regulations and standards at national level, is the logical follow-up activity of the recently promulgated national environmental law.

2.5 Available Topographic Map

The topographic maps that have been collected for the study are listed below:

(1) 1:2,000 prepared SECOPT in 1991, covering the mountain area of the study area,

(2) 1:10,000 prepared in 1970s, covering the valley floor of the Sula Valley,

(3) 1:50,000 prepared in 1963-1980, covering the whole country.

The orientation maps of these topographic maps are shown in Figs. 2.3 (1)~(3).

2.6 Available Aerial Photograph

The aerial photographs collected are listed below:

(1) 1:60,000 taken in 1954, covering the whole study area,

(2) 1:10,000 color photos, taken soon after the hurricane Fifi of 1974, covering only a part of the northern lowland area of Choloma,

(3) 1:20,000 color photos, taken soon after the hurricane fifi, covering only a part of the lowland and mountain area,

(4) 1:20,000 taken in 1975, covering a part of the lowland and mountain,

(5) 1:40,000 taken in 1977, covering the whole study area,

(6) 1:10,000 taken in 1989, covering the whole study area,

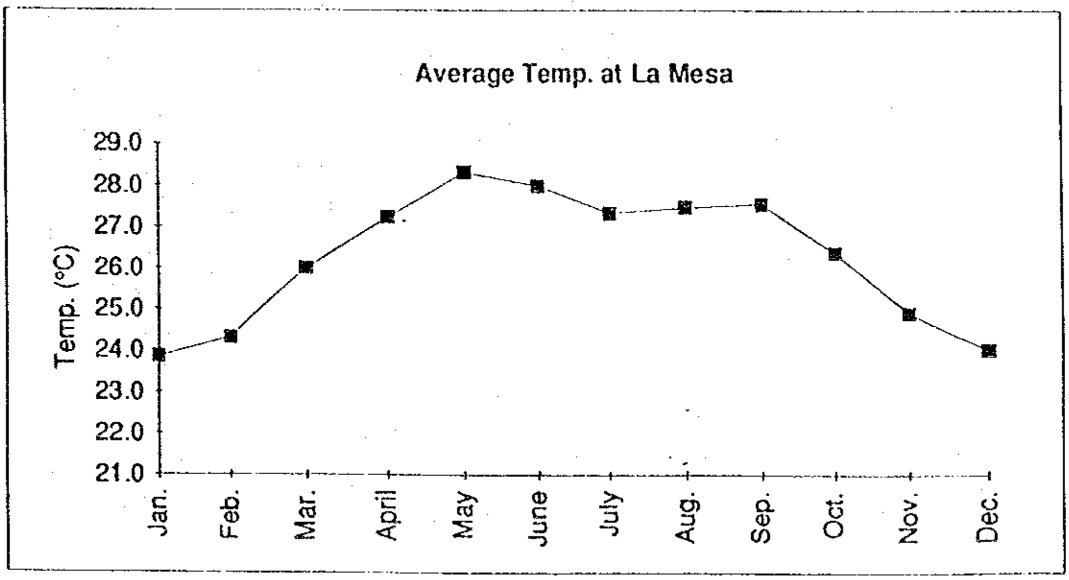
(7) 1:40,000 taken in 1992, covering almost the whole study area.

The orientation maps of these aerial photographs are shown in Figs. 2.4 (1)~(7).

TABLES

TABLE 2.1 MONTHLY AVERAGE TEMPERATURE (LA MESA)

YEAR	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1965	22.9	25.1	26.0	27.5	27.8	28.0	27.0	27.2	27.6	26.2	25.3	24.5
1966	23.0	23.5	23.8	26.8	27.0	26.6	26.6	26.7	26.5	25.7	22.7	22.3
1967	22.8	23.4	24.4	26.0	26.5	26.7	26.1	26.7	26.8	25.4	23.8	23.9
1968	22.8	22.5	23.3	24.9	26.7	26.7	26.1	26.0	26.3	25.4	23.8	23.4
1969	23.6	24.1	25.3	27.0	27.7	27.5	26.6	27.8	28.7	26.6	23.9	23.2
1970	23.9	22.4	25.4	27.2	26.3	27.1	26.7	26.8	26.5	26.2	22.6	23.3
1971	23.2	23.9	24.6	25.1	26.9	26.9	26.6	26.8	27.0	26.2	25.0	24.0
1972	23.9	23.6	25.2	26.9	27.5	27.6	26.5	25.4	26.7	25.1	25.3	22.9
1973	24.6	23.4	27.3	28.3	28.5	28.0	27.3	27.5	27.8	26.5	25.4	22.3
1974	24.5	23.9	26.0	27.3	28.8	28.3	26.9	26.9	27.1	24.9	24.0	23.7
1975	23.9	24.6	26.5	27.1	28.8	28.3	27.6	27.3	26.9	25.6	23.4	22.4
1976	21.8	22.1	25.3	25.6	27.5	26.7	26.6	26.9	27.2	26.0	24.1	23.6
1977	23.1	24.9	26.2	25.6	26.9	26.8	26.8	27.7	27.5	26.3	25.1	24.4
1978	23.3	22.6	24.9	26.8	29.6	27.3	26.5	27.0	27.0	25.9	25.2	24.4
1979	23.8	23.6	26.1	27.8	28.3	27.4	27.8	26.8	26.9	26.3	24.3	23.5
1980	24.1	24.2	26.0	26.1	28.4	26.6	26.8	27.3	27.5	26.3	24.6	22.4
1981	22.0	23.8	26.4	26.5	28.2	27.0	27.0	27.3	27.0	26.3	24.0	23.9
1982	24.6	25.2	26.0	27.5	27.8	28.6	26.5	26.7	27.0	26.8	24.6	24.3
1983	23.8	24.8	26.8	28.0	28.9	29.2	27.0	27.7	27.6	26.6	25.9	25.1
1984	23.1	24.3	26.1	28.0	28.4	27.4	28.1	28.2	27.8	27.9	24.8	24.9
1985	24.2	25.4	27.5	28.2	28.8	29.0	28.3	28.6	28.4	28.2	26.9	25.4
1986	23.6	26.3	26.1	27.6	29.3	29.2	28.0	28.6	28.0	27.4	27.0	25.8
1987	24.1	26.2	28.4	26.8	29.1	30.3	28.5	28.8	29.7	26.5	25.9	26.0
1988	25.0	25.4	26.8	29.2	30.1	30.5	29.0	29.2	29.1	25.9	27.2	24.4
1989	25.3	24.8	26.1	28.3	29.3	29.0	28.7	28.7	28.3	27.0	28.0	24.2
1990	26.9	27.0	27.4	29.5	31.2	29.7	29.9	29.3	29.1	27.3	24.6	25.1
1991	25.8	25.5	27.7	29.5	30.0	29.3	28.1	27.4	27.9	27.5	25.0	25.0
	23.8	24.3	26.0	27.2	28.3	28.0	27.3	27.5	27.6	26.4	24.9	24.0



FIGURES

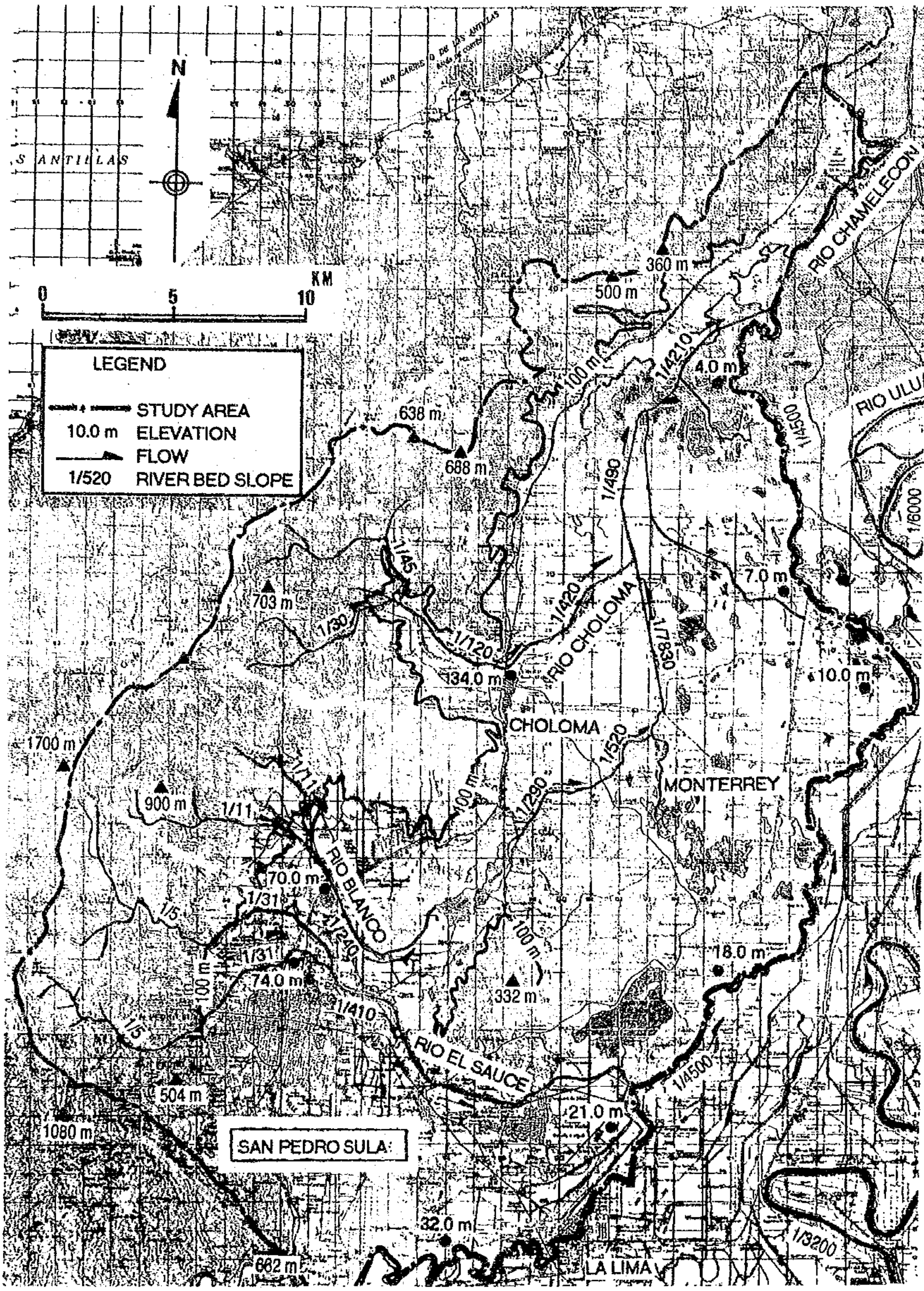


FIG. 2.1 GENERAL TOPOGRAPHIC MAP OF THE STUDY AREA

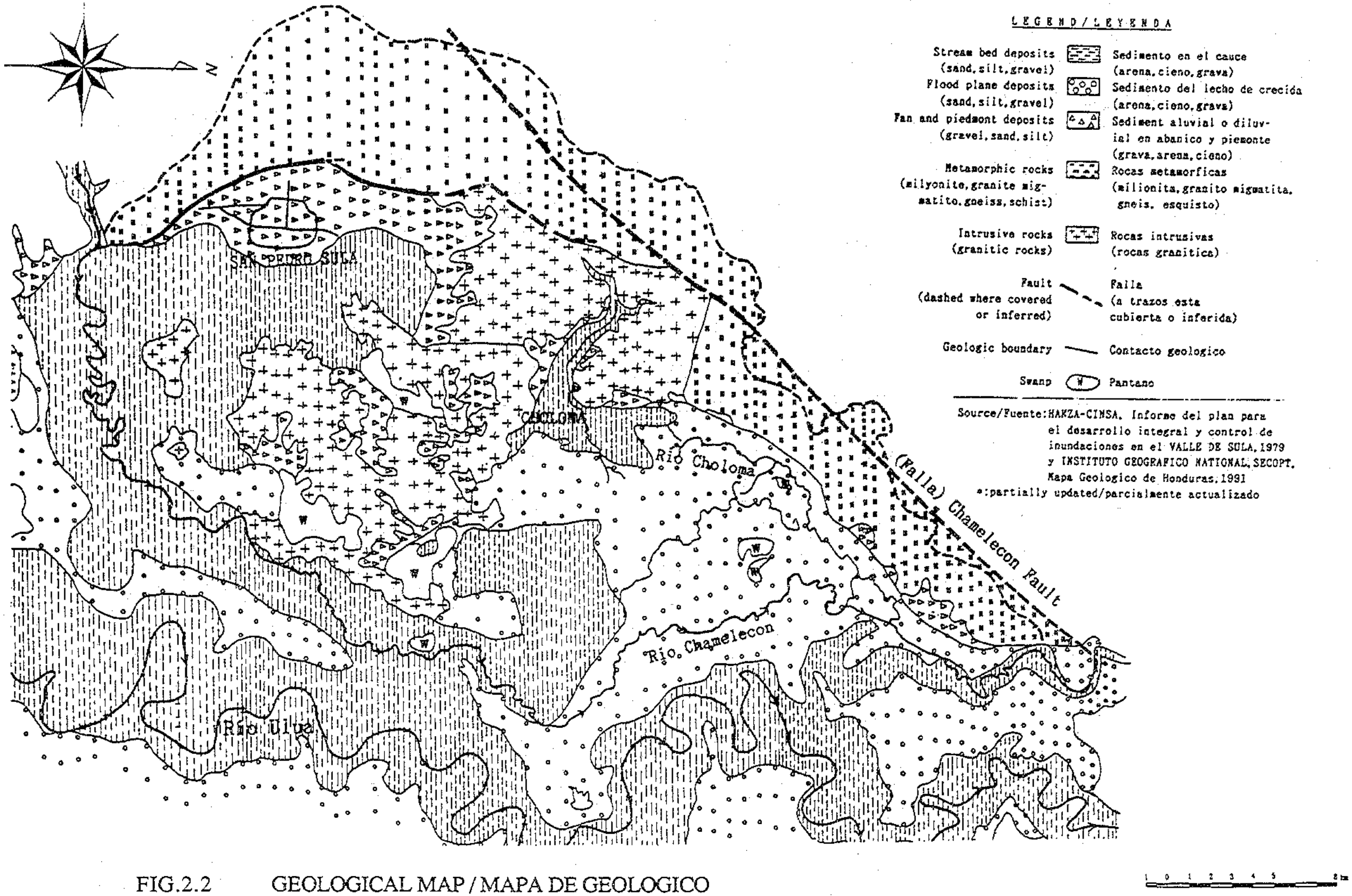


FIG.2.2 GEOLOGICAL MAP / MAPA DE GEOLOGICO

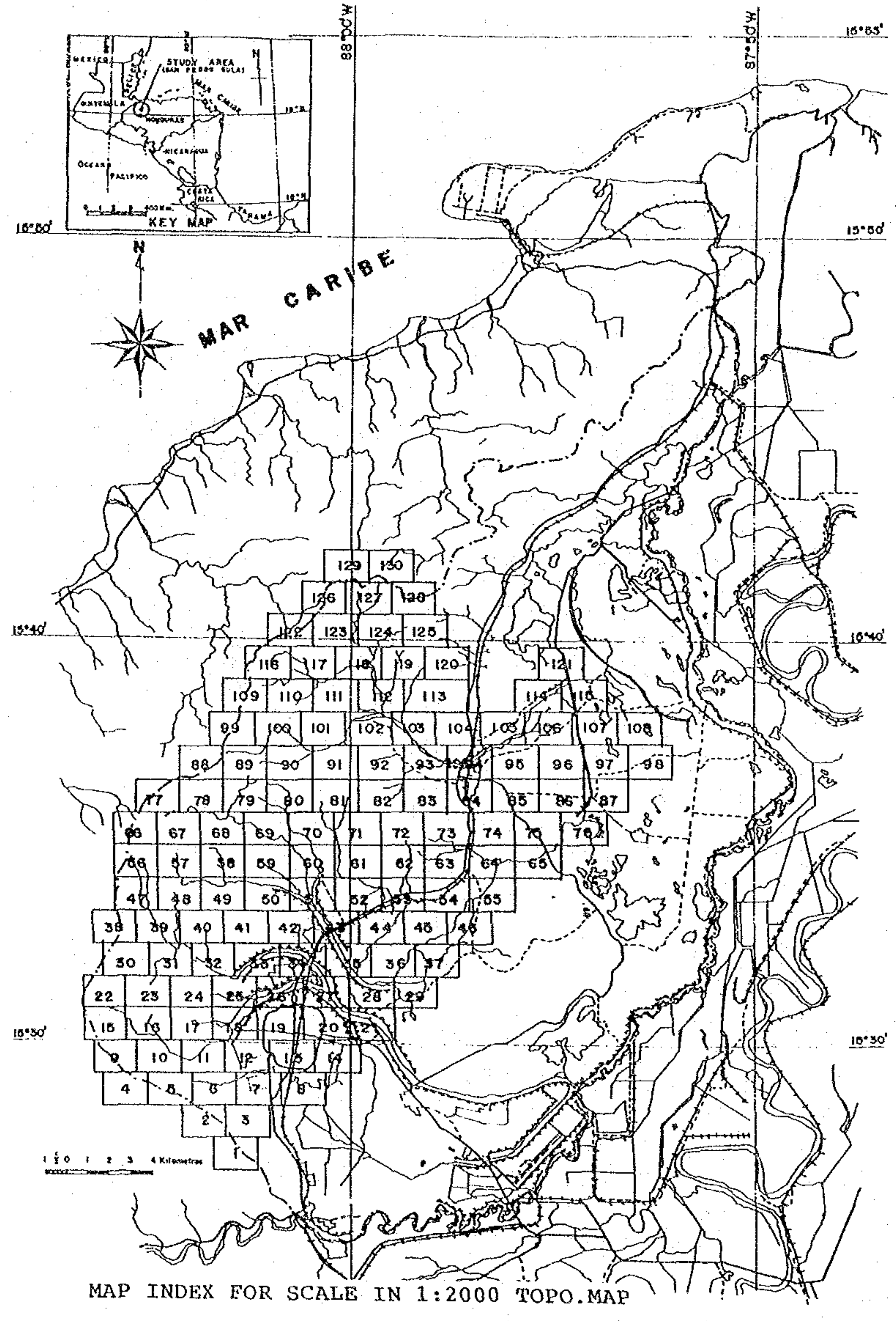


FIG.2.3 (1) COVERED AREA OF TOPOGRAPHIC MAP SCALE IN 1:2,000
AREA CUBIERTA FOR MAPA TOPOGRAFICO ESCALA EN 1:2,000

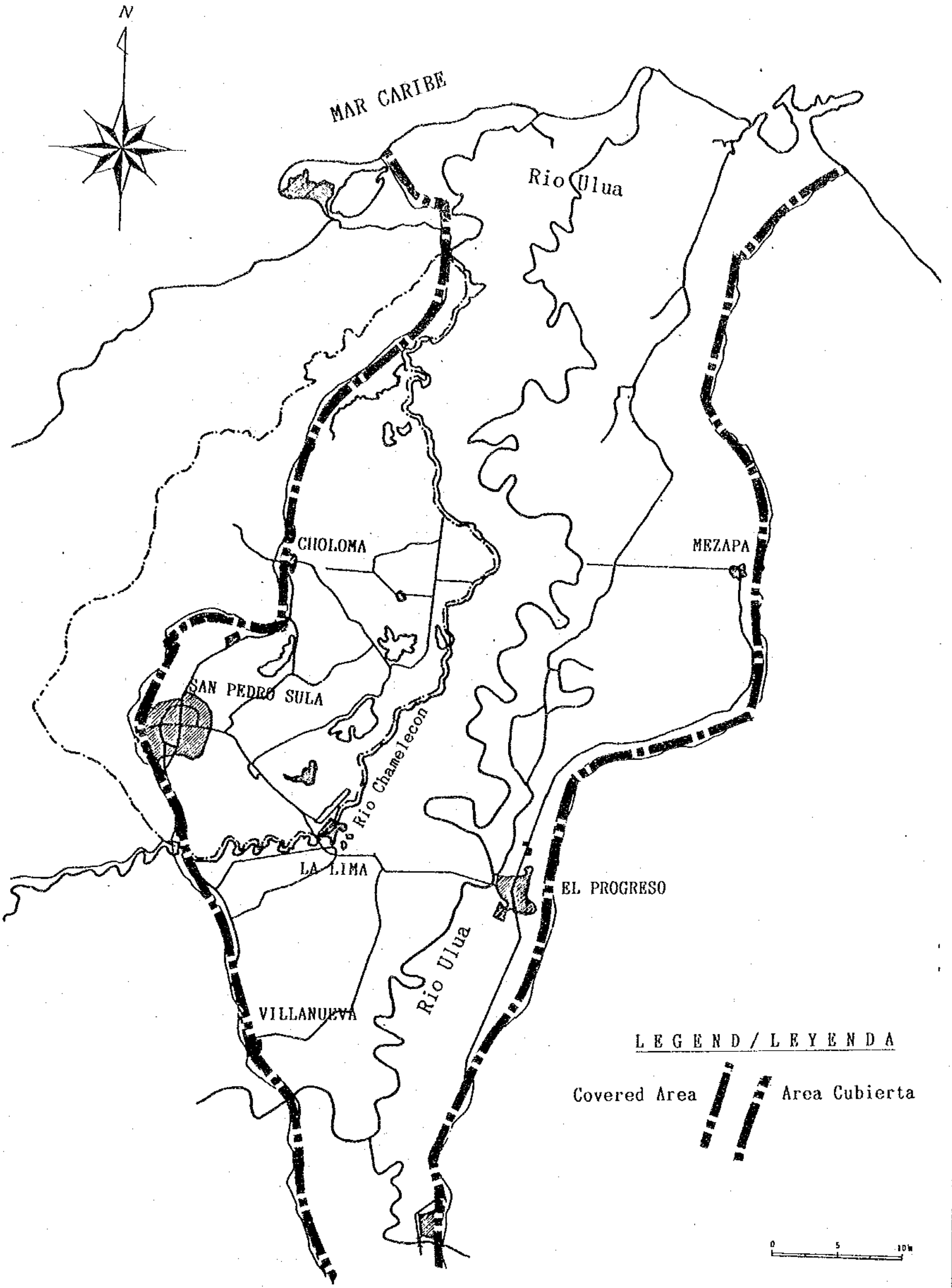


FIG.2.3 (2) COVERED AREA OF TOPOGRAPHIC MAP SCALE IN 1:10,000
AREA CUBIERTA POR MAPA TOPOGRAFICO ESCALA EN 1:10,000

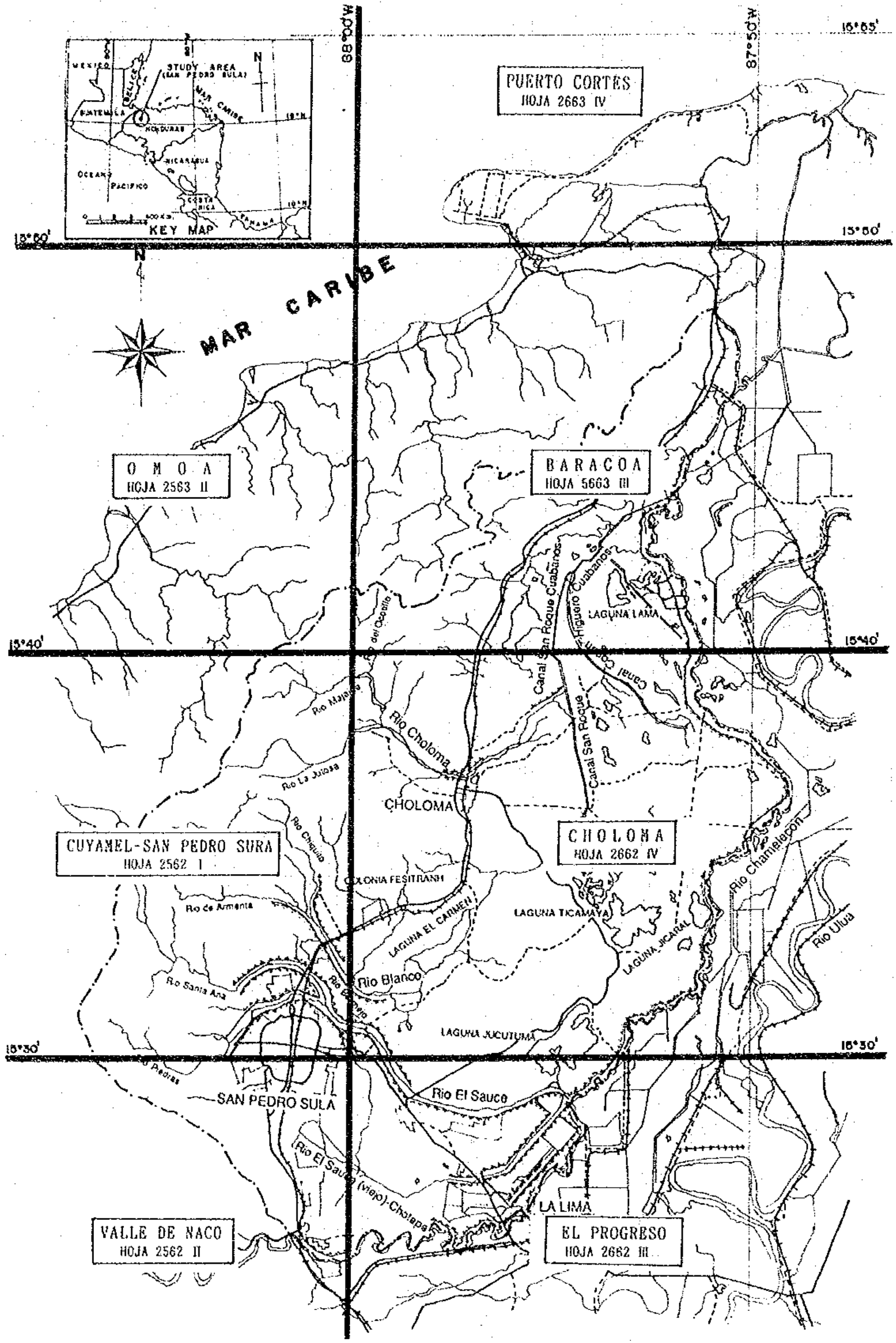
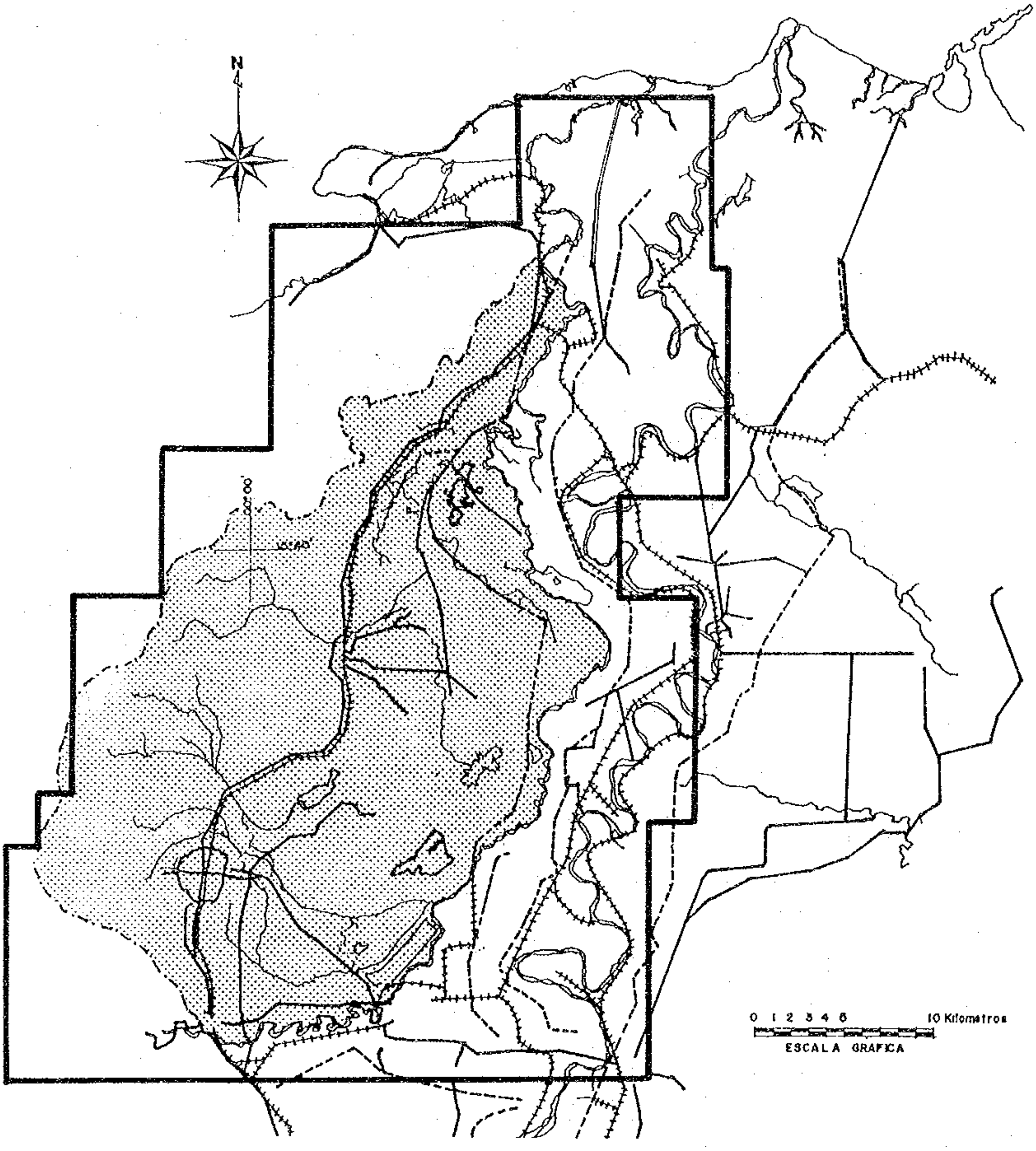


FIG.2.3 (3) COVERED AREA OF TOPOGRAPHIC MAP SCALE IN 1:50,000

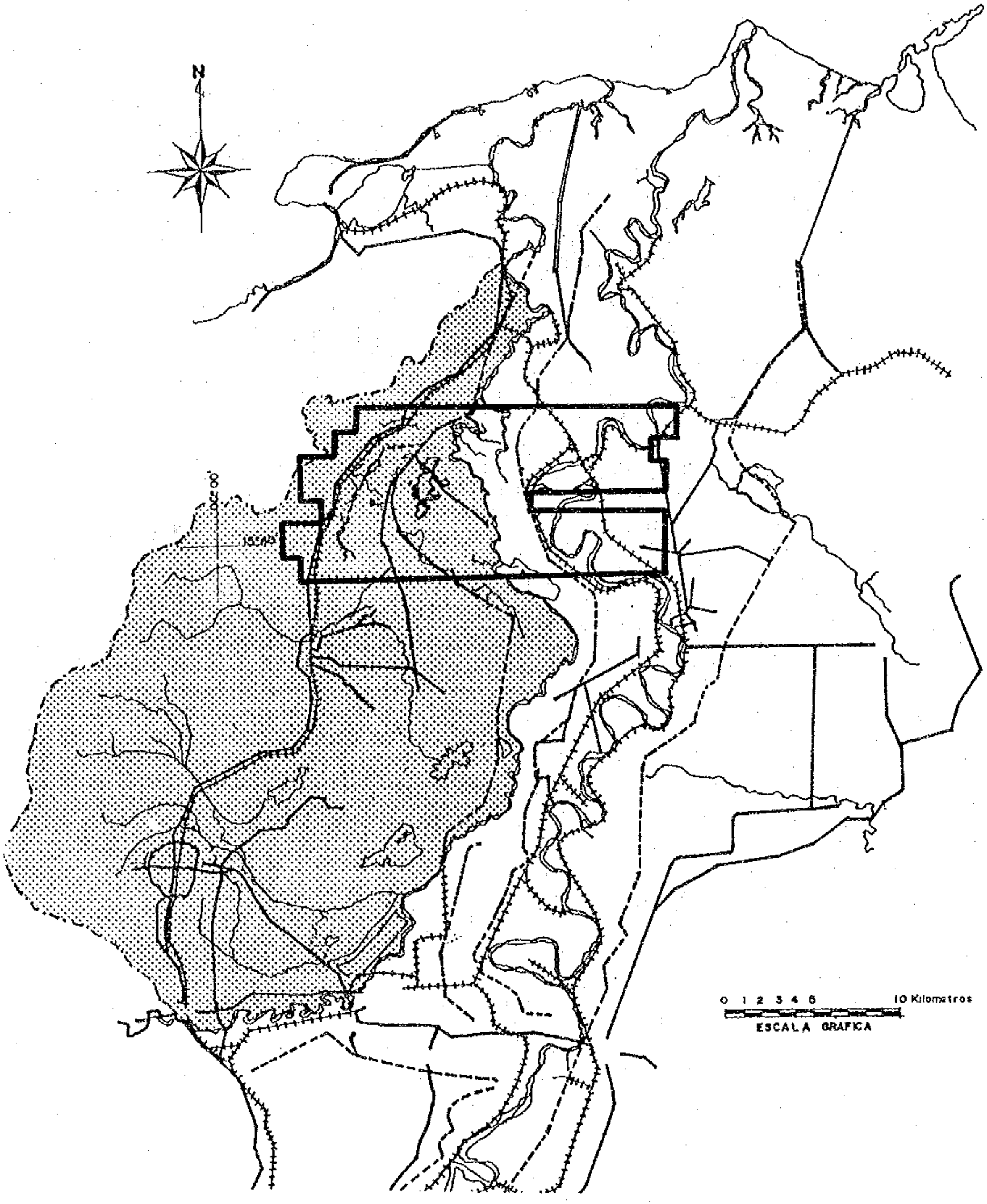


AERIAL PHOTOGRAPH/FOTOGRAFIAS AEREAS

TAKEN IN 1954 | TOMADA EN 1954

SCALE/ESCALA 1:60,000

FIG.2.4 (1) COVERED AREA OF AERIAL PHOTOGRAPH
AREA DE CUBIERTA POR FOTOGRAFIAS AEREAS



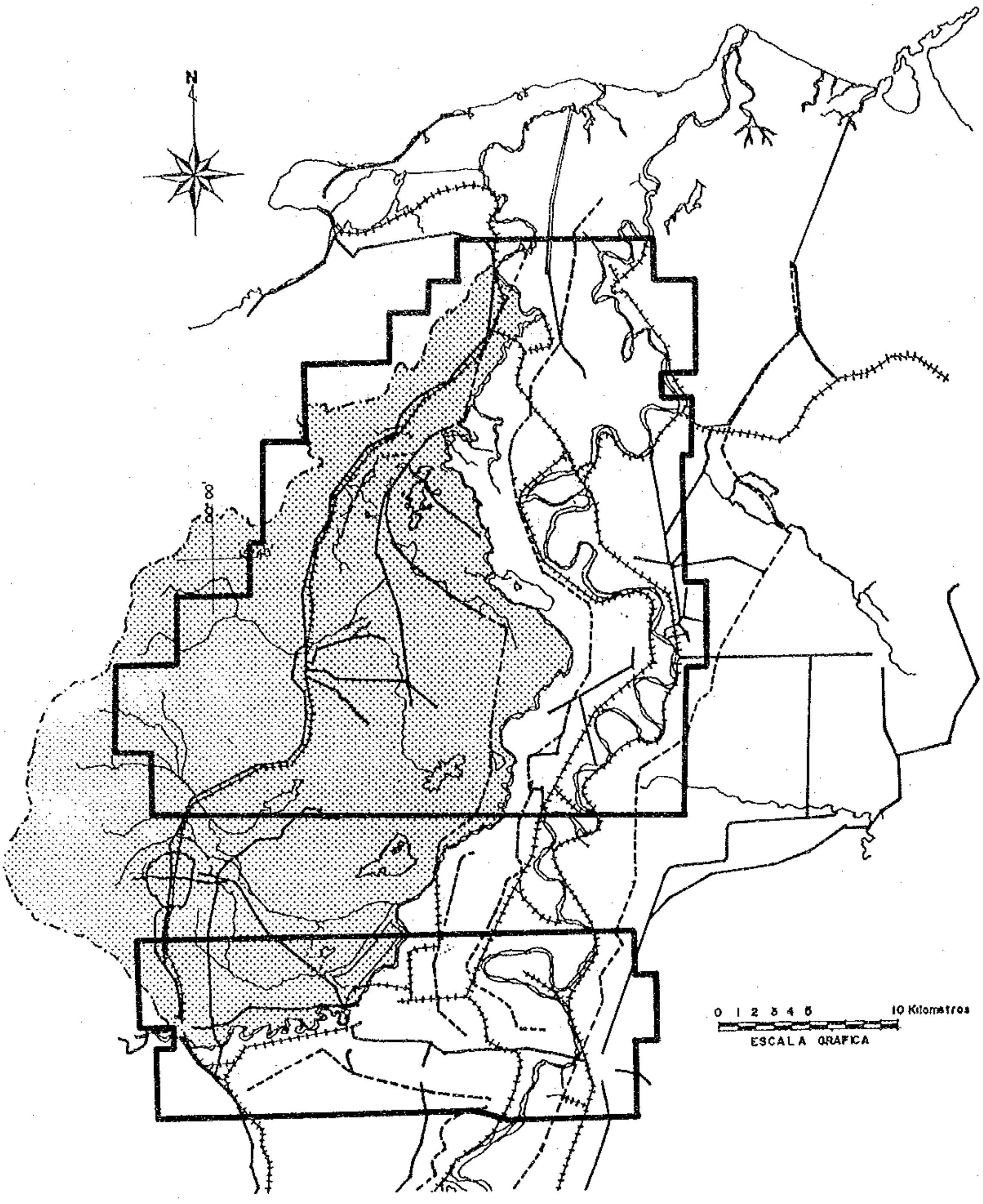
AERIAL PHOTOGRAPH/FOTOGRAFIAS AEREAS

TAKEN IN 1974 | TOMADA EN 1974

SCALE/ESCALA 1:10,000

FIG.2.4 (2) COVERED AREA OF AERIAL PHOTOGRAPH
AREA DE CUBIERTA POR FOTOGRAFIAS AEREAS

JICA

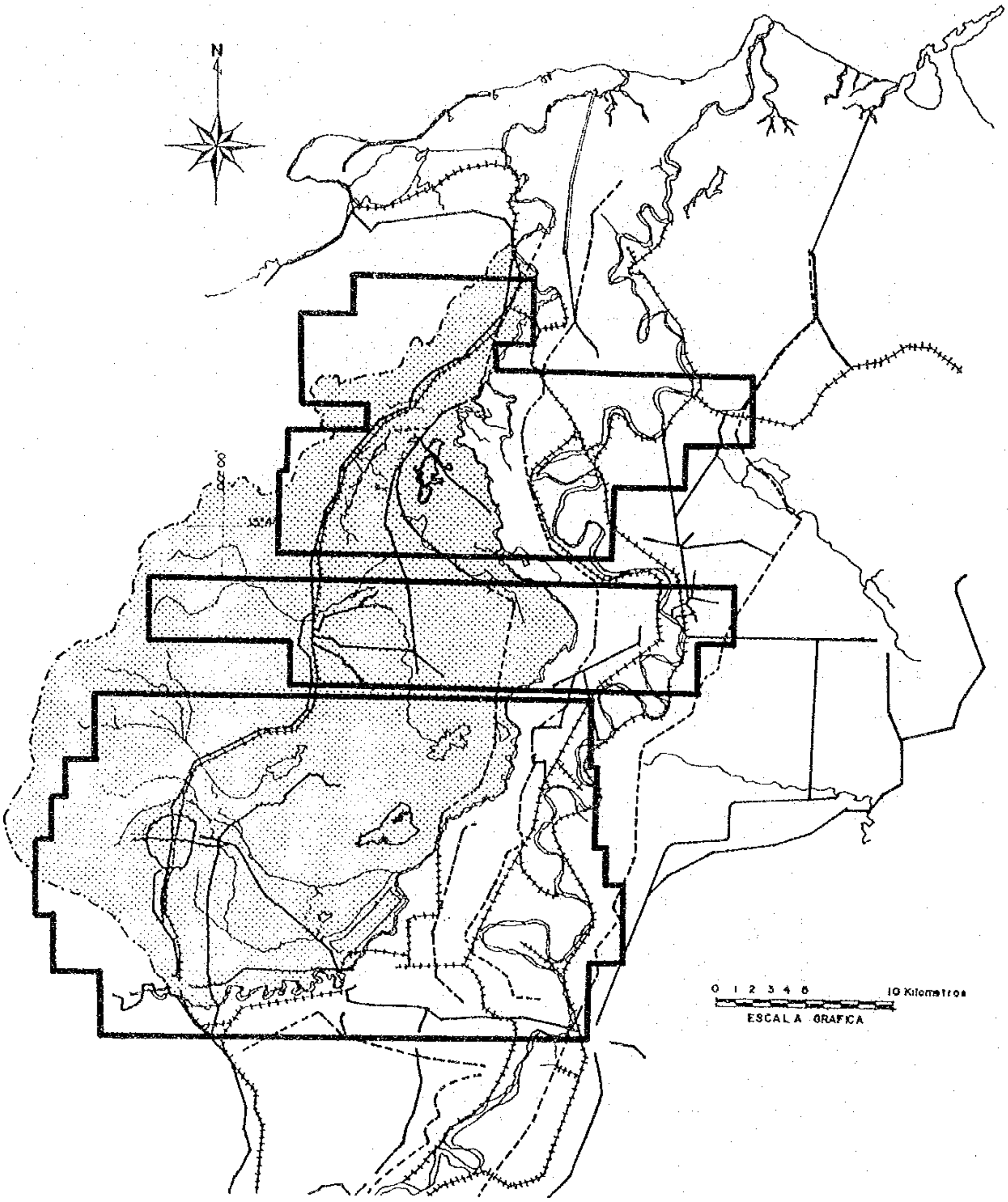


AERIAL PHOTOGRAPH/FOTOGRAFIAS AEREAS

TAKEN IN 1974 | TOMADA EN 1974

SCALE/ESCALA 1:20,000

FIG.2.4 (3) COVERED AREA OF AERIAL PHOTOGRAPH
AREA DE CUBIERTA POR FOTOGRAFIAS AEREAS

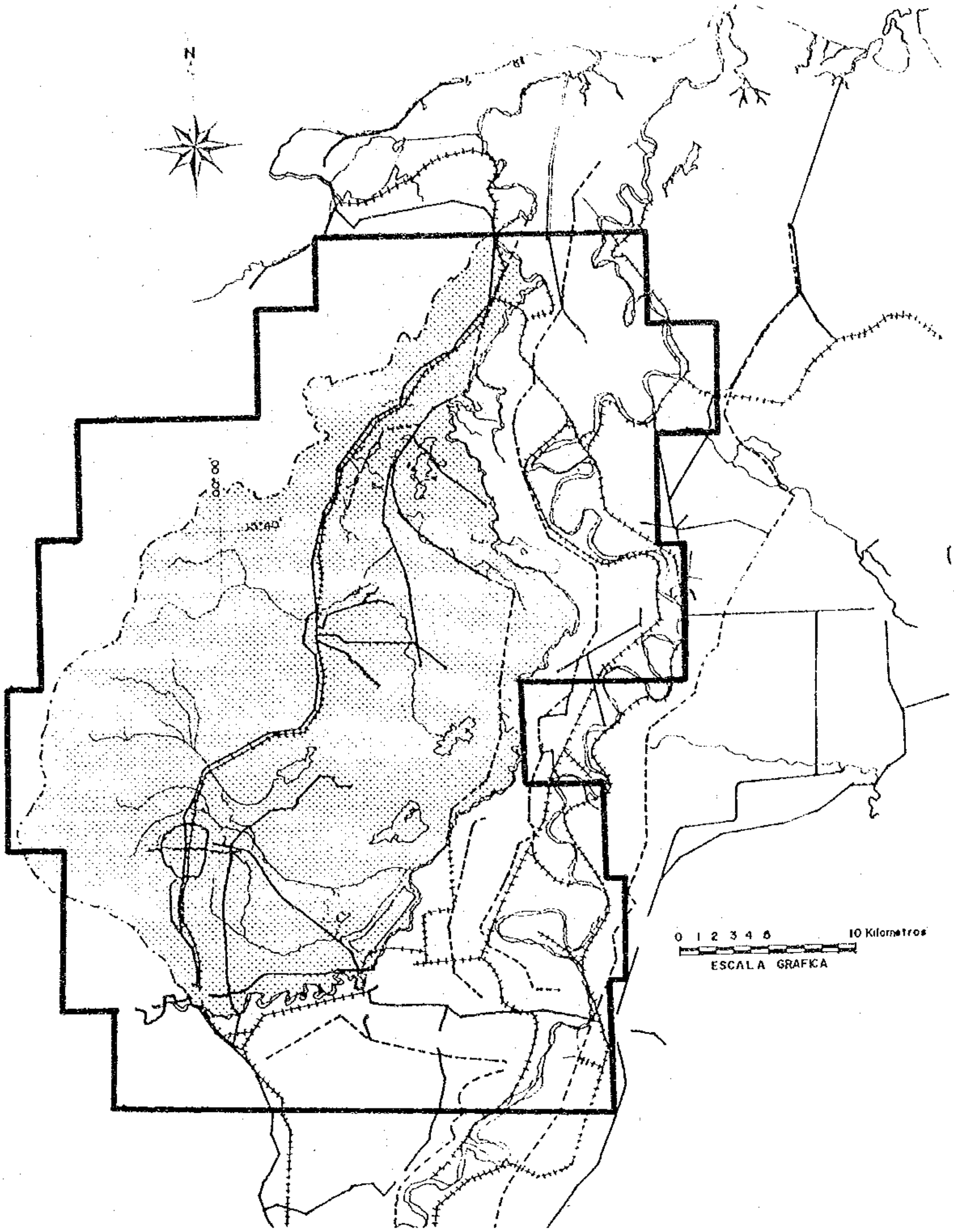


AERIAL PHOTOGRAPH/FOTOGRAFIAS AEREAS

TAKEN IN 1975 | TOMADA EN 1975

SCALE/ESCALA 1:20,000

FIG.2.4 (4) COVERED AREA OF AERIAL PHOTOGRAPH
AREA DE CUBIERTA POR FOTOGRAFIAS AEREAS

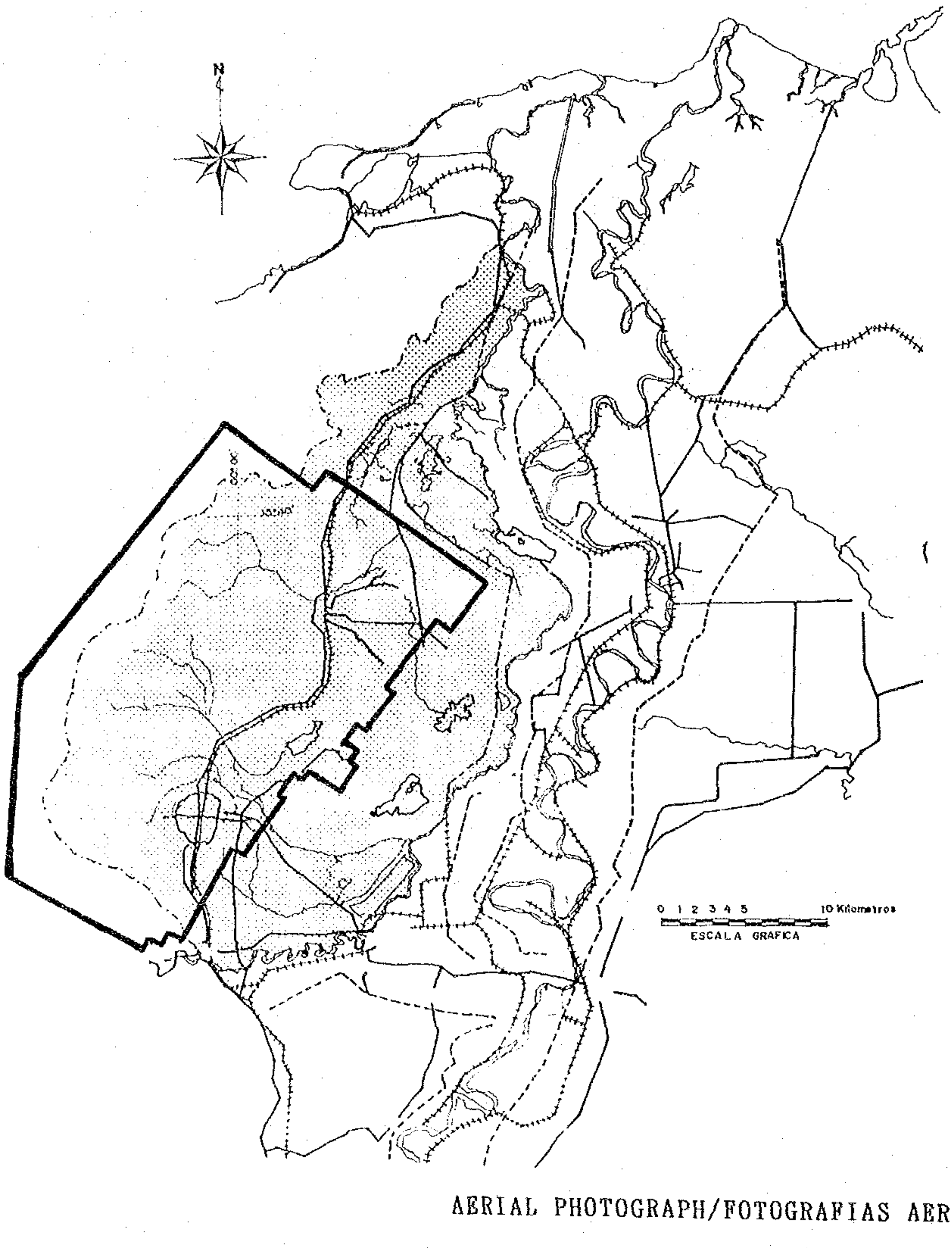


AERIAL PHOTOGRAPH/FOTOGRAFIAS AEREAS

TAKEN IN 1977 | TOMADA EN 1977

SCALE/ESCALA 1:40,000

FIG.2.4 (5) COVERED AREA OF AERIAL PHOTOGRAPH
AREA DE CUBIERTA POR FOTOGRAFIAS AEREAS

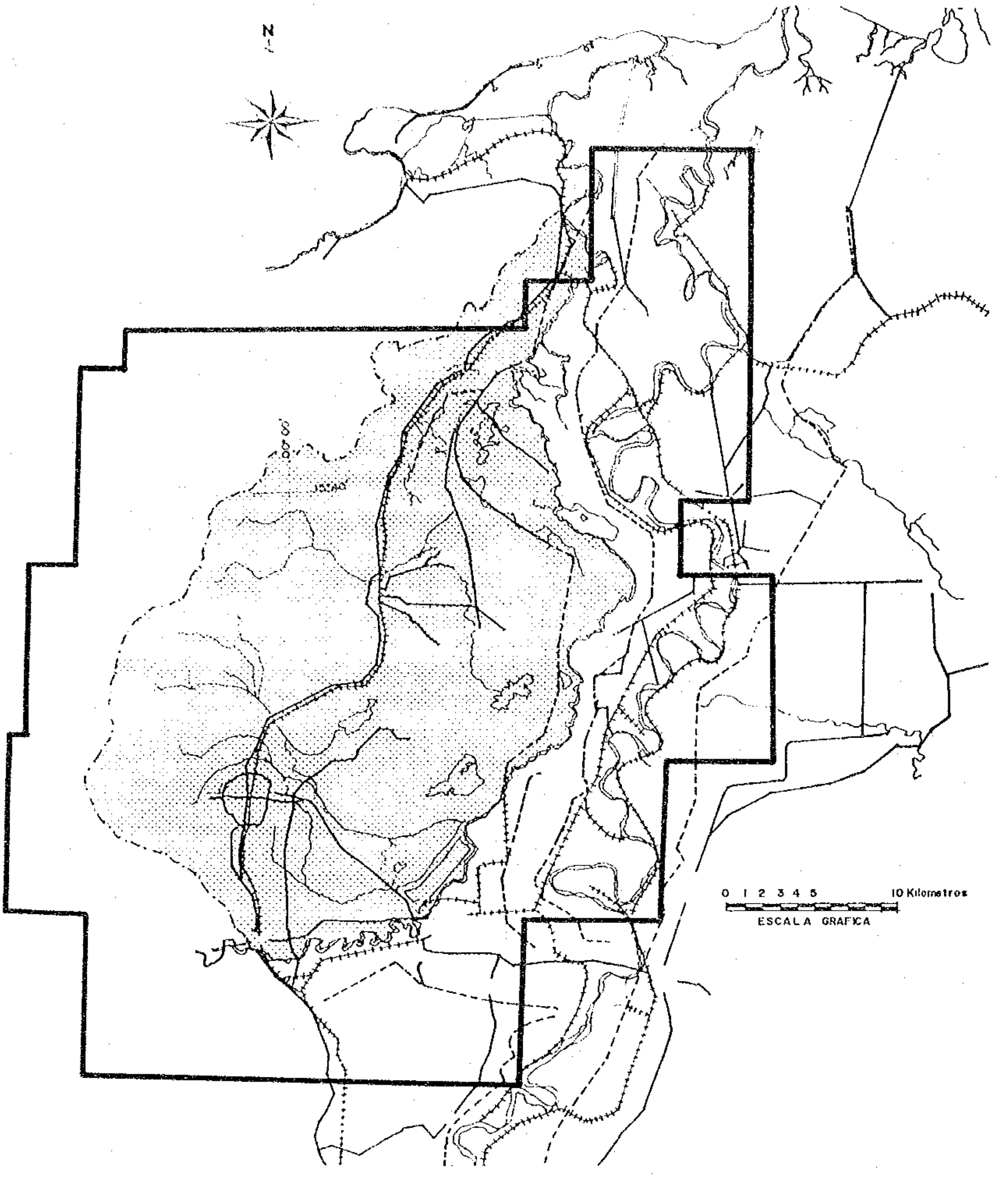


AERIAL PHOTOGRAPH/FOTOGRAFIAS AEREAS

TAKEN IN 1989 TOMADA EN 1989

SCALE/ESCALA 1:10,000

FIG.2.4 (6) COVERED AREA OF AERIAL PHOTOGRAPH
AREA DE CUBIERTA POR FOTOGRAFIAS AEREAS



AERIAL PHOTOGRAPH/FOTOGRAFIAS AEREAS

TAKEN IN 1992 | TOMADA EN 1992

SCALE/ESCALA 1:40,000

FIG.2.4 (7) COVERED AREA OF AERIAL PHOTOGRAPH
AREA DE CUBIERTA POR FOTOGRAFIAS AEREAS

JICA

RAINFALL GAUGING STATION INSTALLED BY JICA AT EL ZAPOTAL NORTE (1993)

CHAPTER 3
HYDROLOGICAL STUDY

CHAPTER 3 HYDROLOGICAL STUDY

3.1 General

In order to formulate a Master Plan on erosion, sediment and flood control for the study area, the rainfall and runoff characteristics were studied and assessed based on the collected data. The hurricane Fifi of 1974 and the other storms were assessed from hydrological aspects.

3.2 Rainfall and River Stage Data

3.2.1 Rainfall Data

The rainfall data of thirty four (34) gauging stations in and around the study area have been collected from the National Meteorological Division (Servicio Meteorologia Nacional: SMN), Ministry of Natural Resources (Ministerio de Recursos Naturales: MRN) and Tela Railroad Co (TRRC). Nine (9) rain gauges of them belong to SMN / MRN, and the other twenty five (25) rain gauges belong to TRRC. Those rain gauges and their observation periods are listed in *Tables* 3.1 (1) and (2). The distribution of the rain gauges located in and around the study area is shown in *Fig*. 3.1.
Among those rain gauges the station at La Mesa is only one that has comparatively a long observation period from 1944 to 1991 and also located in the study area.

3.2.2 River Stage and Discharge Data

River water-level and discharge data are available for the Rio Ulua and the Rio Chamelecon, but their tributaries in the study area has no gauging station. The annual maximum water levels and discharges at the Rio Ulua and at the Rio Chamelecon are shown in *Table* 3.2. The gauging stations and their duration of observation are listed as follows.

Table The Gauging Station and Duration of Observation

Gauging Station	Duration	Data
(Rio Ulua)		
Puente Pimienta	1966~1988	discharge and river stage
1991~1992		
Santiago	1992	river stage
Guanacastales	1992	river stage

(Rio Chamelecon)		
Puente Chamelecon	1966~1973	discharge and river stage
	1980~1989	
Pacmar	1992	river stage

Note: The river stage data of the Puente Pimienta and the Puente Chamelecon are unable to be used for estimation of any flood stage, because of no indication of their datum elevations.

3.3 Rainfall Analysis

3.3.1 Average Rainfall

The annual and monthly rainfall amounts are calculated for La Mesa, El Modelo, Puerto Cortes and Omoa, and shown in *Tables* 3.3~3.6. The tables show that the rainfall amounts at Puerto Cortes and Omoa which are located in the coastal area, are twice as much as those at La Mesa and El Modelo which are located in the inland area.

3.3.2 Maximum Rainfall

Annual and monthly maximum daily rainfalls (from 6:00 AM to 6:00 AM) at both La Mesa and Puerto Cortes are selected and shown in *Tables* 3.7(1)~3.9(2). The tables show that the maximum daily rainfall amounts at both La Mesa and Puerto Cortes are 340 mm and 283.2 mm which are recorded in the hurricane Fifi, but the maximum 6-hour rainfall at La Mesa is 154.4 mm recorded on June 10, 1991. The maximum 6-hour rainfall in the hurricane Fifi is 140 mm at La Mesa.
The hourly rainfall data were also collected, but rainfall recording charts of La Mesa are only available for fifteen (15) years. The maximum hourly and 2-hour rainfalls, based on the rainfall recording charts, are shown in *Table* 3.10.

3.3.3 Frequency Analysis

The frequency analysis of daily rainfalls was conducted for both La Mesa and Puerto Cortes, but the frequency analysis of 6-hour, 2 hour and hourly rainfalls was done only for La Mesa. For frequency analysis the methods of Iwai, Thomas, Hazen, Ishihara/Takase and Gumbel are applied. The results are summarized and shown in *Tables* 3.11~3.13 and *Figs*. 3.2~3.4.

3.3.4 Rainfall Pattern of the Hurricane Fifi

The rainfall recording sheet during the hurricane Fifi was collected only for the station at Tela. The hourly rainfall distribution of Tela during the hurricane Fifi is shown in *Fig*. 3.5.

The hourly rainfall distribution of La Mesa was estimated based on that of Tela and shown in *Figs*. 3.6 and 3.7. Though the total rainfall amounts of the two stations are different but their rainfall distribution during the hurricane Fifi seemed to have a similar hourly distribution.

3.3.5 Rainfall Patterns in the Study Area

The rainfall pattern in the study area is studied based on the collected data from the two stations (La Mesa and El Modelo). The two stations are located nearby each other and their annual average rainfall amounts are similar.

The total rainfalls over 70 mm were selected and shown in *Figs* 3.8 and 3.9. The relationship between the cumulative rainfall depth and the rainfall duration of each rainfall is shown in *Fig*. 3.10. The figure shows that there are two rainfall patterns in the study area, i.e., a long duration with a low rainfall intensity and a short duration with a high rainfall intensity.

3.3.6 Rainfall Intensity and Duration

The relation between probable rainfall depths and duration calculated for the rainfall station at La Mesa are shown in the following table.

Table Probable Rainfall Depth (Gumbel Method) unit : mm

Duration (minute)	Return Period (Year)					
	100	50	30	10	5	2
60	81.3	73.2	67.1	53.9	45.2	32.0
120	104.7	93.5	85.3	67.1	53.2	37.1
360	160.4	143.7	131.3	104.2	86.2	59.1
1440	251.1	222.7	201.6	155.5	124.9	78.8

A relation between the rainfall intensity and the duration of a rainfall was decided by the following formula.

$$r = a/(t^n+b)$$

where,
- r: rainfall intensity (mm/hr)
- t: time duration
- a, b and n: constant

The constants "a" and "b" for each return period were calculated using n=2/3. The results are shown in the following table.

Table Constants of the formula

Return period	a	b	n
1/100	1365	1.49	2/3
1/50	1212	1.26	2/3
1/30	1099	1.07	2/3
1/10	850	0.48	2/3
1/5	681	-0.06	2/3
1/2	439	-1.63	2/3

Fig. 3.11 shows the rainfall intensity and time duration curves calculated.

3.3.7 Evaluation of Hurricane Fifi

On the basis of collected rainfall data, the hurricane Fifi is assessed and summarized as follows:

- The maximum daily rainfall of 340 mm at La Mesa is estimated to be a storm larger than once in 200-year frequency, however the rainfall amount of 280 mm at Puerto Cortes is estimated to be a storm of once in 20~30-year frequency,.

- The maximum six (6)-hour rainfall of 140 mm at La Mesa, is estimated to be a scale of once in 50~70-year frequency.

- Though the hourly rainfall data have not collected, the maximum hourly rainfall intensity is estimated to be 66 mm at La Mesa. The rainfall amount is likely a storm once in 30-year frequency.

3.4 Flood Run-off Analysis

3.4.1 Run-off Analysis Method

For flood runoff analysis purposes, the Rational Formula, the Unit Hydrograph Method and the Storage Function Method have been studied. The methods for this study are decided to apply the Rational Formula and the Nakayasu's Unit Hydrograph Method that was developed in Japan because of the following reasons:

- The Rational Formula is proper to estimate a peak discharge from a comparatively small basin of less than 200 square km. The method is applied for estimating a peak discharge in designing the erosion and debris control works.

- The Nakayasu's Unit Hydrograph Method is widely used in Japan for planning river works. The method is applied for the flood runoff analysis of the pilot river basins that have a similar topographic condition as those in Japan. By using this method, it becomes possible to estimate not only a peak discharge, but also a shape of flood hydrograph,

- The storage function method is also widely used in Japan for planning river works. The method is applied for estimation of a peak discharge and a shape of hydrograph, but it requires discharge data in order to calibrate the shape of hydrograph estimated by the method. The method is not able to be applied properly for this study, because no required discharge data are available in the pilot river basins.

For this analysis, the study area was divided into twenty-two (22) sub-drainage basins. They are summarized in *Table* 3.14. River system models for both the existing river systems and the proposed alternative river systems are shown in *Figs*. 3.12~3.14 respectively.

In order to select an optimum design rainfall pattern, the following three rainfall patterns were studied and the probable discharge of pattern C was decided to be the design rainfall pattern which gives the maximum discharge in general.

-Pattern A : Maximum rainfall intensity occurs at the initial stage of rainfall,

-Pattern B : Maximum rainfall intensity occurs at the middle stage of rainfall,

-Pattern C : Maximum rainfall intensity occurs at the final stage of rainfall.

The rainfall patterns of A,B,and C used for run-off simulation, are shown in *Fig*.3.15. And the probable discharges by those rainfall patterns are summarized in *Tables* 3.15~3.20. The probable peak discharges by the rainfall pattern C are summarized in *Table* 3.21 and 3.22, and *Figs*. 3.16 and 3.17 respectively.

The shapes of hydrograph were calculated for different rainfall patterns both at the junction of the Rio Choloma with the Canal San Roque and at the river mouth of the Rio El Sauce , and they are shown in *Figs* 3.18~3.20.

3.4.2 Simulation of the Hurricane Fifi's Flood

The flood discharge caused by the hurricane Fifi was assessed for the Rio Choloma based on the estimated rainfall pattern with total rainfall of 376 mm. The hydrograph and the peak discharges at major points are shown in *Table* 3.23 and *Fig*. 3.21 respectively.

The peak discharges by the simulation on the hurricane Fifi are assessed as follows:

- At the most downstream of each basin, the peak discharge by the simulation on the hurricane Fifi, is larger than the estimated peak discharge based on a daily rainfall once in 50-year return period,
- At the mid reach of each basin, however, the peak discharge by the simulation on the hurricane Fifi at the mid reach is similar to the estimated value based on a daily rainfall once in 30~50-year return period,
- At the upper reach of each basin the peak discharge by the simulation on the hurricane Fifi is likely less than the estimated peak discharge based on a daily rainfall once in 30-year return period.
- The Fifi's flood was assessed at the same scale of the flood that was calculated by the daily rainfall once in 50-year return period for the whole basin.

3.4.3 Probable Discharge Distribution

The rainfall once in 50-year return period with the rainfall pattern C was selected for the design rainfall of the master plan. The peak discharges estimated are shown in *Figs.* 3.22 and 3.23.

TABLES

TABLE 3.1 (1) AVAILABLE DAILY RAINFALL DATA

Station Name	Available Period	Managed By
La Mesa	1994 - 1991	SMN
El Modelo	1975 - 1990	MRN
Puerto Cortes	1945 - 1950 1962 - 1980	SMN
Omoa	1987 - 1991	SMN
Guaymas	1978-1990	MRN
Peña Blanca	1956-1977	SMN
Morazan	1966-1981	MRN
Quimistan	1968-1981 1986-1990	MRN
Finca 3	1969-1974	TRRC.
Santiago	1969-1974	TRRC.
Bejuco	1979-1981	TRRC.
Barranco	1969-1980	TRRC.
Oliva	1969-1980	TRRC.
Llano	1969-1980	TRRC.
Higuerito Central	1969-1977	TRRC.
Garroba	1975-1980	TRRC.
Blanco	1969-1980	TRRC.
Progreso	1969-1978	TRRC.
Buena Vista	1969-1988	TRRC.
Cobb	1969-1988	TRRC.
Las Flores	1969-1988	TRRC.
Naranjo Chino	1969-1988	TRRC.
Los Indios	1969-1988	TRRC.
Monterrey	1969-1988	TRRC.
Breck	1969-1988	TRRC.
Palomas	1969-1988	TRRC.
Birichiche	1979-1981	TRRC.
La Fragua	1969-1988	TRRC.
Guanacastales	1969-1972	TRRC.
La Lima	1969-1980	TRRC.
Guarumas	1974-1988	TRRC.
Omonita	1975-1988	TRRC.

TABLE 3.1 (2) AVAILABLE DAILY RAINFALL DATA

Station Name	Available Period	Managed By
San Juan	1969-1988	TRRC.
La Curva	1970-1988	TRRC.
Tacamiche	1969-1988	TRRC.
Copen	1969-1988	TRRC.
Corozal	1969-1988	TRRC.
Mopala	1969-1988	TRRC.
Santa Rosa	1969-1988	TRRC.
Ceibita	1969-1988	TRRC.
Indiana	1969-1988	TRRC.
Caimito	1969-1988	TRRC.
Limones	1969-1988	TRRC.
Laurel	1969-1988	TRRC.
Lupo	1969-1988	TRRC.
Mercedes	1969-1982	TRRC.
Tibombo	1969-1988	TRRC.

TABLE 3.2 ANNUAL MAXIMUM WATER LEVEL AND DISCHARGE (RIO ULUA AND RIO CHAMELECON)

Rio Ulua at Puente Pimienta

	Period						Month	Date	Water Level (m)	Discharge (qu. m/sec)
1	May	1966	-	April	1967		Sep.	15	4.58	1,042.00
2	May	1967	-	April	1968		Oct.	12	3.36	981.20
3	May	1968	-	April	1969		Sep.	21	5.00	1,200.00
4	May	1969	-	April	1970		Sep.	3	8.50	2,735.00
5	May	1970	-	April	1971		Aug.	28	4.60	998.00
6	May	1971	-	April	1972		Oct.	9	4.46	943.00
7	May	1972	-	April	1973		Aug.	29	4.16	845.00
8	May	1973	-	April	1974		Aug.	29	5.58	1,370.00
9	May	1974	-	April	1975		Sep.	19	7.30	2,170.00
10	May	1975	-	April	1976		Sep.	24	5.94	1,550.00
11	May	1976	-	April	1977		June	13	6.92	2,269.00
12	May	1977	-	April	1978		June	1	4.64	1,400.00
13	May.	1978	-	April	1979		Sep.	6	6.13	2,104.20
14	May	1979	-	April	1980		June	9	6.52	1,756.00
15	May	1980	-	April	1981		Sep.	13	7.50	2,681.00
16	May	1981	-	April	1982		Sep.	25	7.36	1,687.22
17	May	1982	-	April	1983		June	13	6.04	1,545.94
18	May	1983	-	April	1984		Sep.	29	6.62	1,827.15
19	May	1984	-	April	1985		Sep.	3	6.18	1,653.26
20	May	1985	-	April	1986		Sep.	28	4.60	1,043.43
21	May	1986	-	April	1987		Sep.	13	4.82	982.84
22	May	1987	-	April	1988		Sep.	24	4.90	1,495.17

Max. 8.50 2,735.00

Rio Chamelecon at Puente Chamelecon

	Period						Month	Date	Water Level (m)	Discharge (qu. m/sec)
1	May	1966	-	April	1967		Nov.	21	4.94	341.60
2	May	1967	-	April	1968		Oct.	19	5.66	561.50
3	May	1968	-	April	1969		Sep.	25	4.60	552.00
4	May	1969	-	April	1970		Sep.	3	6.20	833.00
5	May	1970	-	April	1971		Sep	24	4.10	465.00
6	May	1971	-	April	1972		Nov.	21	3.32	322.00
7	May	1972	-	April	1973		July	28	1.58	62.70
8	May	1980	-	April	1981		Oct.	7	5.00	483.00
9	May	1981	-	April	1982		June	23	5.44	902.71
10	May	1982	-	April	1983		Sep.	24	4.78	701.69
11	May	1983	-	April	1984		Nov.	16	5.06	821.66
12	May	1984	-	April	1985		Sep.	3	5.00	429.28
13	May	1985	-	April	1986		Sep.	27	3.04	205.48
14	May	1986	-	April	1987		Sep.	29	3.35	349.45
15	May	1987	-	April	1988		Sep.	21	2.74	218.18

Max. 6.20 902.71

Note: Water level is no an elevation at the station.

TABLE 3.3. AVERAGE MONTHLY RAINFALL AT LA MESA

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1944	-	-	27.2	30.0	35.1	158.2	148.6	177.8	150.6	275.3	69.1	131.6	-
1945	77.5	35.3	18.8	21.1	70.1	99.3	111.5	-	-	146.6	284.2	54.4	-
1946	8.9	73.2	3.0	38.1	12.7	9.9	72.4	31.0	43.7	21.3	28.4	15.0	357.6
1947	44.7	34.0	68.1	7.1	17.0	74.7	261.1	175.5	152.4	40.1	64.3	69.6	1,008.6
1948	96.5	189.2	10.9	16.5	176.8	96.5	193.3	115.6	217.2	60.7	98.3	80.8	1,352.3
1949	79.2	4.3	19.1	14.0	2.0	70.4	95.5	87.4	161.3	75.9	137.9	228.6	975.6
1950	161.3	68.8	85.1	-	-	233.7	96.0	66.8	85.1	172.7	135.9	79.0	-
1951	23.1	19.1	0.0	0.0	101.9	136.1	113.3	96.5	49.0	-	6.1	10.9	-
1952	38.6	62.0	6.1	73.7	39.9	215.4	162.8	-	232.2	159.0	153.7	233.9	-
1953	92.2	48.8	30.7	4.6	213.1	191.3	152.4	140.7	106.7	178.6	210.1	97.3	1,466.5
1954	128.5	22.9	47.5	81.0	55.4	242.6	108.0	122.9	312.2	263.4	145.8	92.2	1,622.4
1955	65.5	68.1	7.4	6.9	2.3	36.6	172.5	136.1	222.0	186.7	150.9	206.0	1,261.0
1956	43.4	20.8	30.7	48.0	132.8	181.4	81.0	167.1	231.4	293.4	269.7	218.2	1,717.9
1957	126.5	31.5	131.8	3.0	99.1	139.2	276.9	213.4	85.3	78.7	60.5	138.2	1,384.1
1958	47.5	16.5	98.3	3.6	65.5	299.5	377.2	175.8	137.4	175.8	68.3	46.5	1,511.9
1959	57.4	6.9	37.1	92.7	28.4	305.3	88.4	77.7	169.9	237.7	161.0	63.8	1,326.3
1960	53.8	41.7	75.7	80.8	38.1	249.9	143.8	86.1	236.2	147.3	205.7	121.9	1,481.0
1961	181.1	74.7	45.7	17.5	23.6	63.8	251.7	64.3	108.2	148.6	103.4	74.4	1,157.0
1962	71.4	25.6	84.1	117.3	45.5	218.4	127.5	87.6	134.6	297.9	72.6	55.9	1,338.4
1963	34.3	133.1	112.5	4.8	33.5	69.8	66.5	141.5	271.8	141.0	114.8	118.6	1,242.2
1964	31.0	61.5	2.0	34.5	51.6	263.4	83.8	59.9	160.0	127.2	88.9	245.6	1,209.4
1965	52.6	-	17.5	8.1	15.7	49.0	329.4	125.5	49.0	63.8	318.5	127.3	-
1966	51.3	172.7	77.5	48.0	62.0	306.3	88.1	145.8	145.0	143.0	129.5	81.0	1,450.2
1967	136.4	98.6	14.7	20.6	20.8	205.7	50.8	83.8	156.7	247.4	222.5	122.9	1,380.9
1968	34.8	32.3	44.5	2.5	262.1	123.2	118.6	86.1	221.7	158.5	146.1	150.6	1,381.0
1969	47.5	9.4	52.8	7.6	152.2	84.8	154.4	133.6	174.8	11.4	274.1	66.6	1,169.2
1970	47.2	54.6	1.5	0.3	30.7	61.7	121.7	96.0	201.9	69.1	124.5	160.5	969.7
1971	83.8	25.4	24.9	27.4	45.7	35.0	52.4	37.8	74.2	46.3	184.6	48.4	685.9
1972	34.8	149.4	30.0	3.5	12.4	151.3	65.8	112.6	103.6	27.5	15.7	59.1	765.7
1973	13.6	25.6	4.2	77.1	83.0	51.6	119.5	145.8	65.4	37.6	108.6	15.0	747.0
1974	17.8	22.4	5.9	5.5	17.0	314.5	41.6	71.4	549.2	430.5	90.8	62.4	1,629.0
1975	6.1	1.4	0.0	0.0	22.4	11.9	6.6	105.0	53.9	106.7	119.9	92.8	526.7
1976	266.5	24.6	0.5	76.8	62.4	159.0	60.2	16.3	24.7	155.8	189.1	141.0	1,176.9
1977	42.8	53.8	13.3	55.9	79.8	176.9	67.3	88.6	58.5	100.2	92.1	112.6	941.8
1978	113.2	31.8	78.4	0.3	199.5	145.8	112.7	113.8	140.9	134.6	170.5	138.4	1,379.9
1979	51.2	88.5	15.1	44.7	66.3	110.1	90.0	165.5	245.5	164.0	257.7	177.6	1,476.2
1980	22.4	61.9	2.4	149.9	41.6	201.5	79.9	71.4	309.6	242.8	181.0	92.6	1,457.0
1981	68.4	219.1	28.6	9.9	26.0	243.7	121.6	156.3	146.6	253.6	53.6	216.5	1,543.9
1982	103.2	98.4	44.6	9.2	68.9	93.8	94.1	90.6	170.7	159.1	92.9	68.7	1,094.2
1983	79.9	9.6	13.7	91.1	13.5	118.5	93.1	152.9	85.3	34.5	98.7	175.2	966.0
1984	82.5	34.6	46.6	3.3	57.0	169.3	204.1	172.4	145.6	65.2	105.0	105.2	1,190.8
1985	45.0	18.7	11.5	46.9	78.9	109.0	138.9	99.5	97.5	38.7	28.1	72.8	785.5
1986	81.1	10.5	45.9	1.8	67.7	84.8	195.9	96.8	109.6	181.1	46.7	86.0	1,007.9
1987	74.9	10.8	65.7	4.5	0.0	64.6	245.0	103.6	93.8	68.3	231.9	221.8	1,184.9
1988	138.2	93.6	34.5	25.0	79.9	146.4	189.6	211.5	152.1	327.0	36.7	253.2	
1989	86.6	70.9	6.7	12.4	49.4	88.6	84.4	78.0	184.2	137.8	128.2	129.3	
1990	44.1	16.0	51.4	1.3	52.6	232.2	35.2	107.2	89.7	75.5	157.2	93.1	955.5
1991	60.0	46.4	44.7	48.3	63.2	68.5	53.9	114.3	101.5	59.0	424.7	67.9	1,152.4
Ave.	71.2	54.8	35.8	31.4	63.3	145.1	129.1	113.2	153.6	144.0	138.7	115.0	1,185.8

(unit : mm)

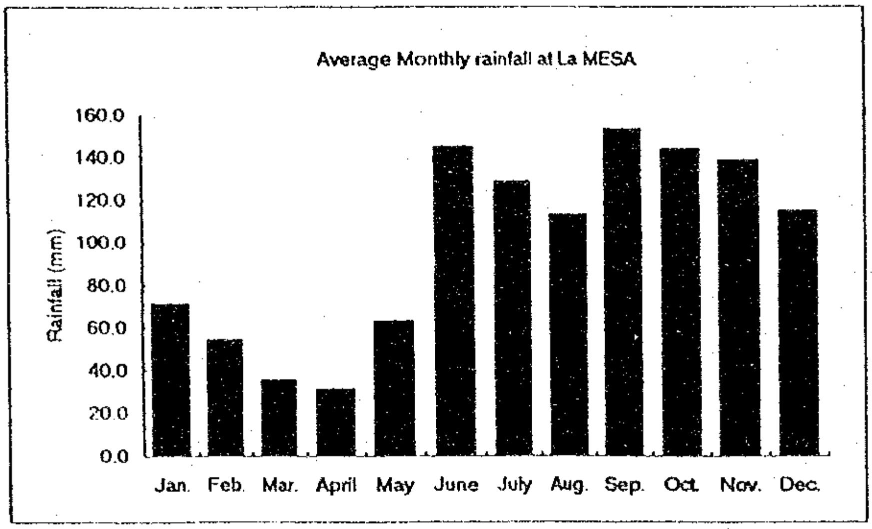


TABLE 3.4 AVERAGE MONTHLY RAINFALL AT EL MODELO

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1975	82.4	7.6	57.7	2.7	2.9	42.2	48.1	76.1	87.4	76.3	102.6	72.5	-
1976	199.3	21.4	2.1	40.3	160.5	138.5	118.8	92.8	90.3	196.4	198.5	136.6	1,395.5
1977	50.6	55.7	13.7	63.2	107.5	395.6	74.5	157.7	-	42.2	119.1	82.6	-
1978	75.0	134.7	86.5	3.2	165.4	135.6	174.7	101.0	203.0	-	178.0	141.3	1,398.4
1979	53.7	80.5	26.6	17.6	-	-	-	-	-	-	-	-	-
1982	137.4	132.5	35.7	61.6	84.3	120.0	61.3	-	-	-	72.9	58.0	-
1984	77.3	30.4	-	-	108.9	-	258.4	179.0	-	65.7	69.2	103.4	-
1985	55.9	28.7	12.9	50.0	53.9	71.4	209.7	100.8	171.7	24.9	46.0	53.4	879.3
1986	89.2	11.8	36.0	0.7	78.4	100.2	201.7	123.2	122.4	190.0	58.7	78.9	1,091.2
1987	82.4	7.6	57.7	2.7	2.3	87.3	213.1	153.9	110.7	62.0	210.2	209.6	1,199.5
1988	107.3	94.8	40.5	29.5	63.5	144.4	217.6	118.4	155.2	267.3	47.0	209.0	1,494.5
1989	87.9	56.5	7.3	4.9	59.3	91.8	46.0	151.3	162.1	112.7	-	-	-
1990	-	-	-	-	-	-	-	132.0	104.8	20.1	173.9	24.4	-
Ave.	91.5	55.2	34.2	25.1	80.6	132.7	147.6	126.0	134.2	105.8	116.0	106.3	1,243.1

(unit : mm)

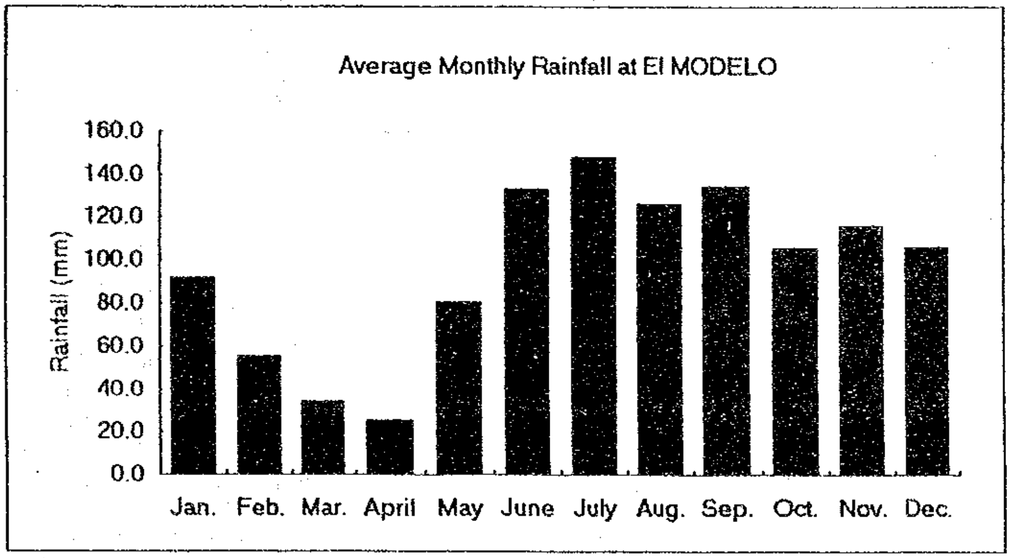


TABLE 3.5 AVERAGE MONTHLY RAINFALL AT PUERTO CORTES

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1945	-	23.9	8.9	0.0	204.2	90.7	188.5	380.0	602.7	-	-	-	-
1946	225.3	92.5	78.0	25.4	9.4	138.4	117.1	103.9	109.5	430.3	589.0	390.1	2,308.9
1947	110.2	295.1	201.7	92.7	34.5	99.8	-	-	128.5	216.4	284.7	577.6	-
1948	660.4	165.9	35.3	50.5	104.1	153.2	147.8	117.3	172.2	450.1	235.5	237.0	2,529.3
1949	162.6	19.3	24.4	48.0	18.0	47.2	115.6	125.5	76.7	246.9	447.5	570.7	1,902.4
1950	144.8	170.4	21.3	27.2	1.3	252.2	256.5	169.9	110.0	777.5	-	-	-
1962	-	-	25.1	-	68.6	-	293.6	117.1	309.6	427.8	390.9	253.0	-
1963	146.3	185.7	322.6	49.3	72.9	54.4	62.5	137.4	241.8	591.1	528.6	387.1	2,779.7
1964	142.7	191.5	-	5.1	23.6	243.8	117.1	286.8	163.8	408.7	409.4	503.7	-
1965	374.4	188.0	68.1	62.0	34.3	169.9	178.3	211.3	158.2	646.4	509.8	501.9	3,102.6
1966	467.4	574.3	243.8	28.2	91.2	454.7	176.5	94.7	94.2	631.7	-	-	-
1967	387.1	301.2	79.2	121.4	127.3	243.8	193.3	157.7	221.7	467.4	525.5	156.7	2,982.3
1968	195.1	196.1	113.7	22.6	100.3	82.8	143.0	278.6	138.7	413.5	457.2	587.5	2,729.1
1969	254.0	72.1	327.9	10.4	242.3	244.9	111.8	78.0	507.0	340.9	807.7	312.4	3,309.4
1970	294.9	242.6	50.3	25.4	115.1	223.3	134.1	87.4	258.1	252.7	385.3	432.6	2,501.8
1971	244.1	179.6	131.8	25.4	35.3	96.5	86.6	244.4	146.3	112.0	498.6	312.4	2,113.0
1972	211.3	459.0	47.8	46.5	95.0	242.8	193.3	209.6	268.0	181.4	111.0	320.8	2,386.5
1973	77.0	232.9	131.8	-	242.3	-	-	160.7	242.0	178.7	263.4	211.3	-
1974	83.9	89.1	32.0	25.0	85.8	155.3	120.0	153.7	578.5	697.9	210.8	171.0	2,403.0
1975	170.7	34.8	0.0	1.8	35.3	78.5	67.4	159.9	182.6	579.8	547.3	438.9	2,297.0
1976	458.5	130.9	8.1	156.5	105.9	242.8	185.7	217.6	155.6	656.6	742.8	470.2	3,531.2
1977	121.5	210.2	50.5	210.6	171.2	155.8	170.6	131.6	77.3	251.1	249.8	311.1	2,111.3
1978	349.0	153.8	543.6	20.4	78.0	128.5	150.4	301.0	171.8	316.6	492.7	623.3	3,329.1
1979	220.9	374.1	93.9	52.8	247.0	261.6	137.6	403.1	288.0	539.7	1,118.4	327.3	4,064.4
1980	189.7	178.2	162.6	-	-	-	-	-	-	-	-	-	-
Ave.	247.5	198.4	116.8	50.3	97.6	175.5	152.2	188.1	225.1	426.7	466.9	385.6	2,728.3

(unit : mm)

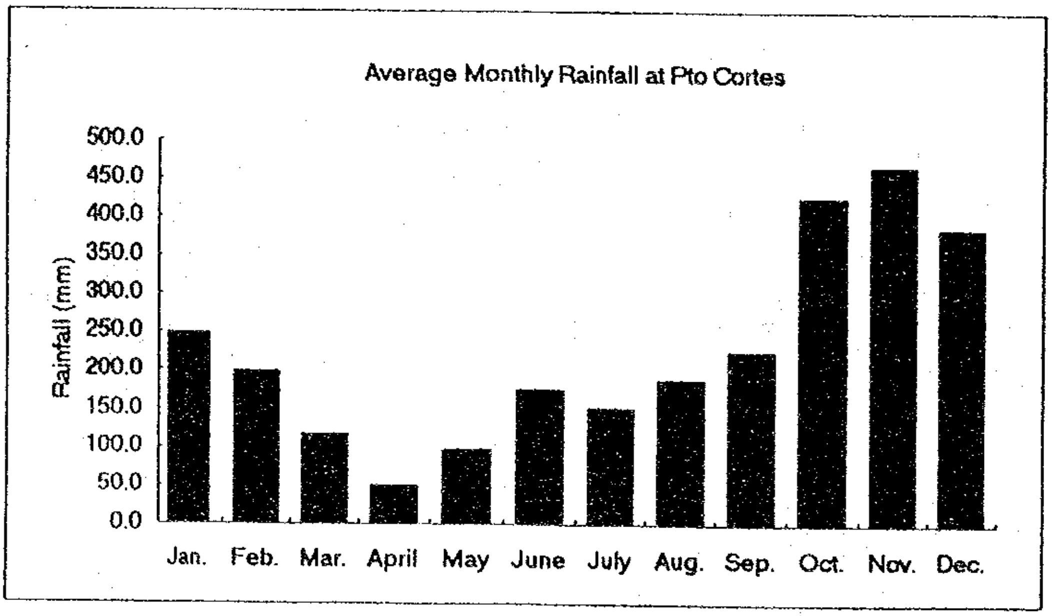


TABLE 3.6 AVERAGE MONTHLY RAINFALL AT OMOA

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1987	140.6	140.9	126.7	55.7	2.7	37.7	214.1	232.1	210.7	216.6	505.1	429.2	2,312.1
1988	459.6	511.6	144.0	116.3	9.4	179.8	253.7	183.5	107.0	1,008.4	180.7	559.8	3,713.8
1989	252.4	136.3	14.5	11.0	15.9	16.9	142.5	100.0	156.3	492.0	706.7	428.2	2,472.7
1990	277.6	241.3	244.8	-	82.8	144.4	254.0	406.5	564.9	226.5	1,031.0	238.8	-
1991	147.7	14.7	94.1	9.9	267.5	91.5	147.4	167.1	257.6	163.1	693.9	189.7	2,244.2
Ave.	255.6	209.0	124.8	48.2	75.7	94.1	202.3	217.8	259.3	421.3	623.5	369.1	2,685.7

(unit : mm)

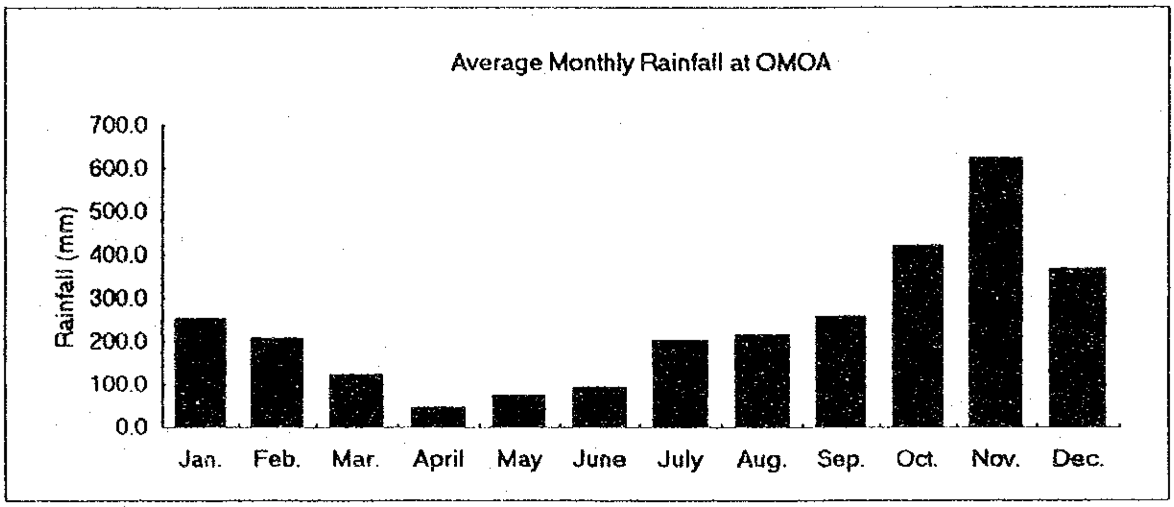


TABLE 3.7 (1) MONTHLY MAXIMUM ONE DAY RAINFALL AT LA MESA

		Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Max.
1944	Date	-	-	9	3	31	17	27	25/27	3/21	25	9	1	
	Rainfall			10.9	30.0	32.0	52.1	21.1	33.0	52.1	53.1	17.0	30.0	53.1
1945	Date	2	25	10	6	21	17	17	-	-	27	23	10	
	Rainfall	11.9	8.9	9.9	9.9	23.1	52.1	24.4			37.1	48.0	20.1	52.1
1946	Date	24	15	9/10	19	5	16/17/26/28	28	12	20	3	27	4	
	Rainfall	3.0	45.0	10.2	25.9	8.9	2.0	58.9	23.9	14.0	4.1	14.0	9.9	58.9
1947	Date	9	14	16	27	9	16	8	1	6	5	1	6	
	Rainfall	13.0	8.1	52.1	4.1	11.9	11.9	97.0	24.9	32.0	22.1	35.1	20.1	97.0
1948	Date	9	2/3	13	3	25	10/21	18	3	24	3	11	30	
	Rainfall	27.9	52.1	10.9	16.0	55.9	21.1	42.9	22.1	52.1	13.0	35.1	52.1	55.9
1949	Date	11	10	20	6	22	22	25	12	26	11	13	25	
	Rainfall	17.3	2.3	9.9	14.0	2.0	23.1	34.0	18.0	45.0	30.0	43.9	34.0	45.0
1950	Date	21	2	30	-	-	28	16	29	14	25	13	11	
	Rainfall	36.1	11.9	48.0			50.0	23.4	50.0	39.9	56.9	19.3	22.1	56.9
1951	Date	25	3			28	23	23	23	9	-	18	17/27	
	Rainfall	9.1	6.4			53.3	97.3	26.4	40.6	21.1		2.8	2.0	97.3
1952	Date	13	27	7	27	12	7	19	-	30	8	27	11	
	Rainfall	10.4	17.0	6.1	34.5	15.2	42.4	57.4		48.3	31.0	23.9	45.2	57.4
1953	Date	24	18	27	22	27	23	26/27	15	25	30	9	31	
	Rainfall	53.3	13.0	12.7	3.3	61.0	48.3	26.7	12.7	24.6	88.9	61.0	31.8	88.9
1954	Date	7	18	4	22	12	14	18	15	27	3	3	15	
	Rainfall	32.0	10.4	25.7	23.9	15.5	45.0	51.3	30.0	148.6	55.4	61.7	17.5	148.6
1955	Date	31	15	28	16	31	21	3	30	2	31	10	16	
	Rainfall	33.0	13.5	2.5	2.5	1.3	10.9	25.7	39.6	56.4	51.6	56.4	68.1	68.1
1956	Date	4	29	25	11	25	10	6	24	15	27	10	27	
	Rainfall	17.5	14.0	14.2	24.6	26.7	33.8	16.5	36.1	50.3	137.2	64.8	49.0	137.2
1957	Date	18	11	26	15	7	21	29	15	11	25	9	9	
	Rainfall	23.6	10.7	71.9	1.8	45.7	34.3	49.8	52.3	38.6	37.8	22.4	36.1	71.9
1958	Date	4/16	3	15	13	16	12	11	10	27	20	3	21	
	Rainfall	10.7	7.6	70.4	3.3	33.8	80.5	37.1	48.8	36.1	43.7	28.4	16.5	80.5
1959	Date	16	2	9	15	31	20	19	6	22	25	28	24	
	Rainfall	12.7	4.8	18.8	31.5	17.8	58.2	13.5	32.8	34.3	62.0	28.4	36.3	62.0
1960	Date	8	26	5	11	23	9	9	28	10	23	25	13	
	Rainfall	13.0	22.6	29.5	41.9	16.0	77.7	31.0	48.0	36.8	31.2	55.4	35.1	77.7
1961	Date	17	4	9	20	25	18	23	14	4	16	5	30	
	Rainfall	56.9	29.2	21.6	9.9	11.7	16.3	102.9	17.5	29.5	34.3	28.4	14.7	102.9
1962	Date	17	12	6	17	2	11	5	14	27	4	25	30	
	Rainfall	24.9	12.2	51.3	49.0	14.0	52.3	18.5	12.4	39.1	94.7	23.1	15.0	94.7
1963	Date	31	20	23	15	20	12	28	17	24	11	2	17	
	Rainfall	8.9	81.5	42.7	3.0	9.1	33.5	20.6	47.0	66.8	23.4	30.2	21.6	81.5
1964	Date	10	29	31	17	31	6	29	13	13	20	7	7	
	Rainfall	16.5	25.9	2.0	15.0	30.5	47.2	17.3	14.7	41.1	37.3	38.1	143.3	143.3
1965	Date	-	25	5	29	1	10	17	15	21	30	5	9	
	Rainfall		17.5	8.1	9.4	31.8	48.8	42.2	13.2	12.7	120.4	39.9	43.9	120.4
1966	Date	26	4	14	10	30	4	6	17	30	25	20	11	
	Rainfall	15.5	75.4	29.0	18.8	26.9	80.0	21.1	40.9	20.3	54.1	34.0	25.9	80.0
1967	Date	29	24	10	4	24	19	16	30	26	19	6	23	
	Rainfall	34.3	35.3	6.4	12.2	10.7	46.0	9.1	39.4	36.3	75.4	51.8	61.0	75.4

(unit : mm)

TABLE 3.7 (2) MONTHLY MAXIMUM ONE DAY RAINFALL AT LA MESA

		Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Max.
1968	Date	13	19	17	11	25	6	31	12	24	18	19	23	
	Rainfall	18.3	15.7	17.8	1.8	101.3	39.9	33.8	11.9	95.5	42.9	50.8	42.7	101.3
1969	Date	5	3	31		17	5	12	28	2	31	6	11	
	Rainfall	22.1	6.1	17.8		48.5	19.8	27.9	27.9	60.2	13.2	62.2	14.5	62.2
1970	Date	6	21	14	11	16	10	13	3	21	30	23	6	
	Rainfall	11.4	10.7	1.0	0.3	21.3	16.8	35.3	36.6	71.1	26.2	22.6	38.6	71.1
1971	Date	20	9	4	6	14	11	28	30	10	21	11	23	
	Rainfall	34.3	12.4	19.8	19.1	20.3	11.0	12.7	26.2	33.7	16.5	62.1	30.0	62.1
1972	Date	16	4	11	2	19	20	8/19	12	2	10	8	16	
	Rainfall	14.9	54.4	13.2	3.3	6.6	31.0	14.0	23.6	45.7	11.4	4.4	29.7	54.4
1973	Date	12	4	17	28	14	20	18	31	18	11	6	7	
	Rainfall	2.6	9.3	2.2	52.9	33.8	23.1	16.5	28.2	14.2	10.6	28.6	5.5	52.9
1974	Date	3	26	8	17	20	25	26	25/31	18	22	12	1	
	Rainfall	11.0	18.6	3.3	2.8	12.3	113.4	8.0	23.0	340.0	80.4	22.1	31.7	340.0
1975	Date	20	13/24			23	13	22	13	11	31	23	7	
	Rainfall	3.0	0.5			11.0	5.0	2.9	22.1	12.0	37.9	43.0	26.7	43.0
1976	Date	9	1	17	26	17	3	5	1	3	10	7	16	
	Rainfall	95.9	6.1	0.5	49.0	18.8	37.4	20.9	5.2	8.0	46.0	46.1	31.3	95.9
1977	Date	17	16	1	23	3	6	13	21	22	13	11	21	
	Rainfall	24.1	36.0	4.2	31.4	30.9	32.1	20.0	28.0	23.2	44.9	50.1	32.1	50.1
1978	Date	28	21	27	14	28	22	25	24	18	19	19	13	
	Rainfall	50.9	16.8	21.5	0.3	100.3	20.3	33.6	50.0	26.9	46.8	73.0	56.3	100.3
1979	Date	9	8	15	17	7	23	22	29	3	11	29	25	
	Rainfall	12.1	23.5	6.9	38.0	22.2	24.0	30.5	36.5	42.5	34.6	83.2	50.6	83.2
1980	Date	4	3	15	17	22	15	27	3	13	5	5	13	
	Rainfall	10.8	14.3	1.4	93.0	39.4	34.8	21.5	18.2	96.4	78.7	44.2	25.0	96.4
1981	Date	10	14	17	18	4	1	12	17	9	18	2	5	
	Rainfall	13.8	56.2	16.4	6.3	16.9	37.2	38.8	43.1	35.4	102.6	28.4	62.8	102.6
1982	Date	11	26	1	30	28	13	4	28	14	4	2	2	
	Rainfall	36.9	33.8	28.6	28.1	12.8	42.0	32.7	19.8	44.0	65.1	43.7	47.4	65.1
1983	Date	11	26	11	16	29	14	31	26	15	25	16	25	
	Rainfall	30.6	3.8	10.3	44.5	13.5	31.3	11.1	27.4	21.2	7.5	61.8	65.6	65.6
1984	Date	15	5	20	5	30	15	29	25	10	26	21	7	
	Rainfall	35.4	24.2	24.7	2.1	14.7	57.5	51.9	33.9	28.6	27.8	33.2	46.0	57.5
1985	Date	22	12	6	2	6	13	4	17	22	16	23	25	
	Rainfall	22.5	12.6	5.8	41.2	46.2	40.0	35.4	37.7	20.0	13.6	12.2	14.8	46.2
1986	Date	19	13	21	21	25	7	19	22	11	28	14	6	
	Rainfall	28.3	3.6	18.9	1.8	17.6	17.8	40.3	17.3	41.2	50.6	10.5	23.2	50.6
1987	Date	11	7	4	27		9	10	25	1	29	11	30	
	Rainfall	36.9	7.8	21.8	1.7		23.5	31.4	32.9	31.0	22.6	69.3	50.5	69.3
1988	Date	11	21	15	11	30	20	29	24	29	12	22	2	
	Rainfall	34.4	39.8	20.7	14.0	67.6	69.6	48.0	65.5	38.1	54.1	14.6	146.0	146.0
1989	Date	21	22	7	18	12	19	23	20	11	11	30	13	
	Rainfall	26.4	19.5	3.3	4.8	30.4	17.4	46.7	20.3	55.0	53.8	31.2	43.7	55.0
1990	Date	25	12	20	27	23	17	30	11	27	25	29	4	
	Rainfall	23.9	31.8	32.4	25.6	14.2	20.0	13.5	15.0	36.4	34.4	104.5	46.9	104.5
1991	Date	7	15	10	1	26	9	4	6	20	19	25	14	
	Rainfall	18.1	6.5	37.2	1.2	17.0	154.4	14.2	26.3	20.4	19.4	37.5	20.3	154.4

(unit : mm)

TABLE 3.8 MONTHLY MAXIMUM ONE DAY RAINFALL AT PUERTO CORTES

		Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Max.
1945	Date	-	3	22		25	20	2	31	28	-	-	-	
	Rainfall		12.7	3.6		66.0	43.4	63.0	154.9	160.5				160.5
1946	Date	25	5	5	28	5	11	18	21	2	30	28	5	
	Rainfall	86.4	21.6	21.6	11.4	8.4	54.9	21.3	35.8	18.0	154.2	180.8	121.9	180.8
1947	Date	24	26	17	17	9	13	-	-	13	21	28	23	
	Rainfall	38.1	76.2	70.4	48.3	24.1	34.8			42.7	80.0	85.1	123.2	123.2
1948	Date	31	3	12	18	21	25	8	19	17	20	12	30	
	Rainfall	120.9	64.8	23.1	28.2	35.1	76.2	31.2	48.5	41.9	97.8	94.7	100.3	120.9
1949	Date	12	2	1	6	23	20	30	31	6	15	1	25	
	Rainfall	47.8	5.3	12.7	22.4	16.3	17.0	40.9	41.9	22.9	15.2	70.9	153.2	153.2
1950	Date	22	17	31	7	8	9	11	12	22	25	-	-	
	Rainfall	30.0	44.2	17.8	25.1	1.0	56.9	73.2	37.3	36.8	163.1	43.9	34.0	163.1
1962	Date	-	-	17	-	6	-	17	2	21	3	11	14	
	Rainfall			17.0		18.5		41.9	48.3	178.8	154.9	152.4	118.4	178.8
1963	Date	21	14	23	4	30	24	14	16	24	5	18	17	
	Rainfall	33.0	70.1	118.6	24.1	36.3	29.0	16.0	55.6	40.6	77.2	214.9	103.4	214.9
1964	Date	10	28	-	16	15	21	20	22	16	20	8	1	
	Rainfall	40.6		69.9	5.1	7.9	51.1	37.1	52.1	38.1	85.1	76.2	150.6	150.6
1965	Date	17	25	4	30	2	9	13	30	14	30	6	8	
	Rainfall	125.0	80.0	31.8	30.5	15.2	64.0	57.7	30.7	31.8	143.5	136.7	83.3	143.5
1966	Date	6	4	30	6	10	4	8	1	9	29	-	-	
	Rainfall	171.2	157.7	71.9	17.3	27.7	207.0	74.9	22.9	34.8	175.3			207.0
1967	Date	29	12	31	5	23	21	24	20	9	9	5	23	
	Rainfall	101.6	71.1	34.3	100.1	71.1	51.1	34.3	63.2	73.4	80.0	83.8	43.2	101.6
1968	Date	16	5	22	6	5	20	5	12	24	24	19	7	
	Rainfall	22.4	74.4	44.5	14.7	127.0	25.4	50.8	119.9	34.3	130.8	127.0	139.7	139.7
1969	Date	19	4	3	2	28	28	19	26	2	24	19	12	
	Rainfall	82.6	53.3	127.3	7.9	81.3	81.3	20.1	29.2	144.8	92.7	157.7	88.9	157.7
1970	Date	9	1	13	3	16	8	11	22	7	20	14	5	
	Rainfall	74.9	34.3	16.8	24.6	50.8	62.0	35.3	12.7	97.0	33.3	81.3	46.2	97.0
1971	Date	16	9	4	3	15	5	5	29	11	13	20	12	
	Rainfall	49.5	66.0	43.2	24.6	18.8	50.8	13.0	50.8	50.8	50.8	102.6	88.9	102.6
1972	Date	17	3	10	2	31	11	19	15	27	3	8	17	
	Rainfall	59.7	114.8	25.9	26.7	59.7	74.9	33.3	39.6	45.7	62.0	33.5	123.2	123.2
1973	Date	28	4	3	-	28	-	-	8/9	2	25	29	7	
	Rainfall	24.6	50.8	45.0		81.3			40.1	49.5	43.4	48.3	113.5	113.5
1974	Date	8	28	13	5	22	28	9	31	18	10	12	17	
	Rainfall	12.7	52.1	19.3	7.1	71.6	43.2	55.9	45.2	283.2	136.7	59.7	87.9	283.2
1975	Date	27	13		4	13	28	1	17	29	28	23	26	
	Rainfall	39.1	11.2		1.0	25.7	46.2	41.9	35.3	46.0	107.2	103.4	91.2	107.2
1976	Date	9	23	5	25	18	4	23	6	12	20	23	23	
	Rainfall	131.3	44.7	4.3	94.0	49.8	78.7	88.9	27.2	33.0	165.9	231.1	101.6	231.1
1977	Date	18	16	23	23	31	1	2	7	17	14	25	21	
	Rainfall	40.6	68.8	36.6	50.8	78.2	58.4	37.1	21.1	17.8	83.1	62.2	132.1	132.1
1978	Date	29	4	4	14	19	16	20	6	4	31	19	11	
	Rainfall	113.0	53.8	108.0	6.4	43.2	20.3	26.4	43.7	41.9	58.9	152.4	209.8	209.8
1979	Date	2	11	26	15	27	30	22	7	24	2	29	25	
	Rainfall	120.9	148.6	24.1	28.4	165.6	51.8	37.3	83.8	50.8	83.3	229.9	95.3	229.9
1980	Date	23	3	2	-	-	-	-	-	-	-	-	-	
	Rainfall	115.8	57.2	6.3										115.8

(unit : mm)

TABLE 3.9 (1) MONTHLY MAXIMUM 6 HOURS RAINFALL AT LA MESA

		Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Max.
1956	Date	4	29	25	26	25	10	6	24	15	27	10	27	
	Rainfall	8.9	14.0	10.9	16.0	26.7	33.8	16.3	36.1	48.8	66.0	35.6	22.9	66.0
1957	Date	11	11	26	15	7	21	29	15	11	25	9	9	
	Rainfall	18.8	10.7	27.7	1.8	45.2	26.2	49.8	50.3	38.6	36.8	22.4	32.5	50.3
1958	Date	29	3	15	13	16	12	11	10	27	20	3	21	
	Rainfall	9.1	5.1	66.0	3.3	33.5	80.5	36.3	47.2	36.1	42.7	28.4	6.4	80.5
1959	Date	16	2	9	15	31	20	19	6	22	25	6	24	
	Rainfall	12.7	4.8	17.8	27.9	17.0	58.2	12.7	30.7	33.0	38.9	23.1	30.5	58.2
1960	Date	9	26	5	11	23	9	9	28	10	24	25	13	
	Rainfall	6.6	22.6	13.7	17.0	16.0	52.8	29.7	45.5	36.8	17.8	44.5	17.8	52.8
1961	Date	17	4	9	2	25	18	23	14	4	16	5	3	
	Rainfall	23.6	25.1	21.6	6.4	7.1	16.3	40.6	15.7	22.4	26.2	27.7	9.4	40.6
1962	Date	23	12	6	16	2	11	5	14	27	4	25	30	
	Rainfall	11.2	8.9	50.0	30.5	14.0	35.6	18.5	12.4	20.8	64.3	17.5	7.6	64.3
1963	Date	31	20	23	15	23	12	28	17	24	11	2	17	
	Rainfall	6.6	28.2	25.7	3.0	9.1	33.5	20.3	45.7	66.8	22.9	23.6	20.3	66.8
1964	Date	10	29	31	17	31	6	29	10/13	22	21	7	7	
	Rainfall	15.0	15.0	1.3	12.7	30.5	47.2	15.0	13.5	32.3	20.6	33.0	53.3	53.3
1965	Date	14	25	5	29	1	10	17	17	21/25	30	5	9	
	Rainfall	10.2	8.4	3.8	9.4	14.7	48.3	37.8	8.9	10.7	82.8	24.9	16.8	82.8
1966	Date	26	4	14	10	30	5	6	17	30	25	29	11	
	Rainfall	10.4	35.6	25.7	18.8	26.9	44.7	21.1	38.4	20.3	51.6	15.2	22.4	51.6
1967	Date	20	12	10	4	24	17	2	30	26	19	10	23	
	Rainfall	22.1	24.9	6.4	12.2	8.9	51.8	7.4	31.0	35.8	66.0	46.5	35.6	66.0
1968	Date	14	19	17	11	25	6	31	25	24	18	30	24	
	Rainfall	10.7	15.2	15.0	1.8	98.6	30.7	33.8	8.6	84.8	37.8	25.1	23.9	98.6
1969	Date	5	3	4	1	17	5	12	28	15	4	20	11	
	Rainfall	20.8	5.8	10.2	7.6	48.5	19.8	27.9	27.9	34.8	3.0	33.0	12.4	48.5
1970	Date	7	22	14	11	17	10	13	3	21	30	28	6	
	Rainfall	11.4	5.8	1.0		15.0	16.8	33.0	29.0	71.1	24.9	20.6	20.3	71.1
1971	Date	20	9	5	6	15	10	28	31	10	14	11	23	
	Rainfall	19.6	5.8	19.8	8.9	20.3	10.2	12.7	26.2	21.3	11.4	25.4	26.2	26.2
1972	Date	17	4	11	2	20	20	8/19	12	2	10	30	16	
	Rainfall	14.7	21.1	12.7	3.3	6.6	31.0	14.0	23.6	45.7	11.4	3.8	13.5	45.7
1973	Date	12	28	1	28	15	20	19	31	17	17	6	8	
	Rainfall	3.0	3.3	2.0	26.2	33.5	21.6	16.4	19.1	11.2	10.4	27.0	5.5	33.5
1974	Date	3	26	8	6/17	21	25	26	25	19	23	12	1	
	Rainfall	11.0	12.0	3.3	2.6	11.9	110.4	8.0	21.0	140.0	80.0	22.0	23.3	140.0
1975	Date	21	24			23	13	7	13	12	31	23	7	
	Rainfall	3.0	0.5			11.0	5.0	2.0	22.1	9.1	36.0	21.2	16.4	36.0
1976	Date	9	2	17	26	17	3	25	1	3	10	7	15	
	Rainfall	46.0	6.1	0.5	37.0	18.8	30.0	18.0	5.2	8.0	36.0	22.7	26.0	46.0
1977	Date	17	16	1	24	4	18	14	27	23	13	11	21	
	Rainfall	16.0	16.1	5.0	29.0	26.7	23.2	20.0	14.7	23.2	25.3	30.0	27.5	30.0
1978	Date	28	21	5	15	28	13	25	25	19	6	20	13	
	Rainfall	32.6	12.4	15.4	0.3	80.0	18.8	33.6	30.0	20.8	23.4	34.4	50.0	80.0
1979	Date	9	19	7	18	7	23	22	29	20	5	14	25	
	Rainfall	11.8	17.0	4.3	38.0	22.2	21.3	30.3	36.5	34.0	22.0	28.1	27.8	38.0

(unit : mm)

TABLE 3.9 (2) MONTHLY MAXIMUM 6 HOURS RAINFALL AT LA MESA

		Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Max.
1980	Date	4	3	15	17	22	15	27	3	13	6	5	13	
	Rainfall	6.2	12.4	1.4	30.0	33.2	34.6	13.1	16.0	96.4	37.2	40.5	12.2	96.4
1981	Date	11	13	17	18	4	16	12	17	9	19	2	5	
	Rainfall	9.3	33.0	14.2	6.3	16.9	36.1	25.8	42.9	34.4	62.0	20.5	24.0	62.0
1982	Date	9	27	2	12	1	13	4	28	22	4	2	13	
	Rainfall	25.5	33.8	25.6	9.0	27.9	39.0	30.2	19.7	41.9	64.2	43.5	22.4	64.2
1983	Date	12	26	11	16	30	14	31	26	15	14	16	30	
	Rainfall	30.6	1.9	8.4	37.5	12.1	24.0	9.4	21.0	19.0	5.3	35.0	60.5	60.5
1984	Date	15	5	21	6	28	16	29	2/25	10	26	22	7	
	Rainfall	15.2	10.0	17.5	1.2	11.6	57.5	51.2	23.6	25.2	22.3	28.5	25.3	57.5
1985	Date	22	12	6	2	7	13	4	17	22	16	23	14	
	Rainfall	10.0	12.1	5.1	38.0	46.2	40.0	35.4	33.7	20.0	10.0	12.2	8.2	46.2
1986	Date	20	3	21	21	28	7	23	18	12	28	14	3	
	Rainfall	13.0	3.5	14.9	1.8	14.5	17.5	31.5	16.0	41.0	47.6	7.4	22.1	47.6
1987	Date	12	7	13	27		9	10	25	1	30	11	17	
	Rainfall	34.7	3.6	16.0	1.6		23.5	28.1	23.2	30.0	10.0	60.0	27.0	60.0
1988	Date	22	21	15	11	30	20	27	24	29	12	22	2	
	Rainfall	22.1	20.2	9.6	9.0	67.2	43.8	38.1	43.0	35.6	30.4	11.9	60.2	67.2
1989	Date	21	22	7	12	12	19	23	20	12	11	30	14	
	Rainfall	15.9	14.6	2.2	3.4	30.0	17.3	46.1	20.3	36.0	51.9	27.7	32.2	51.9
1990	Date	26	12	21	28	27	17	31	11	28	25	29	5	
	Rainfall	23.9	19.7	20.2	25.6	13.3	20.0	13.5	12.0	24.4	28.5	50.8	38.1	50.8
1991	Date	7	16	10	2	27	10	4	6	2	19	25	4	
	Rainfall	18.0	4.1	29.0	0.9	17.0	154.4	14.2	26.3	26.8	11.8	16.2'	15.5	154.4

(unit : mm)

TABLE 3.10 YEARLY MAXIMUM ONE HOUR AND 2 HOURS RAINFALL AT LA MESA

Year	1 hour	2 hour
1966	38.1	40.6
1967	41.9	55.9
1968	-	-
1969	35.6	36.8
1970	27.9	31.8
1971	14.0	19.1
1972	25.4	26.7
1973	22.9	26.7
1974	-	-
1975	21.2	25.0
1976	-	-
1977	-	-
1978	-	-
1979	-	-
1980	54.0	82.1
1981	31.5	36.0
1982	52.5	57.0
1983	33.0	38.0
1984	43.0	49.5
1985	46.2	46.2
1986	-	-
1987	-	-
1988	-	-
1989	-	-
1990	-	-
1991	18.9	20.0

(Unit : mm)

Note : Record sheets are partially lacked.

TABLE 3.11 RESULT OF FREQUENCY ANALYSIS
(ONE DAY RAINFALL AT LA MESA AND PUERTO CORTES)

STATION NAME: **La Mesa** 1 day Rainfall

RETURN PERIOD	IWAI METHOD	THOMAS METHOD	HAZEN METHOD	GUMBEL METHOD
2	75.4	78.4	78.4	78.8
5	107.6	110.9	108.8	124.9
10	132.1	132.9	129.1	155.5
20	157.9	154.4	148.7	184.8
30	173.8	166.9	160.0	201.6
50	194.6	182.7	174.3	222.7
70	209.0	193.2	183.8	236.5
100	224.7	204.4	193.8	251.1
150	243.2	217.3	205.3	267.6
200	256.9	226.5	213.6	279.4
500	302.9	256.5	240.2	316.7
1000	340.7	279.9	260.9	344.9

Unit : mm

STATION NAME: **Puerto Cortes** 1 day Rainfall

RETURN PERIOD	IWAI METHOD	THOMAS METHOD	HAZEN METHOD	GUMBEL METHOD
2	149.3	151.8	151.8	152.2
5	199.1	206.1	199.1	209.1
10	233.5	241.8	229.4	246.8
20	267.3	276.0	257.9	283.0
30	287.1	295.6	274.1	303.8
50	312.2	320.2	294.3	329.8
70	329.1	336.4	307.4	346.8
100	347.1	353.6	321.3	364.8
150	367.8	373.2	337.1	385.3
200	382.8	387.2	348.3	399.8
500	431.5	432.1	383.9	445.8
1000	469.8	466.7	411.0	480.7

Unit : mm

Note : To calculate the probable rainfall, 1962 - 1980 rainfall data are used.

TABLE 3.12 RESULT OF FREQUENCY ANALYSIS (6 HOURS RAINFALL AT LA MESA)

STATION NAME: **La Mesa** 6 hous Rainfall

RETURN PERIOD	IWAI METHOD	THOMAS METHOD	HAZEN METHOD	GUMBEL METHOD
2	58.4	58.7	58.7	59.1
5	81.1	82.9	81.0	86.2
10	96.6	99.2	95.9	104.2
20	111.6	115.2	110.2	121.4
30	120.4	124.5	118.5	131.3
50	131.5	136.2	128.9	143.7
70	138.9	144.0	135.8	151.8
100	146.8	152.3	143.1	160.4
150	155.9	161.9	151.4	170.1
200	162.4	168.7	157.4	177.0
500	183.5	190.9	176.7	199.0
1000	200.0	208.3	191.7	215.6

Unit : mm

TABLE 3.13 RESULT OF FREQUENCY ANALYSIS
(ONE HOUR AND 2 HOURS RAINFALL AT LA MESA)

STATION NAME: **La Mesa** 1 hour Rainfall

RETURN PERIOD	IWAI METHOD	THOMAS METHOD	HAZEN METHOD	GUMBEL METHOD
2	32.5	31.5	31.5	32.0
5	43.7	46.0	43.8	45.2
10	50.4	56.0	52.0	53.9
20	56.4	65.8	59.9	62.3
30	59.7	71.6	64.5	67.1
50	63.7	79.0	70.3	73.2
70	66.2	84.0	74.1	77.1
100	68.9	89.3	78.2	81.3
150	71.9	95.4	82.9	86.1
200	74.0	99.8	86.2	89.4
500	80.5	114.3	97.0	100.1
1000	85.3	125.7	105.4	108.2

Unit : mm

STATION NAME: **La Mesa** 2 hours rainfall

RETURN PERIOD	IWAI METHOD	THOMAS METHOD	HAZEN METHOD	GUMBEL METHOD
2	37.4	36.5	36.4	37.1
5	51.8	54.0	51.3	55.2
10	60.7	66.2	61.4	67.1
20	69.0	78.5	71.2	78.6
30	73.6	85.7	76.9	85.3
50	79.2	94.9	84.2	93.5
70	82.9	101.1	88.9	98.9
100	86.7	107.8	94.1	104.7
150	91.1	115.5	99.9	111.2
200	94.1	121.1	104.1	115.8
500	103.7	139.4	117.8	130.4
1000	111.0	153.9	128.4	141.5

Unit : mm

TABLE 3.14 CATCHMENT AREA OF SUB-BASIN

		Catchment/River	
		C.A. (sq. km)	L (km)
I	**Rio Choloma, Rio Blanco, Canal San Roque, Canal S. R.- C. and Canal C.- H.- C. Basin**		
C-1	River Mouth of the Basin	**420.15**	**48.4**
C-2	Choloma, Blanco, San Roque, Canal San Roque - Cuabanos, C-H-C Basin	**366.45**	**42.1**
	i Canal Copen-Higuero-Cuabanos	33.43	9.6
	ii Choloma, Blanco and San Roque	333.02	42.1
C-3	Rio Choloma, Rio Blanco and S.R. Basin	**297.13**	**37.4**
RC-1	Rio Choloma Basin	**106.89**	**20.7**
RC-2	i at Choloma Bridge	71.64	13.6
RC-3	ii at Jutosa (Junction of Rio La Jutosa)	55.02	9.4
C-4	Rio Blanco - Canal San Roque Basin	**190.24**	**37.4**
RB-1	Rio Blanco Basin	**137.98**	**31.0**
RB-2	i Outlet of Laguna El Carmen	107.41	22.7
RB-3	ii Inlet of Laguna El Carmen	83.72	19.2
RB-4	iii Prop. Diversion Point	71.35	15.7
RB-5	iv Rio del Zapotal and Rio de Armenta	43.90	12.2
II	**Rio El Sauce and Rio El Sauce (viejo) - Chotepe Basin**		
S-1	River Mouth of Rio El Sauce	**215.70**	**29.9**
RS-1	Rio El Sauce Basin	**118.33**	**29.7**
RS-2	i Mid. of Rio El Sauce	79.98	21.8
RS-3	ii Jct. of Prop. Diversion	75.33	18.1
RS-4	iii Rio Santa Ana and Rio Piedras	72.16	15.4
RSB-1	iv Rio Santa Ana Basin (at National Road)	37.63	13.4
RSP-1	v Rio Piedras Basin (at National Road)	30.87	12.6
RSV-1	Rio El Sauce (viejo) - Chotepe Basin	**97.37**	**22.9**

Note: Retention effect of Laguna El Carmen is not considered in this calculation

C.A. : Catchment Area of the Basin (sq. km) L : Maximum River Length of the Basin (km)
S.R. : Canal San Roque S.R.-C : Canal San Roque Cuabanos
C-H-C : Canal Copen-Higuero-Cuabanos

TABLE 3.15 RESULT OF RUN-OFF SIMULATION BY UNIT HYDROGRAPH METHOD (100-YEAR RETURN PERIOD)

		Catchment/River		Peak Discharge (qu. m / sec.)		
		C.A.	L	Rainfall Pattern		
		(sq. km)	(km)	A	B	C
I	**Rio Choloma, Rio Blanco, Canal San Roque, Canal S.R.-C and Canal C-H-C Basin**					
C-1	River Mouth of the Basin	**420.15**	**48.4**	**1023.6**	**1,793.4**	**2,285.9**
C-2	Choloma, Blanco, S.R. ,S.R.-C ,C-H-C Basin	**366.45**	**42.1**	**896.0**	**1,612.4**	**2,114.5**
	i Canal Copen-Higuero-Cuabanos	33.43	9.6	126.3	303.1	387.3
	ii Choloma, Blanco and San Roque	333.02	42.1	822.5	1,487.4	1,949.6
C-3	Rio Choloma, Rio Blanco and S.R. Basin	**297.13**	**37.4**	**764.7**	**1,394.5**	**1,826.7**
RC-1	Rio Choloma Basin	**106.89**	**20.7**	**330.2**	**678.3**	**888.3**
RC-2	i at Choloma Bridge	71.64	13.6	250.1	543.5	688.1
RC-3	ii at Jutosa (Junction of Rio La Jutosa)	55.02	9.4	198.6	458.1	596.7
C-4	Rio Blanco - Canal San Roque Basin	**190.24**	**37.4**	**517.1**	**964.6**	**1,250.1**
RB-1	Rio Blanco Basin	**137.98**	**31.0**	**383.1**	**741.9**	**998.7**
RB-2	i Outlet of Laguna El Carmen	107.41	22.7	325.9	663.4	872.4
RB-3	ii Inlet of Laguna El Carmen	83.72	19.2	270.1	568.1	733.9
RB-4	iii Prop. Diversion Point	71.35	15.7	244.9	527.2	671.2
RB-5	iv Rio del Zapotal and Rio de Armenta	43.90	12.2	165.4	375.3	463.7
II	**Rio El Sauce and Rio El Sauce (viejo) - Chotepe Basin**					
S-1	River Mouth of Rio El Sauce	**215.70**	**29.9**	**575.0**	**1,087.7**	**1,474.7**
RS-1	Rio El Sauce Basin	**118.33**	**29.7**	**336.8**	**663.3**	**885.7**
RS-2	i Mid. of Rio El Sauce	79.98	21.8	252.3	528.1	684.6
RS-3	ii Jct. of Prop. Diversion	75.33	18.1	249.4	530.0	680.2
RS-4	iii Rio Santa Ana and Rio Piedras	72.16	15.4	248.3	534.8	680.7
RSB-1	iv Rio Santa Ana Basin (at National Road)	37.63	13.4	141.4	322.4	397.4
RSP-1	v Rio Piedras Basin (at National Road)	30.87	12.6	119.8	278.7	339.8
RSV-1	Rio El Sauce (viejo) - Chotepe Basin	**97.37**	**22.9**	**297.6**	**611.1**	**800.5**

Note: Retention effect of Laguna El Carmen is not considered in this calculation

C.A. : Catchment Area of the Basin (sq. km) L : Maximum River Length of the Basin (km)
S.R. : Canal San Roque S.R.-C : Canal San Roque Cuabanos
C-H-C : Canal Copen-Higuero-Cuabanos

Rainfall Pattern

A : Maximum intensity of rainfall occures at the beginning of the rain.
B : Maximum intensity of rainfall occures at the midlle of the rain.
C : Maximum intensity of rainfall occures at the end of the rain.

Runoff(100)

TABLE 3.16 RESULT OF RUN-OFF SIMULATION BY UNIT HYDROGRAPH METHOD (50-YEAR RETURN PERIOD)

		Catchment/River		Peak Discharge (qu. m / sec.)		
		C.A. (sq. km)	L (km)	Pattern A	Pattern B	Pattern C
I	**Rio Choloma, Rio Blanco, Canal San Roque, Canal S.R.-C and Canal C-H-C Basin**					
C-1	River Mouth of the Basin	**420.15**	**48.4**	**851.9**	**1,514.6**	**2,010.9**
C-2	Choloma, Blanco, S.R. ,S.R.-C ,C-H-C Basin	**366.45**	**42.1**	**744.6**	**1,360.5**	**1,862.1**
	i Canal Copen-Higuero-Cuabanos	33.43	9.6	100.3	252.4	345.6
	ii Choloma, Blanco and San Roque	333.02	42.1	683.9	1,255.3	1,717.6
C-3	Rio Choloma, Rio Blanco and S.R. Basin	**297.13**	**37.4**	**634.3**	**1,177.5**	**1,610.7**
RC-1	Rio Choloma Basin	**106.89**	**20.7**	**271.3**	**564.8**	**787.7**
RC-2	i at Choloma Bridge	71.64	13.6	202.6	453.2	611.9
RC-3	ii at Jutosa (Junction of Rio La Jutosa)	55.02	9.4	159.6	381.2	531.6
C-4	Rio Blanco - Canal San Roque Basin	**190.24**	**37.4**	**424.7**	**806.7**	**1,104.1**
RB-1	Rio Blanco Basin	**137.98**	**31.0**	**313.6**	**620.6**	**883.7**
RB-2	i Outlet of Laguna El Carmen	107.41	22.7	267.6	552.3	773.4
RB-3	ii Inlet of Laguna El Carmen	83.72	19.2	220.8	473.3	651.5
RB-4	iii Prop. Diversion Point	71.35	15.7	198.8	439.5	596.6
RB-5	iv Rio del Zapotal and Rio de Armenta	43.90	12.2	132.4	313.3	413.1
II	**Rio El Sauce and Rio El Sauce (viejo) - Chotepe Basin**					
S-1	River Mouth of Rio El Sauce	**215.70**	**29.9**	**472.7**	**918.0**	**1,302.9**
RS-1	Rio El Sauce Basin	**118.33**	**29.7**	**276.0**	**551.9**	**784.2**
RS-2	i Mid. of Rio El Sauce	79.98	21.8	206.7	439.9	607.6
RS-3	ii Jct. of Prop. Diversion	75.33	18.1	203.2	441.7	604.2
RS-4	iii Rio Santa Ana and Rio Piedras	72.16	15.4	201.6	445.8	605.0
RSB-1	iv Rio Santa Ana Basin (at National Road)	37.63	13.4	113.0	269.2	354.1
RSP-1	v Rio Piedras Basin (at National Road)	30.87	12.6	95.8	232.8	303.0
RSV-1	Rio El Sauce (viejo) - Chotepe Basin	**97.37**	**22.9**	**244.6**	**508.8**	**709.9**

Note: Retention effect of Laguna El Carmen is not considered in this calculation

C.A. : Catchment Area of the Basin (sq. km) L : Maximum River Length of the Basin (km)
S.R. : Canal San Roque S.R.-C : Canal San Roque Cuabanos
C-H-C : Canal Copen-Higuero-Cuabanos

Rainfall Pattern

A : Maximum intensity of rainfall occures at the beginning of the rain.
B : Maximum intensity of rainfall occures at the midlle of the rain.
C : Maximum intensity of rainfall occures at the end of the rain.

RUNOFF(1/50)

TABLE 3.17 RESULT OF RUN-OFF SIMULATION BY UNIT HYDROGRAPH METHOD (30-YEAR RETURN PERIOD)

		Catchment/River		Peak Discharge (qu. m / sec.)		
		C.A.	L	Pattern		
		(sq. km)	(km)	A	B	C
I	**Rio Choloma, Rio Blanco, Canal San Roque, Canal S.R.-C and Canal C-H-C Basin**					
C-1	River Mouth of the Basin	**420.15**	**48.4**	**724.7**	**1,305.3**	**1,800.9**
C-2	Choloma, Blanco, S.R. ,S.R.-C ,C-H-C Basin	**366.45**	**42.1**	**631.6**	**1,171.2**	**1,669.5**
	i Canal Copen-Higuero-Cuabanos	33.43	9.6	83.7	213.5	313.9
	ii Choloma, Blanco and San Roque	333.02	42.1	579.1	1,080.8	1,540.5
C-3	Rio Choloma, Rio Blanco and S.R. Basin	**297.13**	**37.4**	**536.7**	**1,014.2**	**1,445.8**
RC-1	Rio Choloma Basin	**106.89**	**20.7**	**227.3**	**478.4**	**711.2**
RC-2	i at Choloma Bridge	71.64	13.6	168.7	384.2	553.9
RC-3	ii at Jutosa (Junction of Rio La Jutosa)	55.02	9.4	132.8	322.3	482.2
C-4	Rio Blanco - Canal San Roque Basin	**190.24**	**37.4**	**360.2**	**695.4**	**992.8**
RB-1	Rio Blanco Basin	**137.98**	**31.0**	**265.0**	**534.5**	**796.0**
RB-2	i Outlet of Laguna El Carmen	107.41	22.7	224.5	467.8	698.0
RB-3	ii Inlet of Laguna El Carmen	83.72	19.2	184.1	401.0	588.9
RB-4	iii Prop. Diversion Point	71.35	15.7	165.5	372.5	539.8
RB-5	iv Rio del Zapotal and Rio de Armenta	43.90	12.2	110.7	265.8	374.6
II	**Rio El Sauce and Rio El Sauce (viejo) - Chotepe Basin**					
S-1	River Mouth of Rio El Sauce	**215.70**	**29.9**	**399.7**	**790.2**	**1,172.0**
RS-1	Rio El Sauce Basin	**118.33**	**29.7**	**232.6**	**473.5**	**706.9**
RS-2	i Mid. of Rio El Sauce	79.98	21.8	172.6	372.7	549.0
RS-3	ii Jct. of Prop. Diversion	75.33	18.1	169.0	374.3	546.3
RS-4	iii Rio Santa Ana and Rio Piedras	72.16	15.4	167.8	377.9	547.5
RSB-1	iv Rio Santa Ana Basin (at National Road)	37.63	13.4	94.5	228.4	321.2
RSP-1	v Rio Piedras Basin (at National Road)	30.87	12.6	79.8	197.5	275.1
RSV-1	Rio El Sauce (viejo) - Chotepe Basin	**97.37**	**22.9**	**204.9**	**430.9**	**640.9**

Note: Retention effect of Laguna El Carmen is not considered in this calculation

C.A. : Catchment Area of the Basin (sq. km) L : Maximum River Length of the Basin (km)
S.R. : Canal San Roque S.R.-C : Canal San Roque Cuabanos
C-H-C : Canal Copen-Higuero-Cuabanos

Rainfall Pattern

A : Maximum intensity of rainfall occures at the beginning of the rain.
B : Maximum intensity of rainfall occures at the midlle of the rain.
C : Maximum intensity of rainfall occures at the end of the rain.

RUNOFF(1/30)

TABLE 3.18 RESULT OF RUN-OFF SIMULATION BY UNIT HYDROGRAPH METHOD (10-YEAR RETURN PERIOD)

		Catchment/River		Peak Discharge (qu. m / sec.)		
		C.A.	L	Pattern		
		(sq. km)	(km)	A	B	C
I	**Rio Choloma, Rio Blanco, Canal San Roque, Canal S.R.-C and Canal C-H-C Basin**					
C-1	River Mouth of the Basin	**420.15**	**48.4**	**454.5**	**836.1**	**1,304.4**
C-2	Choloma, Blanco, S.R. ,S.R.-C ,C-H-C Basin	**366.45**	**42.1**	**394.6**	**746.4**	**1,213.0**
	i Canal Copen-Higuero-Cuabanos	33.43	9.6	46.5	124.1	238.9
	ii Choloma, Blanco and San Roque	333.02	42.1	361.3	689.1	1,120.5
C-3	Rio Choloma, Rio Blanco and S.R. Basin	**297.13**	**37.4**	**333.3**	**647.4**	**1,054.5**
RC-1	Rio Choloma Basin	**106.89**	**20.7**	**135.2**	**302.7**	**528.9**
RC-2	i at Choloma Bridge	71.64	13.6	97.9	232.6	416.0
RC-3	ii at Jutosa (Junction of Rio La Jutosa)	55.02	9.4	75.2	190.8	364.9
C-4	Rio Blanco - Canal San Roque Basin	**190.24**	**37.4**	**221.1**	**445.0**	**727.8**
RB-1	Rio Blanco Basin	**137.98**	**31.0**	**160.8**	**340.6**	**587.2**
RB-2	i Outlet of Laguna El Carmen	107.41	22.7	133.8	297.4	518.4
RB-3	ii Inlet of Laguna El Carmen	83.72	19.2	108.8	249.6	439.6
RB-4	iii Prop. Diversion Point	71.35	15.7	96.6	227.3	404.7
RB-5	iv Rio del Zapotal and Rio de Armenta	43.90	12.2	62.6	157.1	283.4
II	**Rio El Sauce and Rio El Sauce (viejo) - Chotepe Basin**					
S-1	River Mouth of Rio El Sauce	**215.70**	**29.9**	**245.6**	**502.3**	**860.2**
RS-1	Rio El Sauce Basin	**118.33**	**29.7**	**140.2**	**302.1**	**522.7**
RS-2	i Mid. of Rio El Sauce	79.98	21.8	102.2	233.0	409.5
RS-3	ii Jct. of Prop. Diversion	75.33	18.1	99.5	230.9	408.7
RS-4	iii Rio Santa Ana and Rio Piedras	72.16	15.4	97.9	230.5	410.5
RSB-1	iv Rio Santa Ana Basin (at National Road)	37.63	13.4	53.3	135.0	243.1
RSP-1	v Rio Piedras Basin (at National Road)	30.87	12.6	44.5	116.8	208.9
RSV-1	Rio El Sauce (viejo) - Chotepe Basin	**97.37**	**22.9**	**121.9**	**272.8**	**476.5**

Note: Retention effect of Laguna El Carmen is not considered in this calculation

C.A. : Catchment Area of the Basin (sq. km) L : Maximum River Length of the Basin (km)

S.R. : Canal San Roque S.R.-C : Canal San Roque Cuabanos

C-H-C : Canal Copen-Higuero-Cuabanos

Rainfall Pattern

A : Maximum intensity of rainfall occures at the beginning of the rain.

B : Maximum intensity of rainfall occures at the midlle of the rain.

C : Maximum intensity of rainfall occures at the end of the rain.

RUNOFF(1/10)

TABLE 3.19 RESULT OF RUN-OFF SIMULATION BY UNIT HYDROGRAPH METHOD (5-YEAR RETURN PERIOD)

		Catchment/River		Peak Discharge (qu. m / sec.)		
		C.A.	L	Pattern		
		(sq. km)	(km)	A	B	C
I	**Rio Choloma, Rio Blanco, Canal San Roque, Canal S.R.-C and Canal C-H-C Basin**					
C-1	River Mouth of the Basin	**420.15**	**48.4**	**284.4**	**505.7**	**916.1**
C-2	Choloma, Blanco, S.R. ,S.R.-C ,C-H-C Basin	**366.45**	**42.1**	**244.9**	**447.3**	**853.6**
	i Canal Copen-Higuero-Cuabanos	33.43	9.6	26.4	74.0	173.8
	ii Choloma, Blanco and San Roque	333.02	42.1	223.6	412.6	789.1
C-3	Rio Choloma, Rio Blanco and S.R. Basin	**297.13**	**37.4**	**204.5**	**387.7**	**743.9**
RC-1	Rio Choloma Basin	**106.89**	**20.7**	**78.7**	**179.8**	**378.0**
RC-2	i at Choloma Bridge	71.64	13.6	55.7	138.2	299.5
RC-3	ii at Jutosa (Junction of Rio La Jutosa)	55.02	9.4	42.7	112.6	264.2
C-4	Rio Blanco - Canal San Roque Basin	**190.24**	**37.4**	**133.6**	**266.6**	**515.3**
RB-1	Rio Blanco Basin	**137.98**	**31.0**	**95.7**	**202.4**	**417.4**
RB-2	i Outlet of Laguna El Carmen	107.41	22.7	78.2	176.7	370.3
RB-3	ii Inlet of Laguna El Carmen	83.72	19.2	62.6	148.3	315.2
RB-4	iii Prop. Diversion Point	71.35	15.7	55.0	135.1	291.0
RB-5	iv Rio del Zapotal and Rio de Armenta	43.90	12.2	35.6	93.5	205.0
II	**Rio El Sauce and Rio El Sauce (viejo) - Chotepe Basin**					
S-1	River Mouth of Rio El Sauce	**215.70**	**29.9**	**148.1**	**298.3**	**609.5**
RS-1	Rio El Sauce Basin	**118.33**	**29.7**	**82.9**	**179.5**	**372.1**
RS-2	i Mid. of Rio El Sauce	79.98	21.8	59.0	138.4	293.3
RS-3	ii Jct. of Prop. Diversion	75.33	18.1	56.9	137.2	293.4
RS-4	iii Rio Santa Ana and Rio Piedras	72.16	15.4	55.7	137.0	295.2
RSB-1	iv Rio Santa Ana Basin (at National Road)	37.63	13.4	30.4	80.3	176.1
RSP-1	v Rio Piedras Basin (at National Road)	30.87	12.6	25.4	69.5	151.7
RSV-1	Rio El Sauce (viejo) - Chotepe Basin	**97.37**	**22.9**	**71.0**	**162.1**	**340.6**

Note: Retention effect of Laguna El Carmen is not considered in this calculation
C.A. : Catchment Area of the Basin (sq. km) L : Maximum River Length of the Basin (km)
S.R. : Canal San Roque S.R.-C : Canal San Roque Cuabanos
C-H-C : Canal Copen-Higuero-Cuabanos

Rainfall Pattern
A : Maximum intensity of rainfall occures at the beginning of the rain.
B : Maximum intensity of rainfall occures at the midlle of the rain.
C : Maximum intensity of rainfall occures at the end of the rain.

TABLE 3.20 RESULT OF RUN-OFF SIMULATION BY UNIT HYDROGRAPH METHOD (2-YEAR RETURN PERIOD)

		Catchment/River		Peak Discharge (qu. m / sec.)		
		C.A.	L	Pattern		
		(sq. km)	(km)	A	B	C
I	**Rio Choloma, Rio Blanco, Canal San Roque, Canal S.R.-C and Canal C-H-C Basin**					
C-1	River Mouth of the Basin	**420.15**	**48.4**	**95.2**	**177.5**	**338.7**
C-2	Choloma, Blanco, S.R. ,S.R.-C ,C-H-C Basin	**366.45**	**42.1**	**81.8**	**157.7**	**316.0**
	i Canal Copen-Higuero-Cuabanos	33.43	9.6	9.2	28.1	65.8
	ii Choloma, Blanco and San Roque	333.02	42.1	74.6	145.6	292.3
C-3	Rio Choloma, Rio Blanco and S.R. Basin	**297.13**	**37.4**	**68.2**	**136.7**	**275.9**
RC-1	Rio Choloma Basin	**106.89**	**20.7**	**26.7**	**63.5**	**141.5**
RC-2	i at Choloma Bridge	71.64	13.6	19.2	50.5	112.7
RC-3	ii at Jutosa (Junction of Rio La Jutosa)	55.02	9.4	14.8	42.3	99.8
C-4	Rio Blanco - Canal San Roque Basin	**190.24**	**37.4**	**44.6**	**93.9**	**191.5**
RB-1	Rio Blanco Basin	**137.98**	**31.0**	**32.0**	**71.6**	**155.6**
RB-2	i Outlet of Laguna El Carmen	107.41	22.7	26.4	62.4	138.5
RB-3	ii Inlet of Laguna El Carmen	83.72	19.2	21.4	52.6	118.2
RB-4	iii Prop. Diversion Point	71.35	15.7	18.9	48.9	109.4
RB-5	iv Rio del Zapotal and Rio de Armenta	43.90	12.2	12.3	35.0	77.4
II	**Rio El Sauce and Rio El Sauce (viejo) - Chotepe Basin**					
S-1	River Mouth of Rio El Sauce	**215.70**	**29.9**	**49.4**	**105.6**	**226.7**
RS-1	Rio El Sauce Basin	**118.33**	**29.7**	**27.8**	**63.4**	**138.9**
RS-2	i Mid. of Rio El Sauce	79.98	21.8	20.1	48.9	109.9
RS-3	ii Jct. of Prop. Diversion	75.33	18.1	19.5	49.1	110.1
RS-4	iii Rio Santa Ana and Rio Piedras	72.16	15.4	19.2	49.7	110.9
RSB-1	iv Rio Santa Ana Basin (at National Road)	37.63	13.4	10.5	30.1	66.5
RSP-1	v Rio Piedras Basin (at National Road)	30.87	12.6	8.8	26.1	57.4
RSV-1	Rio El Sauce (viejo) - Chotepe Basin	**97.37**	**22.9**	**24.1**	**57.2**	**127.5**

Note: Retention effect of Laguna El Carmen is not considered in this calculation

C.A. : Catchment Area of the Basin (sq. km) L : Maximum River Length of the Basin (km)
S.R. : Canal San Roque S.R.-C : Canal San Roque Cuabanos
C-H-C : Canal Copen-Higuero-Cuabanos

Rainfall Pattern

A : Maximum intensity of rainfall occures at the beginning of the rain.
B : Maximum intensity of rainfall occures at the midlle of the rain.
C : Maximum intensity of rainfall occures at the end of the rain.

RUNOFF(1/2)

TABLE 3.21 PROBABLE FLOOD PEAK DISCHARGE OF RAINFALL PATTERN C (PRESENT RIVER SYSTEM)

		Catchment/River		Peak Discharge (qu. m / sec.)					
		C.A.	L	Return Period					
		(sq. km)	(km)	2-year	5-year	10-year	30-year	50-year	100-year
I	**Rio Choloma, Rio Blanco, Canal San Roque, Canal San Roque-Cuabanos and Canal Copen-Higuero-Cuabanos Basin**								
C-1	River Mouth of the Basin	**420.15**	**48.4**	**338.7**	**916.1**	**1,304.1**	**1,800.9**	**2,010.9**	**2,285.9**
C-2	Choloma, Blanco, S.R. ,S.R.-C ,C-H-C Basin	**366.45**	**42.1**	**316.0**	**853.6**	**1,213.0**	**1,669.5**	**1,862.1**	**2,114.5**
	i Canal Copen-Higuero-Cuabanos	33.43	9.6	65.8	173.8	238.9	313.9	345.6	387.3
	ii Choloma, Blanco and San Roque	333.02	42.1	292.3	789.1	1,120.5	1,540.5	1,717.6	1,949.6
C-3	Rio Choloma, Rio Blanco and S.R. Basin	**297.13**	**37.4**	**275.9**	**743.9**	**1,054.5**	**1,445.8**	**1,610.7**	**1,826.7**
RC-1	Rio Choloma Basin	**106.89**	**20.7**	**141.5**	**378.0**	528.9	711.2	787.7	888.3
RC-2	i at Choloma Bridge	71.64	13.6	112.7	299.5	416.0	553.9	611.9	688.1
RC-3	ii at Jutosa (Junction of Rio La Jutosa)	55.02	9.4	99.8	264.2	364.9	482.2	531.6	596.7
C-4	Rio Blanco - Canal San Roque Basin	**190.24**	**37.4**	**191.5**	**515.3**	**727.8**	**992.8**	**1,104.1**	**1,250.1**
RB-1	Rio Blanco Basin	**137.98**	**31.0**	**155.6**	**417.4**	**587.2**	**796.0**	**883.7**	**998.7**
RB-2	i Outlet of Laguna El Carmen	107.41	22.7	138.5	370.3	518.4	698.0	773.4	872.4
RB-3	ii Inlet of Laguna El Carmen	83.72	19.2	118.2	315.2	439.6	588.9	651.5	733.9
RB-4	iii Prop. Diversion Point	71.35	15.7	109.4	291.0	404.7	539.8	596.6	671.2
RB-5	iv Rio del Zapotal and Rio de Armenta	43.90	12.2	77.4	205.1	283.4	374.6	413.1	463.7
II	**Rio El Sauce and Rio El Sauce (viejo) - Chotepe Basin**								
S-1	River Mouth of Rio El Sauce	**215.70**	**29.9**	**226.7**	**609.5**	**860.2**	**1,172.0**	**1,302.9**	**1,474.7**
RS-1	Rio El Sauce Basin	**118.33**	**29.7**	**138.9**	**372.1**	**522.7**	**706.9**	**784.2**	**885.7**
RS-2	i Mid. of Rio El Sauce	79.98	21.8	109.9	293.3	409.5	549.0	607.6	684.6
RS-3	ii Jct. of Prop. Diversion	75.33	18.1	110.1	293.4	408.7	546.3	604.2	680.2
RS-4	iii Rio Santa Ana and Rio Piedras	72.16	15.4	110.9	295.2	410.5	547.5	605.0	680.7
RSB-1	iv Rio Santa Ana Basin (at National Road)	37.63	13.4	66.5	176.1	243.1	321.2	354.1	397.4
RSP-1	v Rio Piedras Basin (at National Road)	30.87	12.6	57.4	151.7	208.9	275.1	303.0	339.8
RSV-1	Rio El Sauce (viejo) - Chotepe Basin	**97.37**	**22.9**	**127.5**	**340.6**	**476.5**	**640.9**	**709.9**	**800.5**

Note: Retention effect of Laguna El Carmen is not considered in this calculation
C.A. : Catchment Area of the Basin (sq. km) L : Maximum River Length of the Basin (km)
S.R. : Canal San Roque S.R.-C : Canal San Roque Cuabanos C-H-C : Canal Copen-Higuero-Cuabanos

TABLE 3.22 PROBABLE FLOOD PEAK DISCHARGE OF RAINFALL PATTERN C (ALTERNATIVE RIVER SYSTEM)

		Catchment/River		Peak Discharge (qu. m / sec.)					
		C.A. (sq. km)	L (km)	Return Period					
				2-year	5-year	10-year	30-year	50-year	100-year
I	**Rio Choloma, Rio Blanco, Canal San Roque, Canal San Roque-Cuabanos and Canal Copen-Higuero-Cuabanos Basin**								
C-1	River Mouth of the Basin	348.80	32.7	326.9	881.5	1,249.8	1,714.1	1,909.7	2,166.0
C-2	Choloma, Blanco, S.R.,S.R.-C ,C-H-C Basin	295.10	26.4	303.0	815.5	1,152.8	1,574.1	1,751.2	1,983.5
	i Canal Copen-Higuero-Cuabanos	33.43	9.6	65.8	173.8	238.9	313.9	345.6	387.3
	ii Choloma, Blanco and San Roque	261.67	26.4	274.8	739.1	1,043.8	1,423.2	1,582.6	1,791.7
C-3	Rio Choloma, Rio Blanco and S.R. Basin	225.78	21.7	257.1	690.1	971.9	1,319.2	1,465.7	1,657.3
RC-1	Rio Choloma Basin	106.89	20.7	141.5	378.0	528.9	711.2	787.7	888.3
RC-2	i at Choloma Bridge	71.64	13.6	112.7	299.5	416.0	553.9	611.9	688.1
RC-3	ii at Jutosa (Junction of Rio La Jutosa)	55.02	9.4	99.8	264.2	364.9	482.2	531.6	596.7
C-4	Rio Blanco - Canal San Roque Basin	118.89	21.7	152.4	407.6	570.9	769.2	852.5	961.8
RB-1	Rio Blanco Basin	66.63	15.3	104.1	276.8	384.7	512.5	566.2	636.8
II	**Rio El Sauce and Rio El Sauce (viejo) - Chotepe Basin**								
S-1	River Mouth of Rio El Sauce	287.05	30.1	285.6	769.1	1,088.1	1,487.6	1,655.7	1,876.0
RS-1	Rio El Sauce Basin	189.68	29.9	204.1	548.3	773.1	1,051.6	1,168.5	1,321.9
RS-2	i Mid. of Rio El Sauce	151.33	22.0	184.9	495.3	695.3	939.8	1,042.4	1,177.1
RS-3	ii Upstream of Jct. of Prop. Diversion	75.33	18.1	110.1	293.4	408.7	546.3	604.2	680.2
RS-4	iii Rio Santa Ana and Rio Piedras	72.16	15.4	110.9	295.2	410.5	547.5	605.0	680.7
RSB-1	iv Rio Santa Ana Basin (at National Road)	37.63	13.4	66.5	176.1	243.1	321.2	354.1	397.4
RSP-1	v Rio Piedras Basin (at National Road)	30.87	12.6	57.4	151.7	208.9	275.1	303.0	339.8
RB-4	iii Prop. Diversion Point	71.35	15.7	109.4	291.0	404.7	539.8	596.6	671.2
RB-5	iv Rio del Zapotal and Rio de Armenta	43.90	12.2	77.4	205.1	283.4	374.6	413.1	463.7
RSV-1	Rio El Sauce (viejo) - Chotepe Basin	97.37	22.9	127.5	340.6	476.5	640.9	709.9	800.5

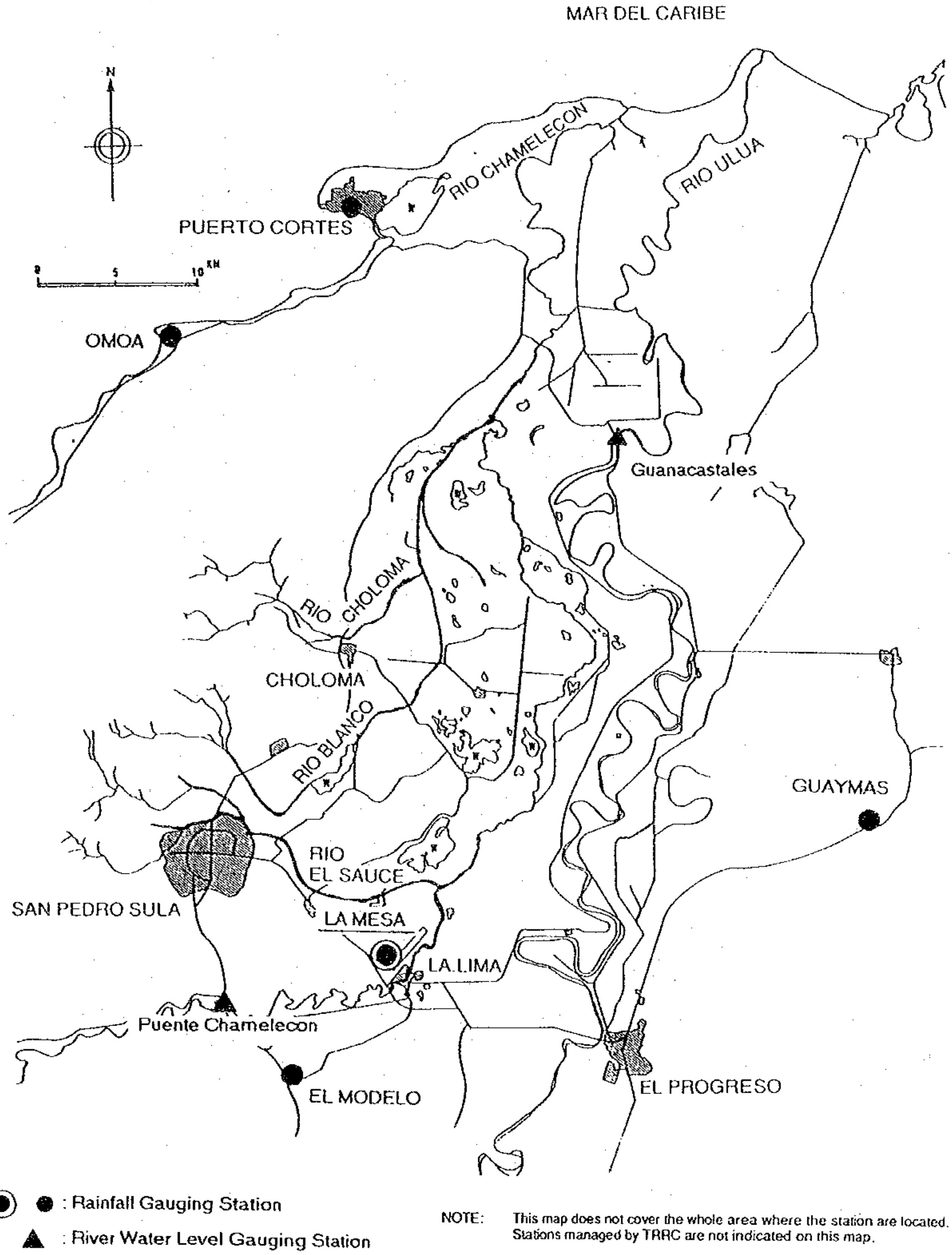
Note: Retention effect of Laguna El Carmen is not considered in this calculation
C.A. : Catchment Area of the Basin (sq. km) L : Maximum River Length of the Basin (km)
S.R. : Canal San Roque S.R.-C : Canal San Roque Cuabanos C-H-C : Canal Copen-Higuero-Cuabanos

TABLE 3.23 SIMULATED PEAK DISCHARGE OF HURRICANE FIFI

		Catchment/River		Discharge
		C.A. (sq. km)	L (km)	Q (qu.n/sec)
I	**Rio Choloma, Rio Blanco, Canal San Roque, Canal S.R.-C and Canal C-H-C Basin**			
C-1	River Mouth of the Basin	**420.15**	**48.4**	**2,079.0**
C-2	Choloma, Blanco, San Roque, Canal S.R.-C ,C-H-C Basin	**366.45**	**42.1**	**1,838.3**
	i Canal Copen-Higuero-Cuabanos	33.43	9.6	297.4
	ii Choloma, Blanco and San Roque	333.02	42.1	1,686.0
C-3	Rio Choloma, Rio Blanco and S.R. Basin	**297.13**	**37.4**	**1,559.0**
RC-1	Rio Choloma Basin	**106.89**	**20.7**	**668.3**
RC-2	i at Choloma Bridge	71.64	13.6	514.7
RC-3	ii at Jutosa (Junction of Rio La Jutosa)	55.02	9.4	453.1
C-4	Rio Blanco - Canal San Roque Basin	**190.24**	**37.4**	**1,039.7**
RB-1	Rio Blanco Basin	**137.98**	**31.0**	**767.7**
RB-2	i Outlet of Laguna El Carmen	107.41	22.7	658.3
RB-3	ii Inlet of Laguna El Carmen	83.72	19.2	546.9
RB-4	iii Prop. Diversion Point	71.35	15.7	500.3
RB-5	iv Rio del Zapotal and Rio de Armenta	43.90	12.2	351.8
II	**Rio El Sauce and Rio El Sauce (viejo) - Chotepe Basin**			
S-1	River Mouth of Rio El Sauce	**215.70**	**29.9**	**1,159.4**
RS-1	Rio El Sauce Basin	**118.33**	**29.7**	**676.3**
RS-2	i Mid. of Rio El Sauce	79.98	21.8	510.8
RS-3	ii Jct. of Prop. Diversion	75.33	18.1	504.6
RS-4	iii Rio Santa Ana and Rio Piedras	72.16	15.4	507.5
RSB-1	iv Rio Santa Ana Basin (at National Road)	37.63	13.4	301.9
RSP-1	v Rio Piedras Basin (at National Road)	30.87	12.6	259.8
RSV-1	Rio El Sauce (viejo) - Chotepe Basin	**97.37**	**22.9**	**602.4**

Note: Retention effect of Laguna El Carmen is not considered in this calculation
C.A. : Catchment Area of the Basin (sq. km) L : Maximum River Length of the Basin (km)
S.R. : Canal San Roque S.R.-C : Canal San Roque Cuabanos
C-H-C : Canal Copen-Higuero-Cuabanos

FIGURES



NOTE: This map does not cover the whole area where the station are located. Stations managed by TRRC are not indicated on this map.

FIG. 3.1 LOCATION MAP OF THE GAUGING STATIONS (RAINFALL AND RIVER WATER LEVEL)

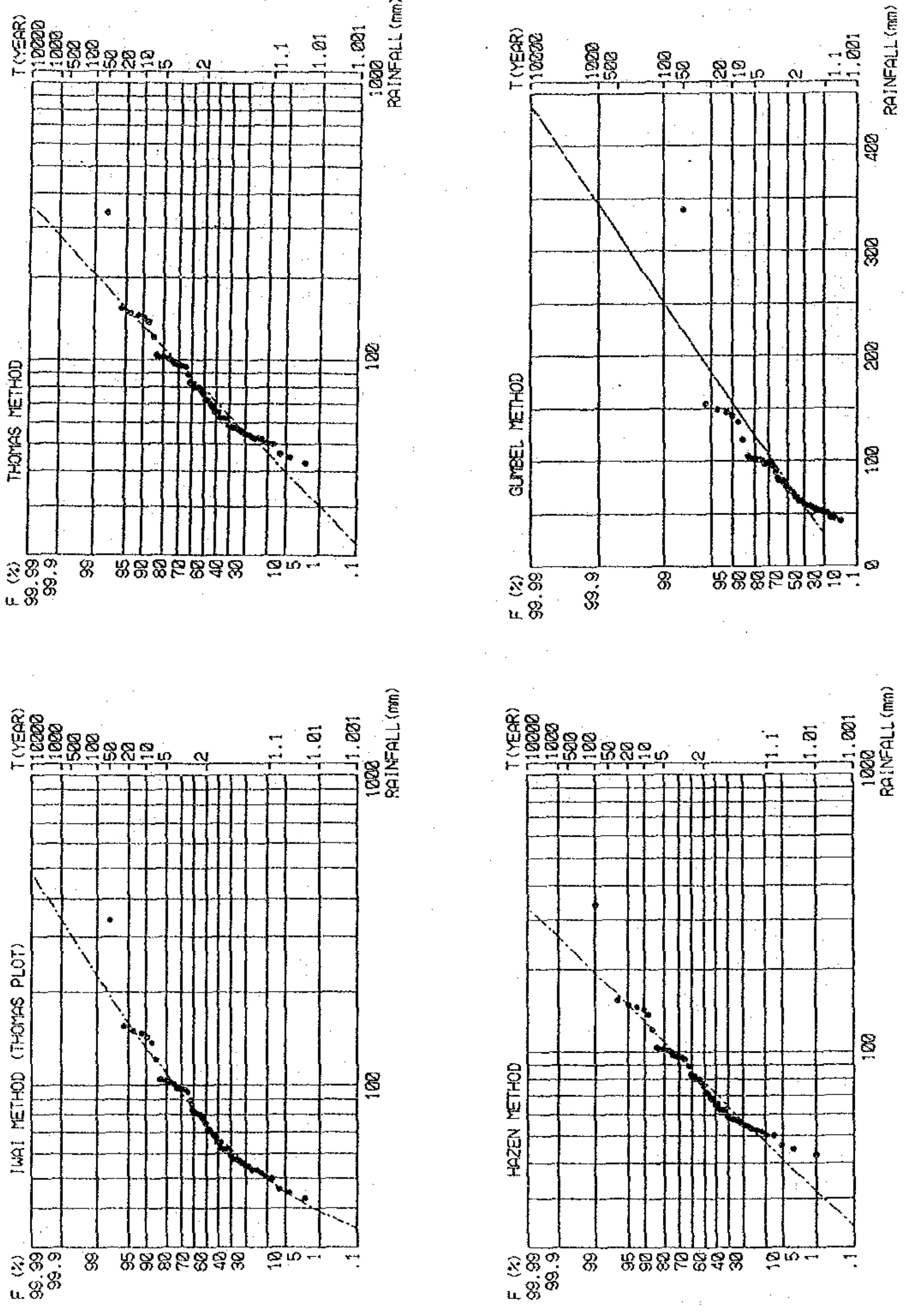


FIG. 3.2 FREQUENCY ANALYSIS ON ONE DAY RAINFALL AT LA MESA

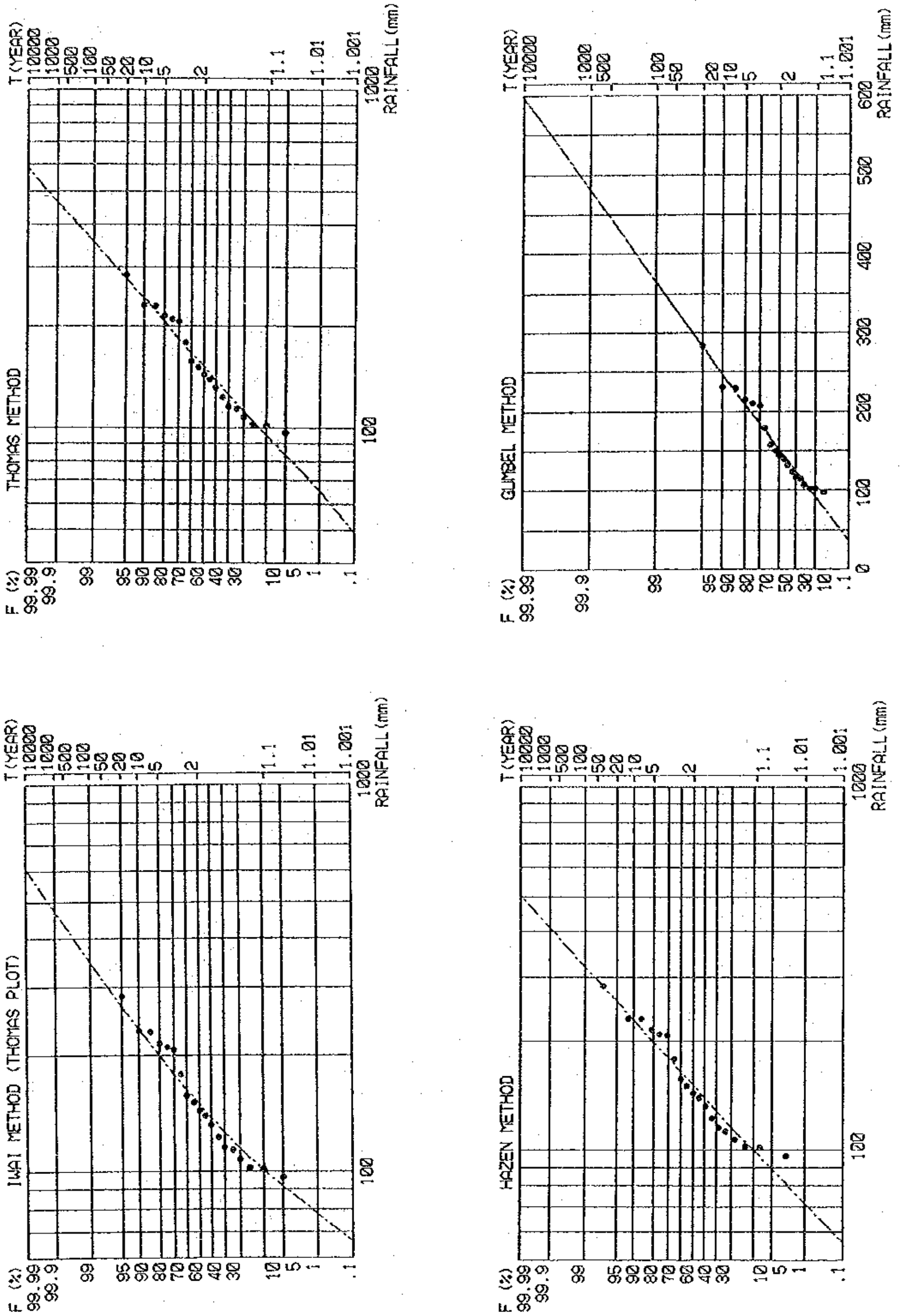


FIG. 3.3 FREQUENCY ANALYSIS ON ONE DAY RAINFALL AT PUERTO CORTES

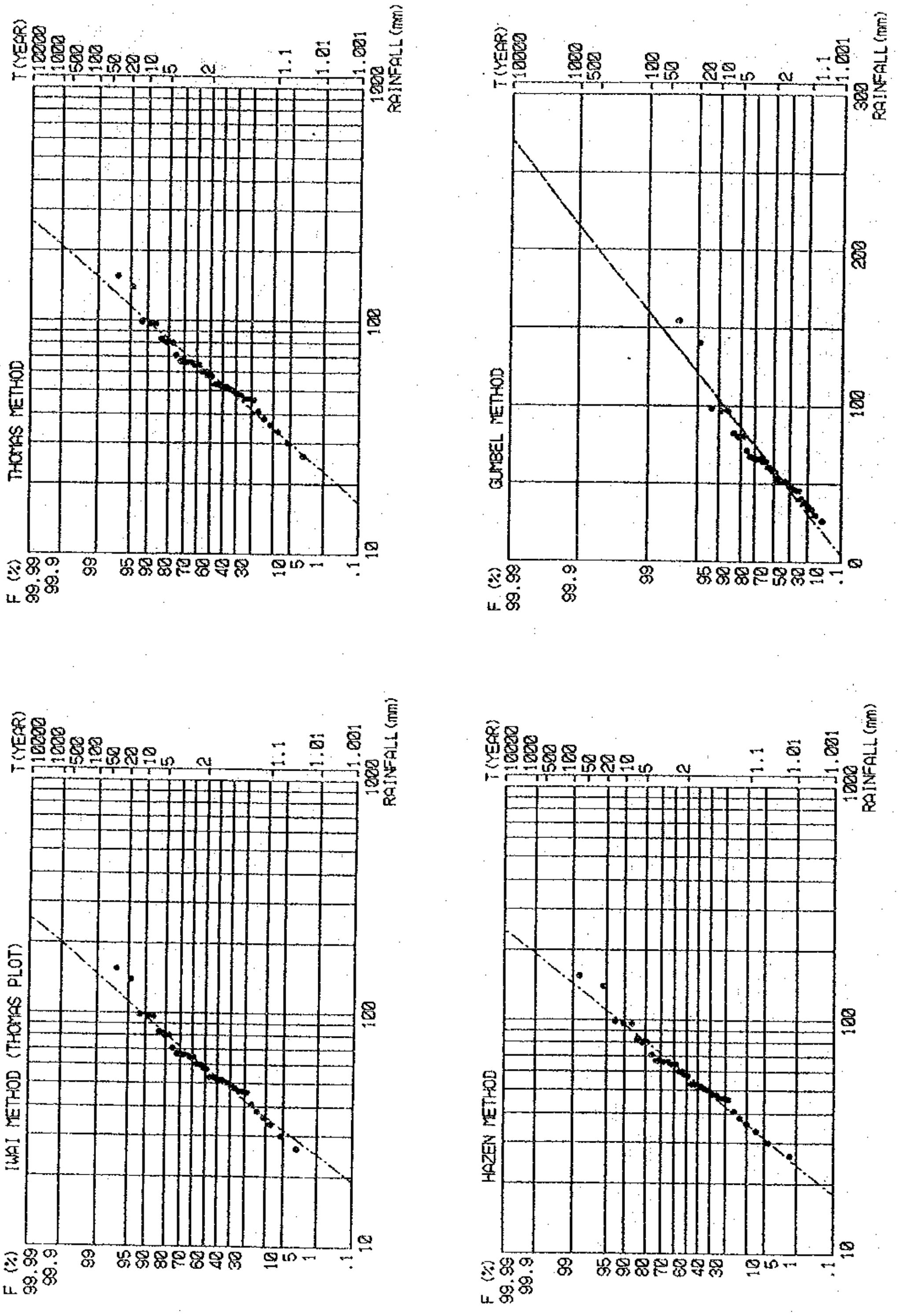
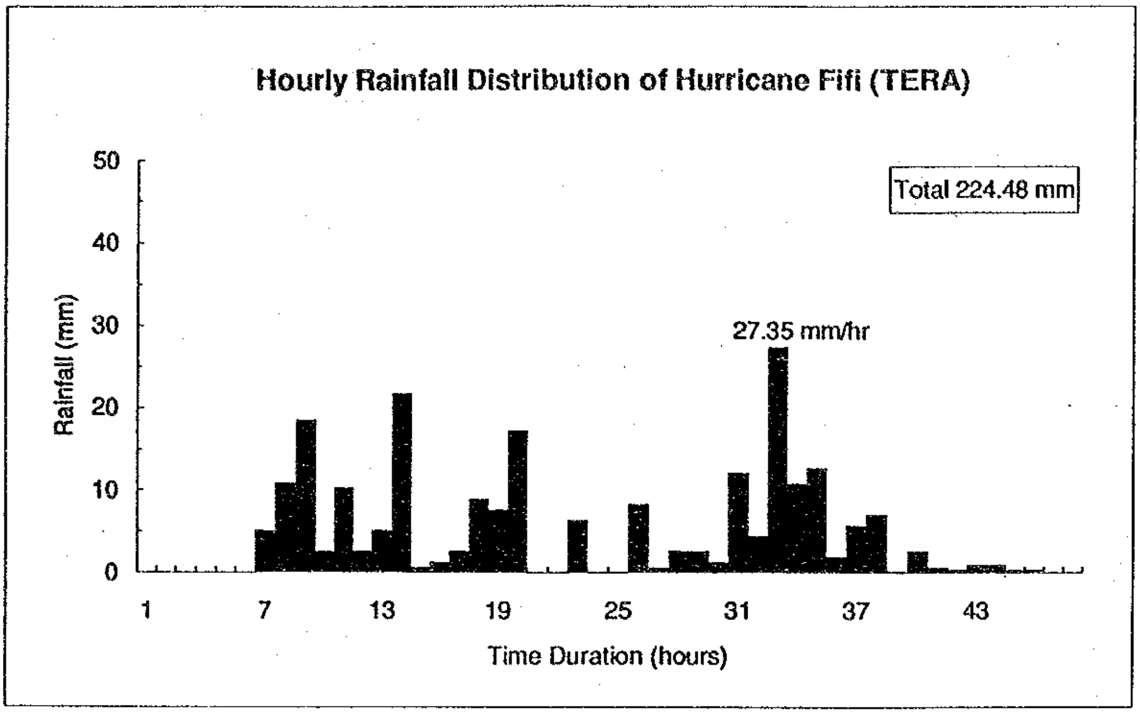
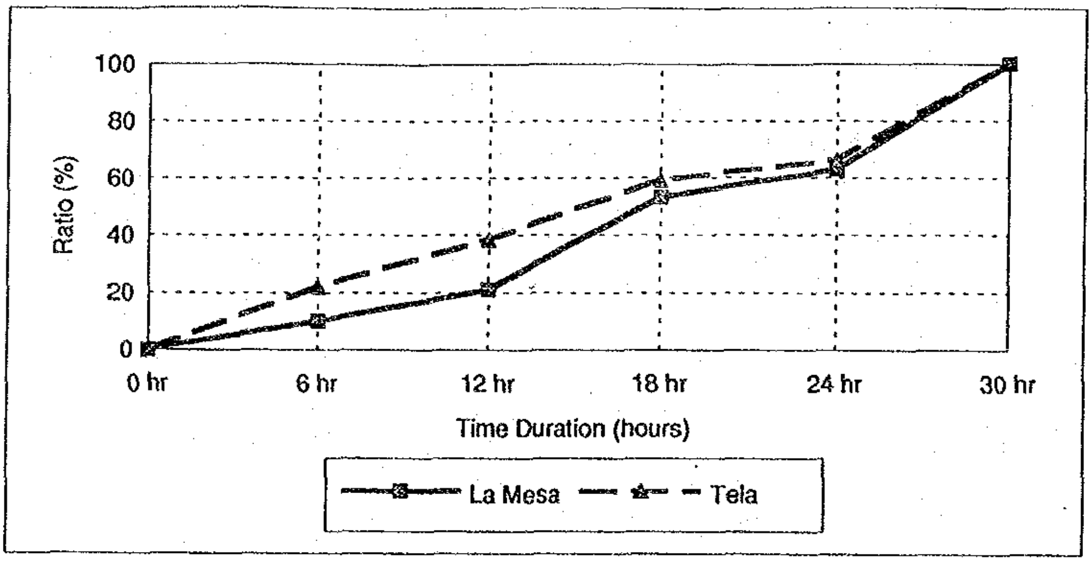


FIG. 3.4 FREQUENCY ANALYSIS ON 6 HOURS RAINFALL AT LA MESA



hr	Rain (mm)	hr	Rain (mm)	hr	Rain (mm)	hr	Rain (mm)
1	0.00	13	5.09	25	0.00	37	5.73
2	0.00	14	21.63	26	8.27	38	7.00
3	0.00	15	0.64	27	0.64	39	0.13
4	0.00	16	1.27	28	2.55	40	2.55
5	0.00	17	2.55	29	2.55	41	0.64
6	0.00	18	8.91	30	1.27	42	0.32
7	5.09	19	7.64	31	12.09	43	0.96
8	10.82	20	17.18	32	4.46	44	0.96
9	18.45	21	0.00	33	27.35	45	0.32
10	2.55	22	0.00	34	10.82	46	0.32
11	10.18	23	6.36	35	12.73	47	0.00
12	2.55	24	0.00	36	1.91	48	0.00

FIG. 3.5 HOURLY RAINFALL DISTRIBUTION OF THE HURRICANE FIFI AT TELA



Accumulative Rainfall Ratio

	6 hr	12 hr	18 hr	24 hr	30 hr
La Mesa	9.6	20.2	52.1	62.8	100.0
Tela	23.1	39.7	59.4	66.3	100.0

(Unit : %)

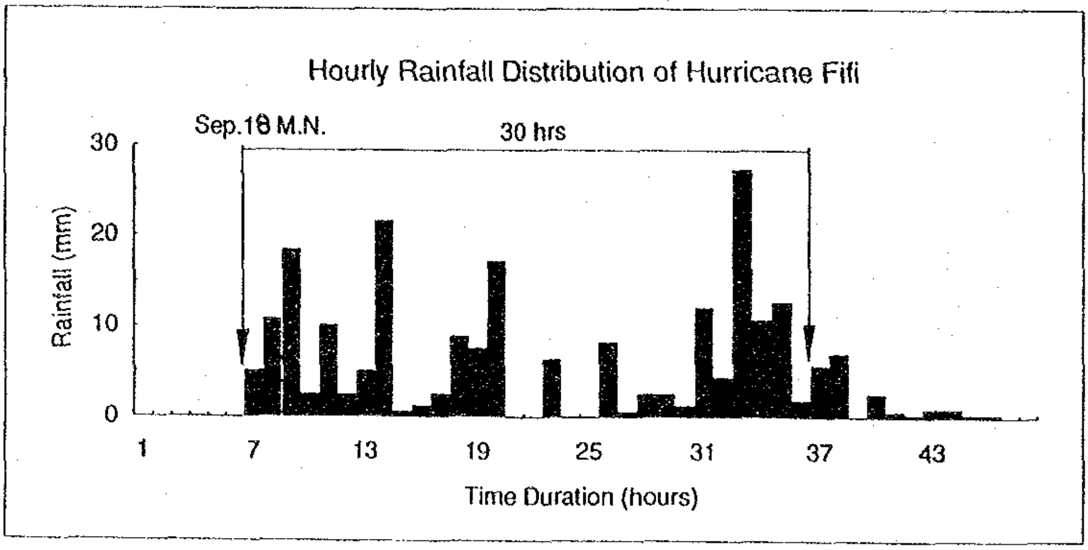
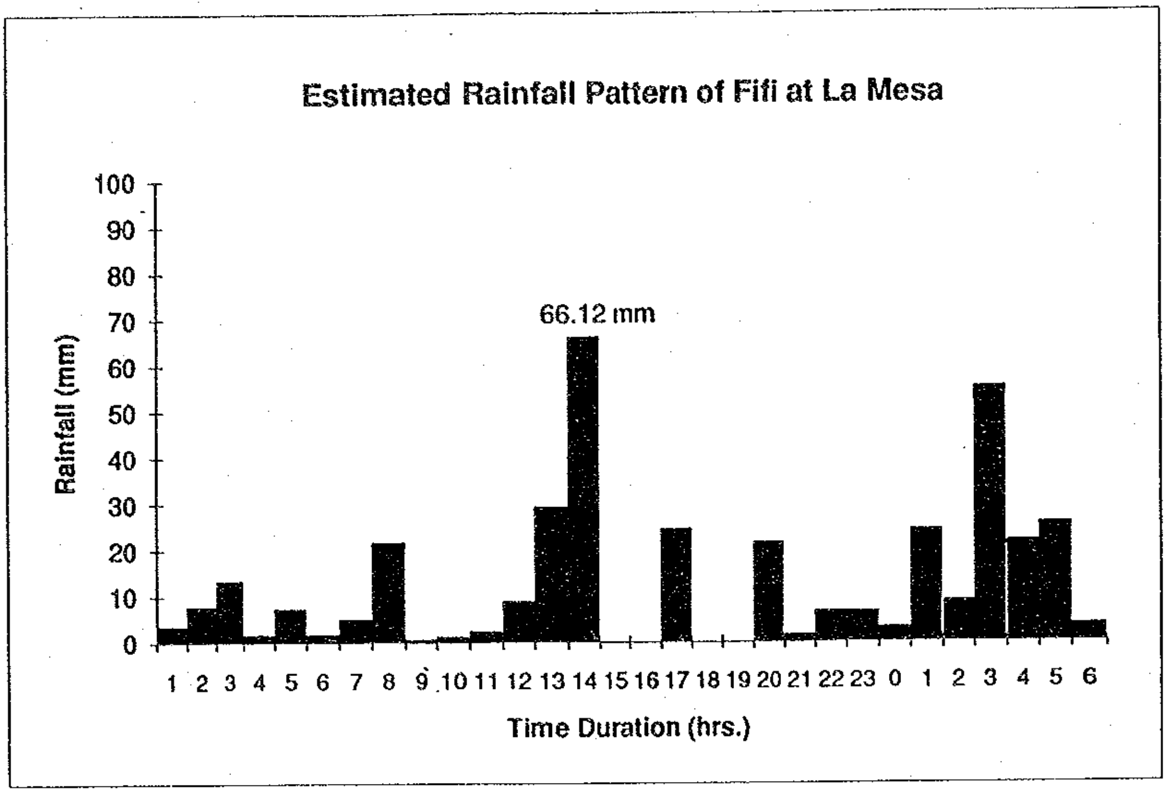
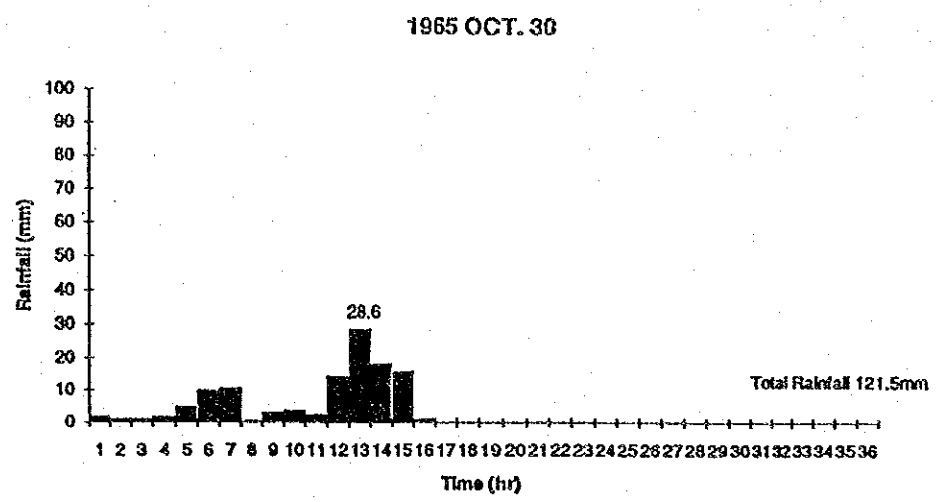


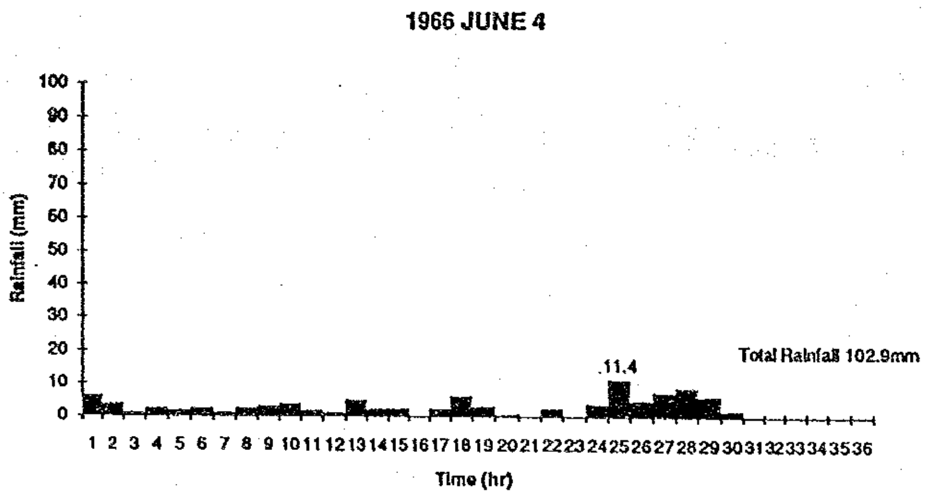
FIG. 3.6 ACCUMULATIVE RAINFALL RATIO OF THE HURRICANE FIFI AT LA MESA AND TELA



	18 - Sept.				19-Sept.
	0 to 6	6 to12	12 to 18	18 to 24	0 to 6
1	3.69	5.08	29.40	0.00	24.40
2	7.85	21.58	66.12	21.65	9.00
3	13.38	0.64	0.00	1.67	55.21
4	1.85	1.27	0.00	6.68	21.84
5	7.38	2.54	24.48	6.68	25.69
6	1.85	8.89	0.00	3.32	3.86
Total	36.00	40.00	120.00	40.00	140.00

FIG. 3.7 ESTIMATED HOURLY RAINFALL DISTRIBUTION OF THE HURRICANE FIFI AT LA MESA





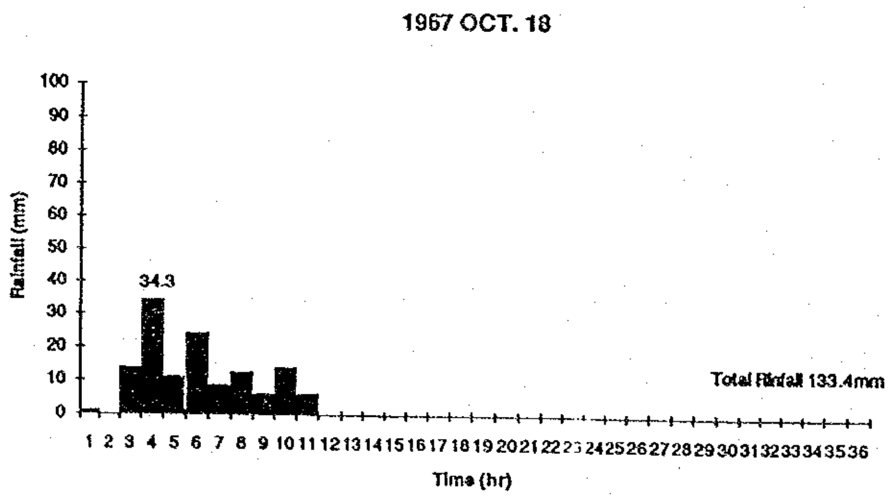
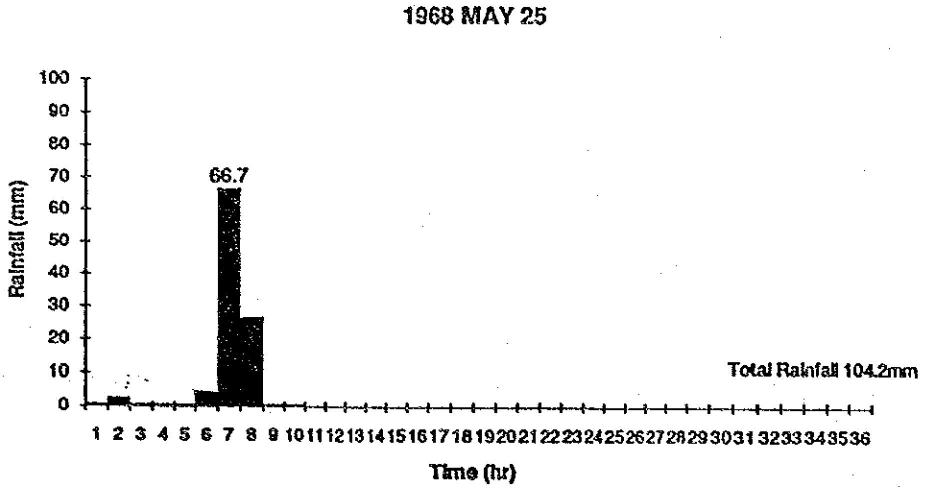


FIG.3.8 (1) HOURLY RAINFALL DISTRIBUTION RECORD AT LA MESA



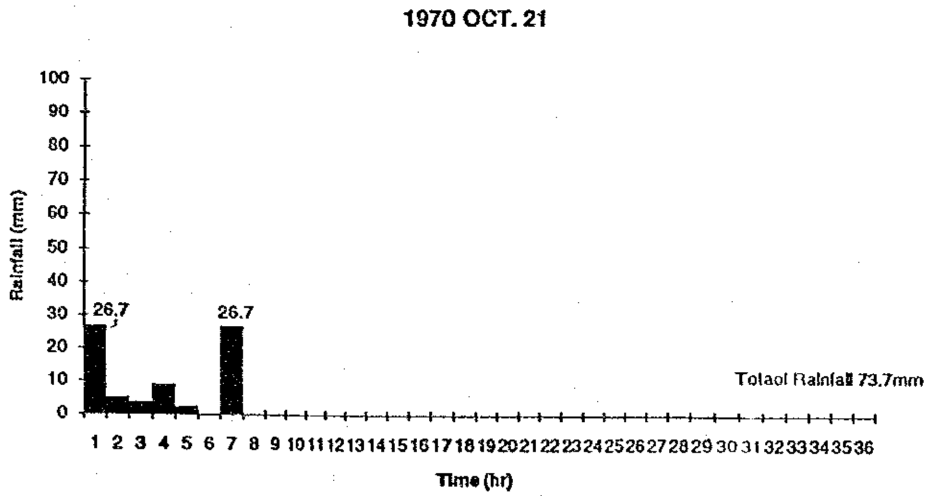
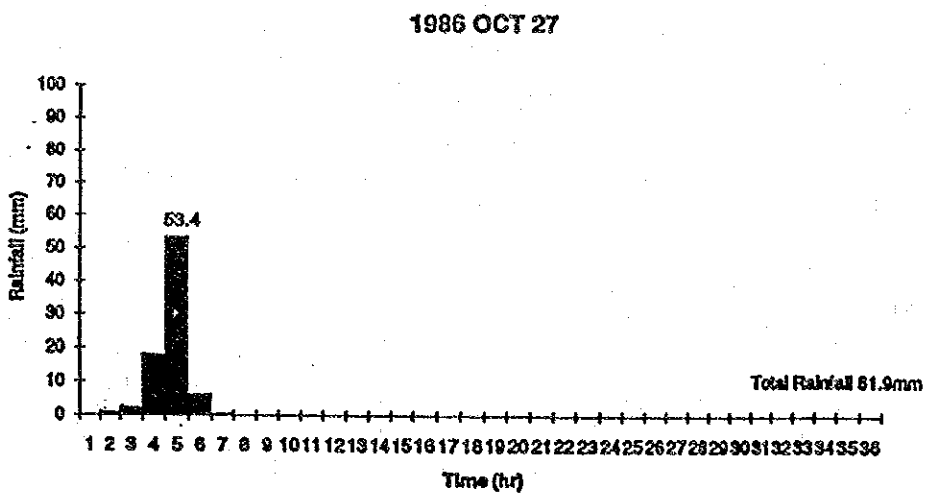


FIG. 3.8 (2) HOURLY RAINFALL DISTRIBUTION RECORD AT LA MESA



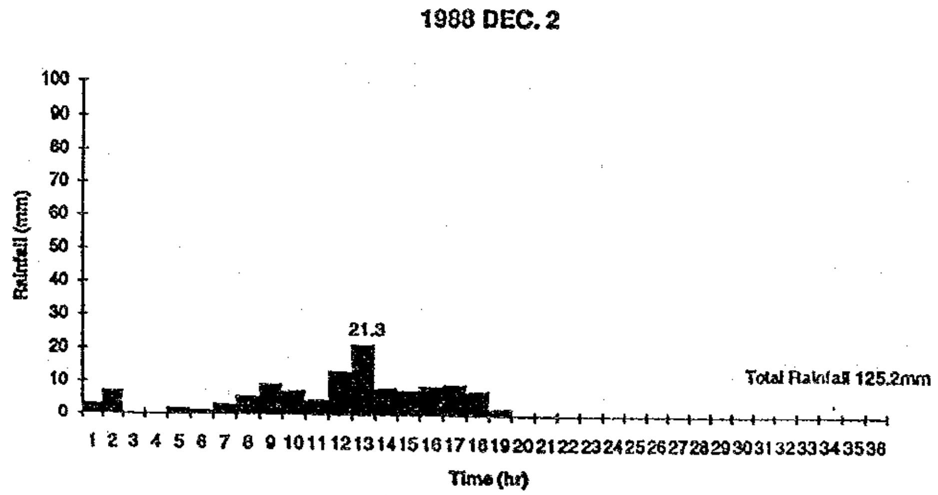


FIG. 3.9 HOURLY RAINFALL DISTRIBUTION RECORD AT EL MODELO

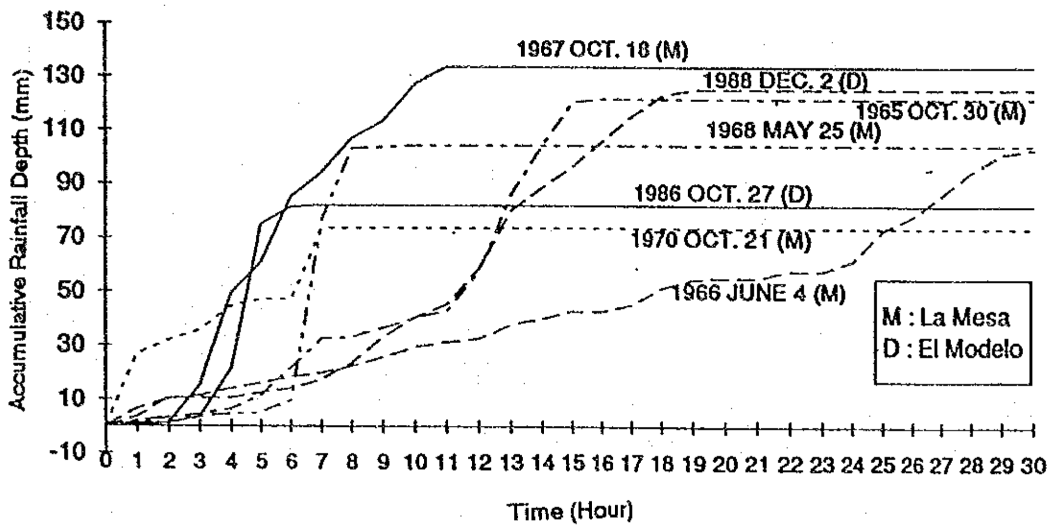


FIG.3.10 ACCUMULATIVE RAINFALL DEPTH AND DURATION CURVE

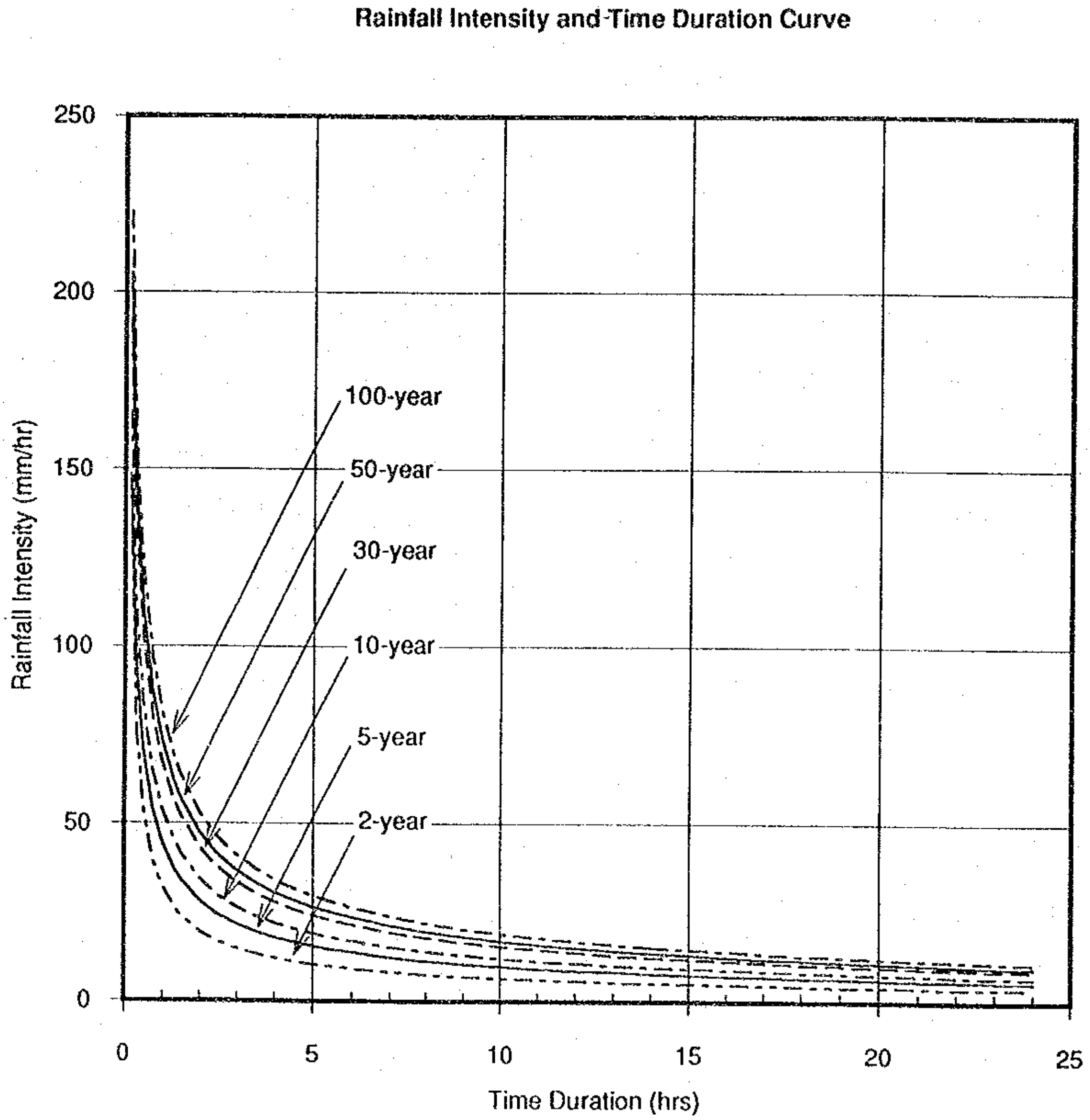


FIG.3.11 RAINFALL INTENSITY AND TIME DURATION CURVE

		Catchment River	
		C.A. (sq. km)	L (km)
I	Rio Choloma, Rio Blanco, Canal San Roque, Canal S. R.- C. and Canal C.- H.- C. Basin		
C-1	River Mouth of the Basin	420.15	49.4
C-2	Choloma, Blanco, San Roque, Canal San Roque - Cuabanos, C-H-C Basin	366.45	42.1
	i Canal Copen-Higuero-Cuabanos	33.43	9.6
	ii Choloma, Blanco and San Roque	333.02	42.1
C-3	Rio Choloma, Rio Blanco and S.R. Basin	297.15	37.4
RC-1	Rio Choloma Basin	106.89	20.7
RC-2	i at Choloma Bridge	71.64	13.8
RC-3	ii at Juteas (Junction of Rio La Juteca)	55.02	9.4
C-4	Rio Blanco - Canal San Roque Basin	192.24	37.4
RB-1	Rio Blanco Basin	137.88	31.0
RB-2	i Outlet of Laguna El Carmen	107.41	22.7
RB-3	ii Inlet of Laguna El Carmen	83.72	19.2
RB-4	iii Prop. Diversion Point	71.35	15.7
RB-5	iv Rio del Zapotal and Rio de Armenta	43.90	12.2
II	Rio El Sauce and Rio El Sauce (viejo) - Chotepa Basin		
S-1	River Mouth of Rio El Sauce	215.70	23.8
RS-1	Rio El Sauce Basin	118.33	29.7
RS-2	i Mid. of Rio El Sauce	79.98	21.8
RS-3	ii Jct. of Prop. Diversion	75.33	18.1
RS-4	iii Rio Santa Ana and Rio Piedras	72.16	15.4
RSS-1	iv Rio Santa Ana Basin (at National Road)	37.63	13.4
RSP-1	v Rio Piedras Basin (at National Road)	30.87	12.6
RSV-1	Rio El Sauce (viejo) - Chotepa Basin	97.37	22.9

Note: Retention effect of Laguna El Carmen is not considered in this calculation

C.A. : Catchment Area of the Basin (sq. km) L : Maximum River Length of the Basin (km)
S.R. : Canal San Roque S.R.-C : Canal San Roque Cuabanos
C-H-C : Canal Copen-Higuero-Cuabanos

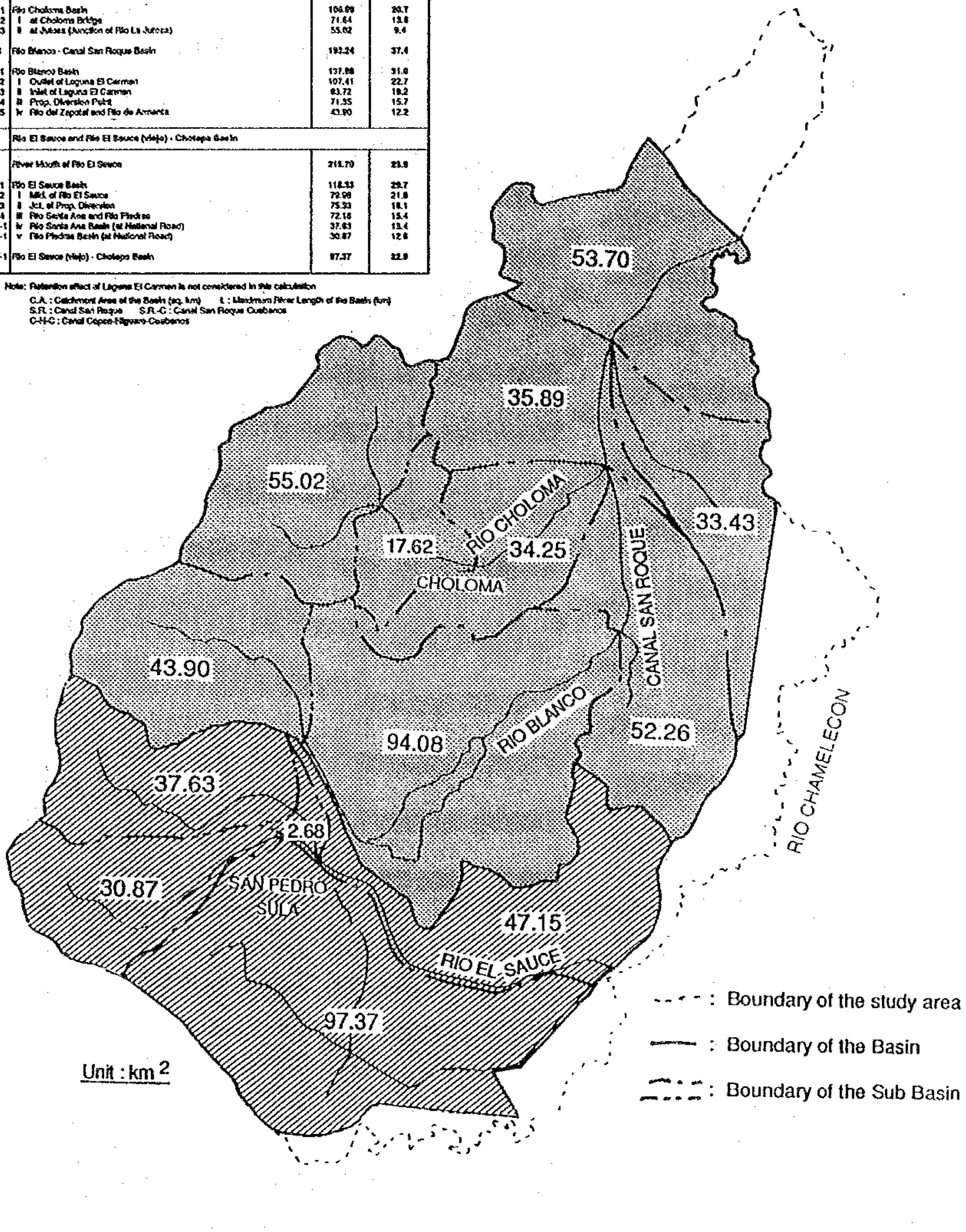


FIG.3.12 SUB-DIVISION OF THE DRAINAGE BASIN

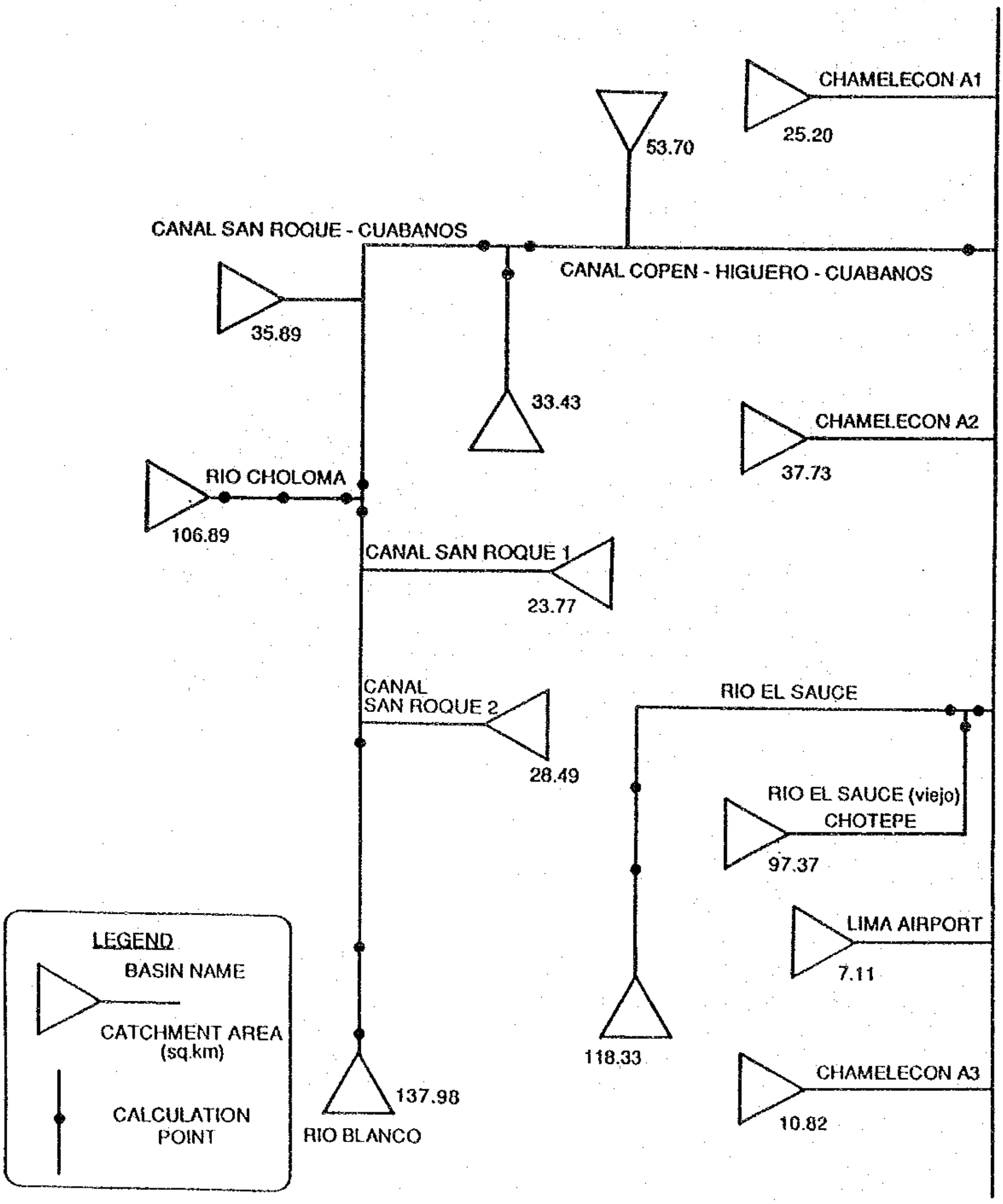


FIG.3.13 RIVER SYSTEM MODEL FOR RUN-OFF SIMULATION (PRESENT RIVER SYSTEM)

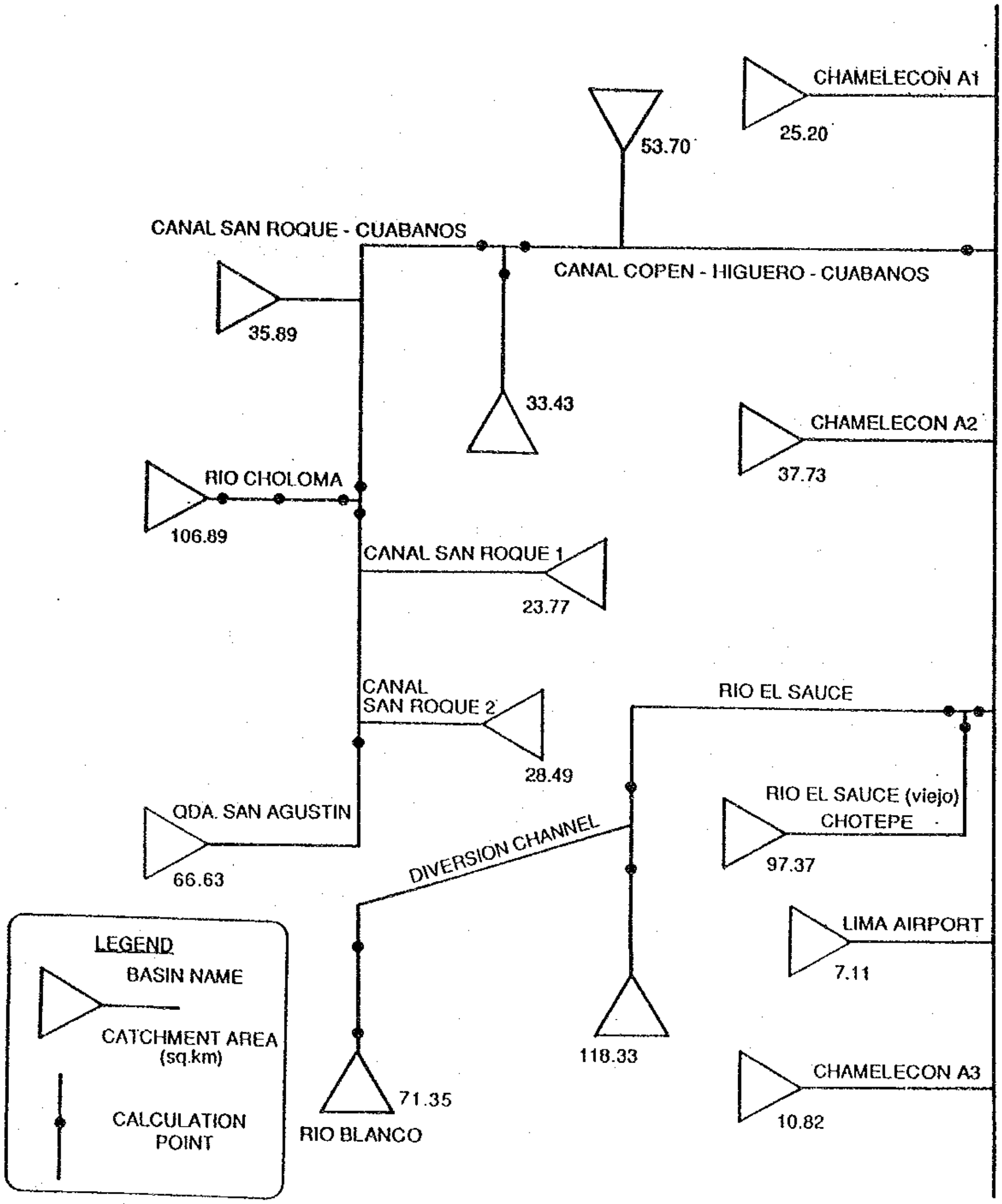
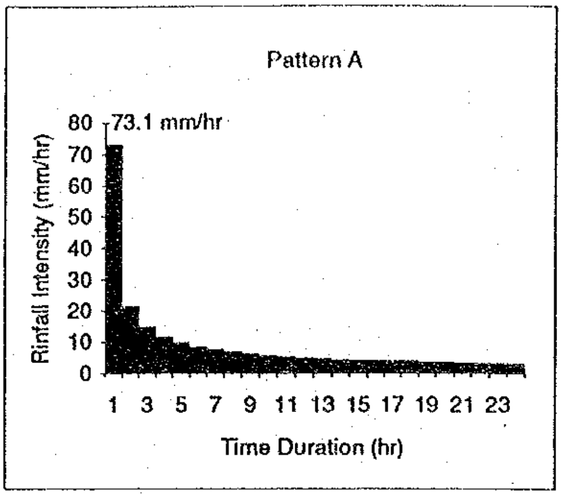
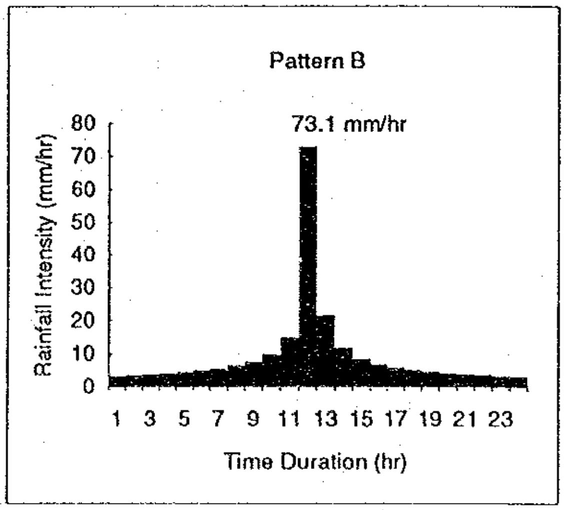


FIG.3.14 RIVER SYSTEM MODEL FOR RUN-OFF SIMULATION (ALTERNATIVE RIVER SYSTEM)

T (hr)	Rainfall Intensity (mm/hr)		
	Pattern A	Pattern B	Pattern C
1	73.1	3.3	3.2
2	21.7	3.6	3.3
3	15.0	3.8	3.4
4	11.8	4.1	3.6
5	10.0	4.5	3.7
6	8.7	5.0	3.8
7	7.7	5.6	4.0
8	7.0	6.5	4.1
9	6.5	7.7	4.3
10	6.0	10.0	4.5
11	5.6	15.0	4.7
12	5.3	73.1	5.0
13	5.0	21.7	5.3
14	4.7	11.8	5.6
15	4.5	8.7	6.0
16	4.3	7.0	6.5
17	4.1	6.0	7.0
18	4.0	5.3	7.7
19	3.8	4.7	8.7
20	3.7	4.3	10.0
21	3.6	4.0	11.8
22	3.4	3.7	15.0
23	3.3	3.4	21.7
24	3.2	3.2	73.1





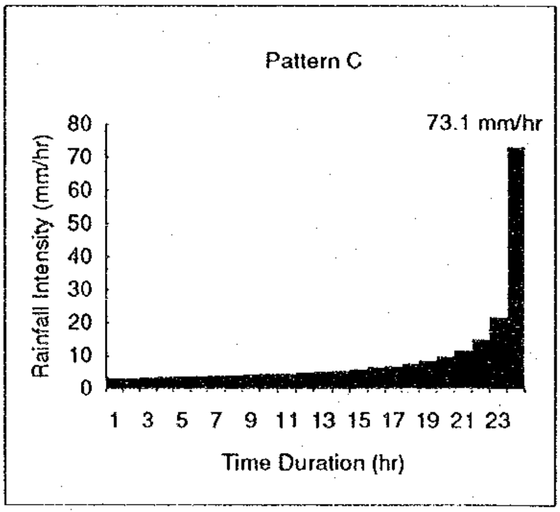


FIG.3.15 RAINFALL PATTERNS FOR RUN-OFF SIMULATION

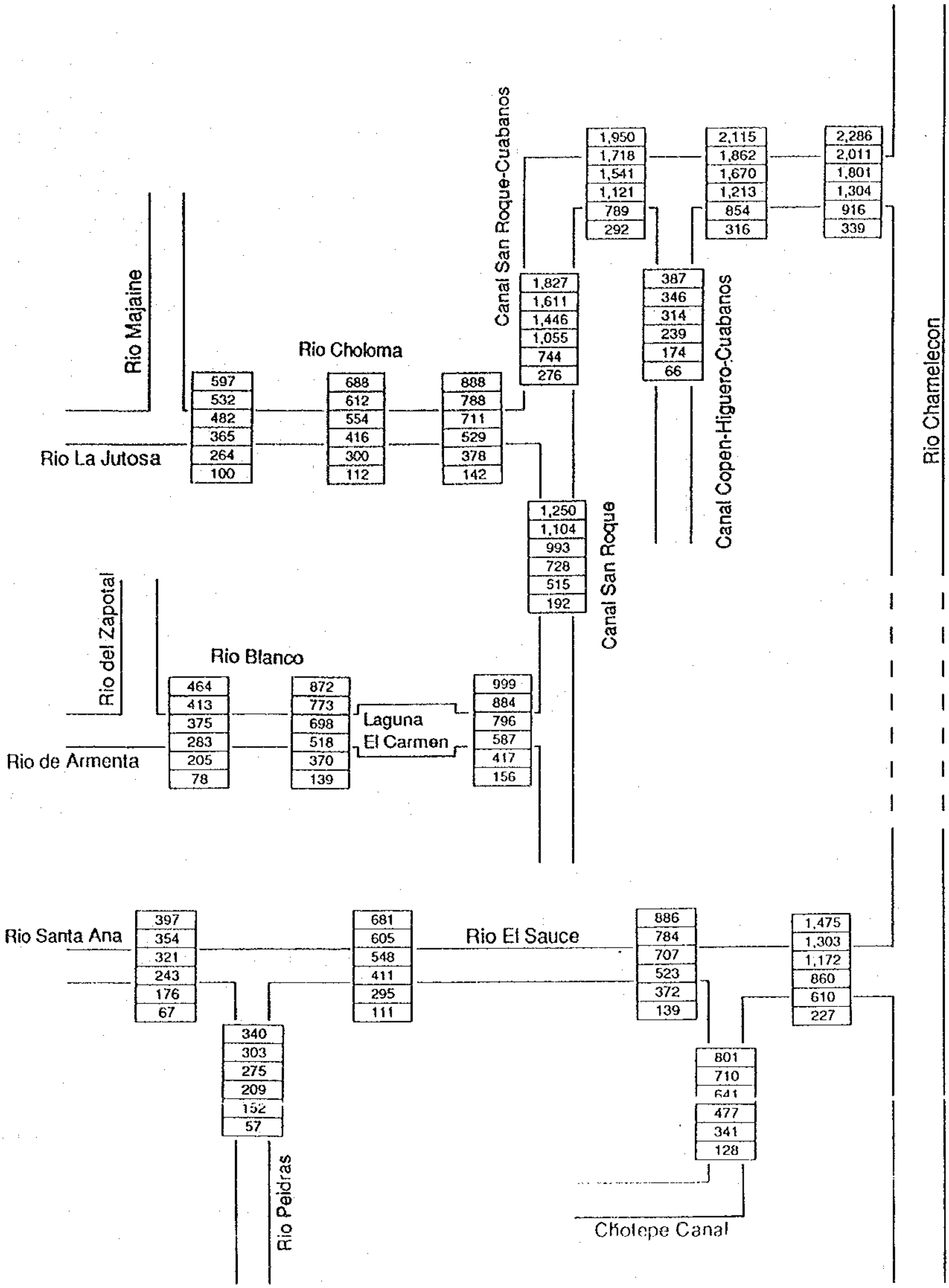


FIG.3.16 PROBABLE PEAK DISCHARGE DISTRIBUTION
- PRESENT RIVER SYSTEM (RAINFALL PATTERN C)

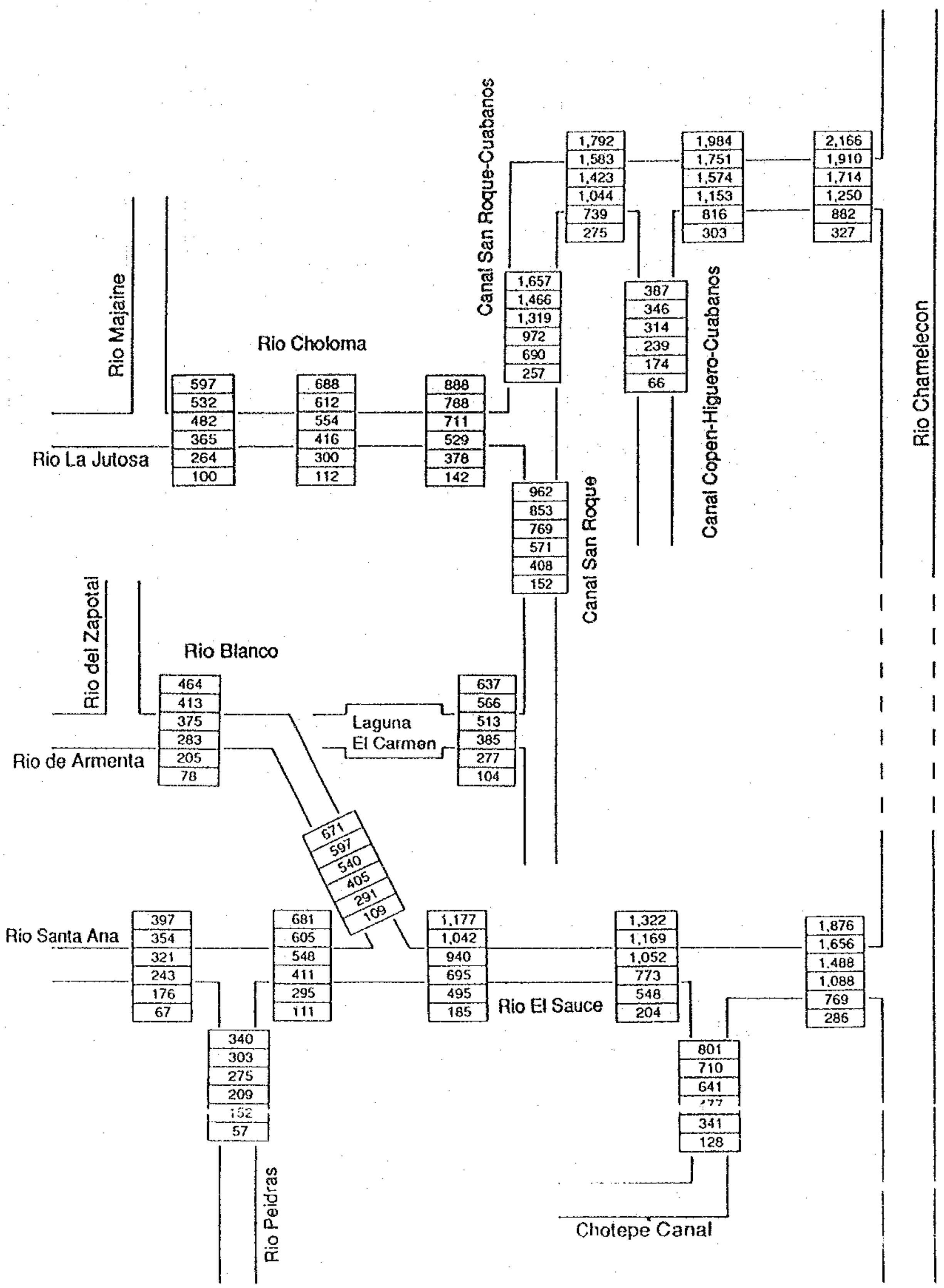
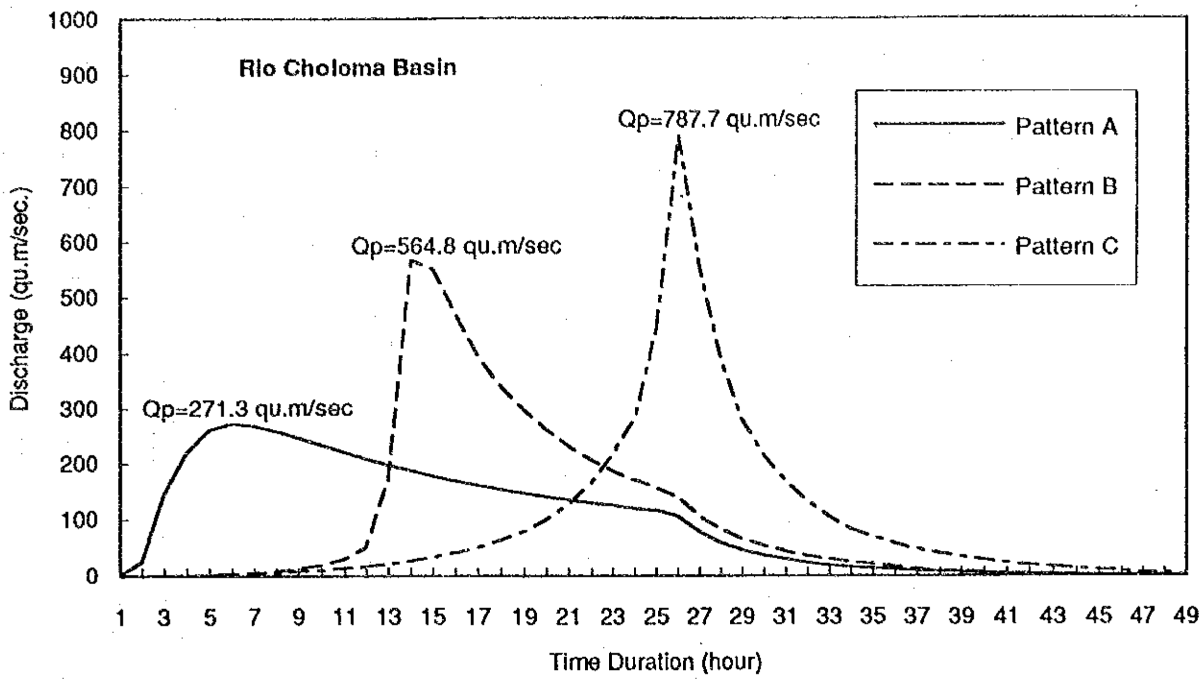


FIG.3.17 PROBABLE PEAK DISCHARGE DISTRIBUTION
- ALTERNATIVE RIVER SYSTEM (RAINFALL PATTERN C)



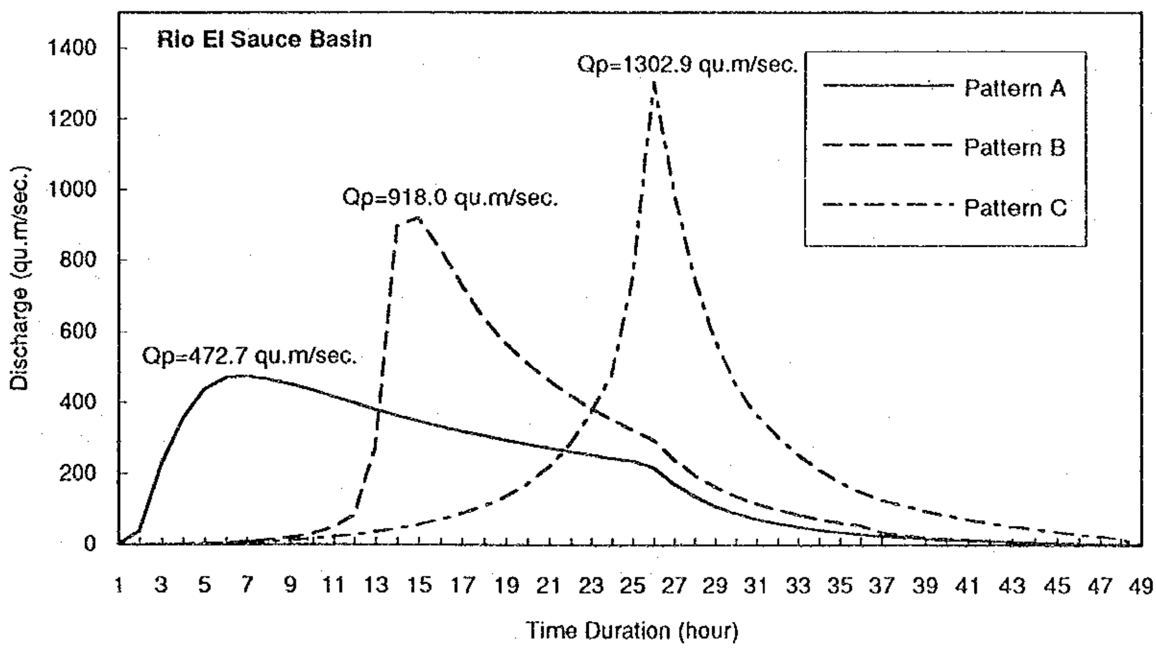
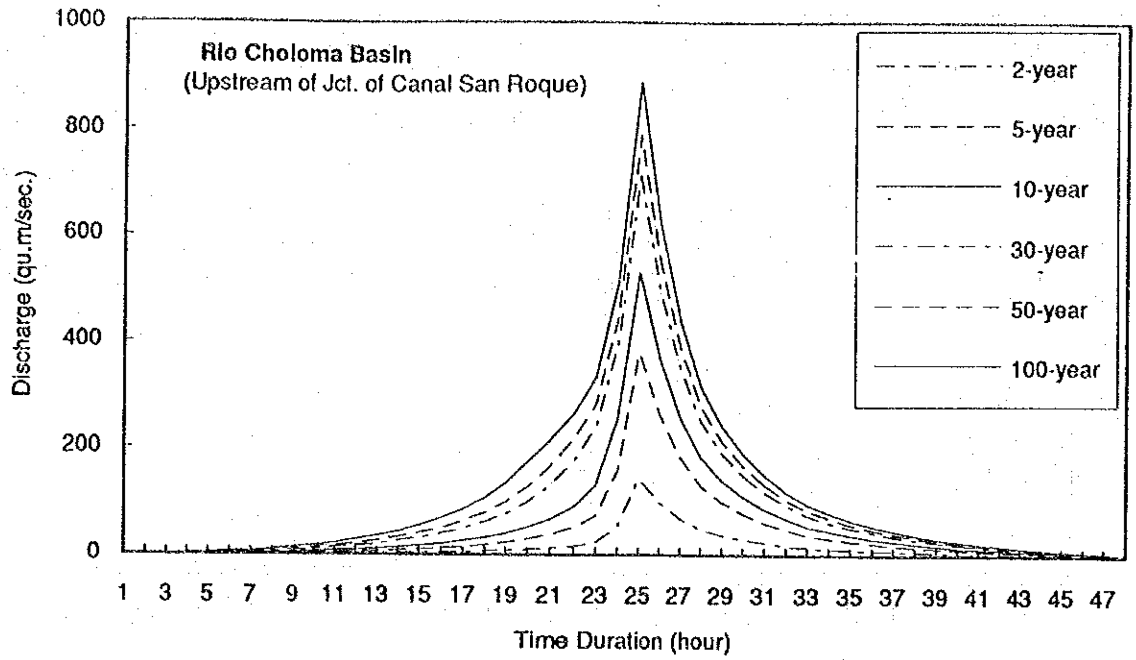


FIG.3.18 DIFFERENCE OF THE HYDROGRAPH BY RAINFALL PATTERN



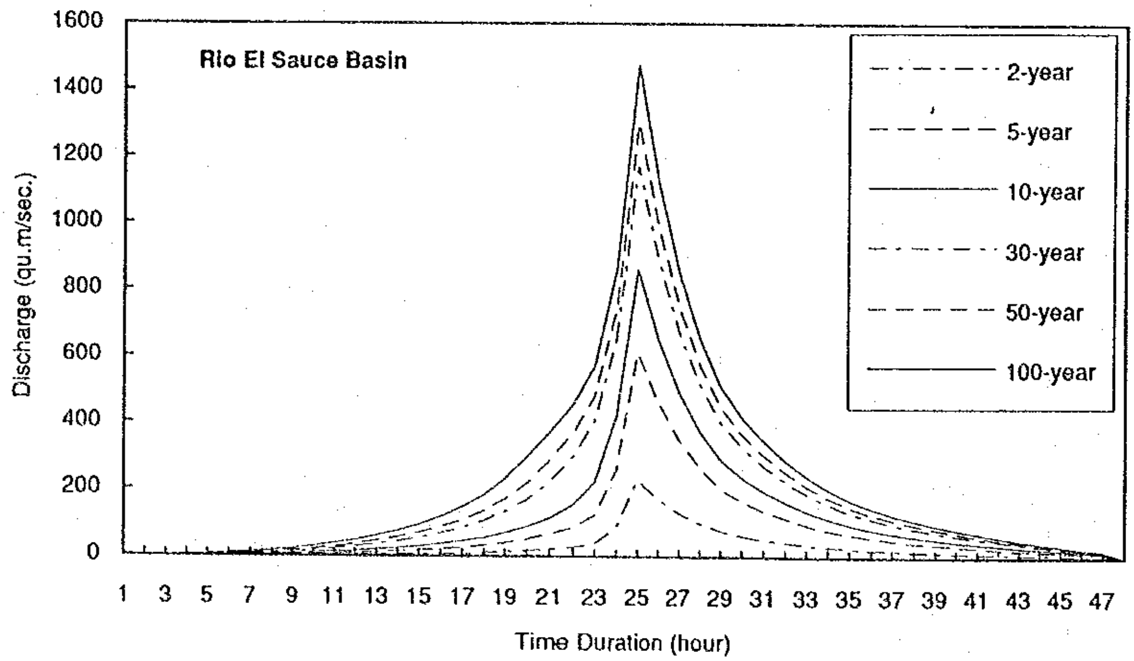
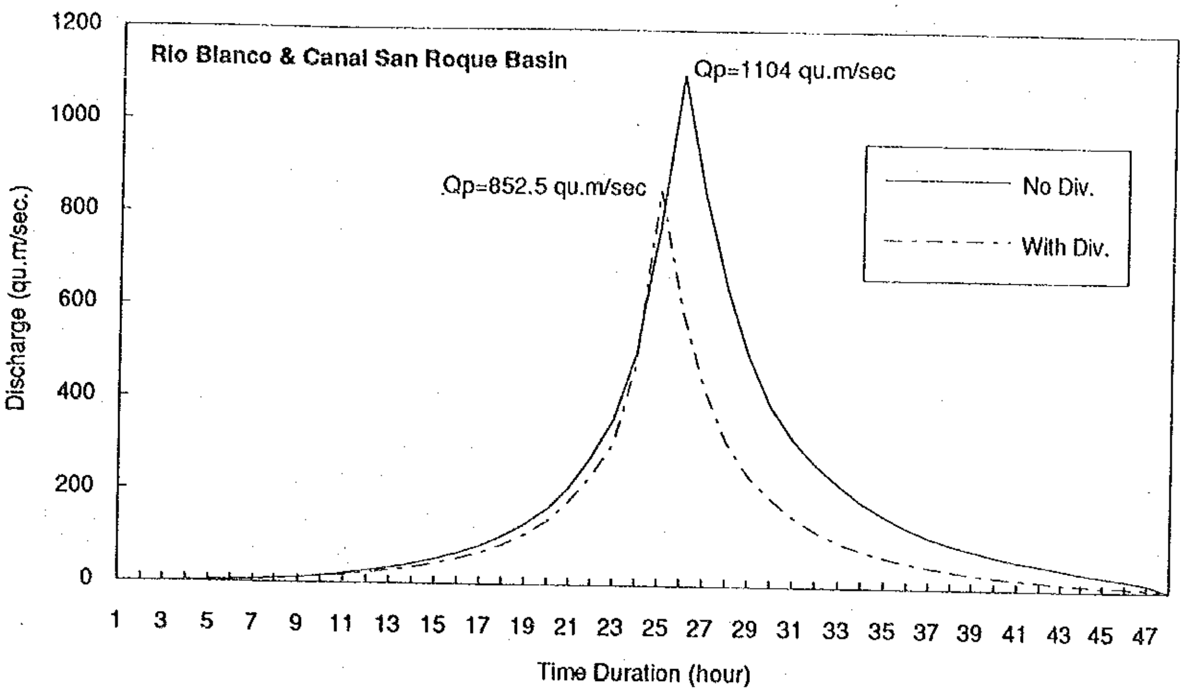


FIG.3.19 PROBABLE FLOOD HYDROGRAPH (RAINFALL PATTERN C)



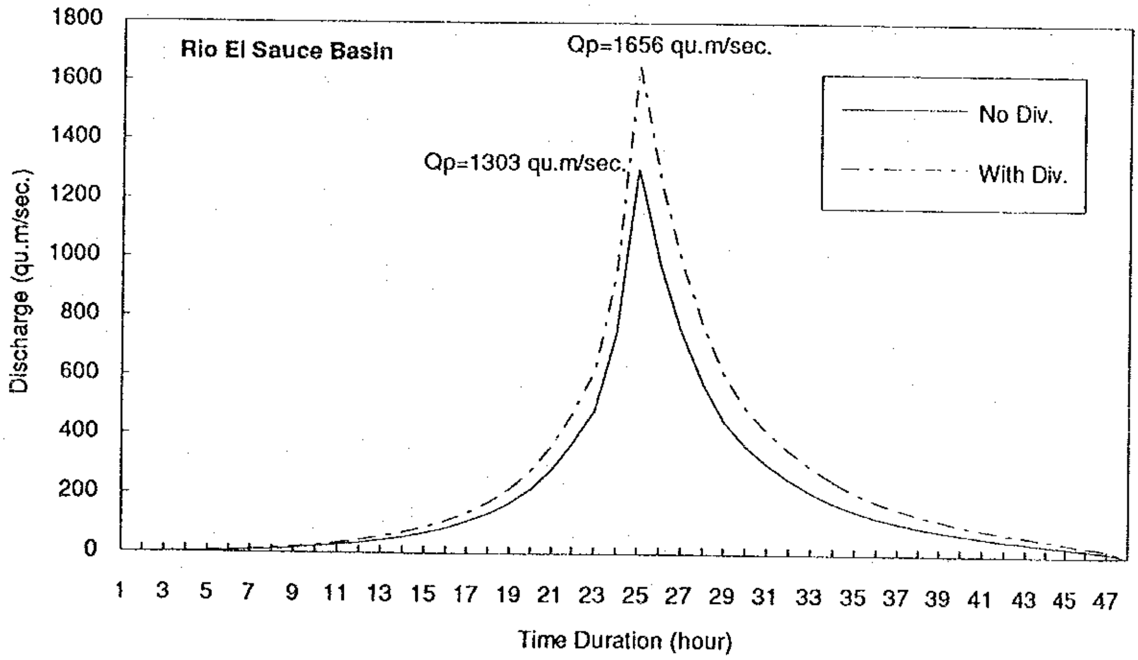


FIG.3.20 DIFFERENCE OF THE HYDROGRAPH BY ALTERNATIVES

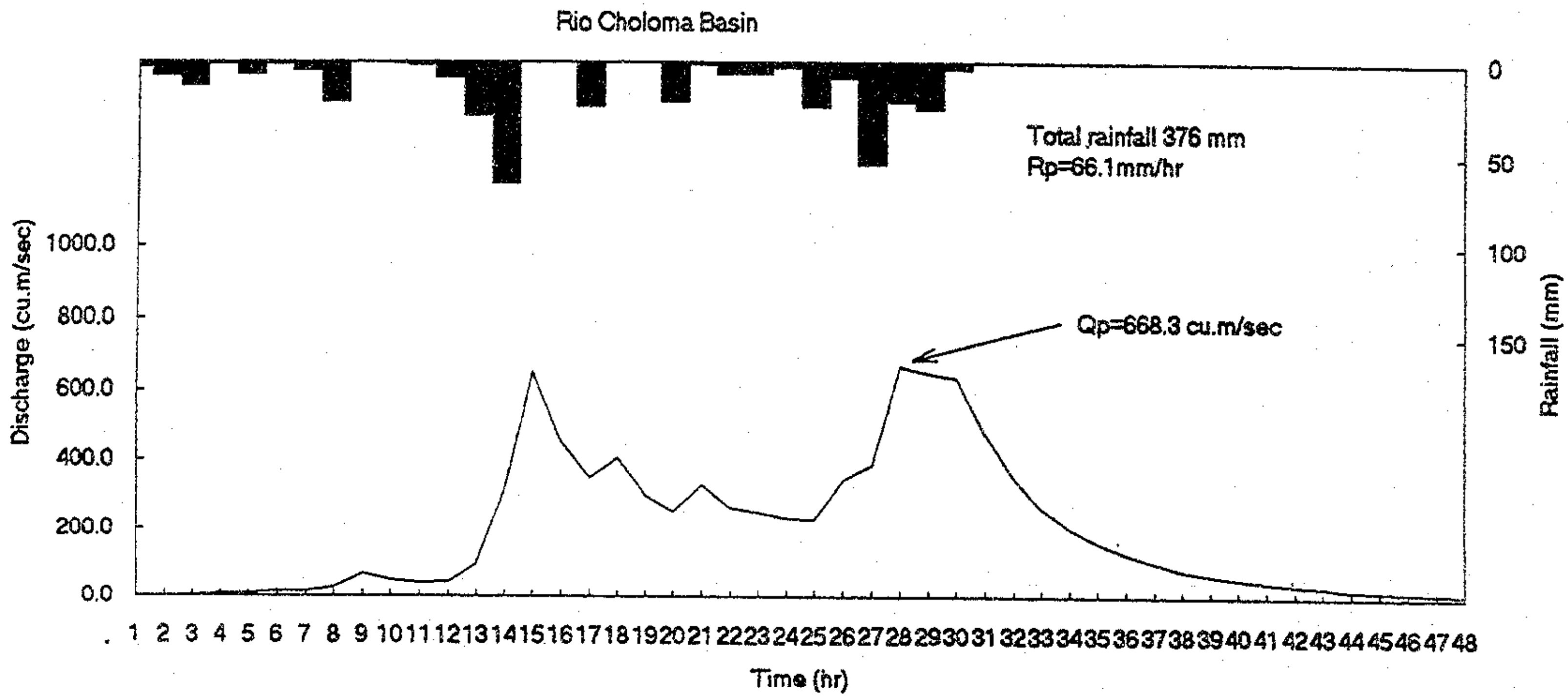


FIG.3.21 SIMULATED FLOOD HYDROGRAPH OF THE HURRICANE FIFI

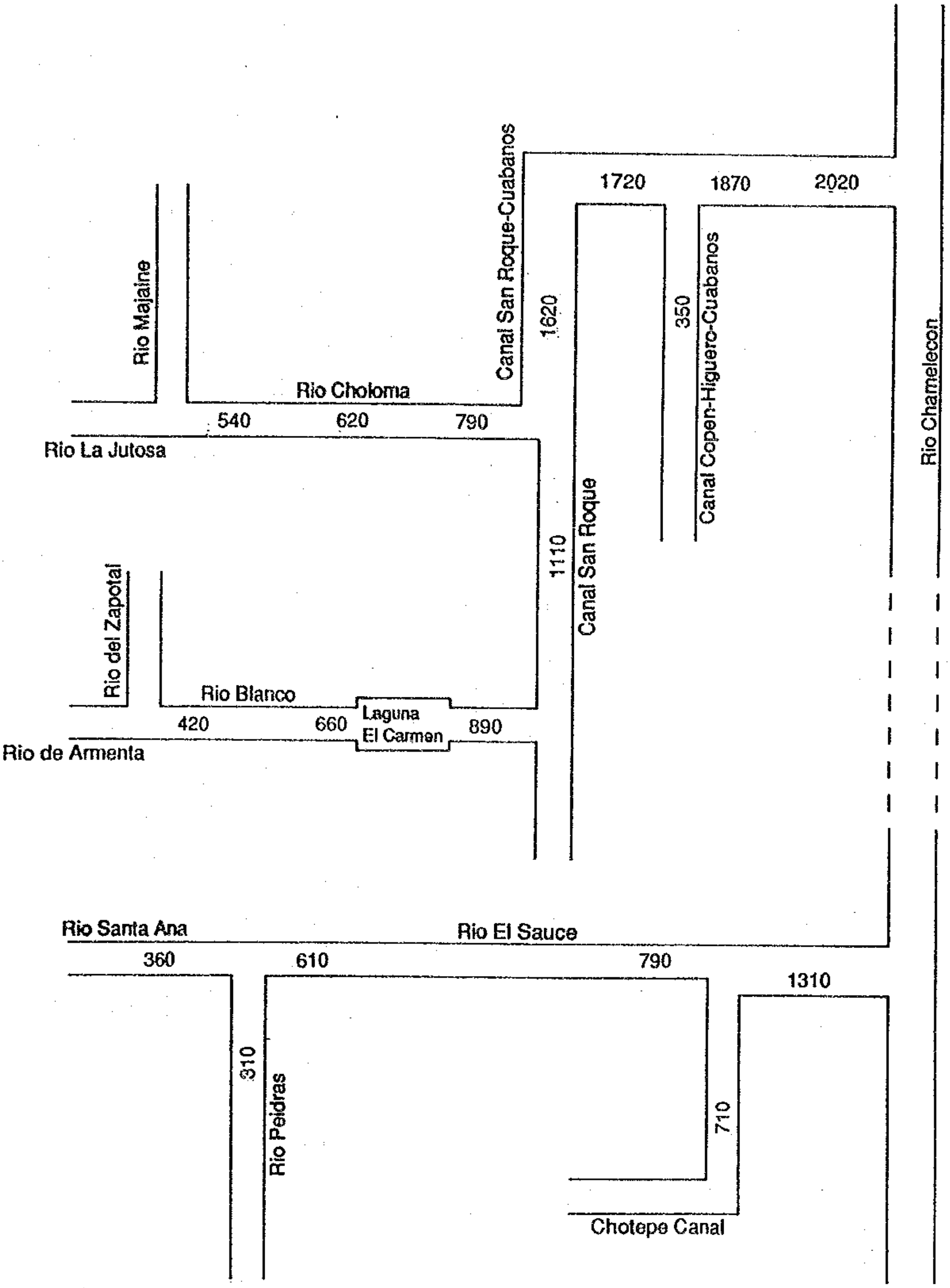


FIG.3.22 PEAK DISCHARGE DISTRIBUTION
(50-YEAR FLOOD / PRESENT RIVER SYSTEM)

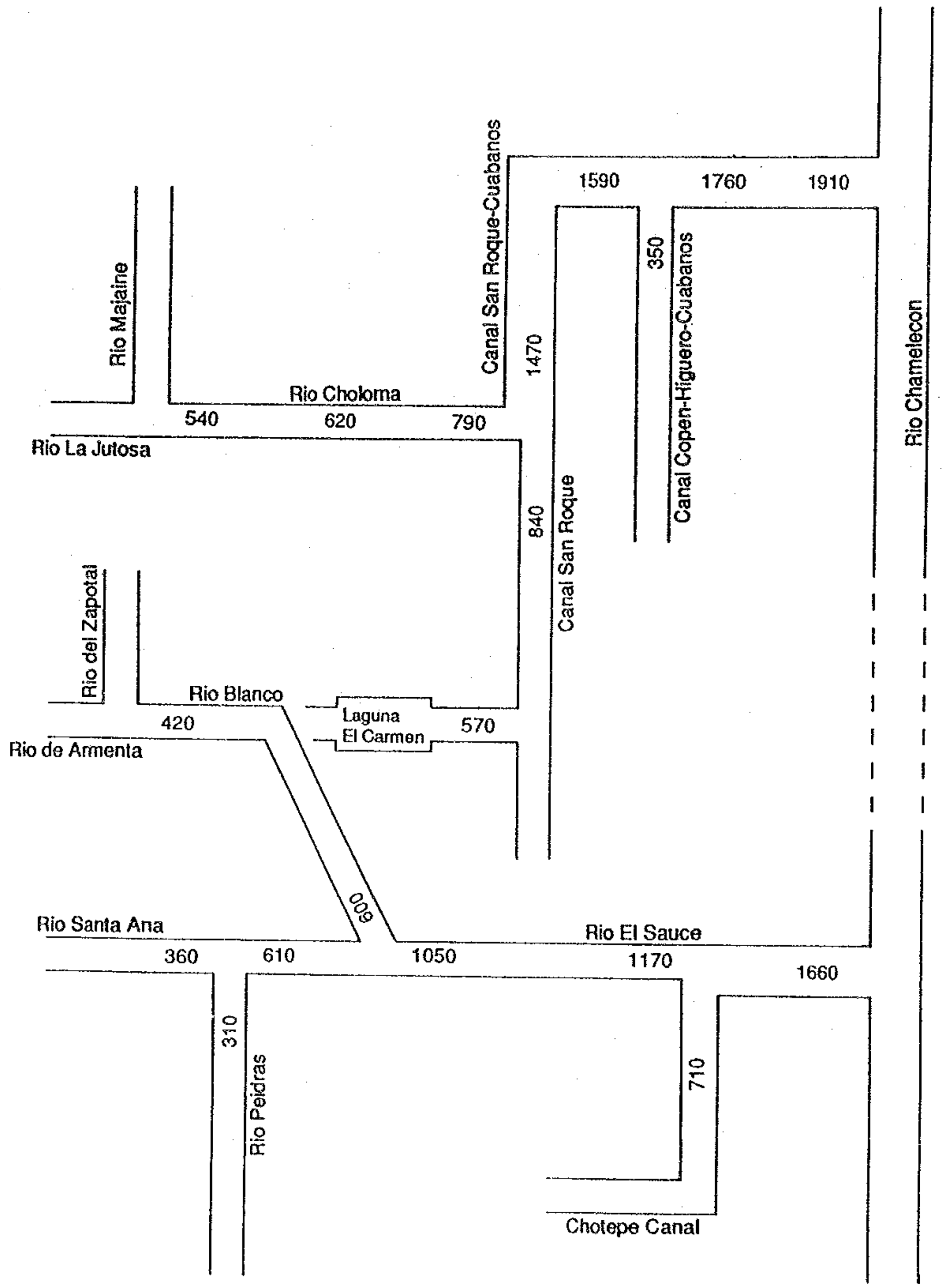


FIG.3.23 PEAK DISCHARGE DISTRIBUTION
(50-YEAR FLOOD / ALTERNATIVE RIVER SYSTEM)

SAN PEDRO SULA (1993)

BANANA PLANTATION ALONG THE RIO CHAMELECON (1993)

CHAPTER 4
SOCIO - ECONOMIC STUDY

CHAPTER 4 SOCIO-ECONOMIC STUDY

4.1 National Socio-Economic Background

4.1.1 Gross Domestic Product(GDP) and Gross National Product(GNP)

GDP and GNP of Honduras showed the average annual growth rate of about 19 % at current prices (real rate of 3 %) during the period 1987-1991, and amounted to Lps. 16,406 million and Lps. 15,274 million respectively at the 1991 market prices (*Table* 4.1). Agricultural sector, which is the major economic activity of the country, accounted for more than 20 % of the total GDP during the said period.

The per capita GNP at current price amounted to Lps. 3,107 in 1991 on the growth at the average annual rate of 14.8 % during the same period, but the real growth was only an average rate of 0.2 % per annum. This real rate indicates that the average living standard of Honduran people was little improvement during the period 1987-1991.

4.1.2 External Trade

In 1991, Honduran exports were about US$ 780 million, being composed of almost agricultural products such as bananas, coffee and sugar. On the other hand, the imports reached about US$ 880 million which consisted of commodities required for the daily life and the social and economic activities of Honduran people.

During the period 1987-1991, the imports exceeded the exports every year, and such a trade deficit was trending toward increase in proportion to decrease in the exports. Actually, the deficit in 1991 amounted to about US$ 100 million.

4.1.3 Balance of International Payments

In the international payments of Honduras, the current account indicated a deficit every year for the period 1989-1991, due to the deficits of trade balance and service account. Its deficit was US$ 194.3 million in 1989, US$ 112.4 million in 1990 and US$ 219.8 million in 1991 *Table* 4.2.

Such a deficit of current account was compensated by the capital account which included an external loan, with the aim of maintaining the balance of international payments. As a result, the external loan of Honduras was being accumulated year by year.

4.1.4 Government Finance

Revenue (or expenditure) of the Central Government increased at the average rate of

17.9 % per annum during the period 1987-1991, and amounted to Lps. 4,643.7 million in 1991. In the same year, more than 80 % of the Government revenue were occupied by tax revenue and internal and external debts. Among the revenue, it is noticeable that the external debt was being considerably increased in recent years. During the said period, a new external debt exceeded amortization of the debt every year, for example, in 1991 the difference between both amounts was Lps. 507.8 million.

On the other hand, the expenditure of the Central Government in 1991 was mainly composed of current expenditure (58 %), investment (17 %) and amortization of public debt (22 %). Details are given in *Table* 4.3.

4.1.5 National Integral Development Strategy

According to the National Integral Development Strategy of Honduras for the period 1990-1994 which was published by the SECPLAN in 1990, the real economic growth is projected at a rate of 3 or 4 % for this period, expecting increase in exports and private investment. During the same period, it is expected that the financial requirements of the government will amount to US$ 2,489 million, which include grants for the balance of payments, operations to pay-off arrears and repayments.

4.2 Socio-Economic Condition in the Study Area

4.2.1 Location and Administration

The Study Area is located in the northern part of Honduras, and extends from 15°24' to 15°48' north latitude and from 87°46' to 88°07' west longitude. It has an area of 717 km^2.

The Study Area is included in the Department of Cortes and spreads over four Municipalities; San Pedro Sula, Choloma, La Lima and Puerto Cortes. Each Municipality is divided into cities (municipios), towns (pueblos) and villages (aldeas) in accordance with a population-scale. San Pedro Sula, the second largest city of Honduras, forms the central area of administration, industry and commerce in the northern part of Honduras..

4.2.2 Population and Housing

1) Population and Housing Censuses

Since 1961, the Republic of Honduras has conducted three population and housing censuses in 1961, 1974 and 1988. The Honduran population amounted to 4,443,721 in 1988, on the increase from 2,656,948 in 1974 and 1,884,765 in 1961. The average annual growth rate was 2.68 % for the period 1961-1974 and 3.74 % for the period 1974-1988. The average population density in the country as a whole was 40 persons/km^2 in 1988 (*Table* 4.4).

The total population of four Municipalities, San Pedro Sula, Choloma, La Lima and Puerto Cortes, which include the Study Area, reached 500,886 in 1988 on the increase rapidly from 281,247 in 1974 and 137,988 in 1961. The average annual growth rate showed 5.63 % for the period 1961-1974 and 4.21 % for the period 1974-1988. The population density came to 268 persons/km^2 in 1988 (*Table* 4.5).

The population censuses indicate that the Study Area and its surrounding areas were trending toward urbanization rapidly since 1961. In the said four Municipalities, urban population accounted for 77 % of the total population in 1988, on the increase from 66 % in 1974 and 58 % in 1961. Especially in the Municipality of San Pedro Sula, the urban population reached 88 % in 1988 (*Table* 4.6).

According to the National Housing Census in 1988, the said four Municipalities had 106,302 houses in total at the average density of 57 houses/km^2, composed of 77 houses/km^2 in San Pedro Sula, 29 houses/km^2 in Choloma, 85 houses/km^2 in La Lima and 35 houses/km^2 in Puerto Cortes (*Table* 4.7).

Further, the 1988 Census indicates that the average family size per house was 4.71 persons/house in the whole area of the four Municipalities, 4.70 persons/house in San Pedro Sula, 5.06 persons/house in Choloma, 4.64 persons/house in La Lima and 4.48 persons/house in Puerto Cortes.

2) Estimates of Population and Number of Buildings in the Study Area

The population and number of buildings in the Municipality shown in *Table* 4.7 are the whole figures in each Municipality, not figures in the Study Area where is composed of a part of each municipal territory. Therefore, with the object of getting a basic data required for analyzing the potential flood damage, the JICA Study Team surveyed the 1992 population together with number of buildings in the Study Area.

The 1992 population in the Study Area is approximately estimated at 520,000, composed of 384,000 in the San Pedro Sula area, 101,000 in the Choloma area, 20,000 in the La Lima area and 15,000 in the Puerto Cortes area.

Out of the total population in the Study Area in 1992, the urban population is estimated at 467,000 accounting for 90 % of the whole, and the remaining populations of 48,000