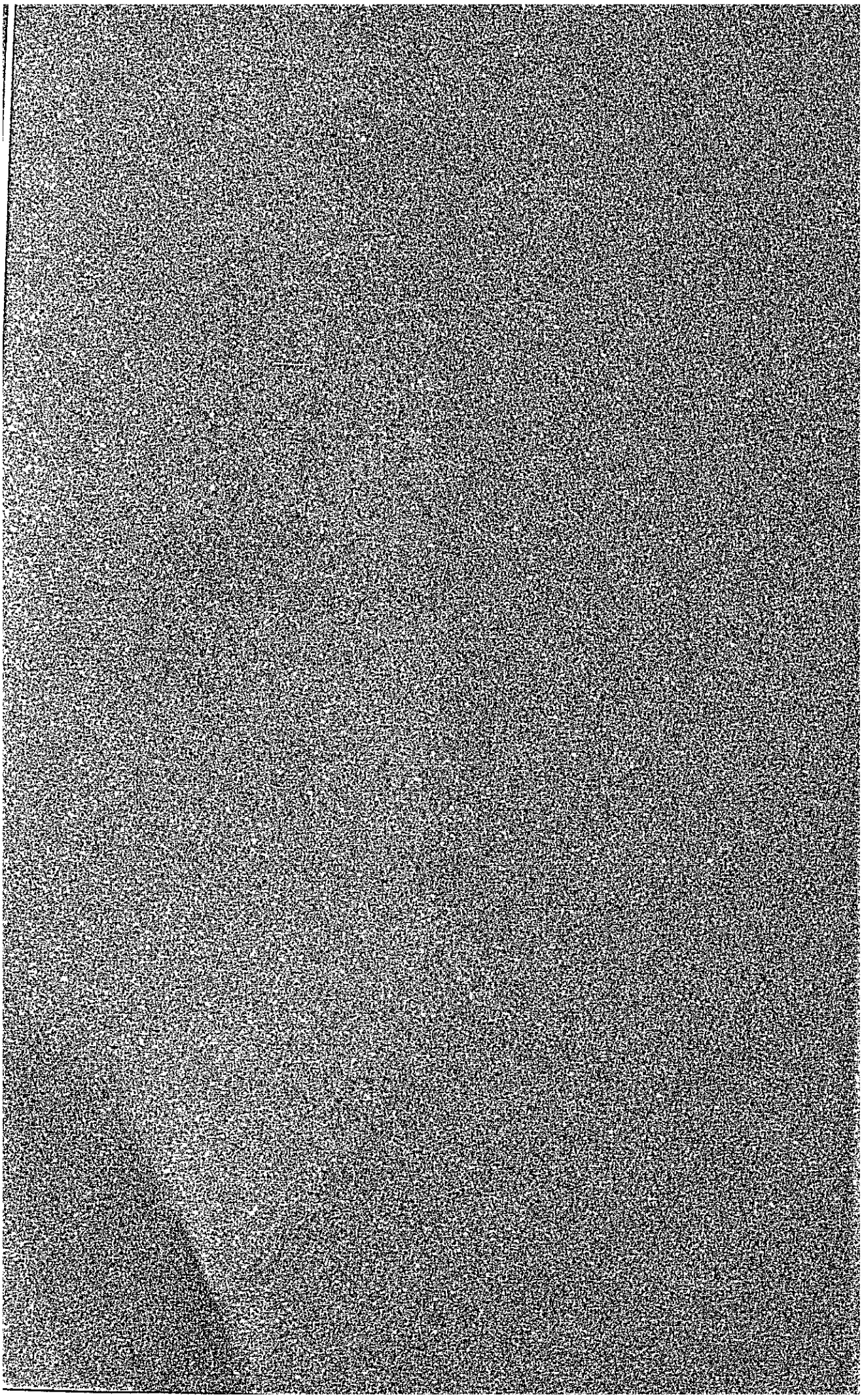
CHAPTER III
PRESENT CONDITIONS OF THE STUDY AREA



CHAPTER III

PRESENT CONDITIONS OF THE STUDY AREA

3.1 The Study Area

The study area is located in the north eastern end of Cucuta District. The boundaries of the study area are the Zulia River on the north, the Grita and Guaramito River on the east and the national road between Cucuta and Puerto Santander on the west. The southern end of the sutdy area is 90 to 100 m.A.S.L. (Fig. 3-1).

The extent of the study area is 3.7 km wide and extends 12 km from the south to the north covering an area of 13,500 ha. The distance from Agua Clara, which is the central part of the study area, to Cucuta city is approximately 40 km.

3.2 Natural Conditions

3.2.1 Meteorology

(1) Location of Observation Stations and Available Data

There are 10 meteorological stations and 18 rain gauge stations in the catchment areas of the Pamplonita and Zulia River. The density of these stations in the lower catchment areas is relatively dense but it is sparsely distributed in the middle and upper reaches of the catchment areas (Fig. 3-2).

The observation items are; air temperature, relative humidity, sunshine hours, wind speed and direction, pan evaporation and daily rainfall. At some observation items are incomplete. Although the observation period is long, there is much incomplete and unprocessed data.

In order to analyse characteristics of the climate in the catchment area of the Pamplonita River, 3 meteorological stations were selected according to the location of the stations and completeness of recorded data (Table 3-1).

Table 3-1 Principal Meteorological Station in the Pamplonita River Basin

Station	Altitude	Location	Recorded Period
Santa Isabel	64 m	Lower Reach*	1969 - 1984 year
Camilo Daza	300 m	Middle Reach	1941 - 1984 year
La Esperanza	1,760 m	Upper Reach	1973 - 1984 year

* Within the study area

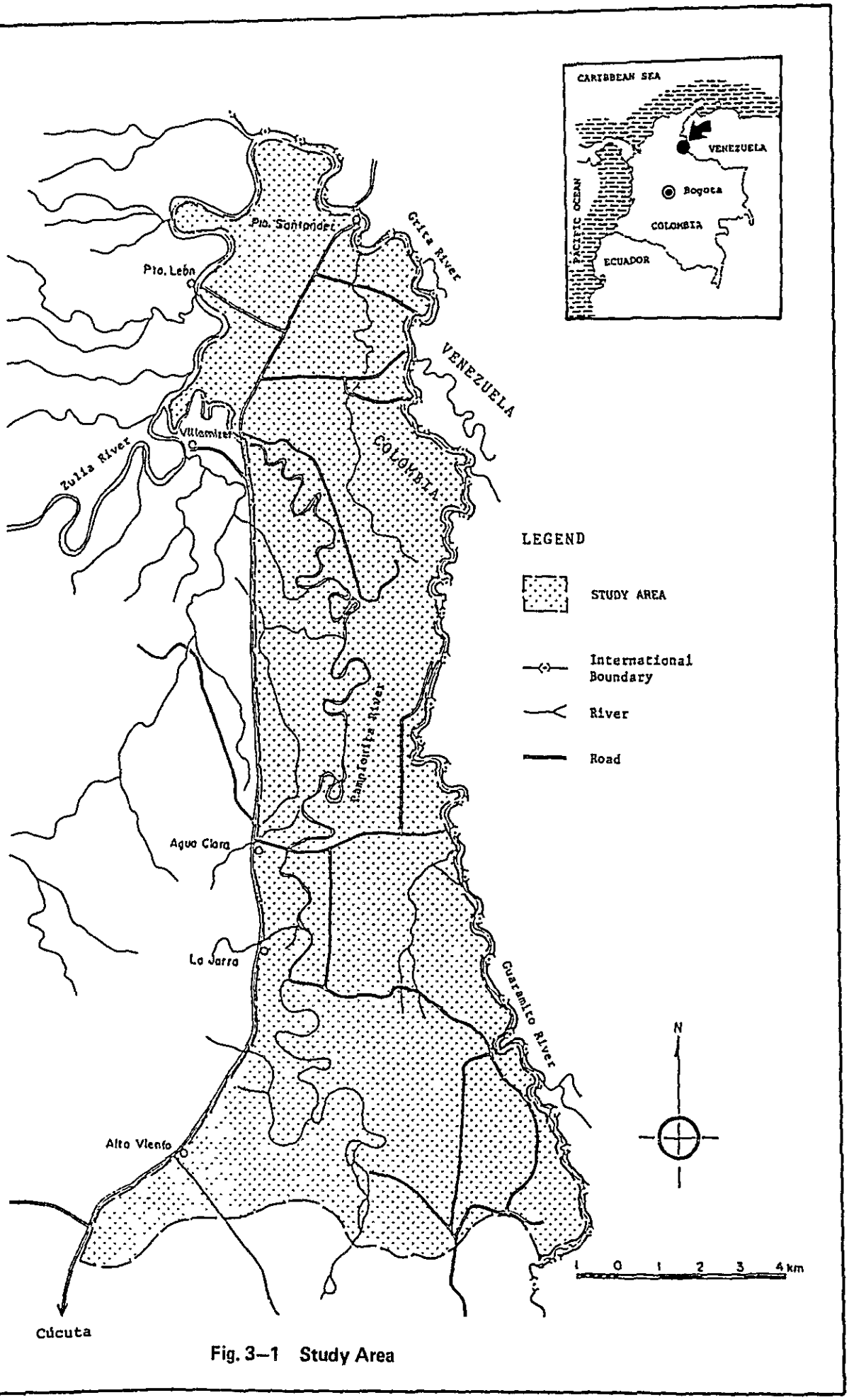


Fig. 3–1 Study Area

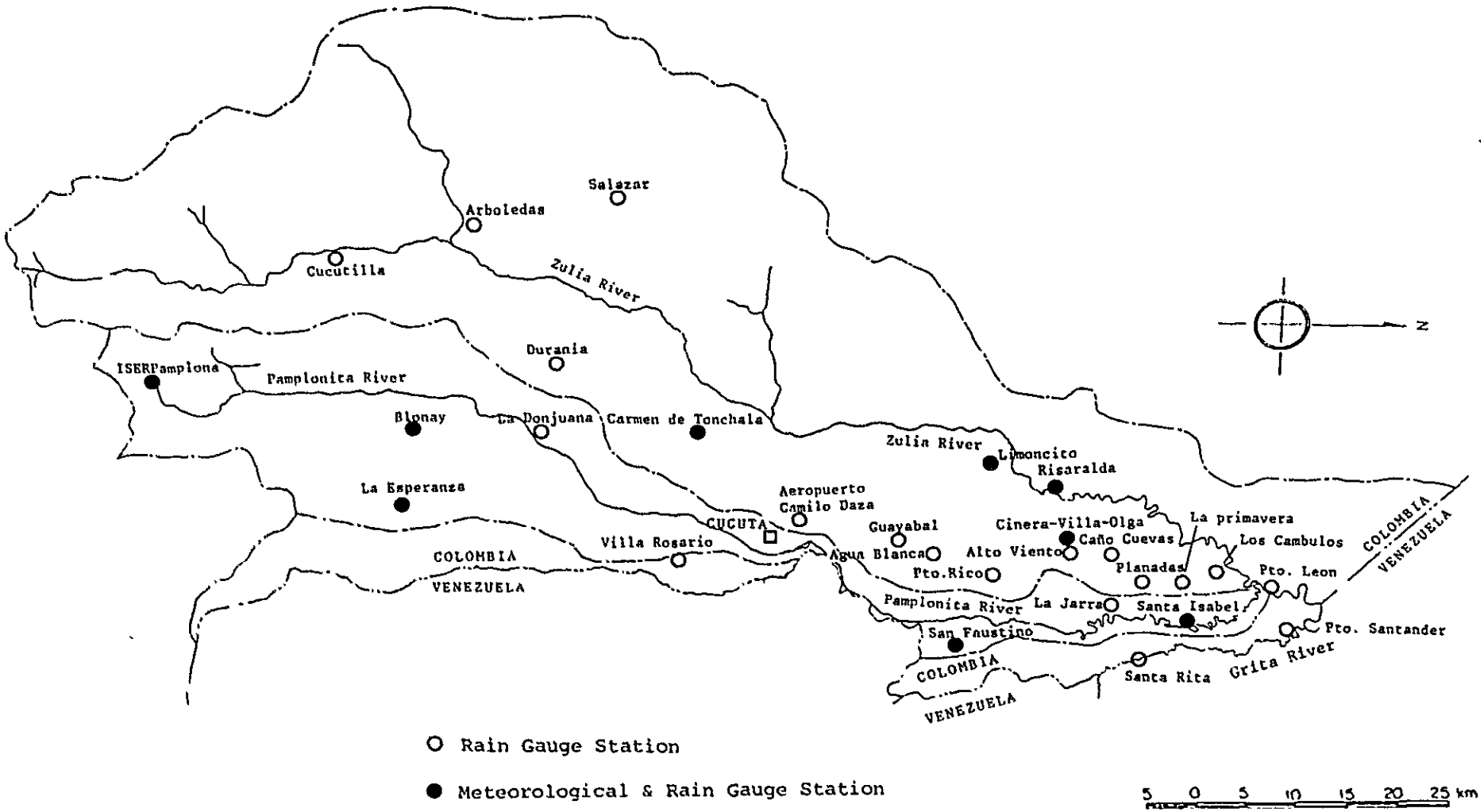


Fig. 3–2 Meteorological and Rain Gauge Stations

(2) General Description of Meteorology

Geographically, the catchment area of the Pamplonita River is located in the tropical climate zone, however, the local climate in the upper, the middle and the lower reaches of the catchment area is different (Fig. 3-3).

Monthly average air temperature in the lower reach is 26.9°C (Santa Isabel) and in the middle reach it is 28.0°C (Camilo Daza). Although variation of monthly average air temperature is less than 5°C, variation of daily air temperature ranges aproximately 12°C. In the upper reach, the monthly average air temperature is 16.6°C (La Esperanza) due to the high altitude.

Monthly average relative humidity in the lower reach is 83% (Santa Isabel) and its annual variation is small. In the middle reach, monthly average relative humidity is 65% (Camilo Daza) and in the upper reach it is 86% (La Esperanza).

In general, monthly average relative humidity is up to 10% higher in the rainy seasons (from April to May and from September to December) than in the dry seasons (from January to March and from June to August).

Sunshine hours were recorded as 1,960 hrs in the lower reach and 2,200 hrs in the middle reach. No data is recorded for the upper reach. There is annual variation in the recorded sunshine hours due to cloud conditions.

Wind speeds in the lower and the upper reaches reaches ranges between 1.0 and 1.7 m/s and its monthly variation is small. In the middle reach rather strong wind speeds (4.5 m/s) are recorded (Camilo Daza).

Predominating wind directions are south and north in the lower reach however, the north west and the south east winds predominate in the middle and upper reaches.

Average pan evaporation is 1,520 mm/year (Santa Isabel) in the lower reach which corresponds to 65% of average annual rainfall in the area. In the middle reach pan evaporation exceeds 2,000 mm/year (Camilo Daza) which corresponds to 230% of annual rainfall.

3.2.2 Rainfall

(1) Area Classification Based on Rainfall Amount

Since both of the catchment areas of the Zulia and the Pamplonita River extend from the south to the north for a wide range of altitudes, the amount of annual rainfall varies in the each catchment areas. Therefore, both catchment areas are classified into three areas based on the amount of annual rainfall (Fig. 3-4).

Some rain gauge stations were selected for further rainfall analysis according to completeness of data and location of the stations representing each classified area (Table 3-2).

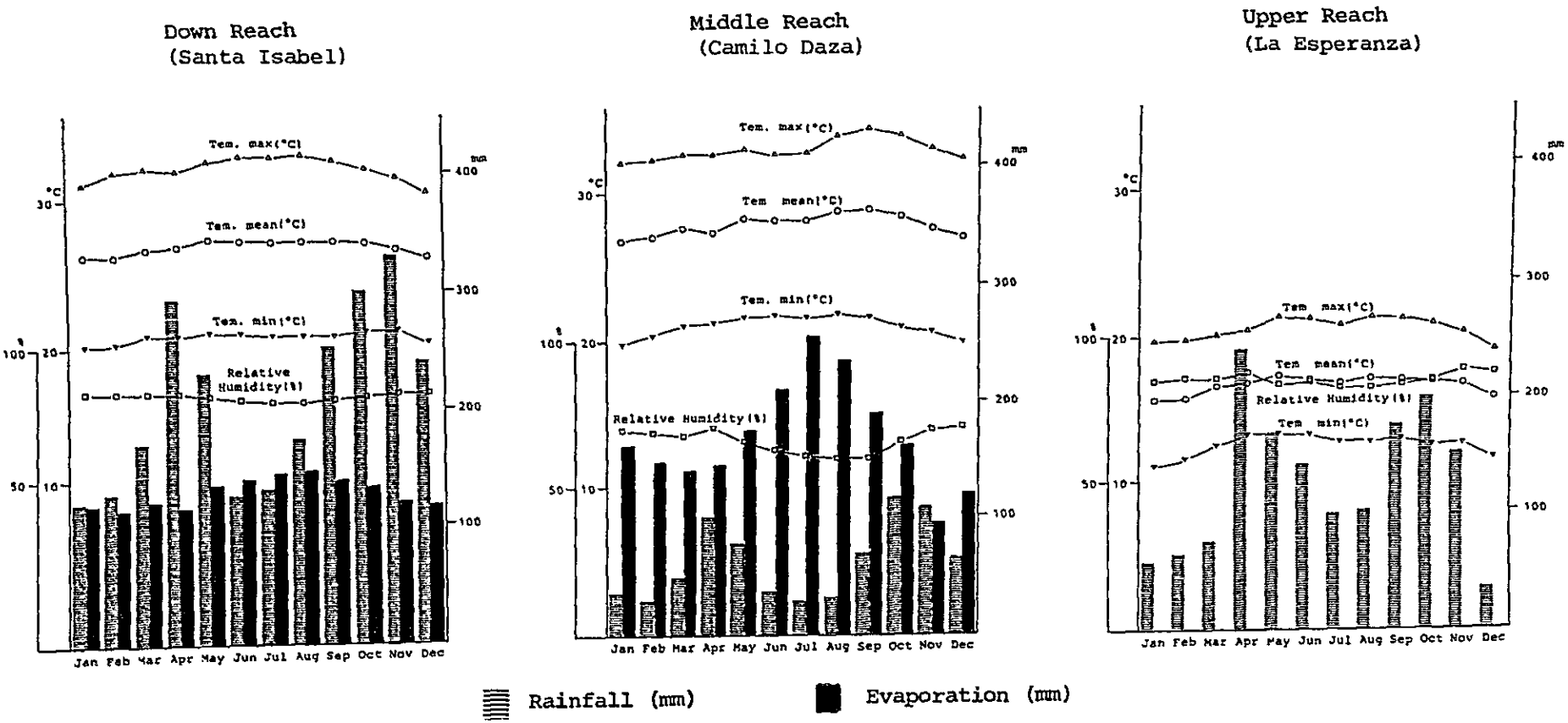


Fig. 3–3 Meteorological Characteristics

Table 3–2 Rainfall Types and Rain Gauge Stations

Area	Type of Rainfall	Rain Gauge Station	Period of Records
I	Wet Area in the Lower Reach of the Pamplonita River Catchment Area	Puerto Leon	1961 - 83
		Santa Isabel	1971 - 83
		La Jarra	1963 - 80
		Alto Viento	1961 - 83
		Cinera	1968 - 83
		(San Faustino)	1968 - 83
II	Dry Area in the Middle Reach of the Pamplonita River Catchment Area	Camilo Daza	1941 - 83
III	Wet Area in the Upper Reach of the Pamplonita River Catchment Area	La Esperanza	1973 - 83
		ISER Pamplona	1978 - 83

( ) located in transition area from I to II

(2) Average Rainfall

1) Average Maximum Daily Rainfall

An average maximum daily rainfall (from rainfalls lasting one day, 2 consecutive days and 3 consecutive days) in each year from 1970 to 1980 is summarized in Table 3-3.

Table 3–3 Maximum Daily Rainfall

(mm)

Rainfall Type	One Day	Two Consecutive Days	Three Consecutive Days
I	120.6 (Cinera)	155.4 (Puerto Leon)	179.8 (Puerto Leon)
II	75.4	92.3	97.2
III	57.6	75.0	91.0

(Based on analysis of maximum daily rainfall recorded at stations shown Appendix 2.2)

2) Average Monthly Rainfall

Average monthly rainfall in each classified area is summarized in Fig. 3-4. The pattern of monthly rainfall hydrographs of three areas classified appear to have the same pattern.

In each area, there is high rainfall in the months in April and May and from September to December. The former is called the small rainy season and the latter, the large rainy season. The rest of the months correspond to dry seasons. In the area of Type I there is more than 100 mm/month rainfall and in the Type II and III areas, the minimum average monthly rainfalls are 30 mm/month and 25 mm/month, respectively.

3) Average Annual Rainfall

Average annual rainfall in the catchment areas of the Pamplonita and the Zulia River varie Significantly from place to place (Fig. 3-5). There is more rainfall in the upper area (Type III) and the lower area (Type I) whereas the intermediate area (Type II) appears relatively dry. Annual rainfall in each area is summarized below:

Area	Rainfall (mm/year)
Type I	2,200 - 2,600
Type II	500 - 1,200
Type III	900 - 1,500

In the records for annual rainfall during 11 years from 1970 to 1980, it appears that there were relatively heavy rainfalls in 1974, 1975 and 1979. The variation of annual rainfall in the area of Type I which includes the study area ranges between 1,500 mm/year and 3,000 mm/year during the same period (Fig. 3-6 and Table 3-4).

Table 3–4 Annual Average Rainfall

(mm)

Type	Station \ Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	Average
I	Pto. León	2707	2831	2262	2341	2950	3235	2329	1936	2814	2848	(1586)	2628
	Santa Isabel	-	2446	2272	2356	2920	3046	2344	1495	2093	2466	2077	2352
	La Jarra	1419	1245	1160	2013	2981	2643	2331	1452	2223	2786	2033	2044
	Alto Viento	2482	2406	2015	2398	3038	2702	2289	1348	1695	2483	1524	2216
	Cinera	2569	2480	1784	2488	2698	2739	2452	1480	2178	2716	1604	2308
	Average	(2294)	2281	1898	2319	2917	2913	2349	1542	2200	2660	1805	
II	San Faustino	2167	2185	1856	1829	2317	(1803)	(1328)	(720)	(1072)	(1205)	1251	1934
	Camilo Daza	764	(855)	(865)	1024	914	1060	1066	(705)	824	(831)	653	904
III	La Esperanza	-	-	-	1214	1489	(1366)	(1325)	(801)	(1346)	(508)	1284	1329
	ISER Pamplona	-	-	-	-	-	-	-	-	774	(128)	788	781
	Average									(960)	(318)	1026	

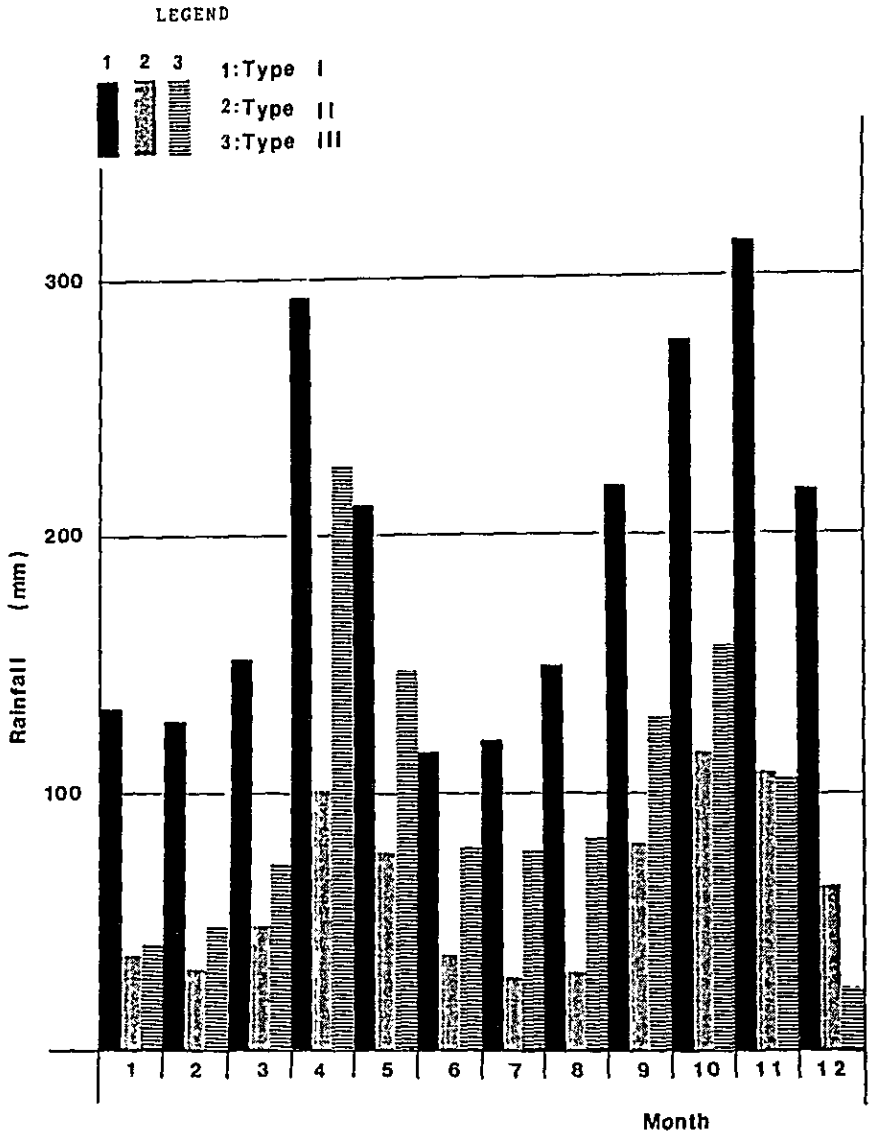


Fig. 3–4 Monthly Average Rainfall by Rainfall Type

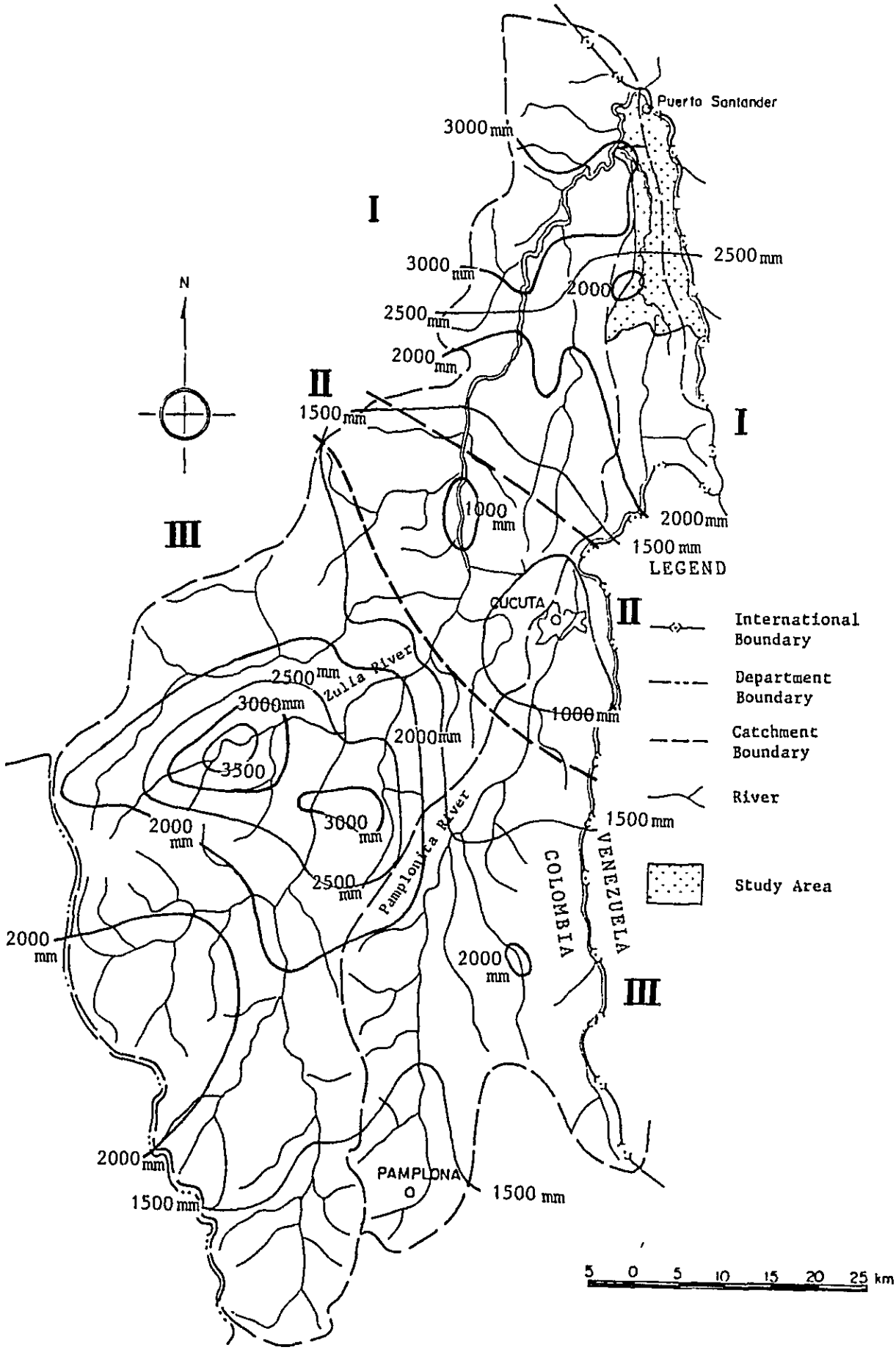


Fig. 3–5 Isohyeto Map of Annual Rainfall

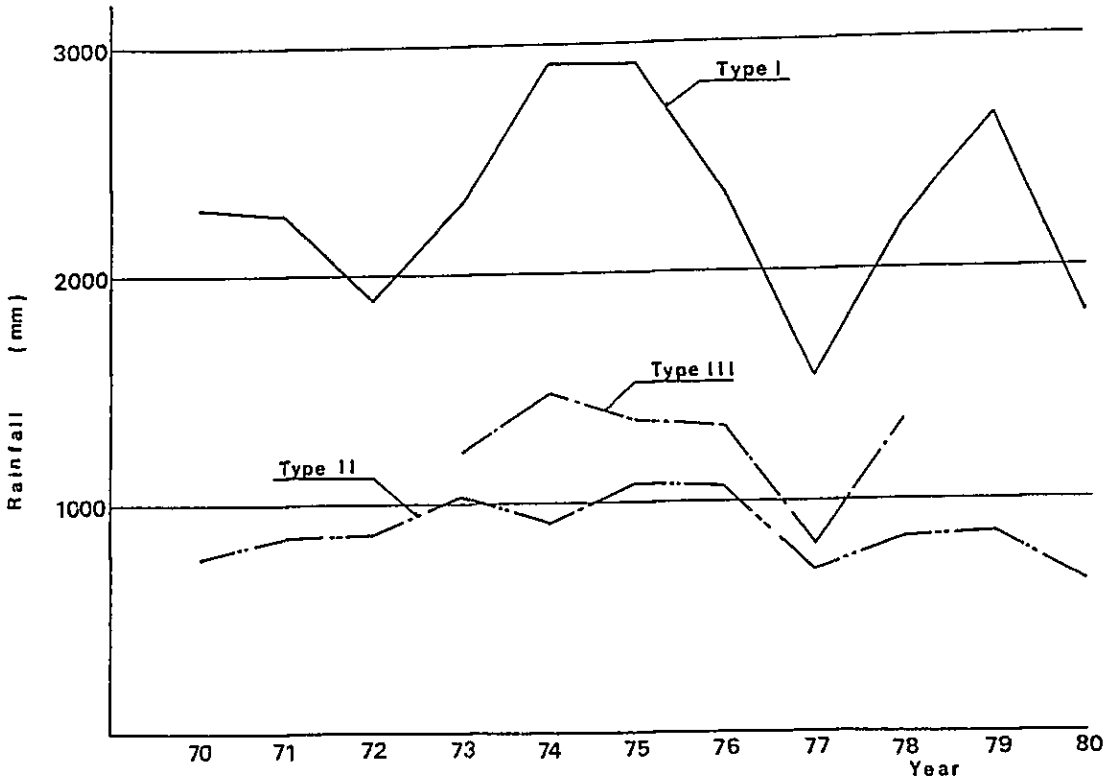


Fig. 3–6 Variation of Annual Rainfall

4) Statistical Analysis of Rainfall

In order to obtain statistical data for the average maximum daily rainfall, analysis was made using the IWAI Method on maximum daily rainfall and two and three consecutive days maximum rainfall during 11 years between 1970 and 1980.

The results obtained by the analysis are summarized in Table 3-5.

Table 3–5 Stochastic Maximum Daily Rainfall

(mm)

Type	Days	Return Period (Year)					
		2	5	10	20	30	50
I	1	116	144	160	175	183	193
	2	148	188	213	237	206	267
	3	173	220	250	277	219	312
II	1	73	89	99	108	113	119
	2	85	106	124	145	158	177
	3	92	111	126	141	151	164
III*	1	52	66	73	79	83	86
	2	75	95	109	122	130	141
	3	97	125	141	157	166	176

* Data at la Esperanza is used for Type III since data at ISER Pamplona is incomplete.

3.2.3 Hydrology

(1) Rivers

In the study area, there are three rivers, the Pamplonita, the Grita and the Zulia River. Basins of these three rivers are part of the Catatumbo River system.

The head water of the Pamplonita River flows from the eastern mountain range (3,200 m.A.S.L.) of the southern regional border toward the north. The total length of the river is approximately 170 km, with about 2,060 km^2 of catchment area. The gradient of the riverbed is approximately 2% upto the southern border of the study area. Since the southern border of the study area is located along the transition area from hill slopes to flat alluvial plain, the gradient of the riverbed changes to almost 0.1%.

The Grita River originates from the Merida Mountain Range (3,900 m.A.S.L.). Most of its catchment area extends into the Venezuelan territory. The extent of the catchment area is estimated as approximately 1,500 km^2.

The Zulia River has its headwater in the eastern mountain range, the same as the Pamplonita River. The catchment area occupies a wide area on the western side adjacent to the catchment area of the Pamplonita River. The river course in Colombia flows from the south to the north along 193 km and has approximately 6,860 km^2 of catchment area.

The dimensions of these rivers are summarized in Table 3-6 and the location of catchment areas are shown in Fig. 3-7.

Table 3–6 River Characters

River System	River	Limit of Catchment Area and Gauging Stations	Catchment Area (km)	Length of the River Course (km)	Remarks
Pamplonita	Pamplonita	Up to confluence with Tachira River	870	82	*excluding Grita River **including Grita River
	Tachira	Up to confluence with Pamplonia River	740	73	
	Pamplonita	Up to confluence with Zulia River	2,060	170	
Zulia	Zulia	San Javier	1,580	92	
	Peralonso	Cornejo	460	56	
	Zulia	Pajarito	2,640	120	
	Zulia	Puerto Santander	5,360* 6,900**	193	
Grita	Grita	Puerto Santander	1,500	-	

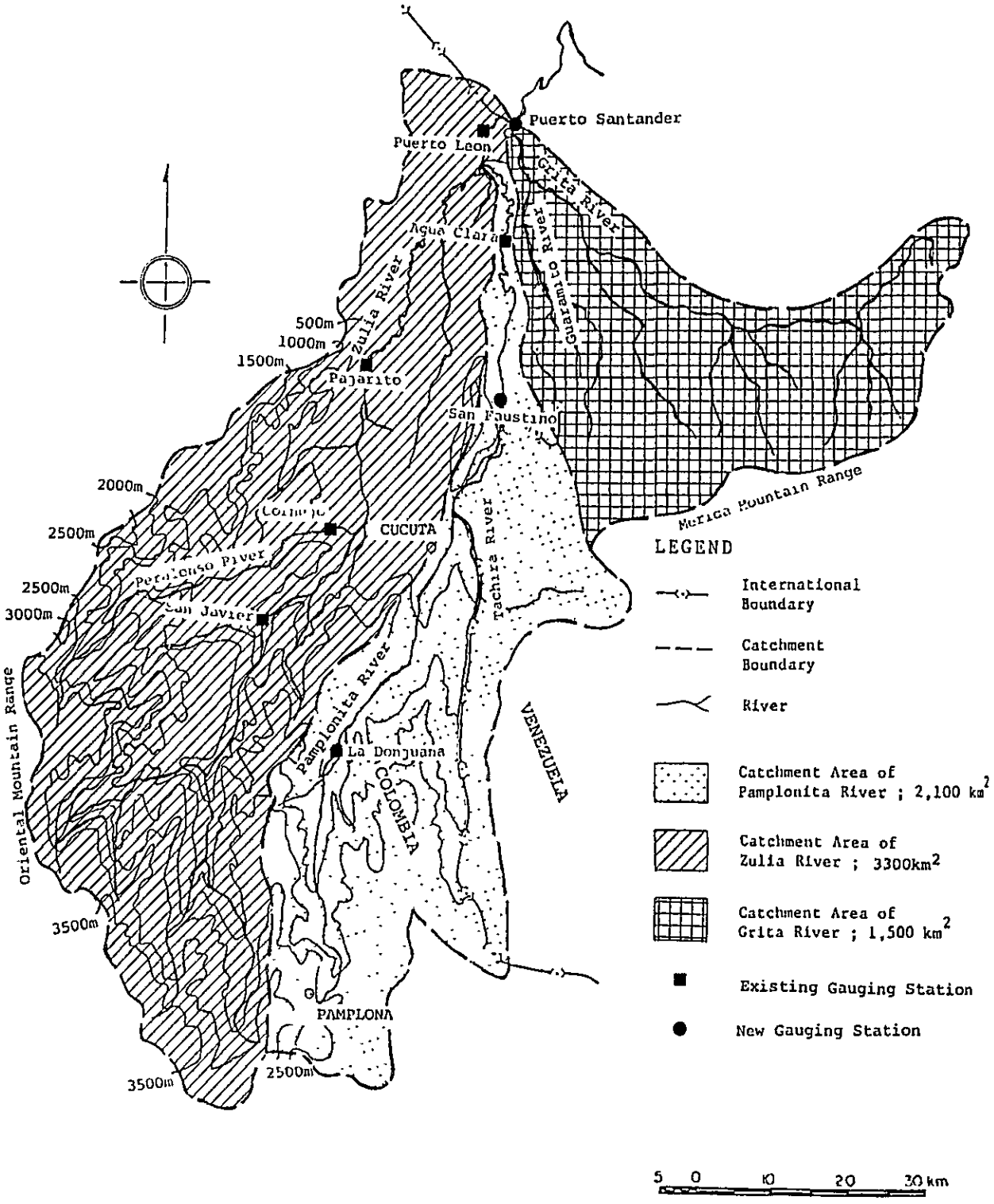


Fig. 3–7 Map of Catchment Areas and Gauging Stations

(2) Location of Gauging Station and Available Data

Location and related information of gauging stations are summarized in Table 3-7.

Table 3–7 Characteristics of Gauging Stations

River System	River	Station	Latitude (N)	Longitude (W)	Altitude (m)	Catchment Area (km^2)	Observation Period
Pamplonita	Pamplonita	Agua Clara	8°14'	72°26'	70	2,020	1966-82
	Pamplonita	La Donjuana	7°42'	72°36'	740	426	1972-82
Zulia	Zulia	Puerto Leon	8°22'	72°26'	50	5,340	1972-82
	Zulia	Pajarito	8°05'	72°34'	140	2,540	1959-82
	Zulia	San Javier	7°51'	73°28'	200	1,580	1958-82
	Peralonso	Cornejo	7'55'	72°39'	300	460	1968-82
Grita	Grita	Puerto Santander	8°22'	72°25'	50	1,500	1966-73

Although the observation period of river discharge is more than 10 years at most stations, data are incomplete in many cases. Of these stations, however, at Agua Clara, Puerto Leon and La Donjuana, almost complete water level data during 10 years between 1973 and 1982 are available (Appendix Table 2-3-6).

The discharge of the Pamplonita River has been observed at La Donjuana. However, since a tributary of which hydrological data is not available (the Tachira with the catchment area of approximately 740 km^2) flows into the Pamplonita River between La Donjuana and the study area, no data is available to estimate inflow through the Pamplonita River into the study area.

In the middle part of the study area, there is a gauging station at Agua Clara, however, only water level data is available during floods.

Under the circumstances, one gauging station was installed at San Faustino in the first stage of the study to obtain records of floods inflow through the Pamplonita River into the study area in order to analyze the behavior of flooding in the study area.

In addition, since no discharge data of the Grita River is available, a new water level recorder was installed at Puerto Santander where there is the confluence of the Grita with the Zulia River.

The purpose of installation of this station is to analyze flood overflow to estimate the water level of the Grita River, moreover, to compare in relation to the discharge recorded at Puerto Leon which is located about 12.5 km upstream along the Zulia River from this new gauging station.

(3) Discharge

Yearly average discharge during 1973 and 1981 of the Pamplonita River at Agua Clara and yearly average discharge during 1972 and 1981 of the Zulia River at Puerto Leon are 22 m^3/s and 114 m^3/s, respectively. As illustrated in Fig. 3-8, there is considerable monthly variation of discharge in both rivers. Higher discharge are observed in the months of April, May, October and November. The maximum monthly discharge occurs in April (39 m^3/s) at Agua Clara and in November (202 m^3/s) at Puerto Leon.

In general discharges between January and March, and July and August appear to be low, however, in the records for the past 10 years, relatively high monthly discharge has occurred even during the months from December to March in some years.

Monthly discharge in July and August is relatively low and steady.

The drought discharge recorded at Agua Clara, La Donjuana and Puerto Leon stations is summarized Table 3-8.

(4) General Description of Floods

1) The Pamplonita River

The flow capacity of the Pamplonita River tends to decrease as the river goes downstream from San Faustino to its confluence with the Zulia River.

Flooding water on the right bank of the Pamplonita River flows to the Guaramito, the Miel and the Grita River. On the left bank, flooding water flows toward the Floresta River.

The flood occurred in 1981 is in the magnitude for approximately 10 year return period. The flood in 1975 is assumed to be approximately in the magnitude for 5 year return period (Table 3-9).

The ground height of the right bank at Agua Clara is lower than that of the left bank by 1.5 m. When water level rises higher than 67.9 m.A.S.L. overflow occurs on the right bank (Appendix 3-1). The flow volume of floods at this stage is estimated to be approximately 300 m^3/s. The height of the riverbed at this point is approximately 65 m.A.S.L.

According to interviews with local resisdents, the floods occurred in 1981 had the highest in the recent years. In general floods occur once every three years and subside within three days.

This is verified in flood water level records, however, due to poor drainage conditions land inundation lasts a long time in some parts of the area.

2) The Grita and The Guaramito River

The Grita River sometimes overflows at Puerto Santander due to backwater from the Zulia River. Since the ground height of the right bank in Venezuela is lower than the ground height of the left bank, no significant overflow occurs in the study area. However, the Guaramito River overflows in the area around the confluence with the Grita River due to backwater from the Grita River.

3) The Zulia River

Overflow of the Zulia River occurs on both sides of the river bank. High water levels in the Zulia River produce backwater to the Grita, the Miel, the Pamplonita and the Venecia River which retard the river flow through these two rivers.

Flooded waters of a magnitude of about 10 year return period occurred in 1975. Floods in magnitude of approximately 3 year return period occurred in 1973 and 1981 at Puerto Leon (Table 3-9). The recorded flood water level at Puerto Leon was 53.4 m.A.S.L. in 1975 and 52.4 m.A.S.L. in 1973 and 1981.

At Puerto Leon, overflow occurs when the water level rises more than 51.8 m.A.S.L. at which time the discharge of flooded waters is estimated to be approximately 500 m^3/s.

Table 3–8 Drought Discharge

(Unit: m^3/s)

Year	Agua Clara	La Donjuana	Puerto Leon	Remarks
1973	1.8	2.2	14.6	* 355-day Discharge
1974	4.2	3.1	50.4	
1975	1.8	3.4	37.8	
1976	4.0	4.2	38.7	
1977	3.7	2.4	23.6	
1978	2.9	2.2	29.2	
1979	3.0	2.9	(30.7)	( ): Estimated Value
1980	4.0	2.2	24.0	
1981	2.5	1.7	(30.7)	
1982	7.5	5.0	29.0	

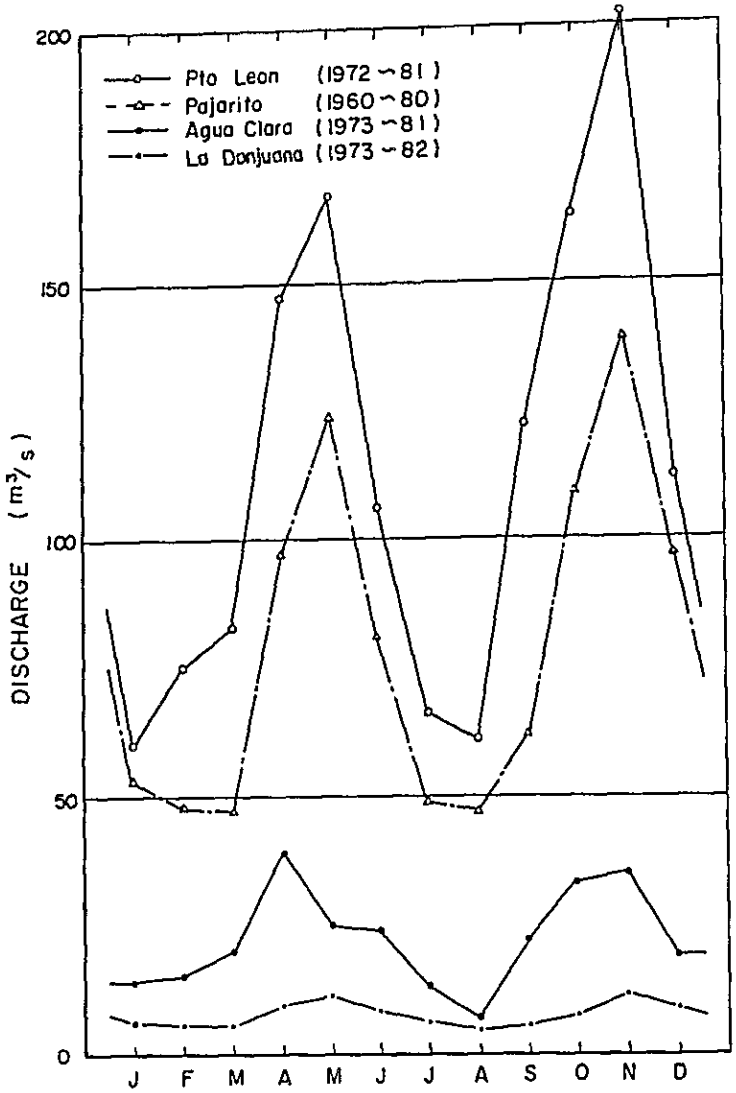


Fig. 3–8 Average Monthly Discharge

Table 3–9 Daily Maximum Water Level

Year	Agua Clara			La Donjuana			Puerto León			Remarks
	Water Level (m)	Discharge (m^3/s)	Date	Water Level (m)	Discharge (m^3/s)	Date	Water Level (m)	Discharge (m^3/s)	Date	
1973	2.87	294+	Nov. 12	1.17	27.5	Nov. 14	4.58	512	Nov. 16	+: Max. value may be estimated more than the value with + when lack of date will be filled.
1974	2.22	270*	May 3	1.25	32.6	May 3	3.90	407	May 3	
1975	3.09	341+	Dec. 16	1.43	51 0	Dec. 28	5.56	1,160*	Dec. 6	
1976	2.23	295	Mar. 7	1.11	29.1	Feb. 11	3.57	564	Oct. 11	
1977	1.19	71	Nov. 9	0.73	11.4	Nov. 7	3.15	280	Oct. 11	* Estimated Value
1978	1.93	196	Apr. 5	1.10	28.5	Apr. 20	4.34	552	Apr. 20	Zero point (m.A.S.L.)
1979	2.05	183	June 10	1.23	36.6	Nov. 26	4.13	579	June 7	
1980	1.41	97	Oct. 7	0.98	17.0	Jan. 21	3.08	302	Nov. 6	Agua Clara: 65.44 m.A.S.L.
1981	3.40+	375+	Apr.~May	1.45	69.0	May 9	4.58	726	May 10	Puerto León: 47.81 m.A.S.L.
1982	1.88	189	Apr. 15	1.10	42.0	May 4	4.45	680	May 2	

(5) Flood Analysis

1) Method of Analysis

The storage function method was proposed to be applied for flood analysis in the first stage of the study. However, since no significant floods occurred during the rainy season in 1983 and no detailed hydrological information of the Tachira River is available, flood analysis is based on existing flood information. For this purpose, existing hydrological data, river morphology, topographic conditions, interviews with local residents and site investigation were synthetically analized.

2) Flooded Water Level and Flood Discharge

The maximum daily water levels of the Pamplonita River at Agua Clara and at La Donjuana and the Zulia River at Puerto Leon are shown in Table 3-9.

In order to analyse the results of flood water level, the duration of consecutive high water levels at Agua Clara and at Puerto Leon were examined as shown in Table 3-10 and 11. The table indicates that flood water levels at Agua Clara go down in a relatively short period, but the flood water levels at Puerto Leon go down more slowly. Typical hydrographs of flood water levels are shown in Fig. 3-9. Since discharge measurement of flood volume is rarely made, the accuracy of the rating curve at high water levels is low.

Statistical analysis of flood water level at Agua Clara and at Puerto Leon was made as shown in Fig. 3-10, 11, 12.

3) Overflow

The riverbed gradients of the Zulia, the Pamplonita and the Grita River systems are as shown in Fig. 3-13, 14 and 15 and summarized as below:

River	Riverbed Gradient
Zulia	1/2,400
Pamplonita	1/240 - 1/2,000
Grita-Guaramito-La China	1/500 - 1/2,000

The riverbed gradient of the Pamplonita River becomes suddenly smaller at the southern end of the study area. The gradient of the Grita - the Guaramito - la China Rivers is almost same in the study area. The water level of flood in 5 year return period is indicated in Fig. 3-13, 14 and 15 together with a longitudinal cross-section of riverbeds. Flooding areas are estimated as shown in Fig. 3-16.

Table 3–10 Consecutive Flood Water Level at Agua Clara

(Unit: m)

Station		AGUA CLARA					
		Daily max		Consecutive 3 days max		Consecutive 5 days max	
		H	WL	H	WL	H	WL
YEAR	1973	2.87	68.32	2.20	67.65	2.03	67.48
	1974	2.22	67.67	1.71	67.16	1.47	66.92
	1975	3.09	68.54	1.96	67.41	1.72	67.17
	1976	2.23	67.68	1.54	66.99	1.23	66.68
	1977	1.19	66.64	1.07	66.52	0.84	66.29
	1978	1.93	67.38	1.62	67.07	1.24	66.69
	1979	2.05	67.50	1.64	67.09	1.60	67.05
	1980	1.41	66.86	1.11	66.56	0.87	66.32
	1981	3.40+	68.85	2.95*	68.40	2.70*	68.15
	1982	1.88	67.33	1.35	66.80	1.35	66.80
PROBABILITY	20	4.5	70.0	3.3	68.8	2.9	68.4
	10	3.8	69.3	2.8	68.3	2.5	68.0
	5	3.2	68.7	2.3	67.8	2.0	67.5
	3	2.7	68.2	2.0	67.5	1.7	67.2
	2	2.3	67.8	1.6	67.1	1.4	66.9

H : Water Depth
WL: Water Level
= H + 65 - 45

* Estimated Value

Table 3–11 Consecutive Flood Water Level at Puerto Leon

(Unit: m)

Station		PUERTO LEON							
		Daily max		Consecutive 3 days max		Consecutive 5 days max		Consecutive 7 days max	
		H	WL	H	WL	H	WL	H	WL
YEAR	1973	4.58	52.39	4.40	52.21	4.27	52.08	3.79	51.60
	1974	3.90	51.71	3.64	51.45	3.33	51.14	3.18	50.99
	1975	5.56	53.37	4.55	52.36	4.27	52.08	4.27	52.08
	1976	3.57	51.38	3.18	50.99	2.92	50.73	2.92	50.73
	1977	3.15	50.96	2.61	50.42	2.57	50.38	2.40	50.21
	1978	4.34	52.15	3.93	51.74	3.09	50.90	3.09	50.90
	1979	4.13	51.94	3.77	51.58	3.48	51.29	3.48	51.29
	1980	3.08	50.89	2.58	50.39	2.38	50.19	2.27	50.08
	1981	4.58	52.39	4.44	52.25	4.30	52.11	3.97	51.78
	1982	4.45	52.26	3.97	51.78	3.77	51.58	3.74	51.55
PROBABILITY	20	5.9	53.7	5.3	53.1	4.9	52.7	4.7	52.5
	10	5.4	53.2	4.9	52.7	4.5	52.3	4.3	52.1
	5	5.0	52.8	4.4	52.2	4.0	51.8	3.8	51.6
	3	4.6	52.4	4.1	51.9	3.7	51.5	3.5	51.3
	2	4.2	52.0	3.7	51.5	3.4	51.2	3.2	51.0

WL = H + 47.81

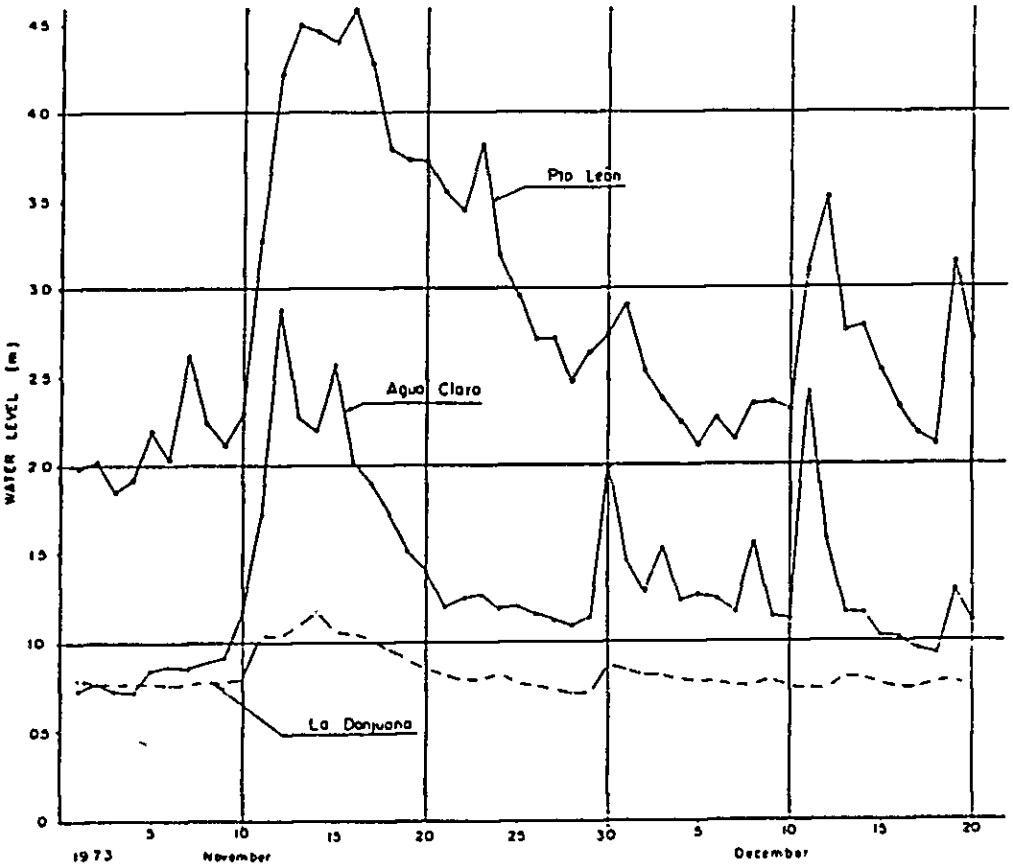
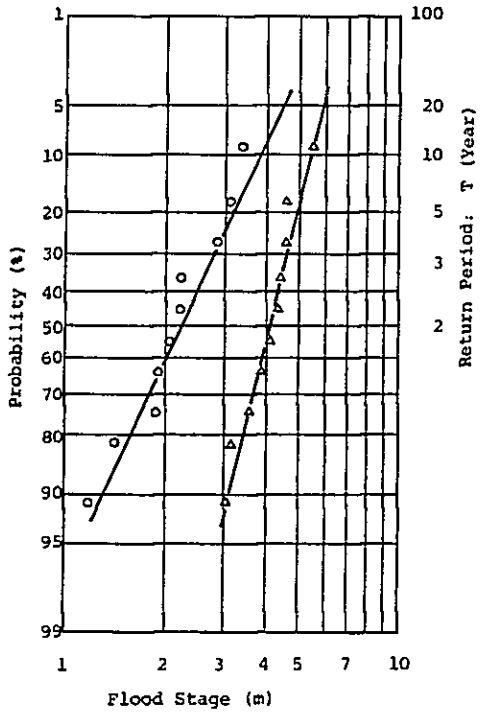


Fig. 3–9 Hydrograph of Flood Water Level

T (Year)	Agua Clara H (m)	Agua Clara WL (m.A.S.L)	Puerto Leon H (m)	Puerto Leon WL (m.A.S.L)
20	4.5	70.0	5.9	53.7
10	3.8	69.3	5.4	53.2
5	3.2	68.7	5.0	52.8
3	2.7	68.2	4.6	52.4
2	2.3	67.8	4.2	52.0



Weibull Plot Method

o Agua Clara

Δ Puerto Leon

Fig. 3–10 Flood Stage Probaility

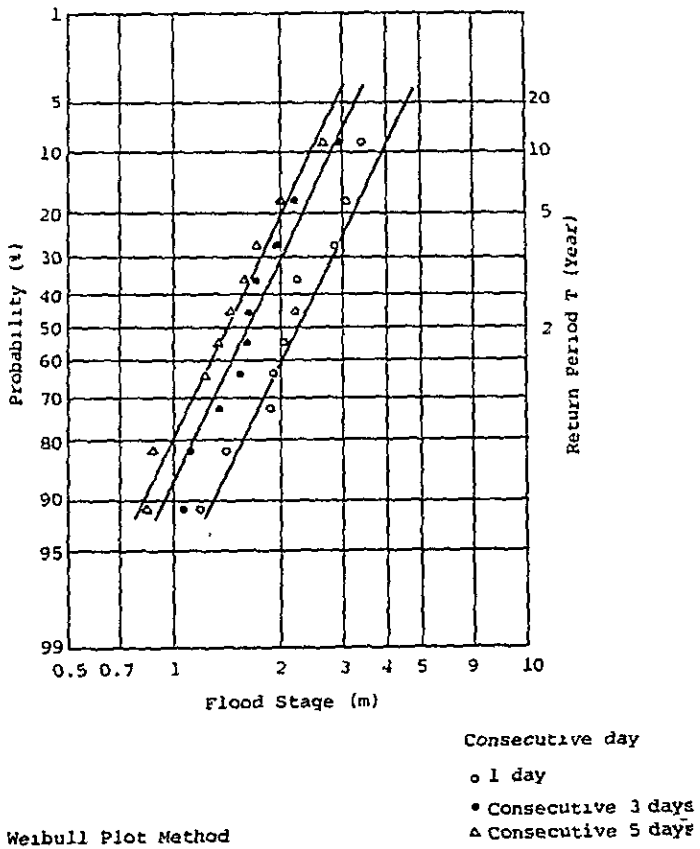


Fig. 3–11 Flood Stage at Agua Clara

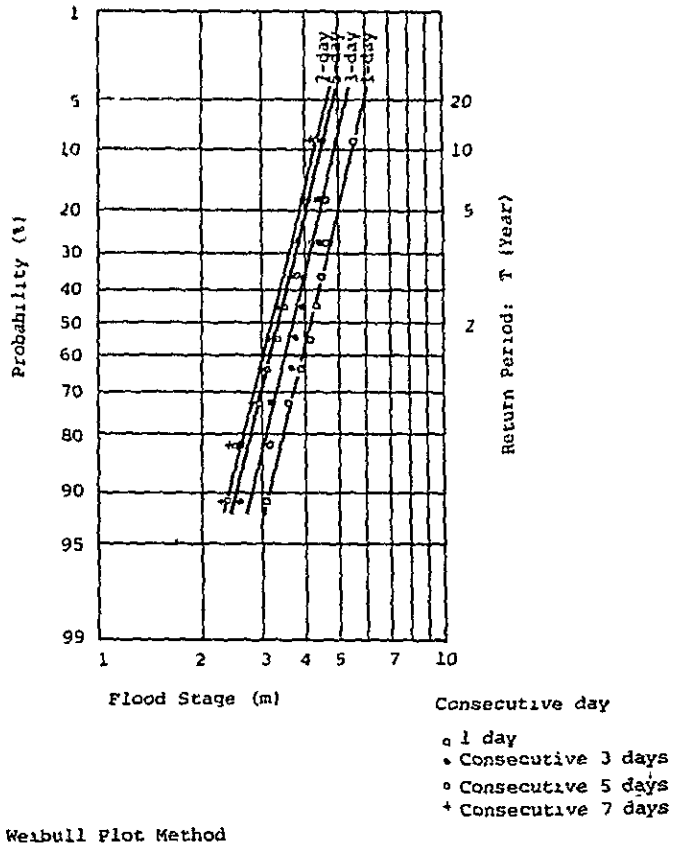


Fig. 3–12 Flood Stage at Puerto Leon

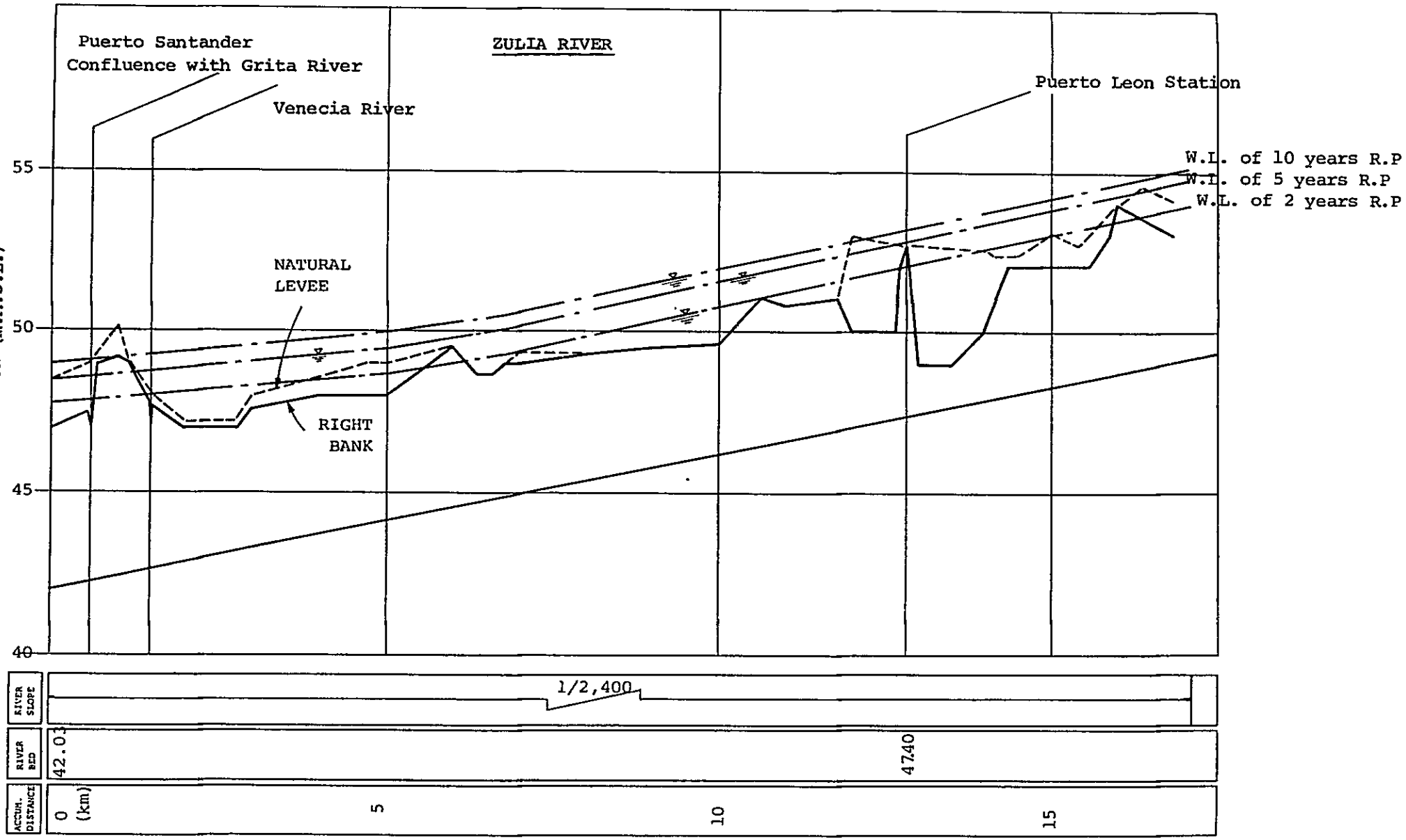


Fig. 3—13 Longitudinal Cross Section of the Zulia River

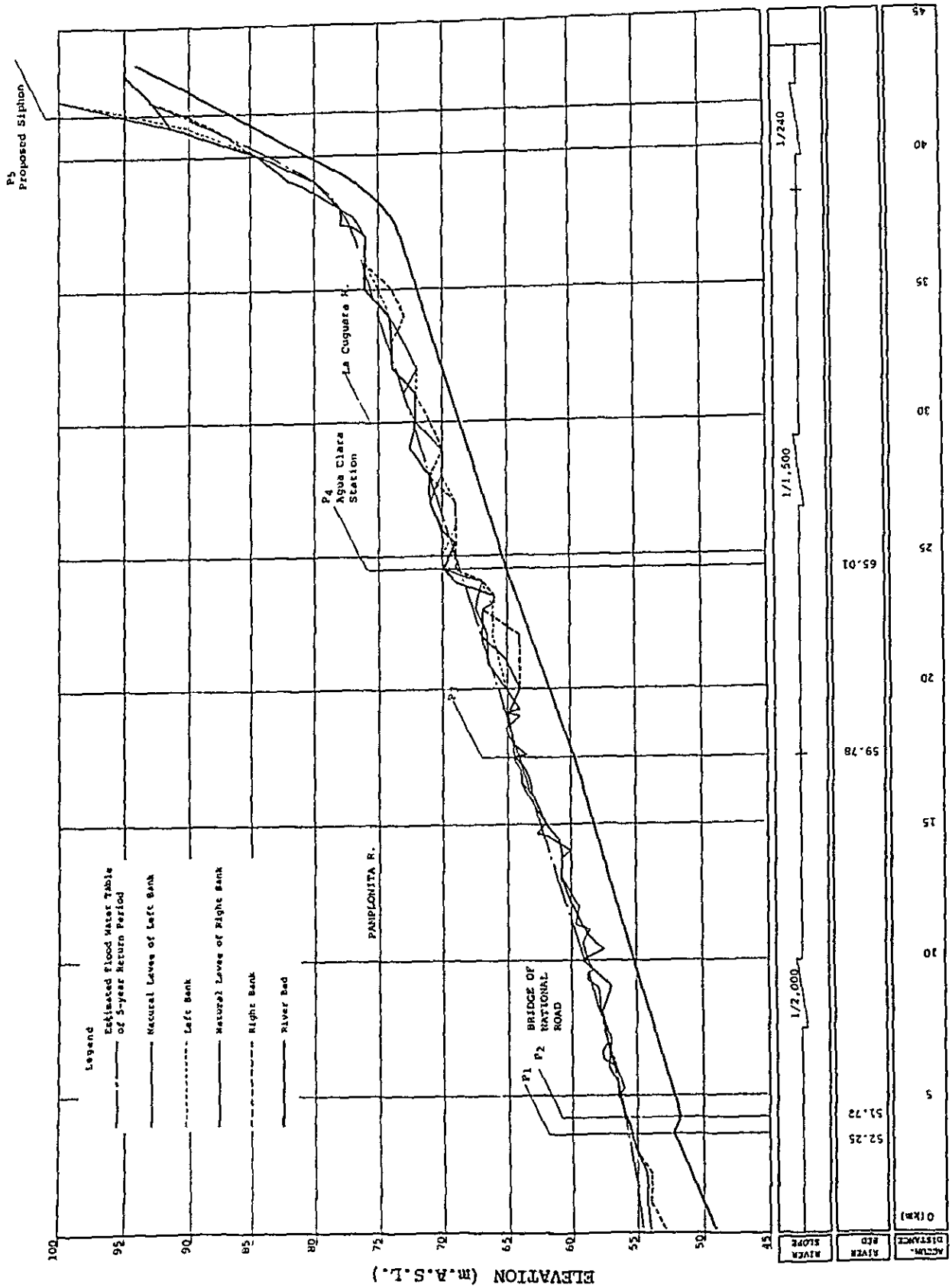


Fig. 3-14 Longitudinal Cross Section of the Pamplonita River

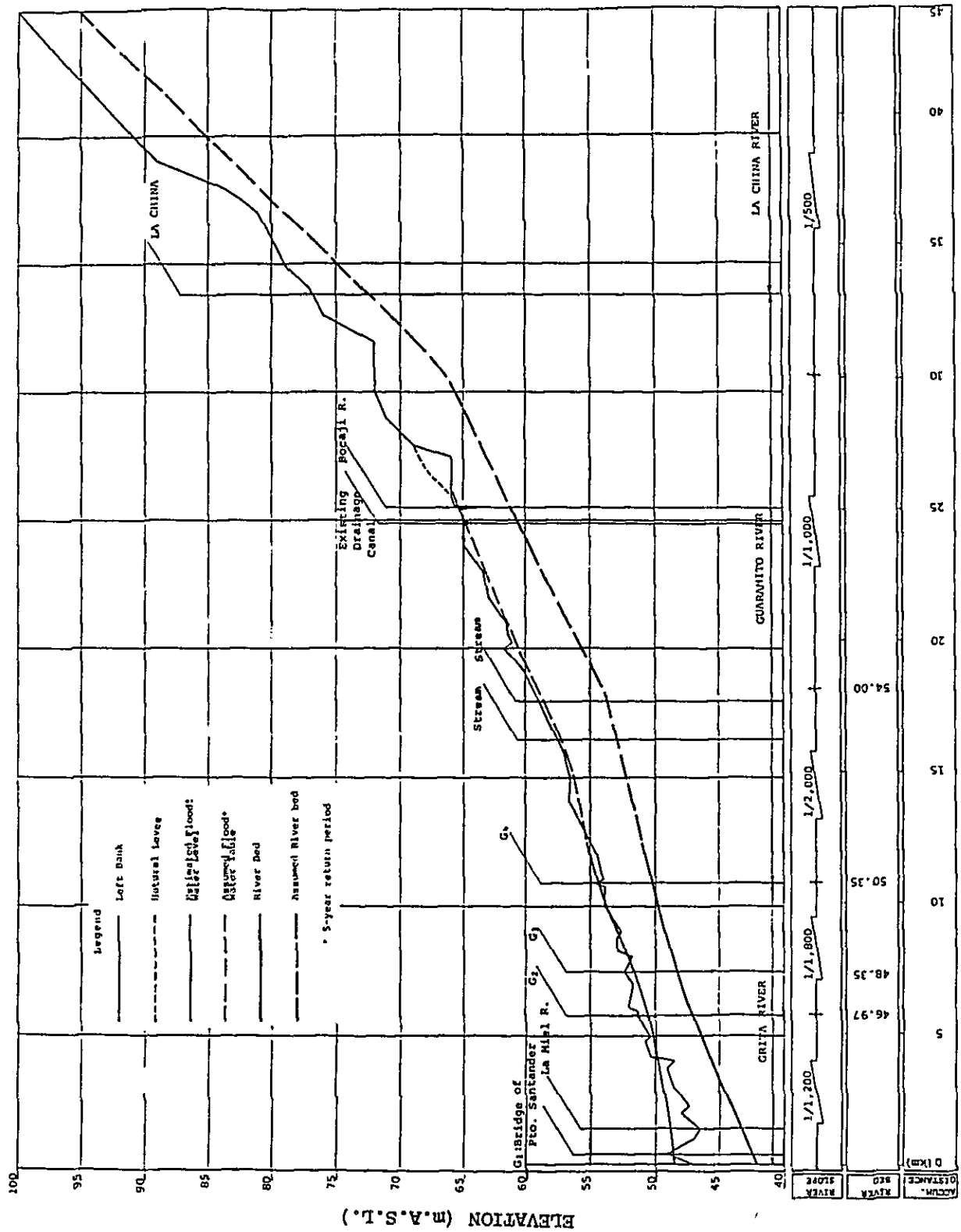


Fig. 3–15 Longitudinal Cross Section of the Grita and Guaramito River

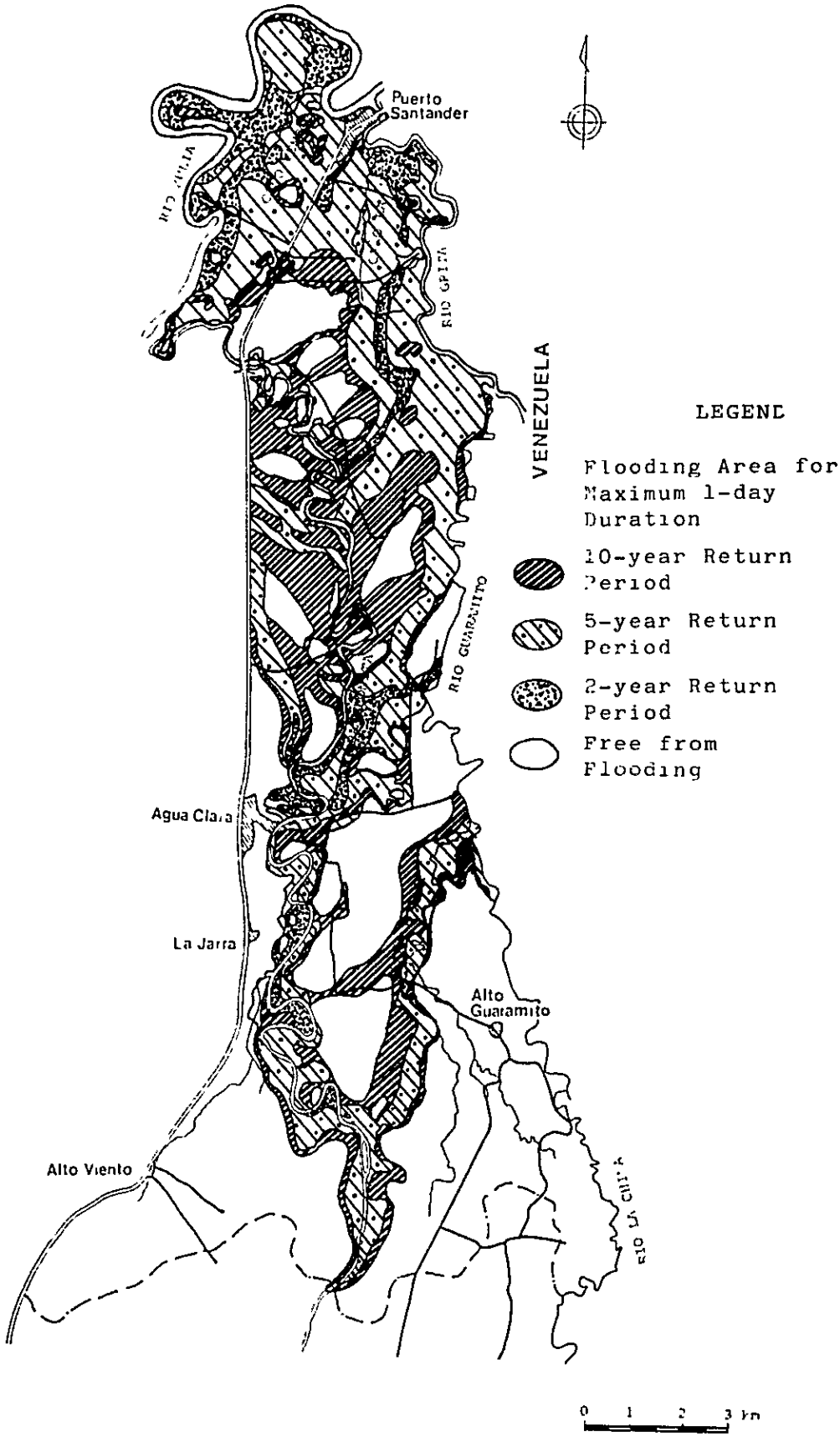


Fig. 3–16 Present Flooding Map

The discharge of overflow in the flooding areas were estimated based on calculation of non-uniform flows referring to Fig. 3-16. The flood water level of the Pamplonita River is estimated based on the water level records at Agua Clara. The depth of flooding flows toward the Guaramito River is estimated by site investigation and interviews with local residents. Assuming a coefficient of roughness of 0.05 in the natural small streams and 0.5 in the flooding area, non-uniform flow calculation is made by trial and error method to obtain the given water level of flooding. As a result, the maximum daily overflow discharge from the Pamplonita River is estimated to be 200 m^3/s in the magnitude of 5 year return period.

The overflow from the Pamplonita River flows over natural levee toward the northeast through the area on the right bank and toward the northwest direction in the area on the left bank. Oxbow lakes distributed along heavily meandering river course function as retarding basin.

The flood waters from the Zulia River in the areas around Puerto Leon flow toward the confluence with the Grita River to the northeast. The number of consecutive days of overflow is estimated based on Table 3-10 and 11. Duration of overflow from the Pamplonita River in the magnitude of 5 year return period is estimated to be approximately 3 days and that in the magnitude of 2 year return period is assumed to be one day or less.

Duration of overflow from the Zulia River is estimated to be approximately 5 days in the magnitude of 5 year return period and one day in the magnitude of 2 year return period.

4) Flooding

Estimated discharge of overflow and flooding areas are confirmed by the non-uniform flow calculation as shown in Fig. 3-17. It clearly shows that the discharge of overflow exceeds the flow capacity of the small streams which function to drain overflow from the main rivers.

Flooding areas are estimated as shown below:

Return Period (Year)	Flooding Area (ha)
2	1,050
5	4,300
10	6,560

Flooding covers wider area in the northern part of the study area than the area in the south.

Referring to the number of consecutive days of flood water level (Table 3-10 and 11), the changing manner of flooding area is estimated in relation to flood recession (Table 3-12). The flooding subsides within three days in case of the flooding of 2 year return period, however, in the flooding of 5 year return period it lasts more than 5 days over 340 ha.

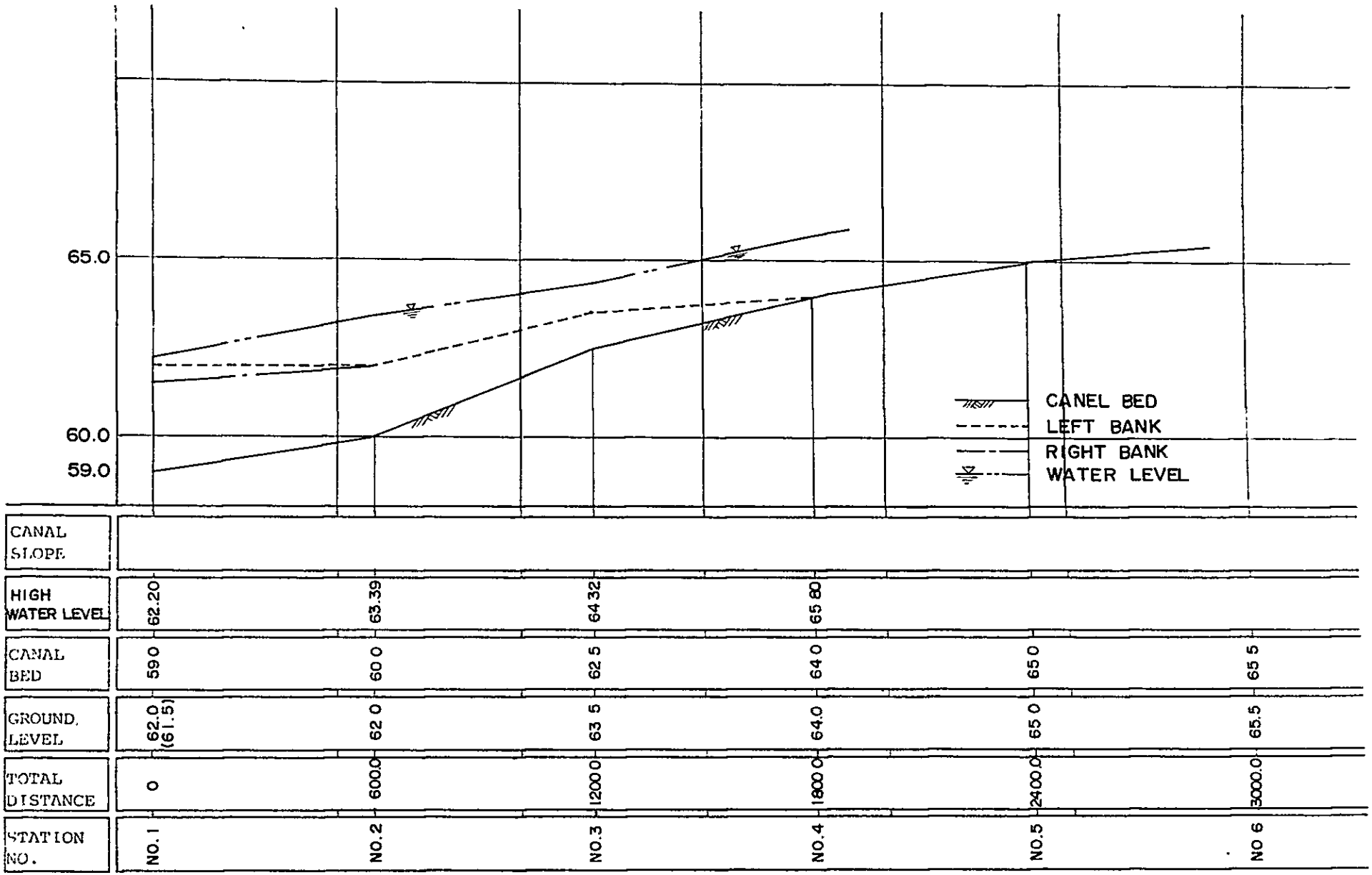


Fig. 3—17 Present Longitudinal Cross Section of Flood Area

Table 3–12 Present Flooding Area

(ha)

Period until subsiding	Return Period		
	2 year	5 year	10 year
1 day	1,050	4,300	6,560
3 days	-	1,470	3,400
5 days	-	340	2,050
7 days	-	-	900

(6) Occurrence of Peaks of Rainfall and Flood

There is time lag more than one day between the two peaks of simultaneous rainfall and flooding in the study area. Comparison is made between typical hyetograph and hydrograph in the records as shown in Fig. 3-18. Further details are shown in Appendix Fig. 2-3-12. The time of concentration for the Pamplonita River is estimated to be 12 to 24 hrs and for small river is 2 to 3 hrs in the study area.

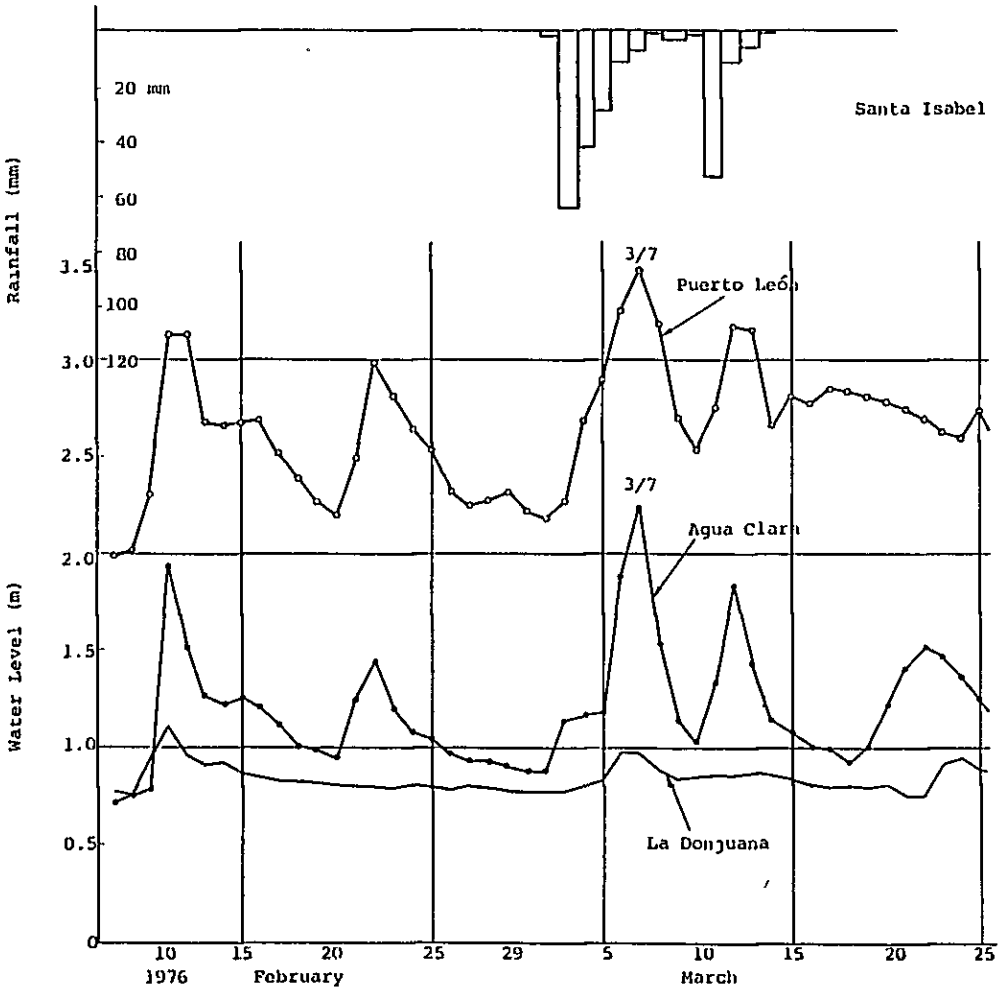


Fig. 3–18 Hyeto-Hydrograph

3.2.4 Topography, Groundwater Level and Others

(1) Topography

The land form in the study area is classified into two types; the river terraces and the alluvial plains.

The river terraces are distributed at the southern part of the study area where the ground height is more than 75 m.A.S.L. occupying 1,960 ha. The gradient of the ground surface is approximately 1/150 with decline to the north.

The alluvial plains extend to the north from the foot of river terraces up to the northern end of the study area. The gradient of the ground surface is approximately 1/500 in the south and 1/800 in the north with intermittent flat ground surfaces. In some part of these flat ground surfaces there found depressions and meandering natural small rivers (Fig. 3-19).

The Pamplonita River flows through the plain along the area where the ground height is relatively higher than the surrounding areas.

Predominating geological formation in the study area is recent alluvial deposits consisting of silts, sands and gravels coming from andesite and silicious rocks. These sediments alternate with layers of maximum thickness 1m.

These alternating layers have steep inclination by the influence of the quarternary orogenic movement and are over lay discordantly by the soil beds with moderate incline to the north.

(2) Groundwater Level

Major source of groundwater recharge seems to come from rainfall in the study area. Due to flat topography and heavy soil distributed in the area the movement of groundwater assumed to be inactive.

Behavior of the groundwater level is analysed on the data recorded at 33 observation wells operated by HIMAT.

In the northern part of the study area, average ground water level ranges between 0.6 m and 1.2 m below from the ground surface.

During the rainy season the groundwater levels rise up at 0.3 m - 0.5 m below from the ground surface. The groundwater level stays at the level of shallower than 1.0 m from the ground surface during the most months in a year.

On the other hand, in the central part the ground water level ranges between 1.0 and 2.0 m from the ground sufrace, however, it rises upto around 0.4 m $\sim$ 1.0 m from the ground surface during the rainy season. During 25% of the period in a year it stays shallower than 1.0 m from the ground surface.

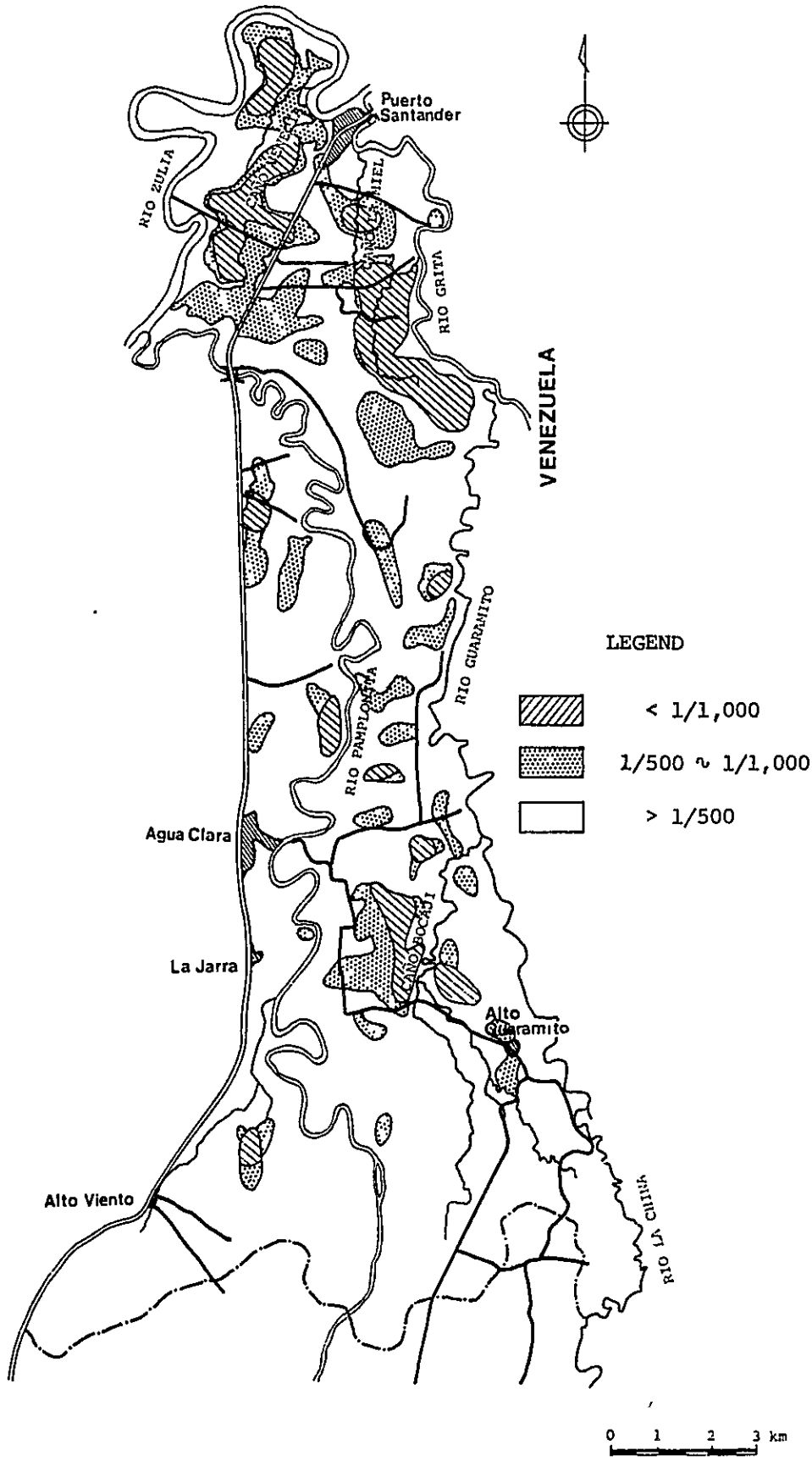


Fig. 3—19 Map of Topographycal Slope

The groundwater levels in the southern part of the study area are recorded to be deeper than 2 to 3 m from the ground surface (Fig. 3-21).

The contour lines of the average groundwater level in the study area are estimated as shown in Fig. 3-20.

(3) Water Quality

The water quality of the Zulia River at Pajarito where the water intake locates for the Zulia Project is classified as C_1S_1 according to the irrigation water quality standards of American Bureau of Reclamation. Sodium adsorption ratio of the water samples obtained at Pajarito is calculated to be less than 1.0. It is, therefore, concluded that the water to be diverted from the Zulia Canal will be suitable for the irrigation in the project area.

The water quality of the Pamplonita River is classified as C_2S_1 in a same manner which is attributed by the fact that waste water from Cucuta City flows into the Pamplonita River.

In the study area, groundwater will be used as sources of domestic water. The quality of these groundwater appears to be suitable for this purpose since electric conductivity ranges between 10μ℧ and 400μ℧ and it is clear without any odour.

3.2.5 Soil and Land Classification

(1) Soil Classification

Soils in the study area are classified into three groups which are further classified into 10 soil series according to the topographic conditions and types of mother material (Table 3-13 and Fig. 3-22).

1) Soils on Natural Levee

These soils distributing within narrow strips along river courses occupy 3,880 ha which correspond to 28.7% of the study area.

Since these soil series distribute on the flat topography, they are subjected to periodical inundation caused by river floods.

Soil series included in this type are Jarilla (JA), Cambulos (CA) and Pamplonita (PA) series. Soil texture of PA is coarse and the rest of the two have medium texture which results in the medium to poor drainage conditions.

These soils have neutral to slightly acidic pH value and the productivity is high.

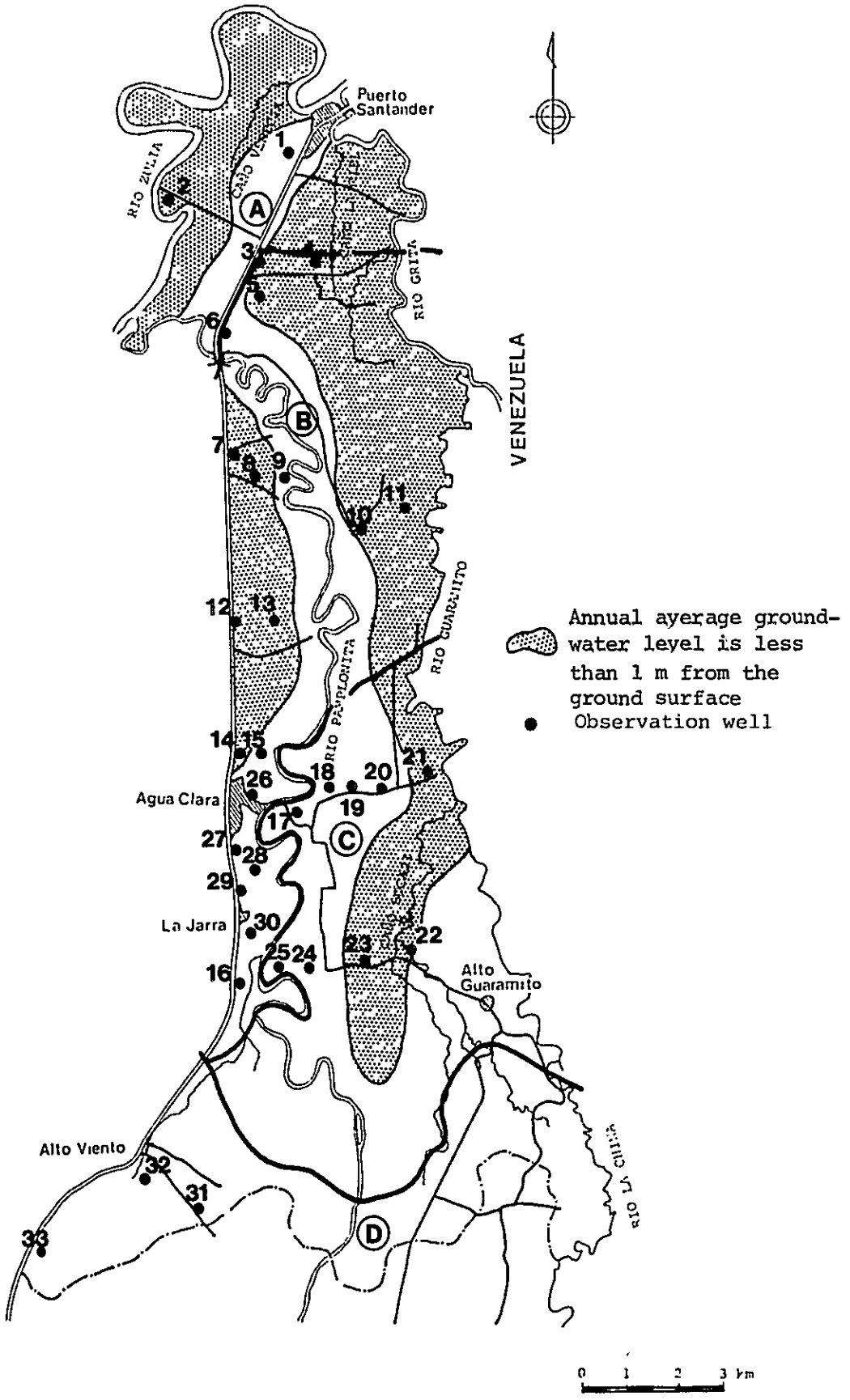
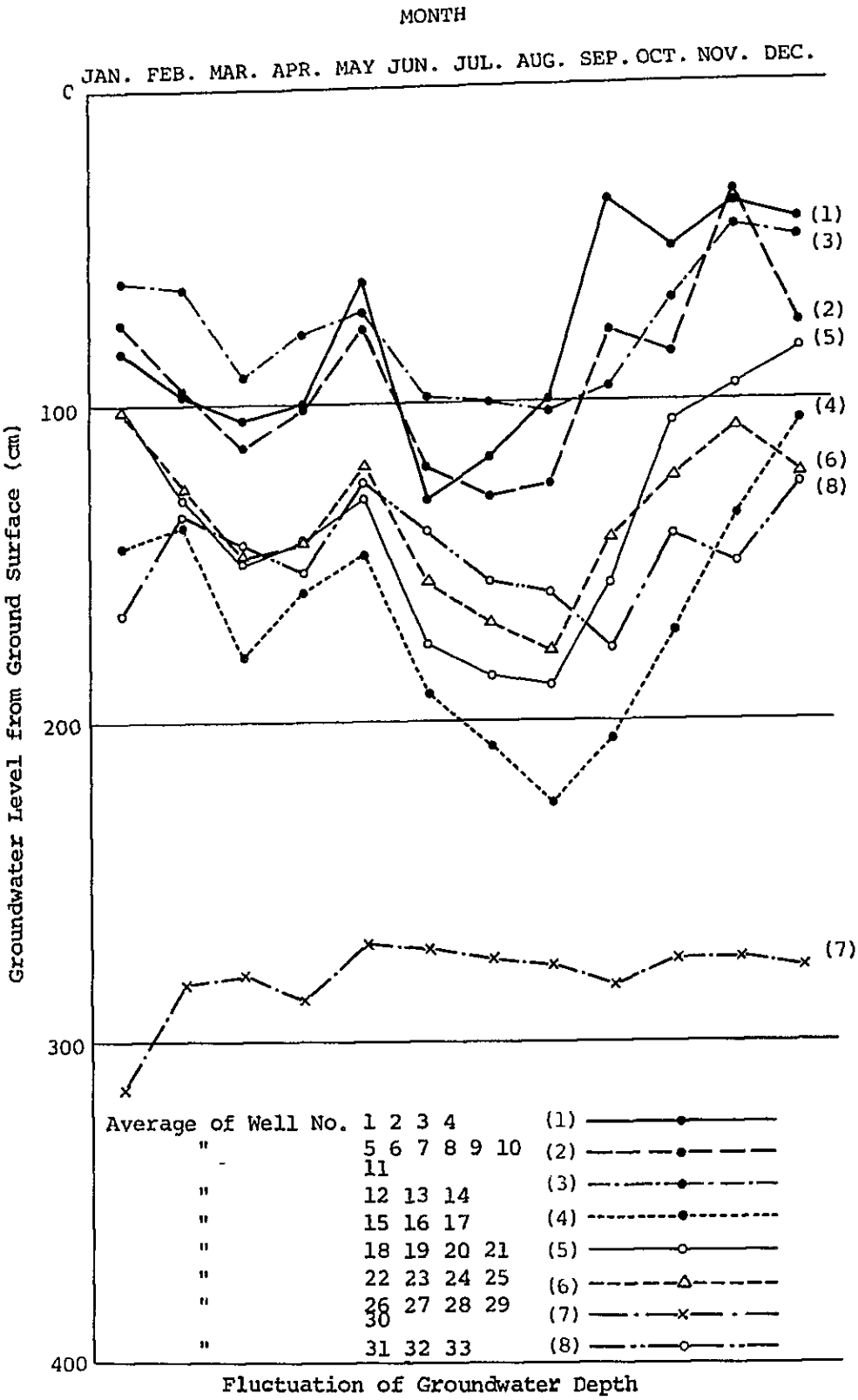


Fig. 3–20 Map of Groundwater Level



Fluctuation of Groundwater Depth

Note: Number corresponds to number of observation well in Fig. 3-20.

Fig. 3–21 Depth to Groundwater

2) Soils on Central Flat Plain

These soils are distributed in the areas surrounded by natural levee in the flat alluvial plains in the central and the nothern parts of the study area. Total area covered by this type of soils extends over 6,870 ha (50.9% of the study area).

Soil texture is fine to medium size which results the poor drainage conditions and high groundwater levels.

Soil series classified into this type are Zulia (ZU), Guaramito (GU) and La Union (LU) series.

Problems of this type of soil is that it is very heavy while in a wet conditions and very hard under dry conditions. "Zuro" is a typical problem of this type of soil which is caused by development of the mesh like gutter by intermittent wet and dry conditions on the flat lands.

These soils have neutral to slightly acidic pH values and high retaining capacity of fertility.

In addition since these soils indicate high saturation rate of cations, the productivity of the land will be much improved providing for drainage facilities.

Table 3—13 Character of Soil Series

Soil Series	Area (ha)	Soil Texture	Topography	Drainage	Productivity
1) Soil distributed on natural levee					
Javila	2,190	CL, SIL	Natural Levee	Moderate - Poor	High - Medium
Combulos	1,380	L, SICL	Natural Levee	Moderate - Poor	High - Medium
Pamplonita	310	SL	Natural Levee	Good - Moderate	Medium - Low
Sub Total	3.880				
2) Soil distributed on central low plain					
Zulia	1,100	SICL	Old river rute or plain	Very Poor	Medium
Guaramito	4,220	C, SICL	Alluvial Plain	Poor - Very Poor	Medium
La Union	1,550	L, SICL	Alluvial Plain	Poor - Very Poor	Medium
Sub Total	6,870				
3) Soil distributed on river terrace					
La Jarra	220	C	River Terrace	Moderate	Medium - Low
Alto Viento	330	SL	River Terrace	Good - Moderate	Medium - Low
Fortaleza	1,210	LS	River Terrace	Good	Medium - Low
Maranon	270	LS	River Terrace	Good	Medium - Low
Sub Total	2,030				
Others (Settlement, Road, River)	720				
Total	13,500				

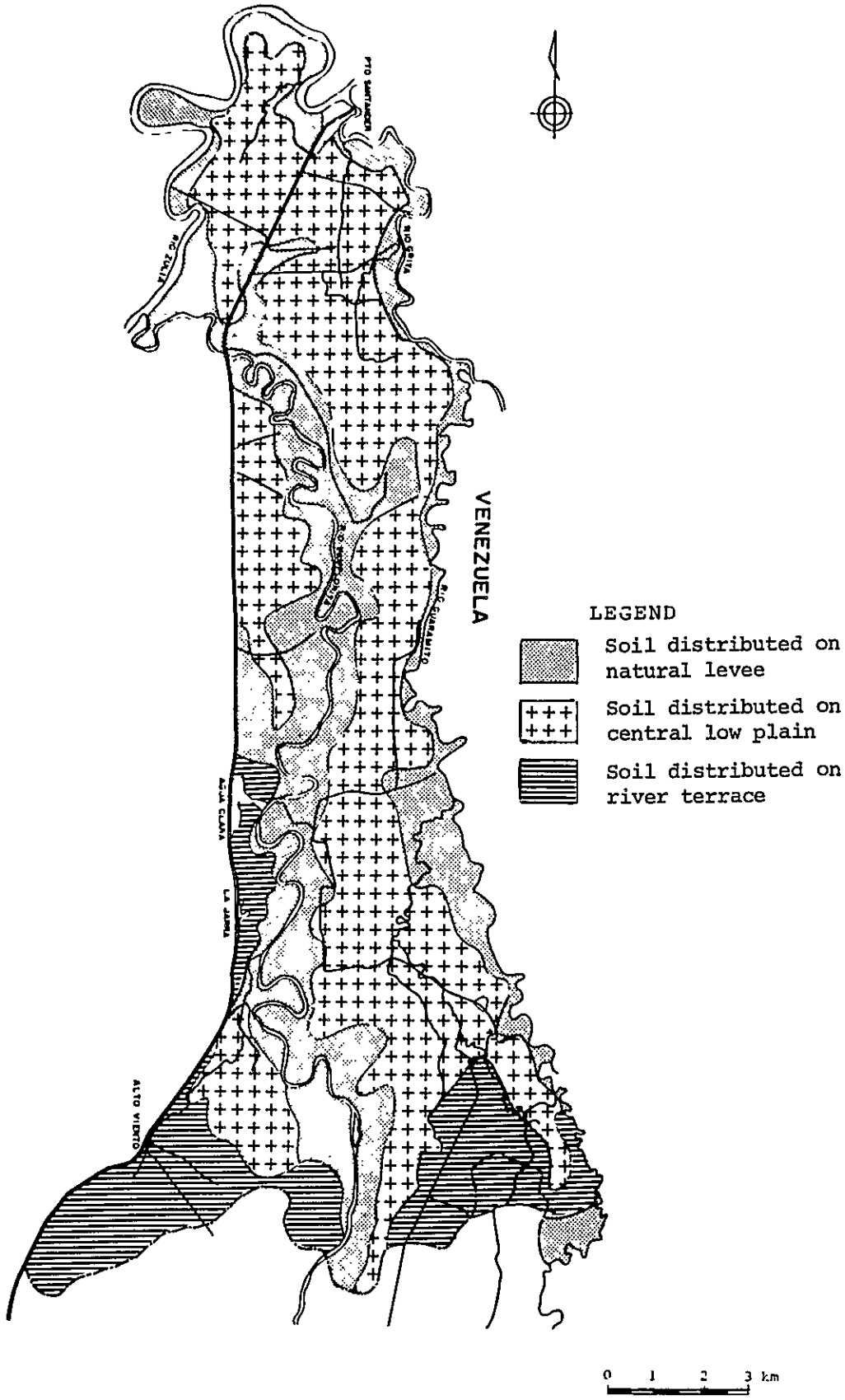


Fig. 3–22 Soil Distribution Map

3) Soils on River Terrace

These soils distribute on the river terraces in the southern part of the study area occupying 2,030 ha (15.1% of the study area). In general drainage conditions of these soils are favourable.

These soils include La Jarra (LJ), Alto Viento (AV), Fortaleza (FA) and Marañon (MA) series. Although LJ has fine texture, the rest of the soils have coarse nature of soil texture.

LJ has very low permeability since it is under lay by a very tight layer. However, the other soils have high permeability due to coarse of soil texture.

Although these soils are easy to cultivate, they are poor in fertility since these soils have been heavily leached. These soils have acidic pH value (pH 4.0 ∿ 4.5) and are short in phosphate. Accordingly, the productivity of these soils is relatively low. Further details of soils are discussed in Appendix 5-2.

(2) Water Holding Capacity and Intake Rate

Field capacity and permanent wilting point of soils in the study area is estimated as below (INCORA, 1970):

Soil Type	Field Capacity (Volume %)	Permanent Wilting Point (Volume %)
Soils on Natural Levee	20 - 30	5 - 15
Soils on Central Flat Plain	25 - 35	15 - 20
Soils on River Terraces	10 - 20	1 - 5

The average available moisture (field capacity-permanent wilting point) is estimated to be 114.5 mm on the basis of setting up the depth of the root zone as 100 cm.

Based on the study made by INCORA in 1970 and field tests made by the study team, the intake rates of soils in the study area are determined as stated below.

Cumulative Infiltration $D = C \cdot T^n = 2.4 \cdot T^{0.55}$ (mm)

Cylinder Intake Rate $1c = 60 \cdot Cn\, T^{n-1} = 79.2 \cdot T^{-0.45}$ (mm/min)

Basic Intake Rate $1b = 60\, Cn[600\ (1-n)]^{n-1} = 6.4$ (mm/hr)

where

T : time (minutes)
C, n : Constants

(3) Land Classification

Land classification of the study area is made by the land classification standards of the U.S.B.R. with some modification of the standards required by the specific conditions in the study area such as influence of floods and drainge. Major factors of land classification standards are soil, topography and drainage conditions (Table 3-14).

Based on the above standards, the study area is classified into five areas:

1. Arable Land

   Class 1 : Highly suitable for cropping
   Class 2 : Moderately suitable for cropping
   Class 3 : Marginally suitable for cropping
   Class 4 : Limited arable or special use

2. Non-arable Land

   Class 6 : Non-arable land

3. Urban Area and Residence

Table 3—14 Basis of Land Classification

Item	Class 1	Class 2	Class 3	Class 4	Class 6
1. Soil					
Soil texture	SL ~ CL	LS ~ C (good penetration)	LS ~ C (good penetration)	S ~ C	
Depth of soil	150 cm<	120 cm<	90 cm<	60 cm<	Inferior to Class 4
pH	pH 5.5 ~ 8.0	pH 5.0 ~ 8.5	pH 4.5 ~ 9.0	pH 4.0 ~ 9.0	
Salinity	Saturation of Na <10% EC <2 mmho/cm	Saturation of Na <10% EC <4 mmho/cm	Saturation of Na <15% EC <6 mmho/cm	Saturation of Na <20% EC <8 mmho/cm	
2. Topography					
Slope	3%>	7%>	7%>	12%>	
Leveling requirement	Not required	Little required	Required	Much required	
Land use	Cultivated or pasture	Cultivated or pasture	Cultivated, pasture or shrub	Cultivated, pasture, shrub or forest	
3. Drainage					
Ground water level from ground surface	<1.5 m	<1.2 m	<1.0 m	<0.5 m	
Flood	No	Occasional (Once in 10 years)	Moderate (Once in 5 years)	Frequent (Once in 2 years)	

The classified lands are summarized as shown in Table 3-15.

Table 3–15 Land Classification

	Land Classification (ha)	Percentage
Arable land		(%)
Class 1	70	5.5 (6.7)
Class 2	1,790	13.2 (16.2)
Class 3	5,410	40.1 (49.0)
Class 4	3,100	23.0 (28.1)
Sub Total	11,040	81.8(100.0)
Non-Arable land		
Class 6	1,740	12.9
Urban areas & residence	450	3.3
Rivers & Roads	270	2.0
Sub Total	2,460	18.2
Total	13,500	100.0

As a result, it is estimated that more than 80% of the study area is arable land, however, 77% of the arable land is classified as Class 3 or worse due to poor drainage conditions.

3.2.6 Vegetation

With regard to the ecology of the area, the potential natural vegetation in the study area is classified as tropical evergreen forest. This type of vegetation coincides with the tropical evergreen forest based on the vegetation classification of Holdrige which is the standard classification system applied by IGAC.

Typical crops cultivated in the area under this category of vegetation in Colombia are banana, paddy, cassava, maize, sugarcane, cacao, african palm, coconut and other fruits.

At present the predominating vegetation in the study area is pasture.

3.3 Poor Drainage Problems

3.3.1 Factors of Poor Drainage

Drainage conditions are very poor over most of the study area for handling rainfall and flooding from rivers.

The most typical symptom of a drainage problem is stagnant water which remains in scattered depressions and low laying lands for 5 days to all the year round. Although flood waters subside within 7 days, stagnant water remains in depressions and low laying land for a long time. The principal water source of these conditions is rainfall.

In the 1960's, construction of drainage canals commenced at El Dave and Campo Alegre, however, the work was not completed and the draiange canals do not function efficiently at present due to poor maintenance. Under the conditions, heavy soils in the flat terrain and "Zuro" accelerate drainage problems (Sections 3.2.4 and 3.2.5).

3.3.2 Drainage Problems by Rainwater

(1) Occurrence

1) Ordinary Conditions

In general, average annual rainfall varies between 1,000 and 3,000 mm. There is more rainfall in the northern part of the study area than in the south.

Average monthly rainfall varies between 100 and 300 mm/month (Fig. 3-4). Monthly rainfall fluctuates in a range between 0 and 800 mm. During the months of April and May and from September to December, rainfall exceeds 200 mm/month. Drainage problems seem to be revealed in these months. The number of rainy days more than 1 mm/day in the rainy season distributes between 10 and 20 days/month and that in the dry season around 10 days/month (Table 3-16).

On an average daily rainfall of 20 mm occurs every two days in the rainy season and that of 10 mm occurs every 3 days even in the dry season. Under such conditions, drainage problems by rainfall have effect through-out the year.

2) Heavy Rainfall Problems

Daily rainfall of 100 mm or more occurs almost every year. During this magnitude of rainfall, surface runoff concentrates in depression and low laying areas causing land inundation. Surface run-off flows into streams where capacity is not sufficient because of trees and shrubs in heavily meandering channels together with insufficient cross section for flow. This is the reason of flooding along small rivers in the study area. The Bocaji and the Miel River are examples of this case.

Table 3–16 Rainy Days at Santa Isabel

(Rainy Days: not less than 1 mm)

Month	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	Total
1971	13	9	15	10	22	9	8	13	18	17	9	15	158
1972	10	14	10	17	11	12	11	10	8	10	12	6	131
1973	2	4	6	6	12	8	9	13	15	16	24	16	131
1974	12	12	19	11	15	9	14	14	17	15	17	15	170
1975	5	9	7	11	14	12	14	18	16	14	18	21	159
1976	11	19	19	13	10	7	9	8	12	19	9	3	139
1977	8	0	8	8	11	17	13	13	15	19	11	0	123
1978	3	8	15	19	13	9	12	9	14	15	9	12	138
1979	9	7	18	17	8	16	12	9	17	17	14	14	158
1980	10	8	1	10	9	13	15	19	17	19	21	19	143
1981	21	15	11	25	21	15	10	10	11	10	11	0	160
Average	9	10	12	12	13	12	12	12	15	16	14	11	148
(%)	(29)	(35)	(39)	(40)	(42)	(40)	(39)	(39)	(50)	(52)	(47)	(35)	(41)

(2) Drainage System

Most of the southern area on the right bank of the Pamplonita River is part of the catchment area of the Bocaji River. The northern part of the study area consists of catchment areas of small rivers like the Miel River.

The southern part of the study area on the left bank of the Pamplonita River belongs to the catchment area of the Pamplonita River. The northern part of the area on the left bank is the catchment area of the Floresta River.

The areas on the right bank of the Zulia River consist of catchment areas of streams which flow into the Zulia River (Fig. 3-23).

(3) Land Inundation by Rainfall

Rainfall drainage problems are observed approximately 10,000 ha in the study area. The areas inundated with depth exceeds 30 cm for more than 10 days are distributed approximately 2,700 ha. As the result of the field survey this poor drainage conditions are distributed mainly in the northern part of the study area approximately corresponding to the areas with the ground surface gradient less than 1/500. Some areas along the Miel River are inundated permanently. In these areas the inundated depth rise up by 10 to 20 cm during heavy rainfall and then subside to the normal level in 2 days, however, continue the constant poor drainage conditions (Fig. 3-24).

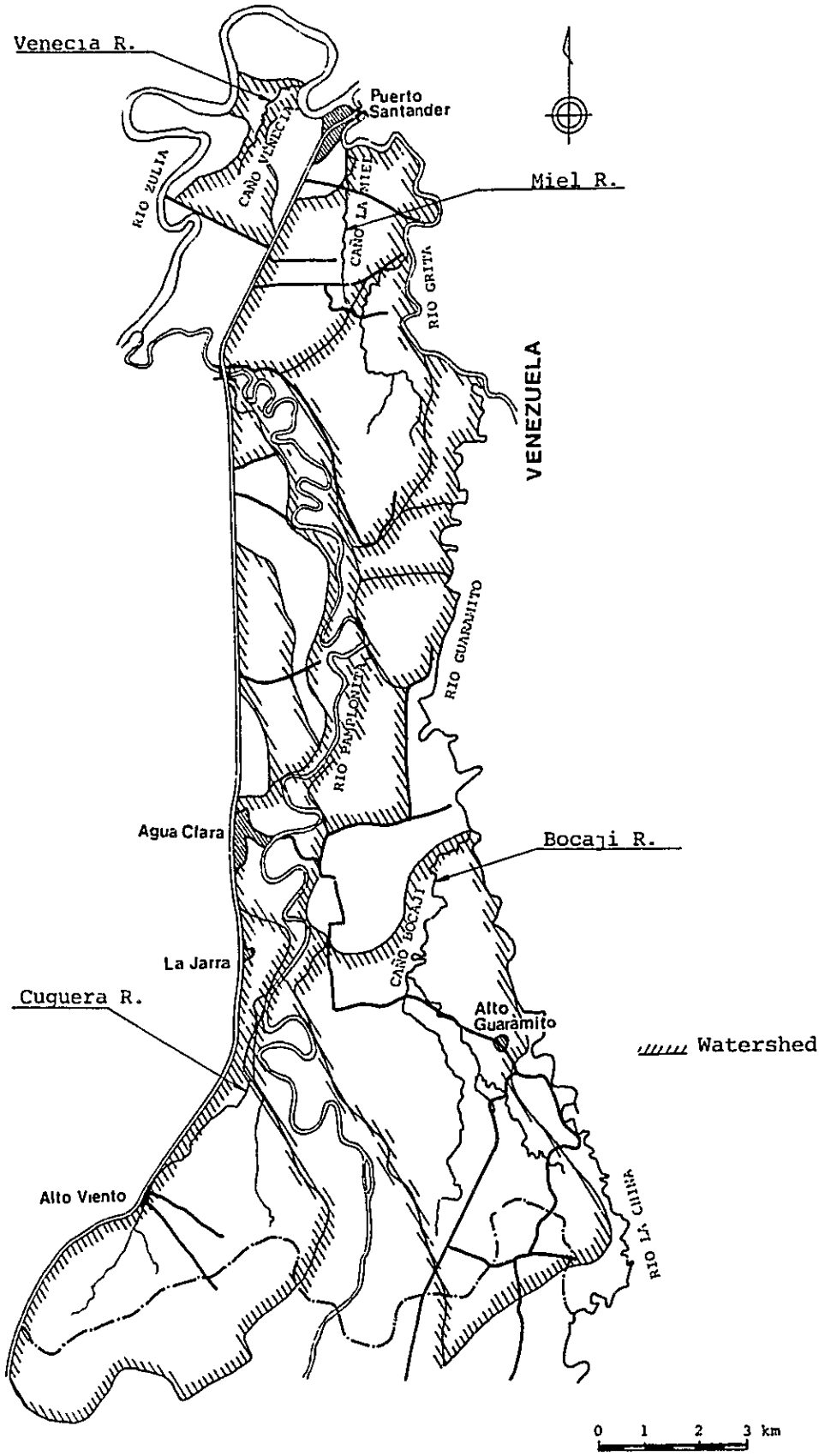


Fig. 3–23 Present Drainage Net Work

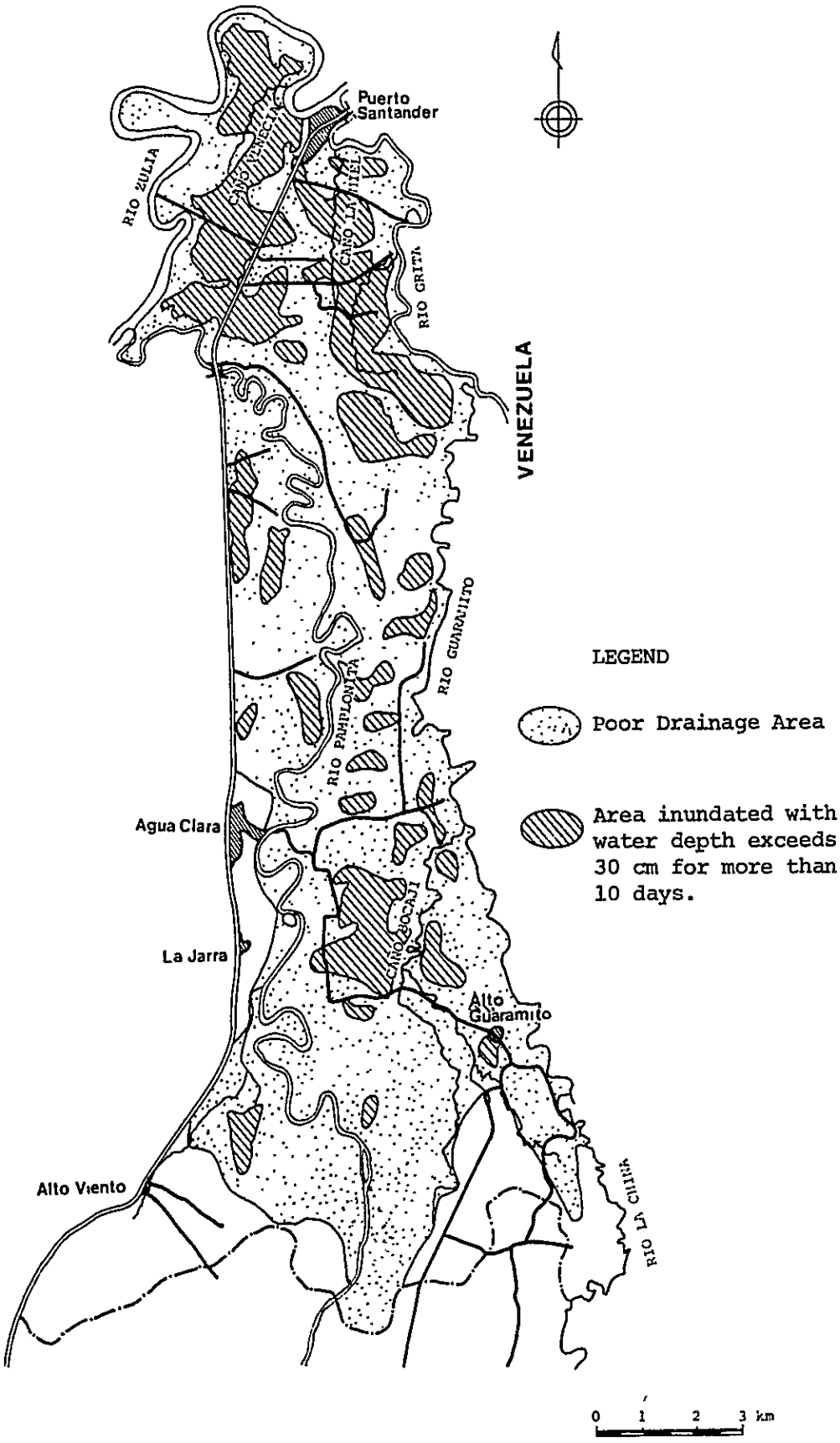


Fig. 3–24 Map of Poor Drainage Zone

3.3.3 Drainage Problems by River Flooding

(1) Occurrence

1) The Pamplonita River

The Area out of the Study Area

Since the maximum daily rainfall in the upper reach of the Pamplonita River (La Esperanza) is 89 mm and that around Cucuta is 66 mm in 5 year return period, the specific flood discharge is relatively small.

When a heavy flood occurs, flooding is regulated in the flood plain between the confluence with the Tachira River and the bridge at San Faustino for a short period. The river course passes through narrow valley from the bridge to the entrance to the study area.

From the Southern End of the Study Area to La Tigra

The riverbed gradient changes from 1/240 to 1/1,500 at about 4 km downstream from the southern end of the study area. In this section, the river flows on the alluvial fans with ground height of 70 to 90 m.A.S.L. and it tends to overflow. The river course changes frequently with large curvatures.

Flood overflow occurs in 2 year return period in a small scale. In the flood of 5 year return period, overflow occurs at oxbow lakes and old river courses and in the area where the riverbed gradient changes abruptly. The overflow occurs over the natural levees on the right bank and flows toward the Bocaji River.

From La Tigra to Agua Clara

The land form on left side of the river bank is hilly and overflow occurs once in every a few years on the lowland along the river course.

From Agua Clara to the confluence with the Zulia River

The river course passes through high level part surrounding by natural levees. The ground height along the river course tends to be slightly higher than the surrounding area due to deposits of the river.

Along the river course, overflow occurs even in the flood of 2 year return period at some places on both banks. Most frequent overflow occurs along the river course approximately for 3 km on the north of the existing main drainage canal at Campo Alegre. In this area, only a few houses are scattered and density of roads is extremely low due to overflow.

2) The Zulia River

The catchment area of this river is 3,200 km^2 before the confluence with the Pamplonita River. However, at the confluence with the Grita River further downstream, it increases to 6,900 km^2. This increase in the catchment area in a short distance of the river course causes heavy overflow along the river course in the study area.

3) The Grita River and the Guaramito River

The ground height of the right bank on the Venezuela side of the Grita River is lower than that of the left bank.

Overflow from the Grita and Guaramito River into the study area are insignificant.

The cross-sectional area of the Guaramito River flow is relatively large so that no significant overflow from this river occurs, although small scale overflow occurs in the lowland around the confluence with the Bocaji River which subsides in a short period. However, in the area around the confluence with the Grita River significant overflow occurs due to backwater of the Grita River and the flood waters flow toward the Miel River.

(2) Flooding and Land Inundation

1) Southern and central Areas

There is time lag of more than one day between flood peaks of the Guaramito or the Floresta and the Pamplonita River. Since the catchment areas of the Guaramito and the Floresta River are small, flooding subsides in a short period and the effect of backwater is insignificant.

2) Northern Area

1. The area between the Zulia River and the National Road

Flooding from the Zulia River flows toward the north east and flows back to the Zulia River. Significant overflow occurs along the river course at its deep curvature into the study area just upstream and downstream of Puerto Leon. When flood water level is considerably high, drop down effect may occur at the confluence of the Venecia River.

As flood water level subsides, flooding is immediately drained to the Zulia River, however, land inundation lasts in depressions and low laying areas for a long time.

2. Area between the National Road and the Grita River

Overflow occurs from the Pamplonita River and from the around of the confluence of the Grita and the Guaramito River and flooding water moves toward the north. In the vicinity of the confluence

of the Miel River with the Grita River, the Grita River causes backwater in the Miel River by the Zulia River during a heavy flood.

When flood water level subsides, flooding is drained to the Grita River, however, inundation lasts in the low lying area along the Miel River.

3. Depth of Flooding

It is estimated that the maximum depth of flooding is above 1 m in a limited area and that of most of areas in the study area it does not exceed 0.6 m during flooding of 5 year return period. Behavior of the flood is summarized in Fig. 3-25.

3.4 Socio-economic Conditions

3.4.1 Social Conditions

The population in the study area is about 7,000 which corresponds to 1.6% of total population in the "Municipio" Cucuta (428,000 persons) (DANE, 1983). Most of the labour force in the study area is engaged in agriculture.

The study area consists of four "corregimentos": Puerto Santander, Puerto Villamizar, Agua Clara and San Faustino.

The main road in the project area is the national road with two lanes running between Cucuta and Puerto Santander on the left side of the Pamplonita River. The total length of this national road within the area is approximately 27.5 km. Rehabilitation and asphalt paving are in progress and are supposed to be completed by the end of 1984.

In general the road system in the area is poor: the density of roads is extremely low and maintenance is insufficient. Both the left and right sides of the river are connected by the only existing bridge throughout the national road. The road network on the left side of the Pamplonita River appears to be better than that on the right side of the River. There is no through road from the southern end to the northern end of the study area on the right side of the Pamplonita River.

As for communication, wireless services are available at Puerto Santander and Agua Clara. These services, however, sometimes receive interference by weather conditions.

There are water supply and sewerage systems at La Jarra and Agua Clara. Also there are water supply systems at Puerto Santander and La Tigra. However, there is no water purification plant in the area. In the areas except the above villages, the water source for domestic water is mainly groundwater and in limited areas, rain water is stored for domestic water.

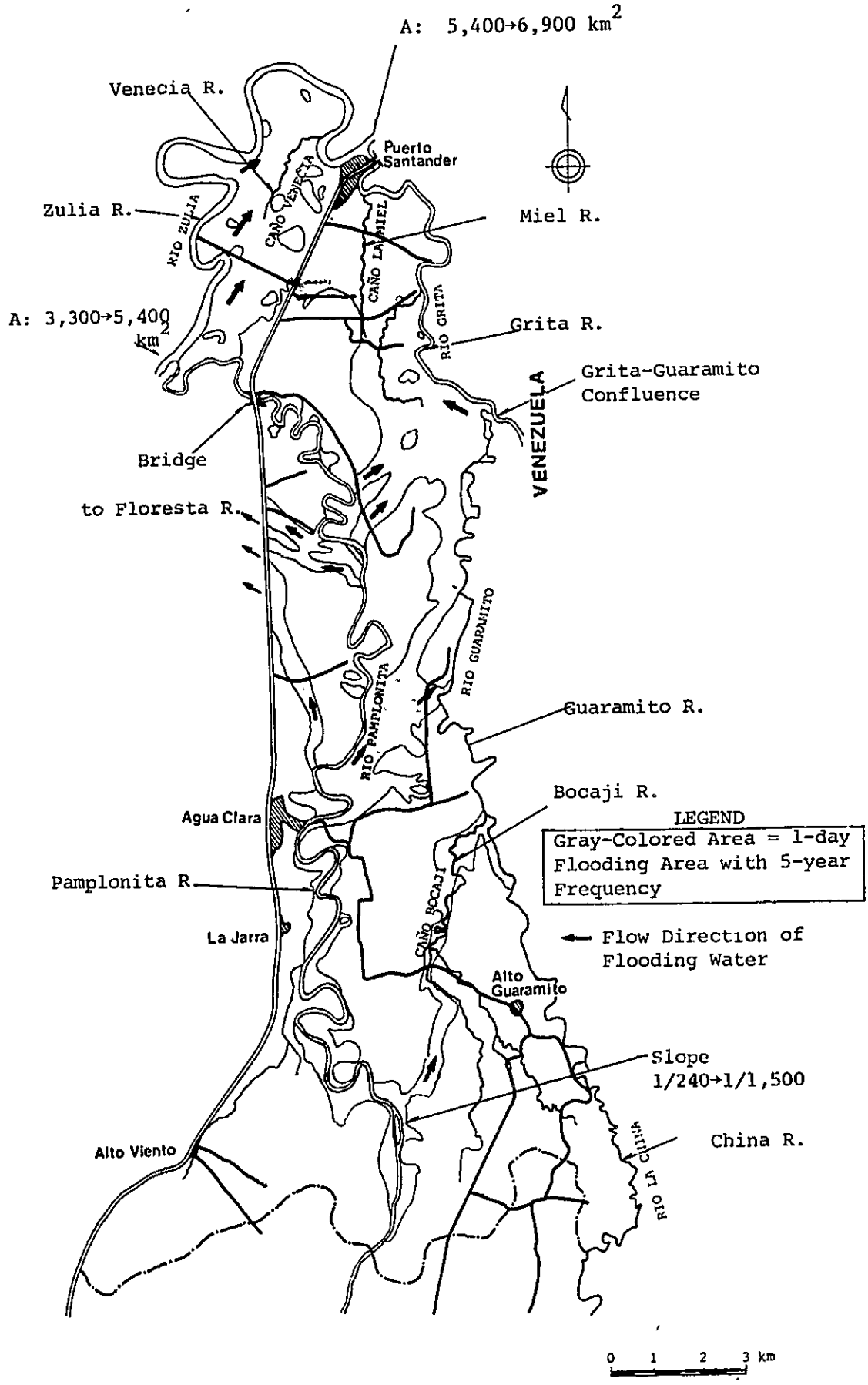


Fig. 3–25 Flow of Flooding Water

The Supply of electricity in the area is limited to Puerto Santander, Agua Clara and some villages and private houses along the national road. In the rest of the area, the common method of lighting is by kerosine lamps and candles.

Public transport between Cucuta and Puerto Santander is run by two private firms. Common modes of transport in the rest of the study area are taxis, motor-cycles, bycicles and horses. Tractors are commonly used in agricultural work, but horses are rarely used for cultivation.

There are 11 primary schools and two secondary schools in the study area. Number of primary and secondary school students is 1,260 and 470, respectively. The number of staff for these educational facilities are insufficient. The percentage of children of school age attending school is 67% in the area which is far less than the national average rate (98%). Only a few students have the opportunity to have higher education. The rate of illiterace in the study area is estimated to be 18.7% (Secretario Regional de Education).

Clinics at Puerto Santander and Agua Clara have docters and nurses permanently stationed, however, no hospital facilities are available. Common diseases in the area are intestional diseases, viral diseases and intestional parasites.

Houses are built by bricks and roofed by slates, however, it is necessary to improve the earth flooring for health reasons.

3.4.2 Economic Conditions

The Venezuelan market was used to play a large role in the economy of the study area since the area is located near the national border. However, since the devaluation of Venezuelan currency by 40% in February 1983, the exportation of agricultural and livestock products into Venezuelan market has decreased significantly. On the other hand, the consumption price index in The Republic has continuously increased. Accordingly, people in Colombia side tend to purchase foods, electric equipment, cars and livestock in Venezuela. In addition a large volume of illegal importation of agricultural and livestock products into Colombian territory has worsened the local economy in the frontier area (Banco de la Republia, Cucuta, 1983).

Under such economic conditions, many factories have gone bankrupt and many Colombian workers have returned to mother land. This has resulted in an increase in the unemployment rate, especially in the low income class of which monthly income is less than COL$9,000. The unemployment rate at Cucuta is estimated at 10.3% in June 1983 (DANE, 1983).

3.5 Land Use

Almost 75% (10,140 ha) of the study area (13,500 ha) is utilized for agricultural purposes. The common form of land use is pasture which occupies 9,630 ha or 95% of the total agricultural land.

Pasture used for extensive beef cattle raising is classified into two types; artificial and natural pasture.

In the artificial pasture, most resistive species for humidity of the Braquiaria are planted, however, replacement of grass and application of fertilizer are not practiced. The yield of these pasture is estimated to be 100 t/ha and the stocking rate is assumed to be 2 head/ha.

In the natural pasture, rampant weeds cause reduction in the available amount of pasture. Also damage caused by insects and diseases occurs in the natural pasture more frequently than in the artificial pasture. The stocking rate of the natural pasture seems to be 0.5 head/ha on average.

The area ratio between the artificial and the natural pasture is 3 : 7 in the study area.

Other common field crops are maize, and cassava for domestic consumption. The total area cultivated with these crops is 90 ha corresponding to only 1% of the total agricultural area in the study area.

Cacao orchards are distributed in the central and the southern end of the study area totalling 320 ha. There are some cashew nut on about 70 ha.

Natural forest coverage has been decreasing since the commencement of immigration in the beginning of the 1960's. Only 2,640 ha of natural forest corresponding to 19.6% of the study area remains scattering over the area at present.

Existing land use in the area is summarized in Table 3-17.

Table 3–17 Present Land Use

	Agricultural Land						Non-Agricultural Land				Total
	1] Cultivated Land	Pasture			2] Orchard	Sub Total	Forest	Town and Residence	Road and River	Sub Total	
		Artificial Pasture	Natural Pasture	Total							
Area (ha)	90	2,890	6,740	9,630	420	10,140	2,640	270	450	3,360	13,500
Percentage (%)	(0.9) 0.7	(28.5) 21.4	(66.5) 49.9	(95.0) 71.3	(4.1) 3.1	(100.0) 75.1	19.6	2.0	3.3	24.9	100.0

1] Mainly maize and cassava

2] Mainly cacao, cooking banana, cashewnut and guava.

Note: Calculation by mean of Aerial Photograph and field survey.

3.6 Land Ownership

There are 320 households in the study area. Of these, 102 households (32%) own less than 25 ha of land per family which occupies about 13% of the total land area. On the other hand, families who have more than 65 ha of land per family own 26% of the total land. The number of these family corresponds only to 9% of the total number of households in the area (Table 3-18).

Farmers in the study area are classified into two groups: "Parceleros" or immigrants who obtained lands by means of the INCORA's immigration project and "Particulares" or particular farmers who obtained their land by inheritance or purchase (Fig. 3-26).

Parceleros are distributed around El Dave in the northern part and Campo Alegre in the central part of the study area. According to the INCORA Land Distribution Map, 202 families immigrated and now occupy over 5,600 ha. Average land holding size is 28 ha. These Parceleros purchased their lands with INCORA credit, however, only 43% of the families have repaid their credit at present (Credit Ledger of INCORA, 1983).

Particulares are distributed mainly in the southern and the central part of the study area. The total number of Particulares families is 118. Their lands are registered by IGAC.

Land registration is not completed yet for a small portion. By a interpretation of aerial photographs, the average size of landholding of the Particulares in these incompleted areas is estimated to be 56 ha, ranging between 20 and 100 ha.

The largest parcel of land held by Particulares is 250 ha. The number of Particulares families holding land more than 100 ha is 12.

Table 3–18 Land Ownership Classification

		Parceleros	Particulares	Total
Less than 5 ha	Number of Farm (%)	2 (1.0)	-	2 (0.6)
	Area (ha) (%)	5 (0.0)	-	5 (0.0)
	ha/Farm	3	-	3
5 - 25 ha	Number of Farm (%)	86 (42.5)	14 (11.8)	100 (31.2)
	Area (ha) (%)	1,308(23.3)	290 (44)	1,598(13.1)
	ha/Farm	15	21	16
25 - 45 ha	Number of Farm (%)	105 (52.0)	48 (40.7)	153 (47.8)
	Area (ha) (%)	3,831(68.3)	1,633(24.9)	5,464(44.9)
	ha/Farm	36	34	36
45 - 65 ha	Number of Farm (%)	8 (4.0)	29 (24.6)	37 (11.6)
	Area (ha) (%)	400 (7.1)	1,564(23.8)	1,964(16.1)
	ha/Farm	50	54	53
More than 65 ha	Number of Farm (%)	1 (0.5)	27 (22.9)	28 (8.8)
	Area (ha) (%)	68 (1.2)	3,082(46.9)	3,150(25.9)
	ha/Farm	68	114	113
Total	Number of Farm (%)	202 (100.0)	118 (100.0)	320 (100.0)
	Area (ha) (%)	5,612(100.0)	6,569(100.0)	12,181(100.0)
	ha/Farm	28	56	3.8

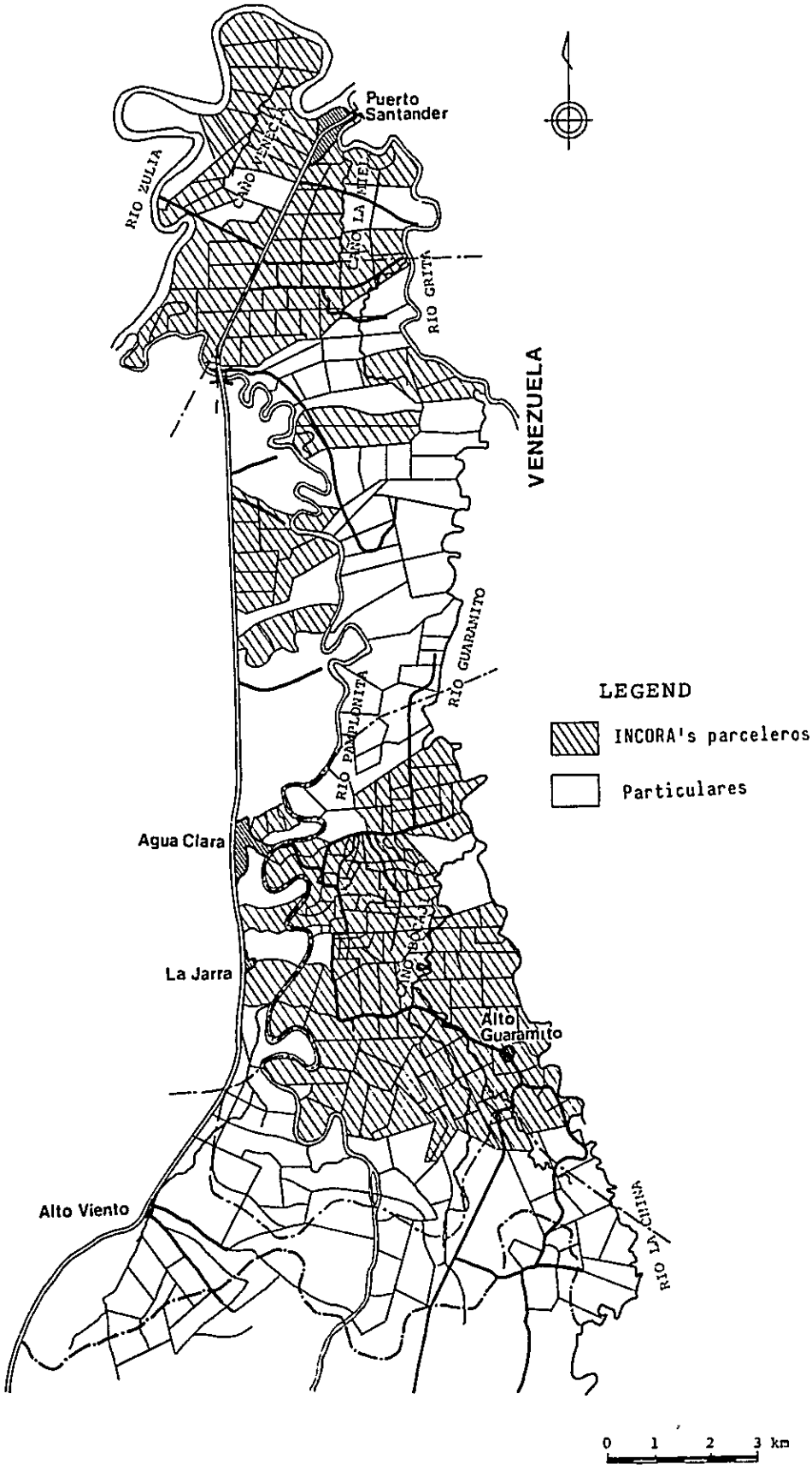


Fig. 3–26 Land Distribution Map

3.7 Zone Classification

Through the field study it is found that the spatial conditions in the study area differ widely.

In order to define spatial conditions in each zone in the study area and to determine development levels appropriate to each part of the study area, a zone classification is made based on the following factors:

1. Topography and soil types,
2. Drainage Conditions,
3. Effects from floods,
4. Type of land ownership and
5. Present land use.

Based on the above factors, the study area was classifed into four zones (Fig. 3-27).

The boundary between Zone A and Zone B is determined by flooding influence of different rivers. The major difference between Zone B and Zone C is type of land ownership. Criteria to divide Zone C and Zone D come from topography and soil types. The characteristics of the each Zone are summarized in Table 3-19 and briefly outlined as follows:

Zone A: This zone is subjected to periodical inundation caused by floods of the Zulia River. The major land use is extensive beef cattle raising by Parceleros.

Zone B: This zone is subjected to periodical inundation mainly caused by floods of the Pamplonita River. The major land use is also extensive beef cattle raising by Particulares.

Zone C: Flood damage is limited in this zone. The predominate land use is extensive beef cattle raising and cacao orchards by Parceleros.

Zone D: This zone is free from flood damage. Due to sandy soil types, drainage conditions are favourable compared with the rest of zones. Typical land use in this zone is extensive beef cattle raising by Particulares.

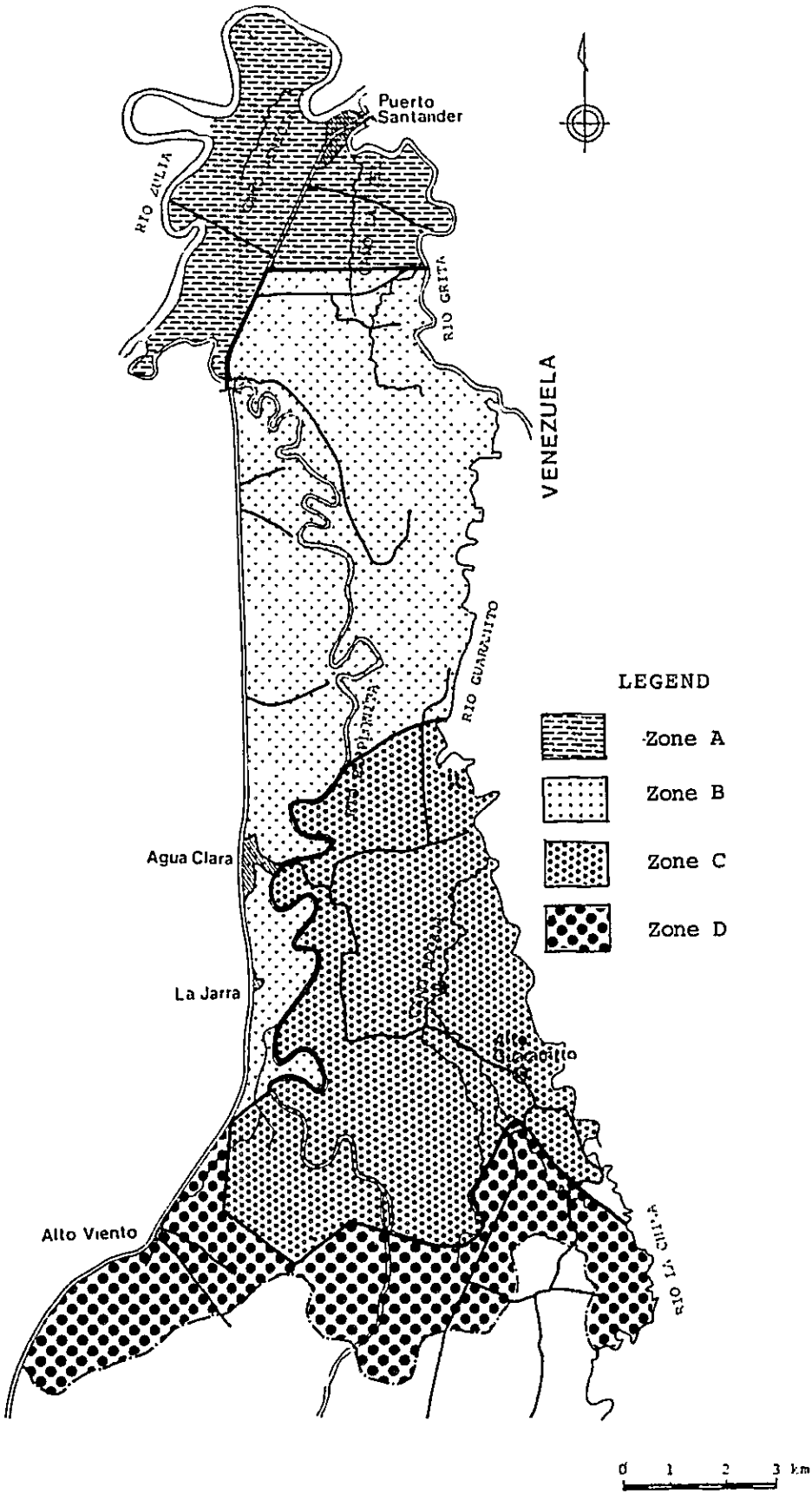


Fig. 3–27 Zone Classification Map

Table 3–19 Zone Characteristics

Zone	Acreage (ha)	Agricultural Land (ha) 1/	Number of Farm (house)	Acreage per Farm (ha/house)	Topography (Elevation) Average Slope	Soil Soil Texture (Productivity)	Drainage and Flood Condition			Principal Land Ownership	Principal Land Use
							Flood Day 3/ and Flooding Area	4/ Flooding Area (ha)	Annual Average 5/ to Groundwater Level (m)		
A	1,930	C: 10 P: 1,510 O: 0 T: 1,520	I: 34 P: 4 T: 38	40	Alluvial plain (47 to 55 m) 1.5%	Low plain soil Medium to fine (Moderate to high)	5 days 1,570 ha	44	60 to 110	INCORA's parceleros	Pasture
B	4,750	C: 40 P: 3,130 O: 90 T: 3,260	I: 42 P: 60 T: 102	32	Alluvial plain (51 to 75 m) 2%	Low plain soil Medium to fine (Moderate to high)	3 days 1,760 ha	25	60 to 140	Particu-lars	Pasture
C	4,860	C: 30 P: 3,450 O: 260 T: 3,740	I: 123 P: 14 T: 137	27	Alluvial plain (63 to 81 m) 2%	Low plain soil Medium to fine (Moderate to high	1 day 880 ha	14	90 to 200	INCORA's Parceloros	Pasture Partially Cacao
D	1,960	C: 10 P: 1,540 O: 70 T: 1,620	I: 3 P: 40 T: 43	38	River terrace (75 to 100 m) 7%	Terrace soil Coarse (Moderate to low)	1 day 90 ha	0	170 to 310	Particu-lars	Pasture
Total	13,500	C: 90 P: o,630 O: 420 T: 10,140	I: 202 P: 118 T: 320	32	(47 to 100 m) 2%		4,300 ha				

Notes: 1/ C: Cultivated Land
P: Pastures
O: Orchard
T: Total

2/ I: INCORA's Parceleros
P: Particulars
T: Total

3/ Consecutive flood days and area by flood of 5 years return period

4/ Topographic slope < 1/500, Ponding depth 30 cm and period more than 10 days

5/ Below the ground surface

3.8 Agriculture and Livestock

3.8.1 Agriculture

In the study area the major crops are cacao, cassava and maize. Brief descriptions of these crops are made in the following subsections.

(1) Cacao

The Department produces 1,750 tons of cacao per year which corresponds to 4.2% of the annual national production. Major production areas are the alluvial plains in the Catatumbo; Sandinata, Zulia, Pamplonita and Grita River zones. Total area of cacao orchards at present in The Department is estimated to be 3,650 ha (Banco de la Republica, 1982). In the study area, there are 350 ha of cacao orchards distributed in the area around Campo Alegre. According to the farm survey, it is found that most of the cacao orchards are owned by Parceleros and the average dimension of cacao area is 5.2 ha/household. Approximately 70% of these cacao trees are planted in the natural forest making use of the shade of the trees.

Cooking bananas are used as shade for cacao in the rest of the area.

Cacao cultivation commenced in the early 1960s in the study area and at present almost 70% of cacao trees are in matured condition. The harvest amount increases during the months from March to June. The average yield of cacao in the study area is estimated to be 520 kg/ha.

Cultivating techniques have improved greatly. Hybrids were introduced and application of agricultural chemicals and weedicide are common practice in 30% of the cacao orchards in the area. Technical extension services and agricultural credits are available through ICA, INCORA, Caja Agraria and FEDECACAO. There is a plan to extend cacao orchard from actual 350 ha to 1,000 ha by INCORA before 1988.

Problems of cacao cultivation observed at present in the study area are poor management caused by lack of agricultural investment, poor drainage conditions and plant disease (Monilia).

(2) Cashew Nut

At present cashew nuts are planted only in a limited area of about 70 ha at Alto Viento in the southern end of the study area. Cashew nuts were introduced on Parceleros' farms ten years ago. However, cashew nuts cultivation failed in the rest of the areas and it remains only at near of Alto Viento. These cashew nut orchards are owned by a few families. Harvesting is once a year and the ground surface between cashew nut trees is utilized as pasture.

(3) Cultivated Crops

The major crops in the study area are cassava and maize. Cultivated land size of these crops is 0.3 ha/household and mainly cultivated by Parceleros. The planting area of cassava tends to be wider than that of maize.

Fertilizers or agricultural chemicals are rarely applied and cultivation is made by manual labour. Usually a local variety of maize is planted for domestic consumption.

Typical present cropping pattern is shown in Fig. 3-28.

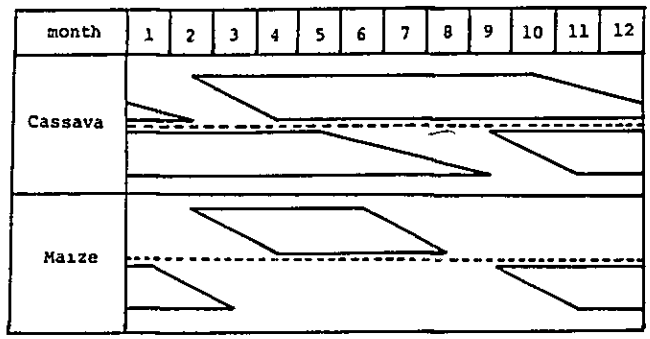


Fig. 3–28 Present Cropping Pattern

3.8.2 Livestock

The major livestock enterprise in the study area is beef cattle raising and other animals like goats, pigs, and fowl and kept for domestic consumption only.

(1) Beef Cattle Raising

There are three types of beef cattle raising in the study area:

Type 1: Breeding
Type 2: Fattening
Type 3: Breeding and Fattening

Type 1 and 2 are common types for small-scale farmers with land holdings of approximately 30 ha and Type 3 is practiced by medium to large-scale farmers holding more than 50 ha. Grazing capacity by type of beef cattle raising is: 1.8 to 2.0 head/ha for Types 1 and 3 and 1.3 head/ha for Type 2.

Predominating stocks of cattle are Cebu, a cross bred of Cebu and "Criollo" (domestic race) and a Cross bred of Cebu and "Pardo Suizo" (Brown Swiss). They constitute about 70% of the cattle in the study area. More than 90% of bulls are Cebu. A few bulls of Pardo Suizo, Hornstein and Romosinuano are kept by some large-scale farms.

Common cattle diseases in the area are foot and mouth disease, anthlax, black leg and hemorrhagic septicemia.

Vaccination is rarely practiced in the small-scale farms and ecto and endo parasites are commonly observed.

It is assumed that farmers' expense for salt and minerals for cattle are only 60 to 70% of the proposed standard expense by ICA.

(2) Pasture

Only 30% of the pasture in the study area is artificial grasses. This can be attributed to the fact that the greater part of the study area suffers from poor drainage which makes difficult to renew pasture periodically. Common types of grasses planted as pasture are "Braquiaria", "Angleton" and "Aleman".

At Tibu, near to the study area, an experiment is now introduced Tropical Kudzu (Pueraria Phaseoloidos) of leguminous. The results of the above experiment indicate that 600 g/day of weight gain for one beef cattle. This shall encourage farmers in the study area to introduce Tropical Kudzu into their pasture.

The typical grazing method in the study area is continuous grazing, however, rotational grazing is also practiced in some farms. Pasture management is poor especially in small-scale farms. Neither plow application of fertilizer is practiced in small-scale farms and cattle fences and cattle troughs are insufficiently installed. Further details are discussed in Appendix 6.4.

3.8.3 Household Economy

In order to analyse the present state of household economy in the study area, a general farm survey was made for 58 farms. In addition, a special survey was made on livestock production for 20 farms and on cacao production for 10 farms.

Based on the analysis of these farm surveys, the average state of household economy is described in the following part in this section.

(1) General

The 80% of the sample farms are independent farms whose land holding size varies between 30 and 40 ha. The average numbers of family members is 6.8 persons of whom 3 persons provide family income mainly by engaging in agriculture. The average number of children per family is 4.8.

Cumulative labour requirements per farm is 174 man-days/year of which 124 man-days/year is met by family labour and the balance by employed labourers. Employed labourers are required during harvesting period from December to April (Appendix 6.2).

The average value of houses is estimated to be COL$310,000 and the value of agricultural equipment owned by farmers is estimated to be

equivalent to COL$25,000 excluding tractors. The 14% of the sampled farms have tractors.

(2) Farmhousehold Income

Farm income seems to be low due to low productibity caused by extensive method of beef cattle raising and lack of capital to purchase calf for fattening. The average annual gross income varies between COL$10,800 and COL$14,400. The average production cost varies between COL$5,400 and COL$7,200. Therefore, the balance (the average net income from beef cattle raising) varies between COL$5,400 and COL$7,200 per family.

An average size of cacao orchard per family is 5 ha and annual production is estimated to be COL$65,000/ha. The farm gate price of cacao in the study area is COL$120/kg ∿ COL$125/kg in July, 1983. Average production cost of cacao is estimated to be COL$26,000/ha of which 75% is labour cost especially for repair and rehabilitation of drainage canals in the orchard (15 man-days/ha/year). Therefore, the balance between the production value and the production cost is estimated to be COL$39,000/ha.

Other crops common in the study area are cassava and maize. Average cultivation of these two crops varies between 0.3 and 0.5 ha farm. Cassava tends to be planted over wider areas than maize. Average production cost of both crops is estimated to be COL$10,000/ha, however, the yield of cassava is three times of the yield of maize. Since the farm gate price of the two crops is the almost same (COL$15/kg. ∿ COL$20/kg), cassava is more profitable than maize.

Non-agricultural income per family is estimated to be COL$56,250 on average.

Since the value of agricultural products for domestic consumption is estimated to be COL$28,900/farm, the average total household expense is estimated as shown in Table 3-20.

Table 3–20 Annual Household Income

(Unit: COL$)

Zone A	Zone B	Zone C	Zone D	Average
319,000	316,000	357,000	365,000	340,000

(3) Living Cost

The average household living cost is estimated to be COL$100,000/farm with variation by classified zone as shown in Table 3-21.

Table 3–21 Annual Household Expenses (cash)

(COL$/Farm)

Zone A	Zone B	Zone C	Zone D	Average
98,900	99,300	102,100	107,300	101,900

The total household expense including self-support foods is about 130,000 COL$/farm.

Annual total expense is allocated as follows: 56% food, 15% clothing, 13% education, 5% energy and 11% health and others.

3.8.4 Agricultural Production

Unit prices such as production cost, unit yield and farm gate price are estimated as shown in Table 3-22 based on the farm survey, market survey, statistics and interviews with local experts.

Table 3–22 Present Production Cost, per ha yield, Farm Gate Price

Crops	Production Cost (A) (COL$/ha)	Labour Cost (B) (COL$/ha, B/A x 100%)	Unit Yield (t/ha)	Farm Gate Price (COL$/kg)
Beef Cattle (Zone A, B)	5,400	1,050 19%	0.12	90
Beef Cattle (Zone C, D)	7,200	1,050 15%	0.16	90
Cassava	10,180	10,180 100%	6	15
Maize	10,160	7,660 75%	2	17
Cacao	26,000	18,000 69%	0.52	125
Cashew nut	45,700	13,500 30%	5.0 (fruit) 1.0 (apple)	4

Note: Based on farm survey.

Further details of production cost is shown in Appendix Table 6-7-3.

Based on the Table 3-22 and present land use, total production in the study area is estimated as shown in Table 3-23. At present, total production in the study area is estimated to be COL$155 million/year which produces net profit of COL$81 million/year. The average net profit is assumed to be about COL$8,000/ha/year.

Table 3–23 Present Farm Production by Zone

Zone	Crop	Area (ha)	Production (t)	Production Value (10^3 COL$)	Production Cost (10^3 COL$)	Net Profit (10^3COL$)	Net Profit/ha. (COL $/ha)
A	Beef cattle	1,510	181.2	16,308	8,154	8,154	5,400
38	Cassava	10	60	900	102	798	79,800
	Total	1,520	241.2	17,208	8,256	8,952	5,890
B	Beef cattle	3,130	357.6	33,804	16,902	16,902	5,400
102	Cassava	30	180	2,700	305	2,395	79,800
	Maize	10	20	340	102	238	23,800
	Cacao	90	46.8	5,850	2,340	3,510	39,000
	Total	3,260	622.4	42,694	19,649	23,045	7,070
C	Beef cattle	3,450	552	49,680	24,840	24,840	7,200
137	Cassava	10	60	900	102	798	79,800
	Maize	20	40	680	203	477	23,800
	Cacao	260	135.2	16,900	6,760	10,140	39,000
	Total	3,740	787.2	68,160	31,905	36,255	9,690
D	Beef cattle	1,540	246.4	22,176	11,088	11,088	7,200
43	Maize	10	20	340	102	238	23,800
	Cashew nut	70	Fruit 350 Nut 70	1,400 2,940	3,199	1,141	16,300
	Total	1,620	686.4	26,856	14,389	12,467	7,700
Total	Beef cattle	9,630	1,355.2	121,968	70,984	60,984	6,520
320	Cassava	50	300	4,500	509	3,991	79,800
	Maize	40	80	1,360	407	953	23,800
	Cacao	350	182	22,750	9,100	13,650	39,000
	Cashew nut	70	Fruit 350 Nut 70	1,400 2,940	3,199	1,141	16,300
	Total	10,140	2,337.2	154,918	74,199	80,719	7,960

Note: 1) Minor items for domestic consumption such as pigs, fowl, cooking banana and vegetable are not included.
2) Cooking bananas used as shade of cacao trees are included in cacao production.

3.8.5 Marketing of Agricultural Products

(1) Cacao

Cacao is collected by the two buyers and transported to four small-scale factories and the two major processors: Luker and National at Bucaramanga. The branch office of FEDECACAO at Sardinata acts as contract agent collecting an agent's fee of 2% of the total amount of deals.

There is seasonal variation in cacao production in The Department; high production is observed in the months from January to March (200t/month) and low production (less than 20 t/month) in September and October.

In the Cucuta, the peak collection of cacao is made in May and June (80 - 100 t/month) and the lowest collection in August and September (4 - 8 t/month).

(2) Other Crops

Other crops like cassava and maize are mainly for domestic consumption and only a limited amount is sold to collectors and shipped to the Cucuta market. Although the farm gate price of these two crops is almost same, the market price of cassava is higher than that of maize. This may be caused by a higher handling charge for cassava than for maize.

(3) Livestock

1) Beef Cattle

Live beef cattle is sold at the cattle market in Cucuta. There are two types of cattle dealers:

"Mayoristas" (big dealers), and
"Minoristas" (small dealers).

In the Cucuta market there are 4 Mayoristas and 20 Minoristas.

There is no price control for beef cattle at present. Dealers purchase beef cattle directly from local farmers at prices determined by supply and demand. For determination of the price of live beef cattle, only the weight of cattle is accounted and no attention is payed to breed, sex and nutrition condition. Since devaluation of Venezuelan currency, a lot of beef cattle has come to be shipped from Venezuela to Cucuta, and this prevents any rise in the price of live beef cattle at the Cucuta market.

Apart from sales of beef cattle at the cattle market in Cucuta, beef cattle are sold locally by local butchers who have their own slaughter facilities. The price of beef cattle purchased by the local butcher appears to be 15 - 20% less than the price at the cattle market in Cucuta.

2) Milk

Milk is produced in the study area, however, the amount of production is limited. Milk is sold to collectors and shipped to Cucuta. The producers' price of milk depends on its freshness and appearance.

3) Beef cattle

Feeder cattle for fattening and the better breeds are sold at the cattle market in Cucuta. The price mechanism for feeder cattle is the same as the marketing price for beef cattle. Sales of feeder cattle for fattening in the local market are made directly between seller and buyer. Usually only visual weight is made and the price is determined based on the price at Cucuta.

The marketing system in the area around the cattle market in Cucuta is summarized in Fig. 3-29.

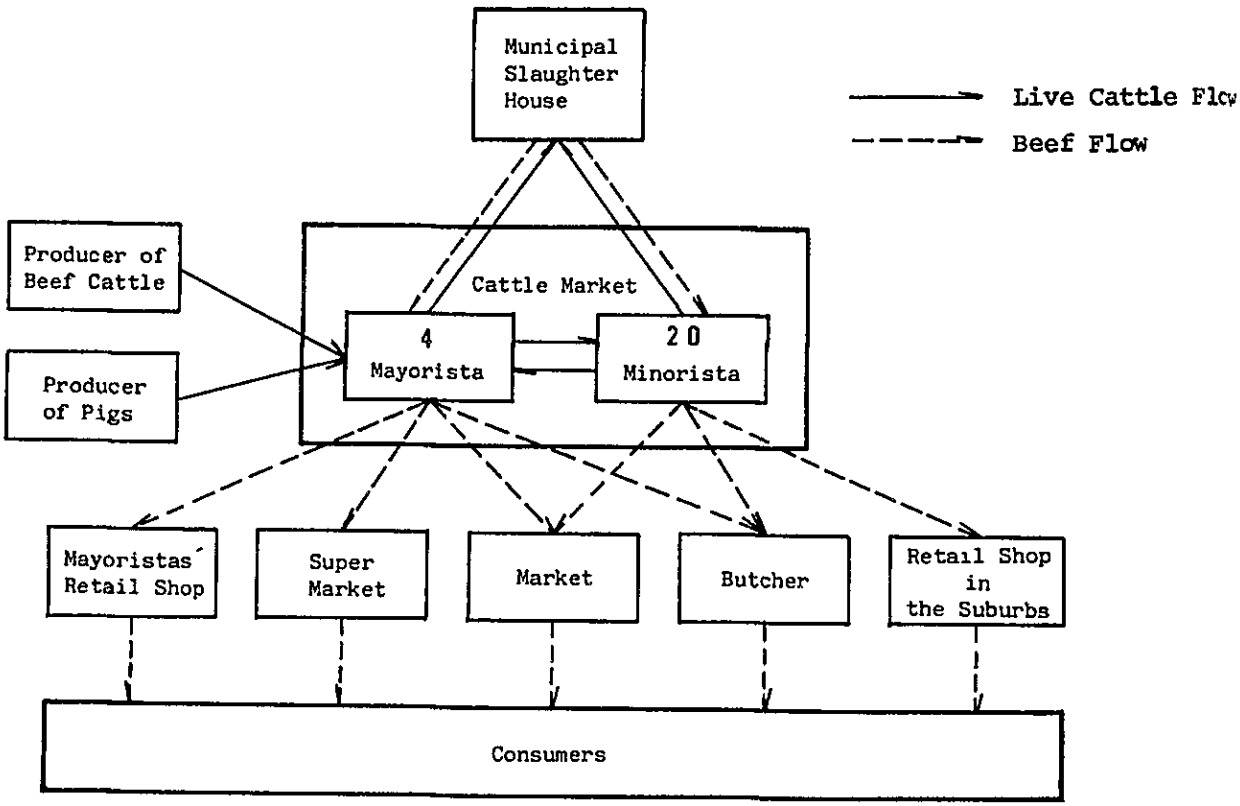


Fig. 3–29 Present Marketing System of Cattle and Beef at Cucuta

(4) Market Price

The price of cacao is determined by FEDECACAO (Appendix Table 6-5-5). The market prices for processors are recorded as shown below:

Table 3–24 Marketing Prices of Cacao

(Unit: COL$/kg)

Date	Farm Gate Price	Market Price	Processor Purchase Price
Jul. 1983	125	130	135
Nov. 1983	150	155	160

Transport cost from Cucuta to Bucaramanga is COL$2.4/kg for 240 km of distance.

The farm gate price of cassava and maize in the study area is 20 - 50% higher than the average farm gate price in The Department as shown in Table 3-25.

Table 3–25 Marketing Prices of Cultivated Crops

(Unit: COL$/kg)

Crops	Cassava	Maize	Cooking Banana
Study Area	15	17	15
Average of The Department	10	15	11

Commodities like rice, maize and cacao have official prices. The market prices of commodities with an official price and of meat appear to be steady without significant seasonal variation. The market price of cassava and cooking banana drops 20% to 30% during the months of March and April due to oversupply of these commodities in the market.

The market price of live beef cattle varies between COL$100/kg and COL$105/kg at the Cucuta market. The same price in the local market is about COL$90/kg, although sometimes older beef cattle is sold at approximately COL$70/kg. The transport cost of the beef cattle from the study area to the cattle market at Cucuta is COL$10/kg.

The market price of pork was COL$105/kg in July, 1983, however, the price was reduced to COL$90/kg in November, 1983 due to the influx of pork and pigs from Venezuela.

(5) Official Price

The purchase price of major agricultural products is announced by IDEMA twice in a year (Appendix Table 6-5-5). The IDEMA purchase prices in June, 1983 are as shown below:

White maize	COL$25.18/kg
Yellow maize	COL$22.78/kg
Sorghum	COL$19.24/kg

These prices do not include transportation cost from the farm to the IDEMA warehouse. When breed and quality are below IDEMA's standards, a lower price is applied.

3.8.6 Agriculture Related Public Institutes

The study area has branch office of INCORA and COAGRONORTE at Agua Clara. The local slaughter house and the regional slaughter house at Cucuta are of importance for the local economy in the study area.

(1) The Branch Office of INCORA

This office provides agricultural services for about 320 farms of Parceleros distributing over 9,000 ha in the catchment area in the down stream area of the Pamplonita River.

The annual budget of the office is about COL$4 million. The office consists of the following staff members:

Function	No. of personnel
1. Director	1
2. Vaccination	2
3. Agricultural Credit	4
4. Social-infrastructure	1
5. Agronomy	2
6. Veterinary	2
7. Improvement of Living Conditions	1
8. Secretary	1
Total	14

Major activities of this office are:

1. Assistance for farming,
2. Assistance for processing of agricultural credits, and
3. Assistance for improvement of local social-infrastructure.

Close coordination is made with other related public institutions to assist farmers in better farming practices. For example, assis-

tance for improvement of sanitary aspects of livestock and for artificial insemination are provided under the technical guidance of ICA.

The majority of Parceleros utilize some kind of agricultural credits. A 5 year plan was formulated for 1984 to 1989 in the immigration area of INCORA. The major objectives of this plan are:

1. land improvement at the farm level,
2. increase in agricultural production and
3. rural electrification, expansion of farm road width and improvement of the farm road system.

For this purpose, credits are available totalling COL$5 million in each year during the plan. In addition, emphasis is placed on cacao by INCORA. Accordingly, an effort has been made by INCORA for supply of hydrid seeds and technical services. The target of cacao production in the study area is to increase cacao orchards upto 1,000 ha and to attain a unit yield of 1,000 kg/ha.

(2) COAGRONORTE

COAGRONORTE was organized under INCORA to supply farm items to local farms, however, it was transferred to private commercial operation. The regional main office attends more than 3,000 member farms located at Cucuta and a service branch is available at Agua Clara which supplies farm items. These items are: seeds, fertilizer, agricultural chemicals and agricultural machinery. The COAGRONORTE intends to expand their services of technical extension in the future.

(3) Slaughter Houses

The public slaughter house is located at Cucuta and there are also some local private slaughter facilities in the study area. Handling capacity of the public slaughter house is 250 heads of cattle/day with a planned expansion for 50 pigs/day. Slaughtering facilities for cattle are functioning satisfactorily. The facilities for pigs is under preparation. There is no freezing facility. The function of this slaughter house is only direct slaughter of cattle and no meat inspection is made.

The slaughter charge of the public slaughter house is COL$1,600/head of cattle or COL$800/head of pig is planned. About 100 beef cattles were handled in November, 1983 during the field study.

Although the local butchers purchase cattle directly from farms and slaughter them by themselves for sale, they have to pay the slaughter charge to the departmental government at rate of COL$230/head and have to receive facilities inspection by the veterinary officer of the departmental government in every three months.

3.9 Present Conditions and the Prospective Development

In order to formulate the future development framework, this section of the reprot will identify the existing obstacles hindering the agriculture from the attainment of efficient utilization of existing potencial of land resources in the study area.

3.9.1 Characteristics of Agriculture in the Study Area

The predominating form of land use is extensive beef cattle raising which occupies 95% of total agricultural land. The amount of beef cattle production is about 79% of the total gross agricultural production or 78% of the total net production value in the study area.

The next major crop in the study area is cacao, totalling about 17% of the total net production value. Other crops are only for domestic consumption (Table 3-26).

Table 3–26 Present Farm Production

Item	Agricultural Area (ha)	Gross Production *		Net Production *	
		Per ha (COL$)	Total (10^6 COL$)	Per ha (COL$)	Total (10^6 COL$)
Beef cattle	9,630 (95.0%)	12,665 (1.0)	121,968 (78.7%)	6,520 (1.0)	62,788 (77.8%)
Cassava	50 (0.5%)	90,000 (7.1)	4,500 (2.9%)	79,800 (12.2)	3,999 (5.0%)
Maize	40 (0.4%)	34,000 (2.7)	1,360 (0.9%)	23,800 (3.7)	959 (1.2%)
Cacao	350 (3.4%)	65,000 (5.1)	22,750 (14.7%)	39,000 (6.0)	13,650 (16.9%)
Cashew nut	70 (0.7%)	62,000 (4.9)	4,340 (2.8%)	16,300 (2.5)	1,141 (1.4%)
Total	10,140 (100%)	15,278 (1.2)	154,918 (100%)	7,960 (1.2)	80,719 (100%)

* Parenthesis: index of value on the basis of beef cattle = 1.0

The standard farm scale varies from 30 to 40 ha. This scale is the transitional one between the intensive agriculture in the smaller scale and the extensive beef cattle raising in large scale.

3.9.2 Low Productivity

The productivity of crops in the study area appears to be relatively low compared with the national average productivity of the same type of crops. The poor drainage conditions are the major obstacle.

(1) Poor Drainage

Although drainage conditions differ from place to place, in general, poor drainage conditions are caused by stagnating water in depressions or flat land surfaces brought by floods from the Pamplonita and the Zulia River. Rainfall also produces the same problem over a greater part of the study area. Together with the flat topography, the low percolation capacity and permeability of soils result in high groundwater levels. Land inundation caused by flood waters and high groundwater levels limit land use.

Taking the poor drainage conditions as the stagnating water on the ground surface 30 cm deep and for duration more than 10 days, the coverage of the poor drainage conditions extends over 20% (2,670 ha) of the study area (Table 3-27). Zone A is covered by this type of drainage conditions over 44% of the area and in Zone B about 25% of the area is estimated to be a poor drainage area. The northern part (Zones A and B) is more affected by poor drainage conditions than the southern part of the study area (Zone C and D).

Table 3–27 Present Poor Drainage Area

Zone	Zone Area (1) (ha) (%)	Poor Drainage Land (2) (ha) (%)	Ratio of Poor Drainage Land (2)/(1) (%)
A	1,930 (14)	840 (31)	44
B	4,750 (35)	1,170 (44)	25
C	4,860 (36)	660 (25)	14
D	1,960 (15)	- (-)	-
Total	13,500 (100)	2,670 (100)	20

The flooded area in 2 year return period of the Pamplonita and the Zulia River extends over 1,050 ha corresponding to 8% of the total study area. Those in 5 year return period covers almost 4,300 ha corresponding to 32% of the total area. The flooding water causes the damage of inundation mainly in Zones A and B. Zone A especially suffer from poor drainage conditions (Table 3-28).

These floods have close relationship with distribution of groundwater levels. The area where the groundwater level is less than 1 m from the ground surface extends over 40% of the study area distribute in Zones A and B in the northern part. The groundwater level in these zones has close relationship with rainfall.

Table 3–28 Present Flooding Area

Zone	Area (ha)		Flooding Area					
			2 year * Return Period Area		5 year * Return Period Area		10 year * Return Period Area	
			(ha)	(%)	(ha)	(%)	(ha)	(%)
A	Total	1,930	690	(36)	1,570	(85)	1,850	(96)
	Agricultural Land	1,520	550	(36)	1,180	(83)	1,450	(95)
B	Total	4,750	230	(5)	1,760	(35)	2,980	(63)
	Agricultural Land	3,260	80	(2)	1,170	(33)	2,050	(63)
C	Total	4,860	130	(3)	880	(18)	1,590	(33)
	Agricultural Land	3,740	20	(1)	330	(9)	930	(25)
D	Total	1,960	0	(0)	90	(5)	140	(7)
	Agricultural Land	1,620	0	(0)	50	(3)	70	(4)
Total	Total	13,500	1,050	(8)	4,300	(32)	6,560	(49)
	Agricultural Land	10,140	650	(6)	2,730	(27)	4,500	(44)

* Estimated by flood records.

These drainage conditions definitely affect the productivity of the land. The effects of drainage conditions on the agricultural productivity can be estimated. For this purpose, some farms of the farm survey were selected from the area where no drainage problems are observed in the study area. A comparison of the productivity is made between the standard farms in the study area and these farms without drainage problems. As a result, it is estimated that the productivities of the farms without drainage problems is much higher than the average productivity in the study area by 90% in beef cattle raising and by 48% in cacao production (Table 3-29 and 30). The difference in productivity may be easily recovered by improvement of drainage conditions.

Table 3–29 Comparison of Existing Average and Projected Yield of Beef Cattle

	Percentage of Improved Pasture	Weight Gain (kg/ha/year)	Production (COL$/ha)	Production Cost (COL$/ha)	Net Production (COL$/ha)
Average in Study Area (A)	30	140	12,665	6,145	6,520
Farm in well drained area (B)	91	332	29,924	17,510	12,419
B - A	61	192	17,259	11,365	5,899

Source: Farm Survey

Table 3–30 Comparison of Existing Average Yield and Projected Yield of Cacao

	United Yield of Matured Tree (kg/ha)	Production (COL$/ha)	Production Cost (COL$/ha)	Net Production (COL$/ha)
Average in Study Area (A)	520	65,000	26,000	39,000
Farm in well drained area (B)	772	96,500	38,600	57,900
B - A	252	31,500	12,600	18,900

Note: Based on Farm Survey (Appendix Table 6-2-2)
Farm Gate Price is COL$125/kg
Production Cost is COL$50/kg

(2) Necessity of Improvement of Social Infrastructure

In the study area there are many aspects of the social infrastructure which can be improved: the density of farm road network is extremely poor and there is only one bridge to tie both sides of the Pamplonita River. Transportation of materials and goods necessary for everyday life and farming is very difficult. The poor road system also results in insufficient agricultural extension services. These conditions may affect the outlook of farmers.

(3) Necessity of Extension Services and Credits

Almost half of the area is INCORA immigration area. These immigrant farmers (Parceleros) have only limited capital and hence agricultural credits are required by the farms. Other farmers in the study area (Particulares) may receive technical extension services from ICA. However, due to the poor condition of the road network, these services provided by INCORA and ICA does not reach every farm. As for beef cattle raising, fattening may be more profitable than breeding, however, it is very difficult for farmers without capital to purchase cattle for fattening. Furthermore improvement of pasture and sanitary care of cattle are insufficient due to lack of capital and extension services.

3.9.3 Possibility of the Future Development

The important role played by beef cattle raising at present is likely to continue into the future. However, the size of farms may be the limiting factor to increase farm income if household economy depends entirely on beef cattle raising. It is, therefore, necessary to examine the possibility of the introduction of more profitable cash crops and to maintain mixed farming system for sound farm economy.

Based on the farm survey, it was found that farms without drainage problems have greater unit production (2 times) than the national

average beef cattle production (Table 3-29). Therefore, when the drainage conditions are improved, increase in production of beef cattle will be possible. These levels to which present drainage conditions are to be improved are:

1. Groundwater levels at 70-80 cm from the ground surface, and
2. Occurrence of submergence, once more than in 2 years.

These are the minimum requirements to improve beef cattle production in the study area without any drastic change in the farming system.

The cacao unit production in farms without drainage problems in the study area is also higher (1.5 times) than the national average unit yield (Table 3-29). Cacao is a highly profitable crop in the study area, however, drainage problems limit the expansion of cacao orchards. In order to improve drainage to the level suitable for cacao production, the following conditions must be maintained:

1. Ground water levels is more than 100 cm from the ground surface, and
2. Frequency of submergence is less than once within 5 years.

These are the conditions required to maintain sound production of cacao.

According to the recommendation made by the committee for regional development of The Department (Diagnostico Agropecuario, 1980), it is pointed out that there are large potentials for improvement of cultivation method and productivity of crops like cassava and maize.

The advantage of theses crops is that their capital withdrawal period is shorter than that of cacao and beef cattle raising. In addition these grain crops such as maize and sorghum are adaptable to mechanized largescale cultivation with irrigation.

It is, therefore, proposed that the future development plan in the study area is based on improved beef cattle raising combined with promotion of other crops of higher profitability than beef cattle raising.