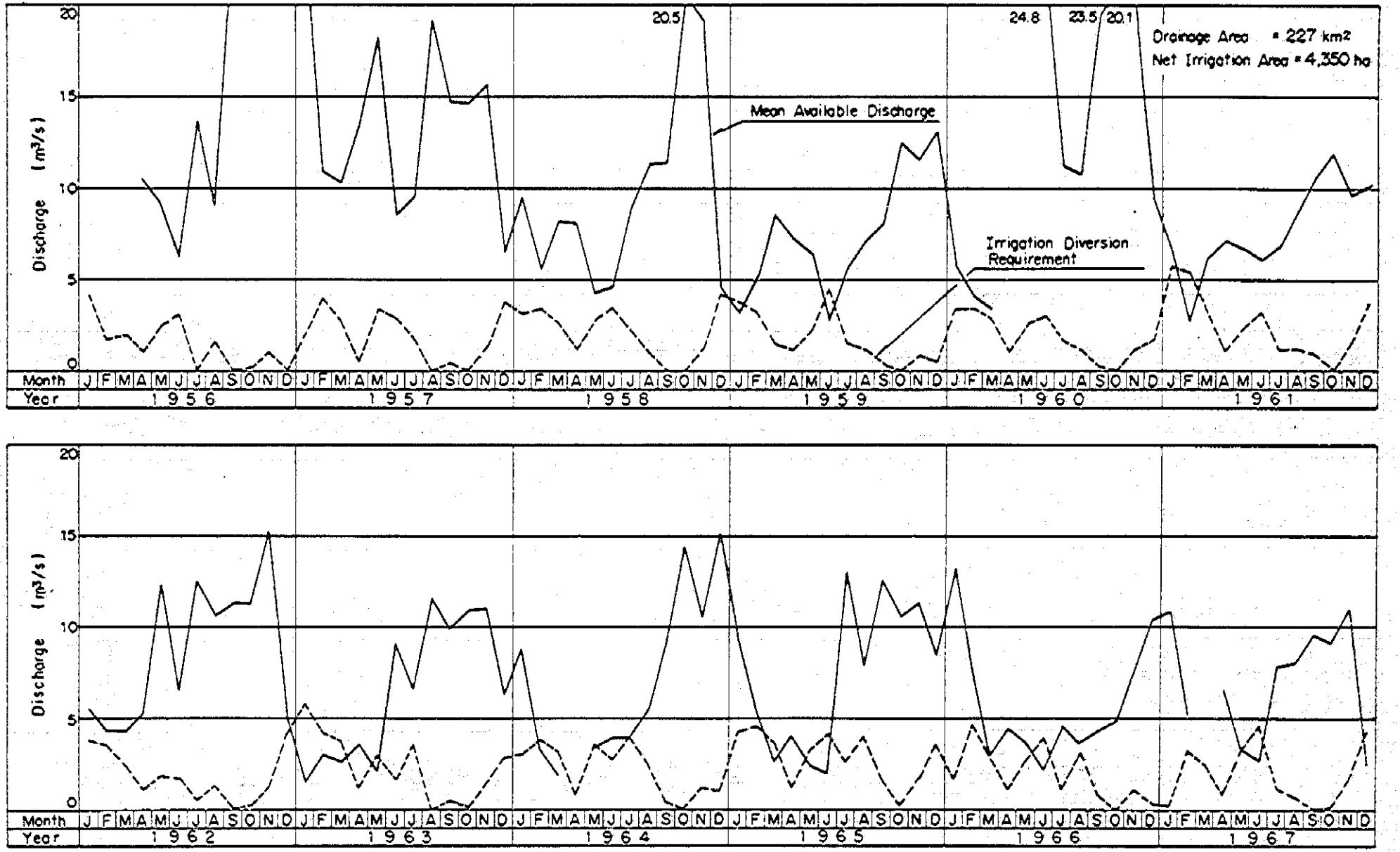


Fig · Ⅶ - 6 MONTHLY WATER BALANCE AT SOUTH QUINALI HEADWORKS (2/2)

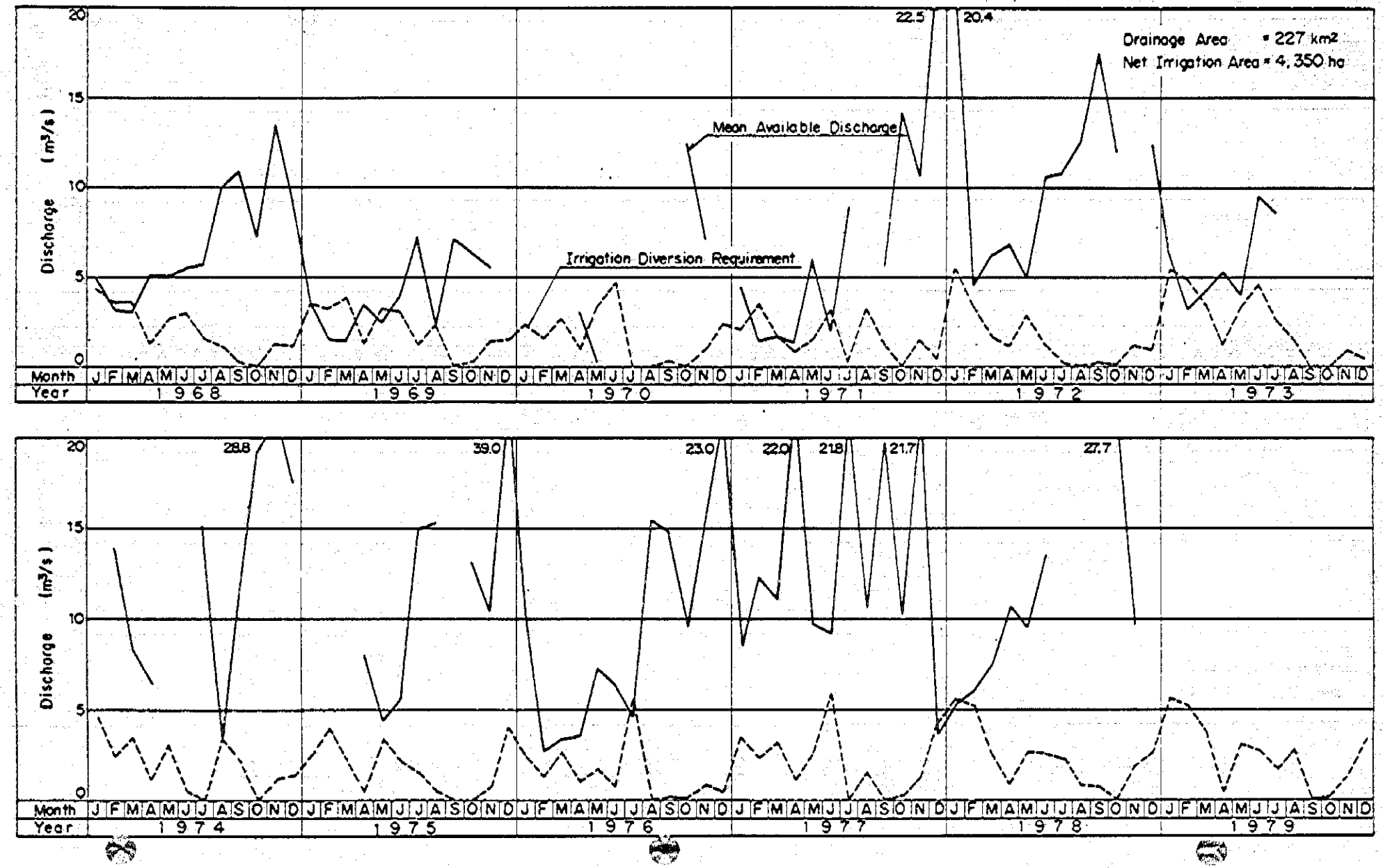
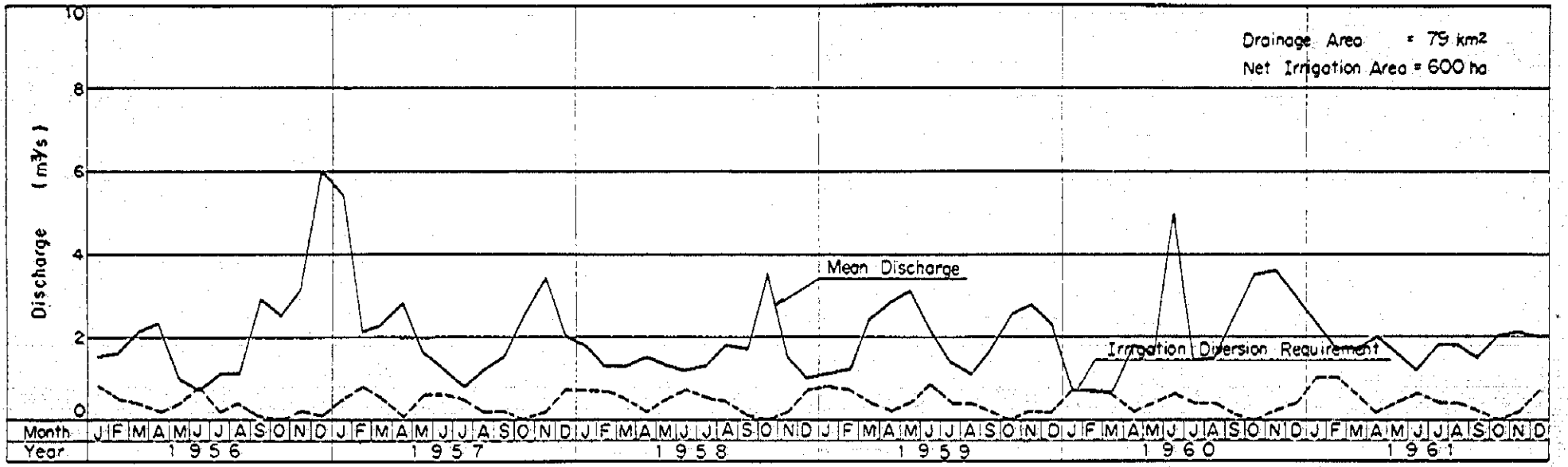


Fig · Ⅶ-7 MONTHLY WATER BALANCE AT QUINALI HEADWOKS (1/2)



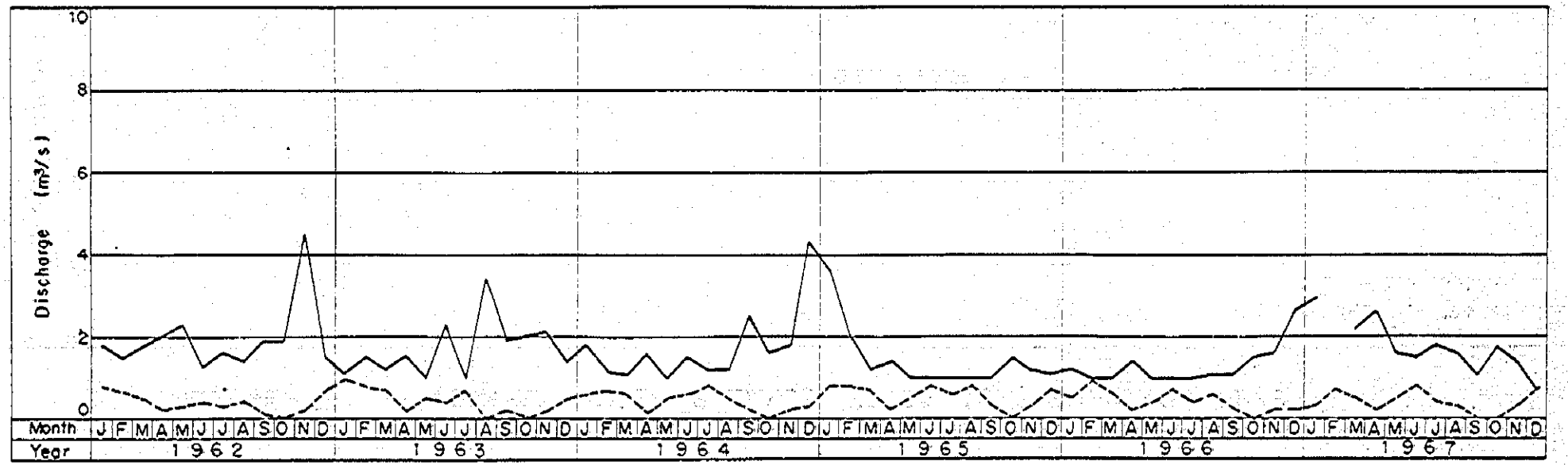


Fig. Ⅶ - 8 MONTHLY WATER BALANCE AT QUINALI HEADWORKS (2/2)

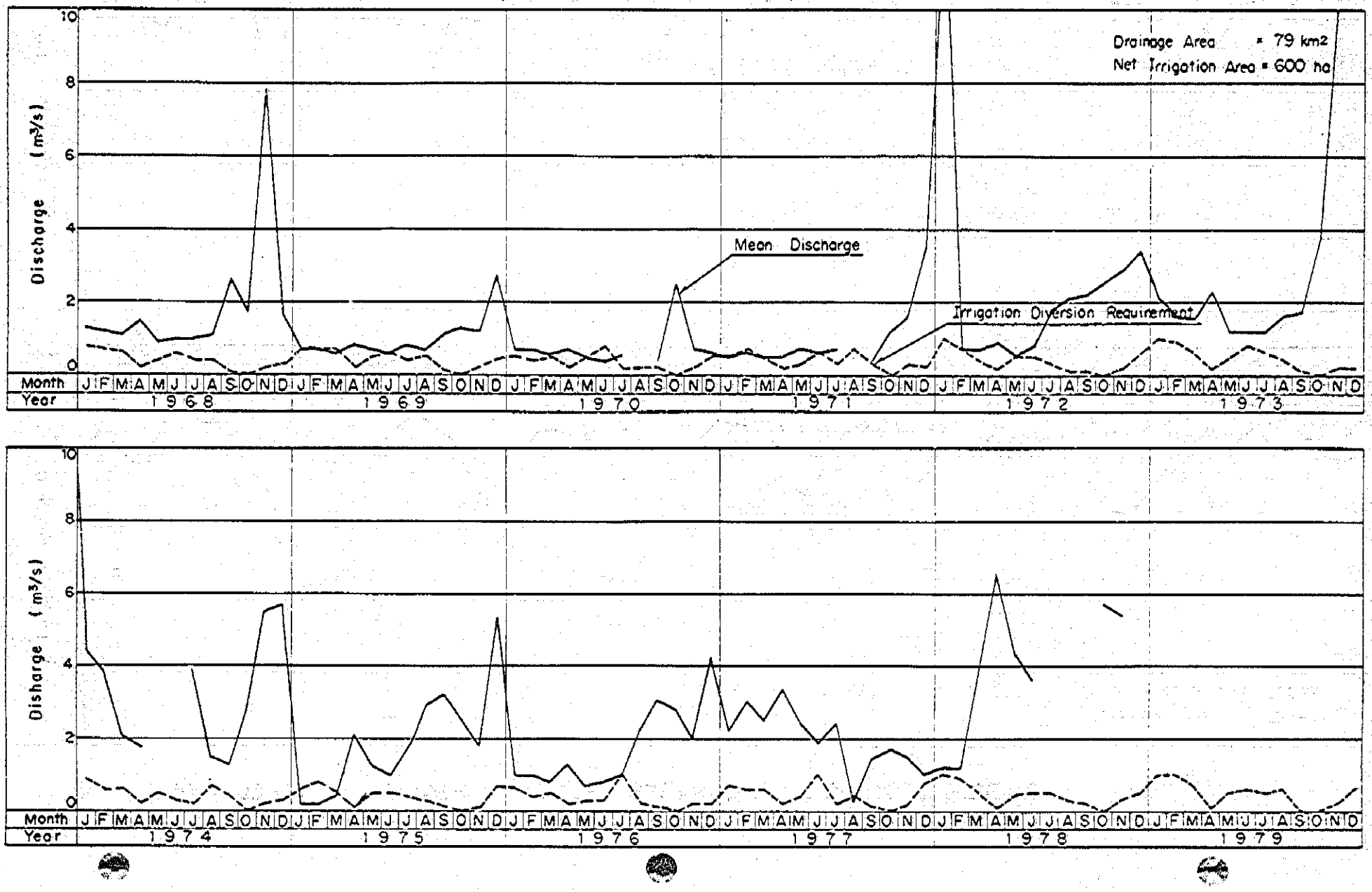


Fig. Ⅶ-9 MONTHLY WATER BALANCE AT BANTAYAN HEADWORKS (1/2)

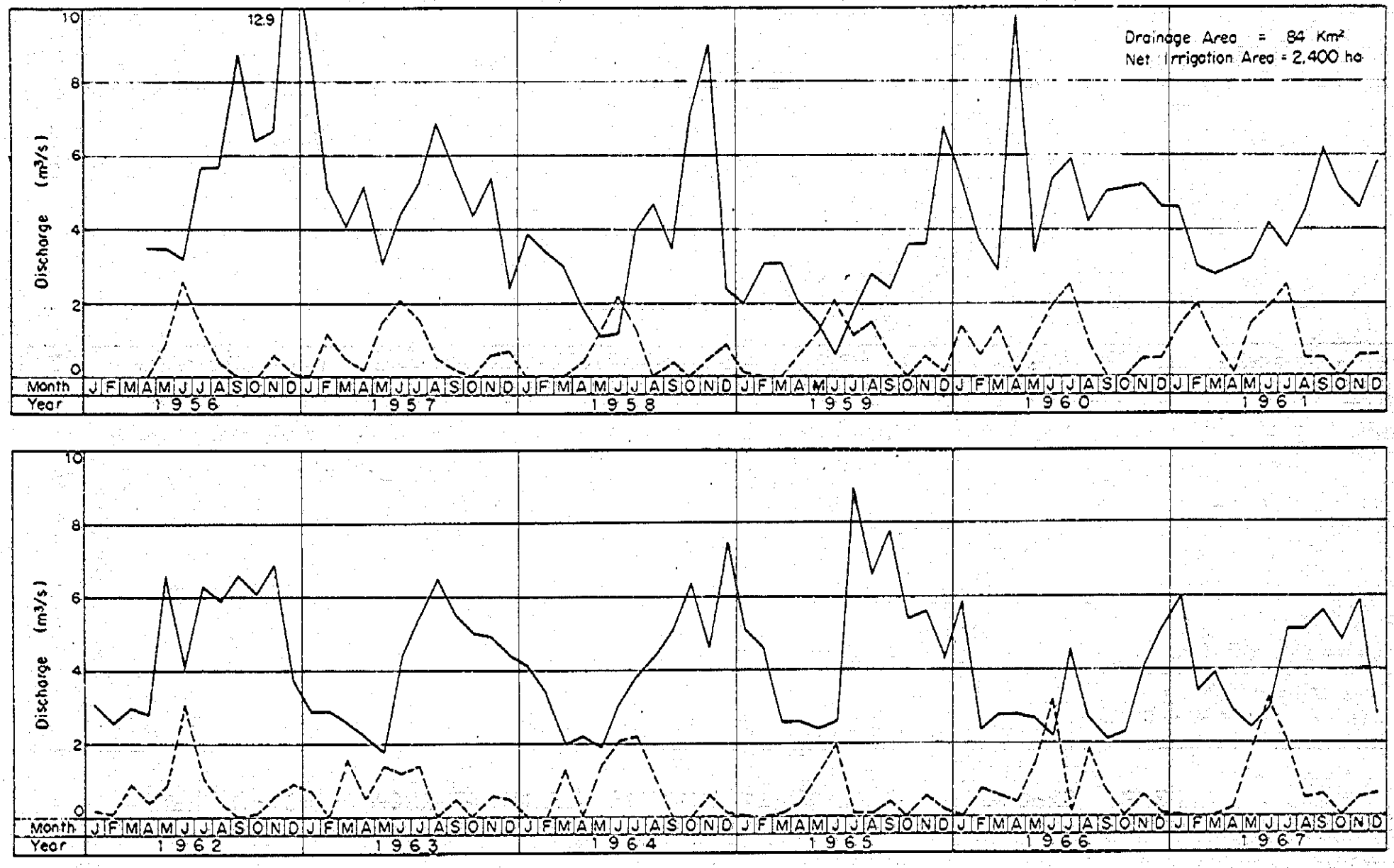


Fig. VII-10 MONTHLY WATER BALANCE AT BANTAYAN HEADWORKS (2/2)

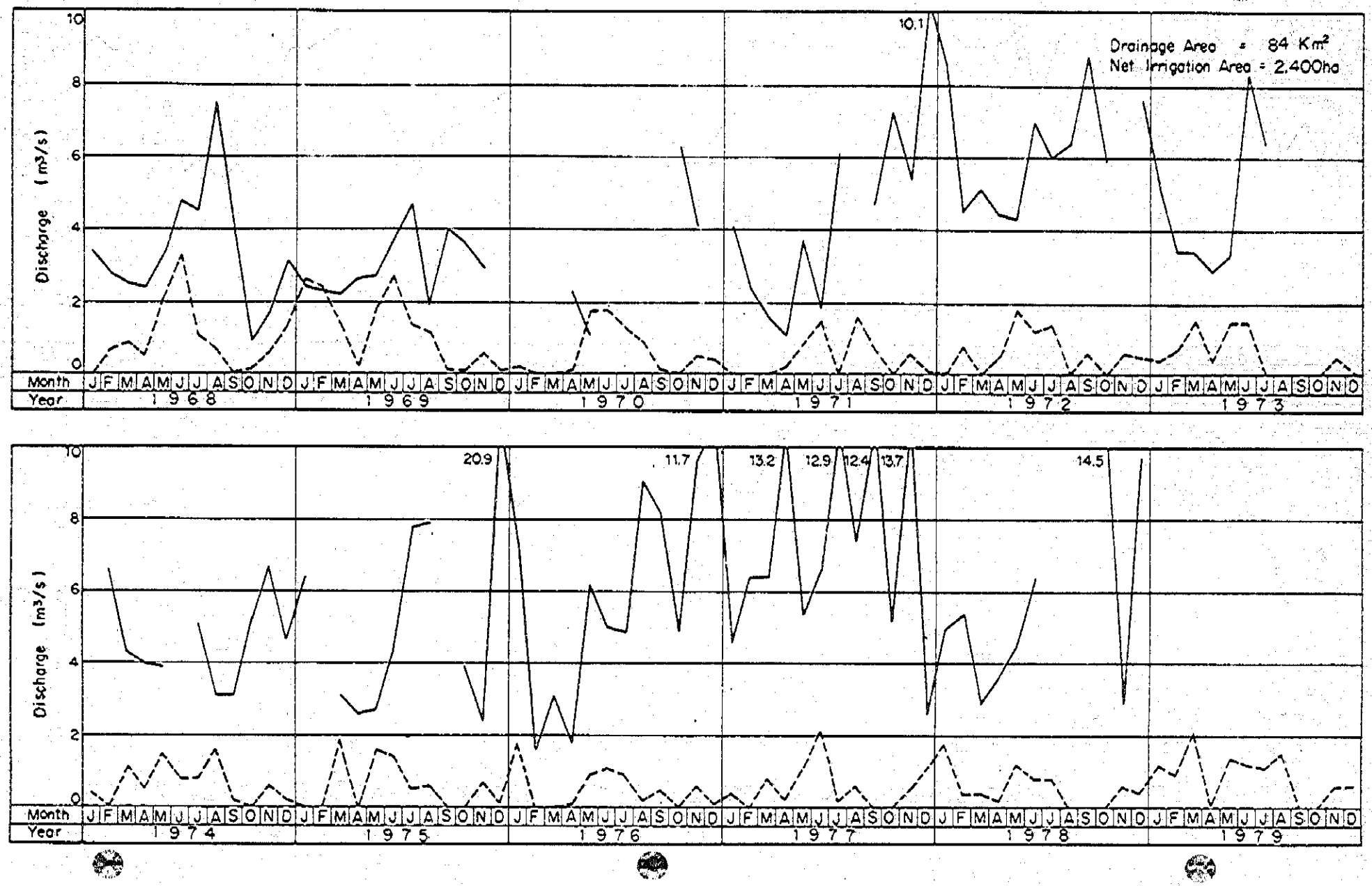
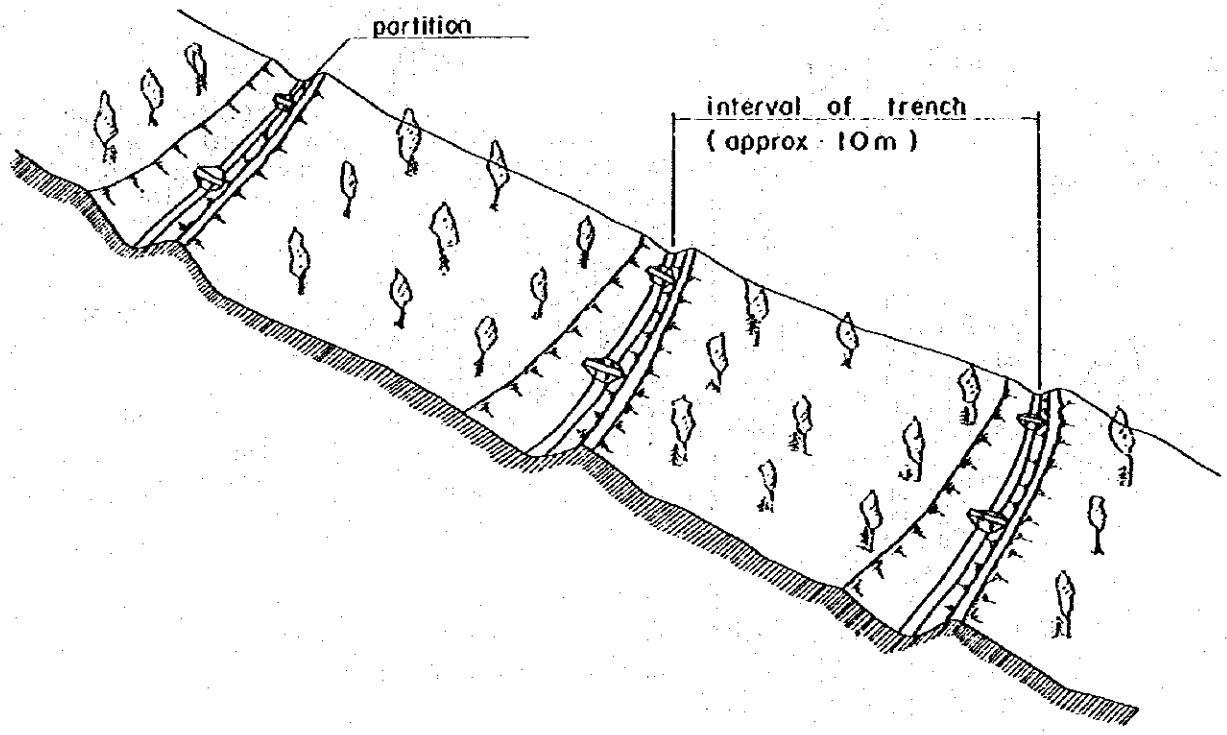


FIG.-X.1 CONTOUR TRENCH METHOD

GENERAL PLAN



TYPICAL CROSS SECTION

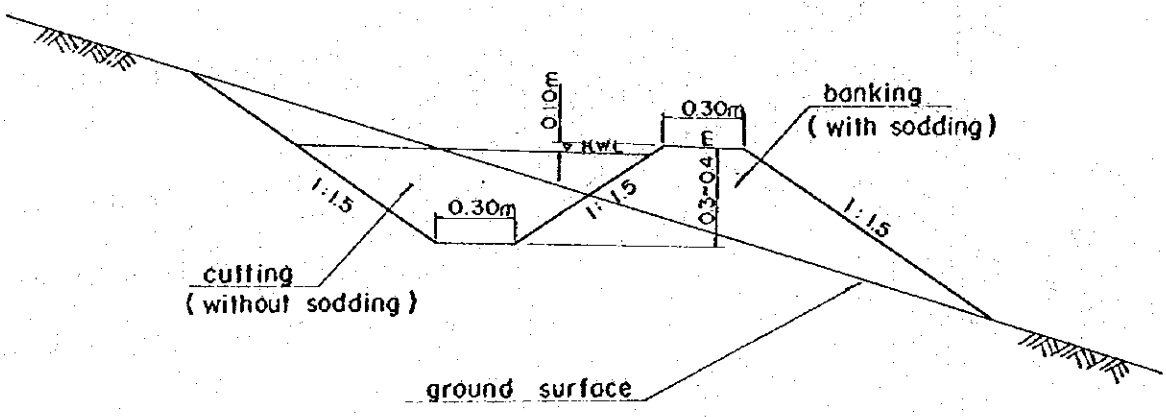
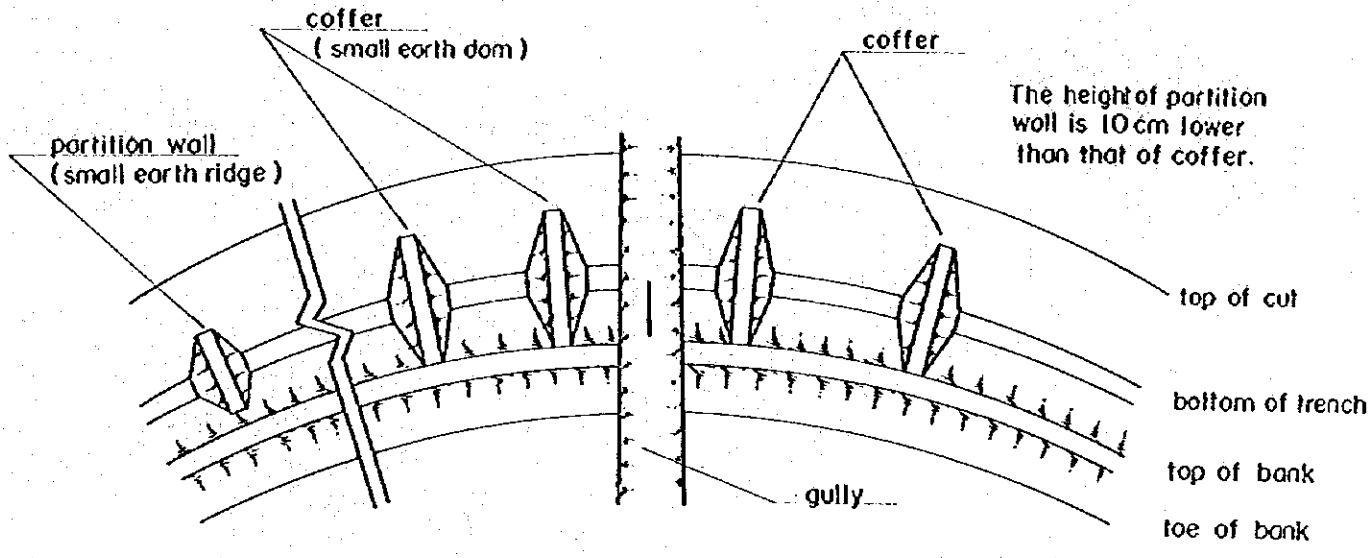


FIG.-X.2 CONTOUR TRENCH METHOD

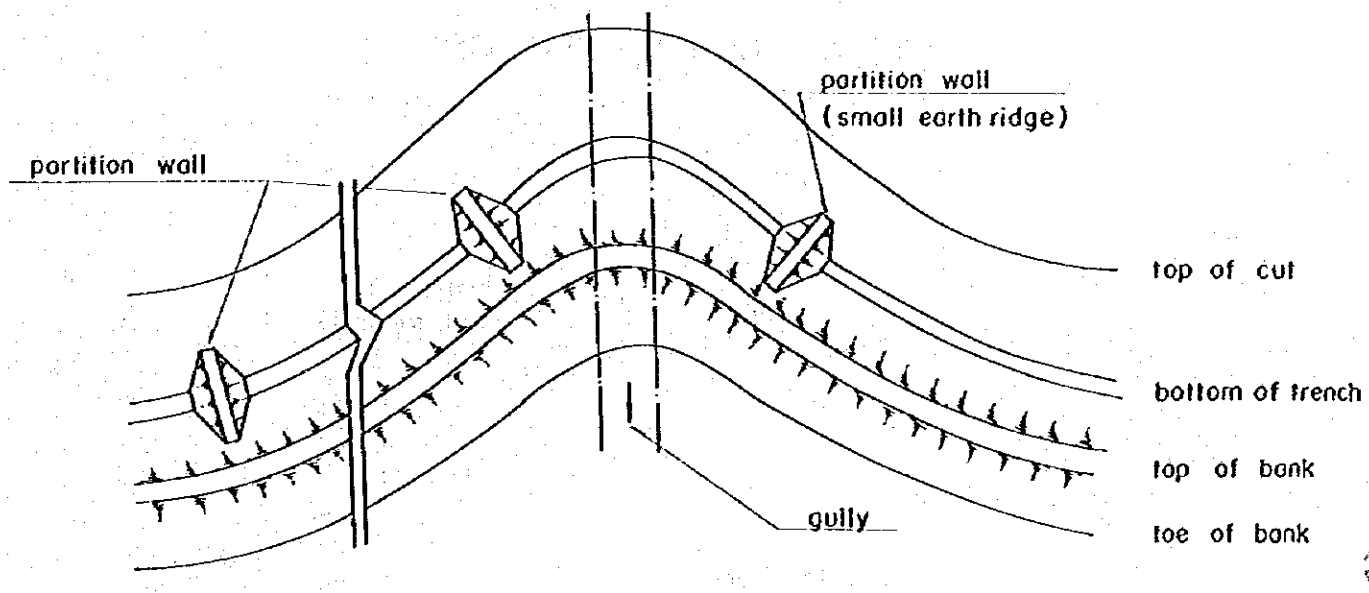
PLAN

1. For the gully bigger than 0.6m wide x 0.6m deep



Remarks : The coffer is to be made so as not to drop the water into gully where the contour trench is crossed by gully bigger than 0.6m wide x 0.6m deep.

2. For the gully smaller than 0.6m wide x 0.6m deep



Remarks: The contour trench is to be continued where the gully is smaller than 0.6m wide x 0.6m deep.

FIG.- X.3 ONE UNIT OF CRIB WORKS

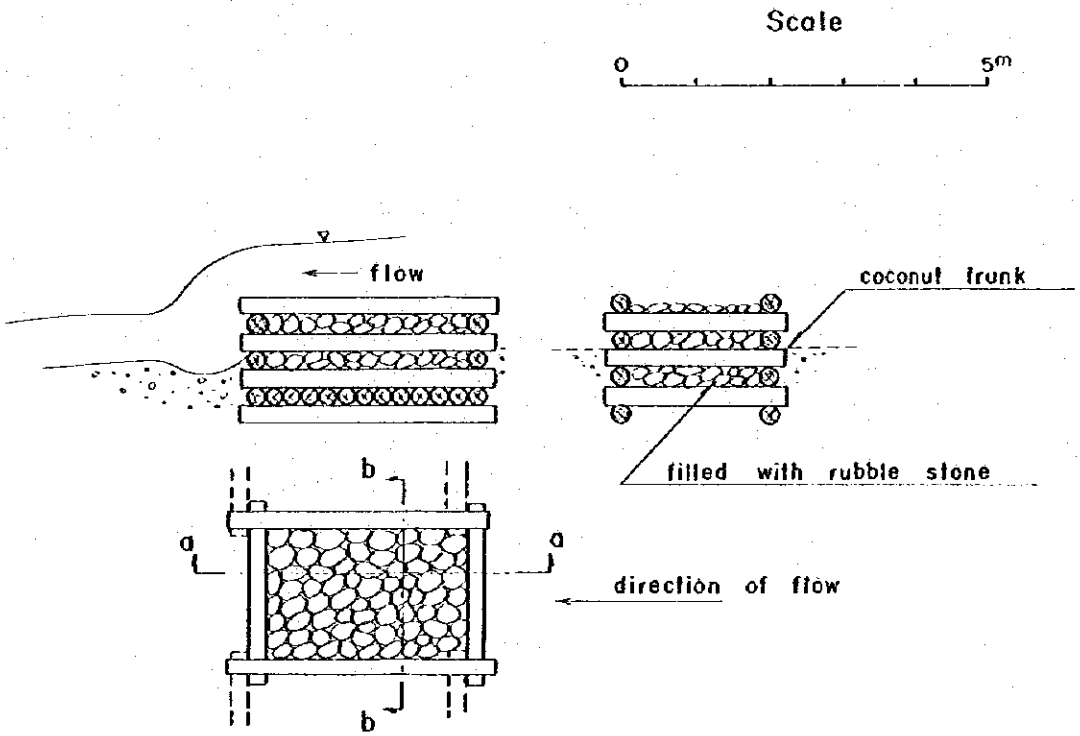
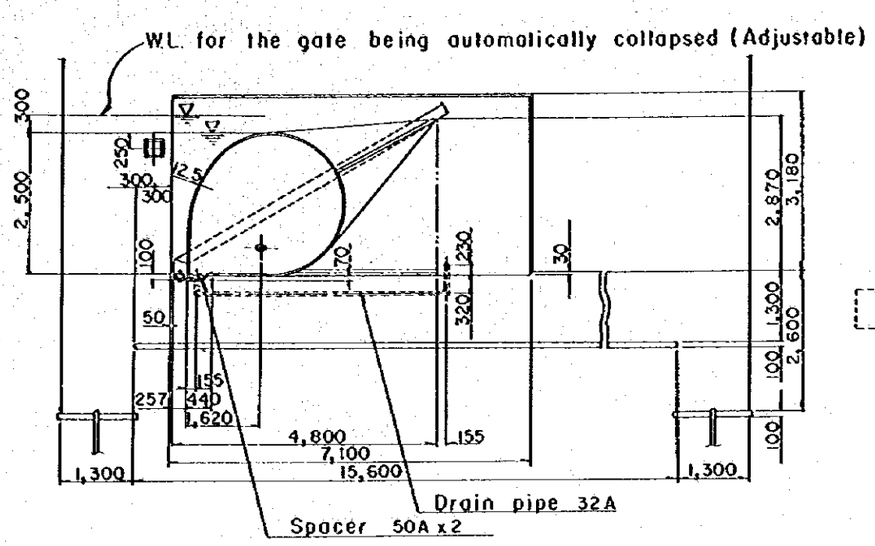
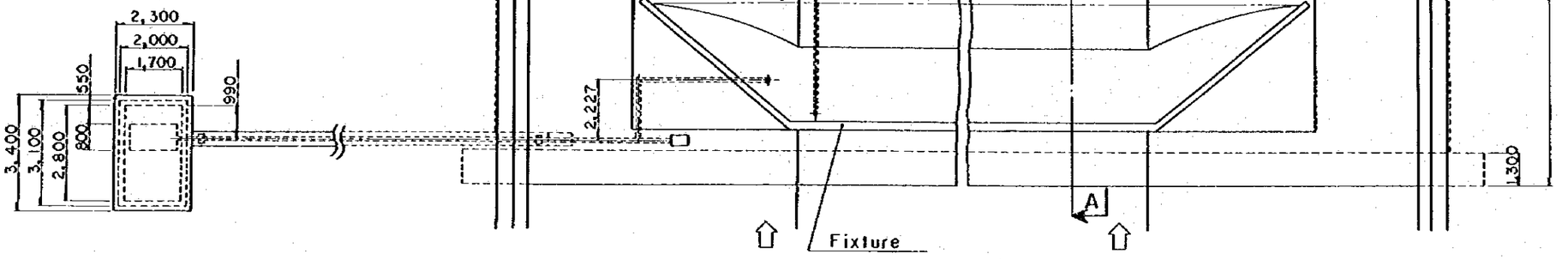


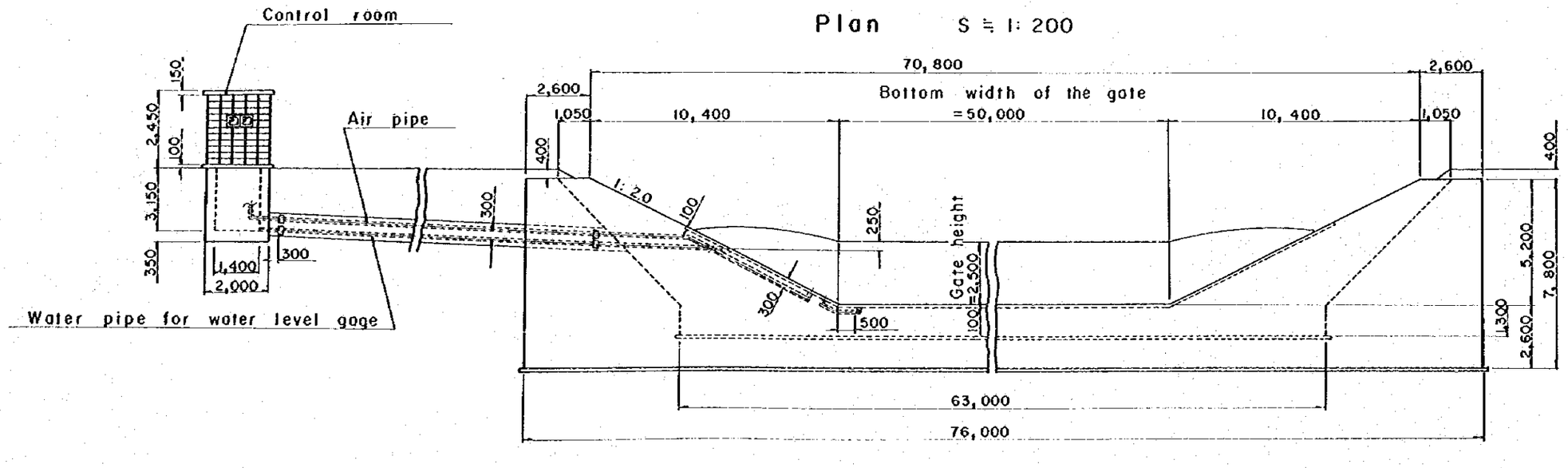
FIG.-X.4 MOVABLE WEIR (RUBBER DAM)



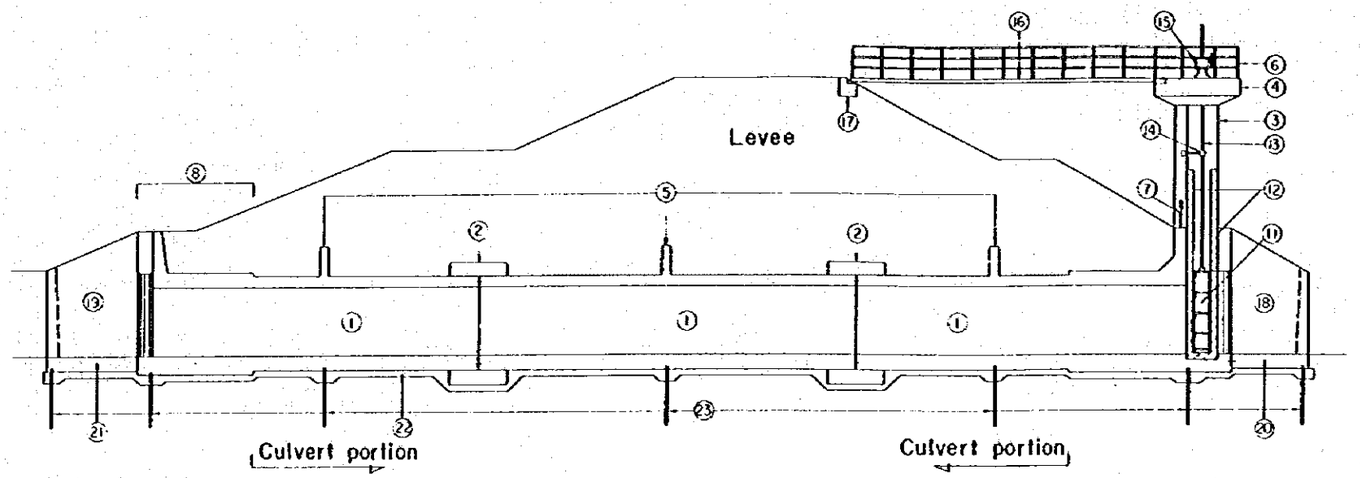
Section A - A S = 1 : 100



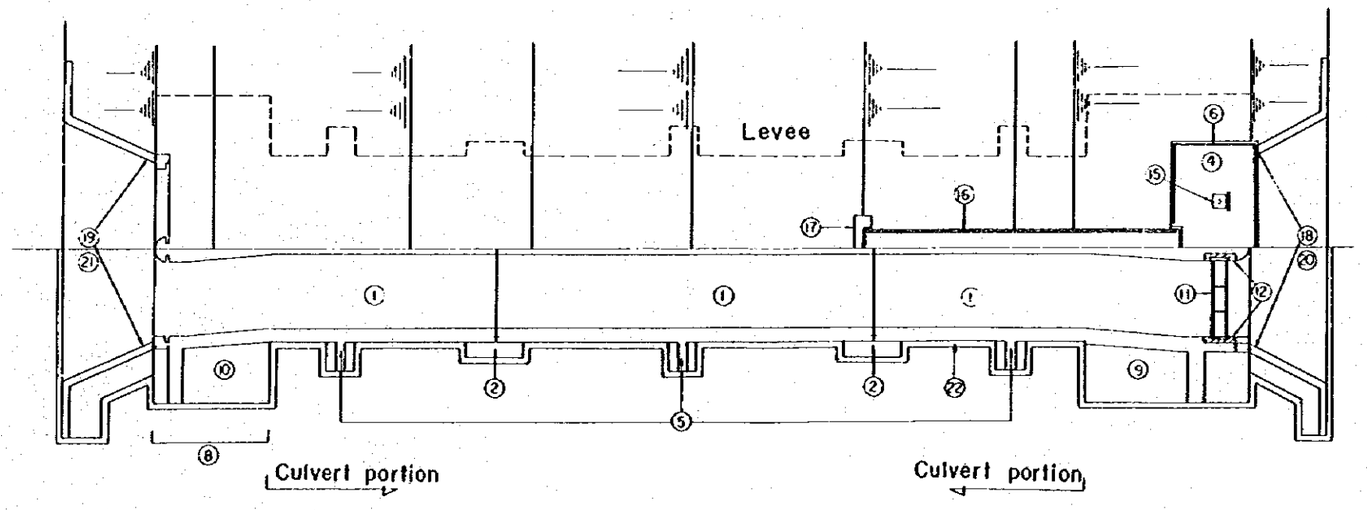
Plan S = 1 : 200



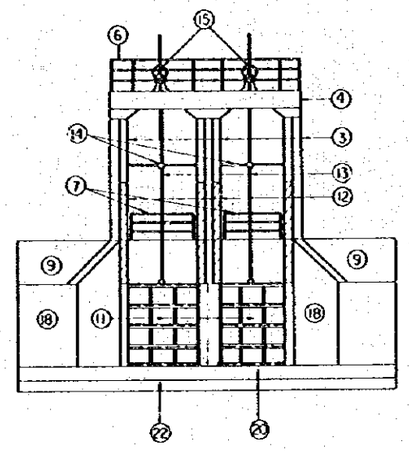
Elevation S = 1 : 200



Profile



Plan



Elevation

NO.	DESCRIPTION	
1	Box culvert	
2	Contraction joint	
3	Hoist tower	Hoist tower
4		Hoist deck
5	Intercepting wall	
6	Handrail	Hoist deck
7		Gate slot
8	End portion of box culvert	(Inland side)
9	Parapet wall	River side
10		Inland side
11		Main body
12		Blockout for gate slot
13	Gate	Spindle
14		Spindle support
15		Hoist
16	Bridge for maintenance	Bridge
17		Abutment
18	Wing wall	River side
19		Inland side
20	Apron	River side
21		Inland side
22	Foundation works	
23	Sheet pile type intercepter	

FIG.- X. 5 SLUICEWAY FOR DRAINAGE

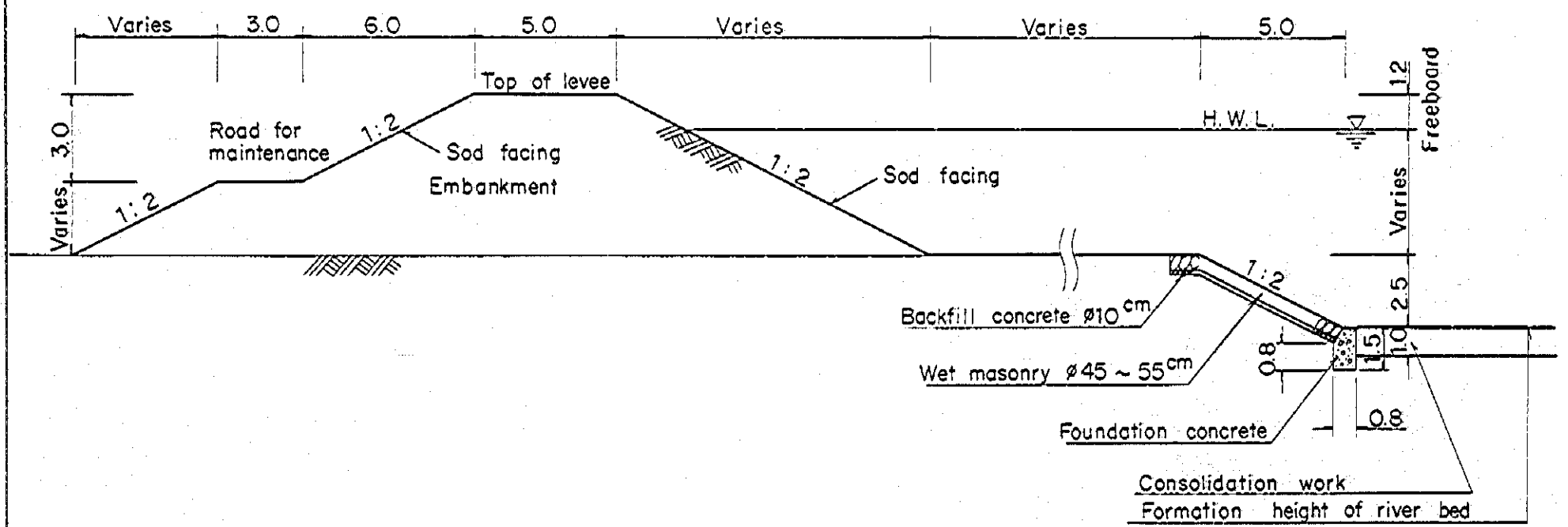


FIG.– X. 6 TYPICAL SECTION OF REVETMENT AND FOOT PROTECTION

JICA