Table 5.2.1 CORRELATION OF STRATIGRAPHIC SEQUENCE

AGE			LOS LLANOS: BARINAS	LOS LLANOS: EL BAUL	LOS LLANOS: ORIENTAL	LOS ANDES	CORDILLERA DE LA COSTA
QUATERNARY	HOLOCENE		Alluvium	Alluvium	Alluvium	Alluvium	Alluvium
	PLEISTOCENE		Guanapa		Mesa	Guanapa Carvajal Lagnillas	Tuy Guatire
CENOZOIC	PLIOCENE		Rio Yuca		Las Piedras	Rio Yuca Parángula Betijoque Isnotú Palmar	Siquire
	MIOCENE	SUPERIOR					Aramina Carenero
		MEDIUM	Parangula		Freites		Galera
		INFERIOR		Chaguaramas	Oficina		
	OLIGOCENE				Merecure		Quebradón
	EOCENE	SUPERIOR	Tilangona	Roblecito		Carbonera	
		MEDIUM	Paguey Masparrito	La Pascua			Los Cajones
		INFERIOR	(Gobernador) (El Santuario)		Caratas	Misoa Mirador	
	PALEOCENE				Vidoño	Valle Hondo Los Cuervos Barco	Guarico
MESOZOIC	CRETACEOUS	MAASTRICHTIAN	Burguita; Esperanza		San Juan	Mito Juan	Mucaria
		CAMPANIAN				Colon	Paracotos Garrapata Aragüita
		SANTONIAN	Quevevedo		Tigre	La Luna	
		CONIACIAN	La Moraca				
		TURONIAN	Escandalosa; Fortuna			Capacho	Chuspita Villa de Cura Las Mercedes Antimano Peña de Mora
		CENOMANIAN	Maraca		Cañoa		
		ALBIAN	Basement			Maraca Aguardiente	
		APTIAN				Apon	
		BARREMIAN				Rio Negro	
		NEO COMIAN					
	JURASSIC					La Quinta	Las Brisas
	TRIASSIC			Guacamayas			
PALEOZOIC	PERMIAN						
	CARBONIFEROUS			Cañaote; El Baul	Carrizal	Palmarito Sabaneta Mucuchachi	
	DEVONIAN			Cerrajon	Hato Viejo		
	SILURIAN				Basement		
	ORDOVICIAN			Mireles		Tostos	Sebastopol Complex
	CAMBRIAN						
PRE CAMBRIAN						Iglesias Group Bella Vista	Basement

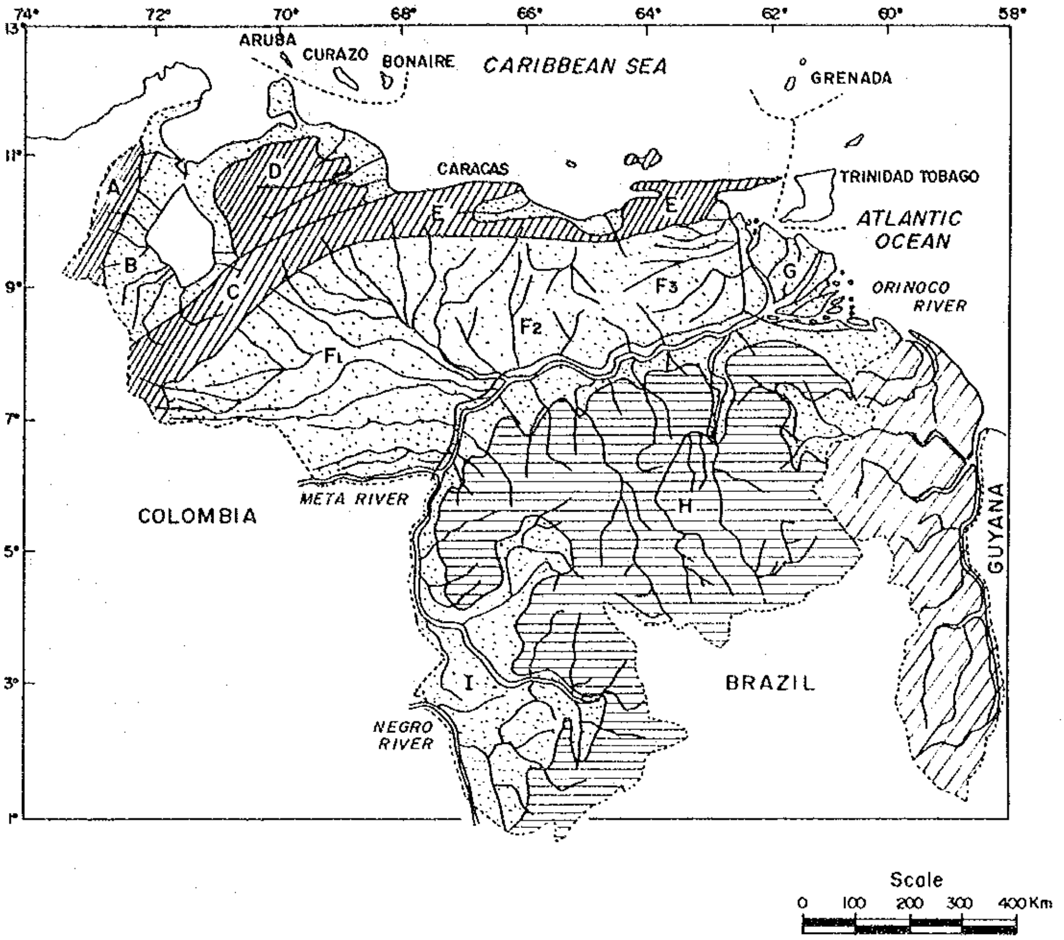
BY GEOLOGIA DE VENEZUELA
Y DE SUS CUENCAS PETROLIFERAS
FONINVES (1980)

Table 6.1.1 MOISTURE CONTENTS FOR DEGREE OF COMPACTION

Sample No.	Maximum Dry Density rdmax (kg/m^3)	Dry Density rd • D90 (kg/m^3)	Optimum Moisture W opt (%)	Moisture Contents W • D90 (%)	Soil Type	Natural Moisture Content (%)
TP-1	1.752	1.577	17.2	23.8	CL	13.3
TP-2	1.658	1.492	20.0	27.0	CL	7.4
TP-3	1.726	1.553	13.0	28.8	CL	14.4
TP-4	1.560	1.404	17.5	33.6	SP	28.0
TP-5	1.710	1.539	16.5	23.2	CL	20.6
TP-6	1.769	1.592	15.6	22.5	CL	16.3
TP-7	1.765	1.589	17.0	22.0	CL	13.1
TP-8	1.712	1.541	14.8	22.3	SM	6.8
TP-9	1.752	1.577	14.5	26.8	CL	7.2
TP-10	1.715	1.544	17.6	24.5	CL	10.5
TP-11	1.820	1.638	13.6	19.6	CL	6.6
TP-12	1.627	1.464	20.6	30.0	ML	15.1
TP-13	1.881	1.693	12.2	18.0	ML	16.3
Mean Value	1.727	1.554	16.2	24.8	-	13.5

Note : D90 = rdmax x 90 (%)

FIGURES

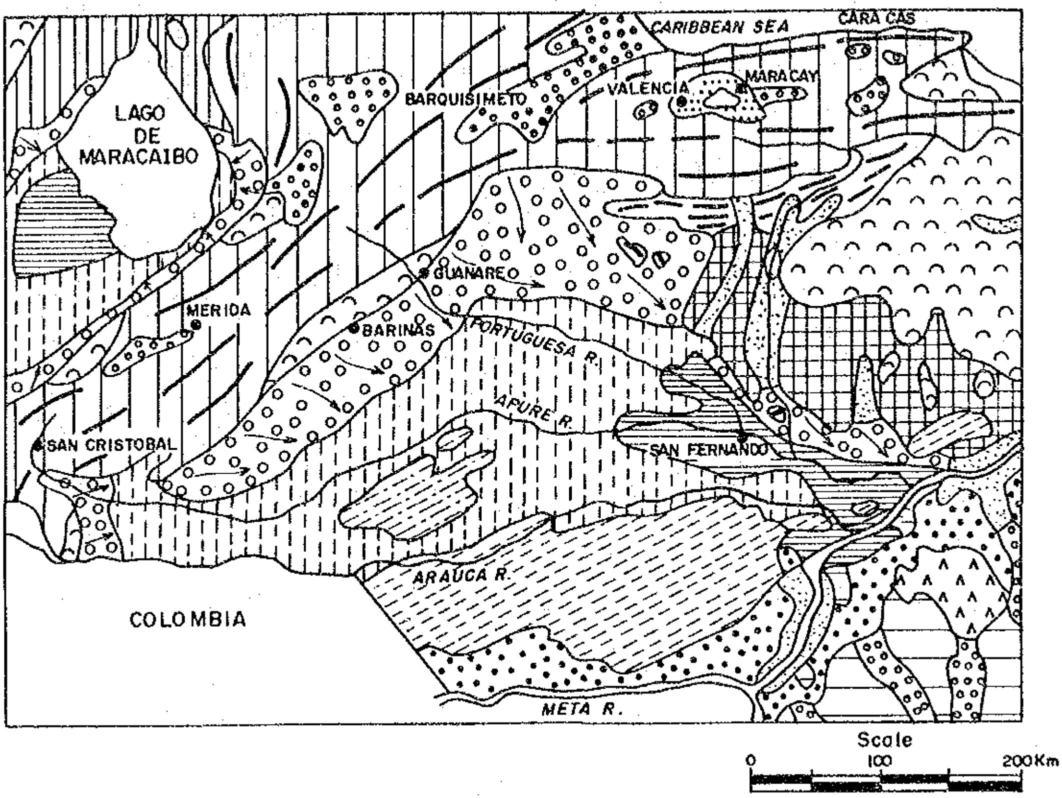


Legend

Plains and Terraces	A Perija Mountains	F1 Western Llanos
Mountains and Hills	B Maracaibo Basin	F2 Central Llanos
Shield and Table Mountains	C Andes Mountains	F3 Oriental Llanos
Dispute Zone	D Falon-Lara Mountains	G Orinoco Delta
	E Caostal Mountains	H Guyana-Amazonas Mountain massif
		I Casiquiare Plain

Fig. 2.1.1 Geomorphological Classification of Apure River Basin

THE REPUBLIC OF VENEZUELA
COMPREHENSIVE IMPROVEMENT
OF THE APURE RIVER BASIN
JAPAN INTERNATIONAL COOPERATION AGENCY



Legend

Precambrian Mountains	Leoss
Younger Folded Mountains (Paleozoic-Tertialy)	Valley Bottom Plain
Tertiary Mountains	Fluvial Plan
Tertiary Hills	Alluvial Fan
Bad Land	Flood Plain
Erosional Rock Terrace	Inland Delta
Hill and Terrace (Pliocene-Pleistocene)	Lacustrine Low land
Gravely Terrace (Quaternary)	Marine Lowland
Inland Dune	

Note : Michel Pouyllau (1985) CENTRE D'ETUDES DE GEOGRAPHIE TROPICALE, CNRS BORDEAUX, FRANCE

Fig. 2.1.2 Geomorphological Map of Apure River Basin

THE REPUBLIC OF VENEZUELA
COMPREHENSIVE IMPROVEMENT
OF THE APURE RIVER BASIN
JAPAN INTERNATIONAL COOPERATION AGENCY

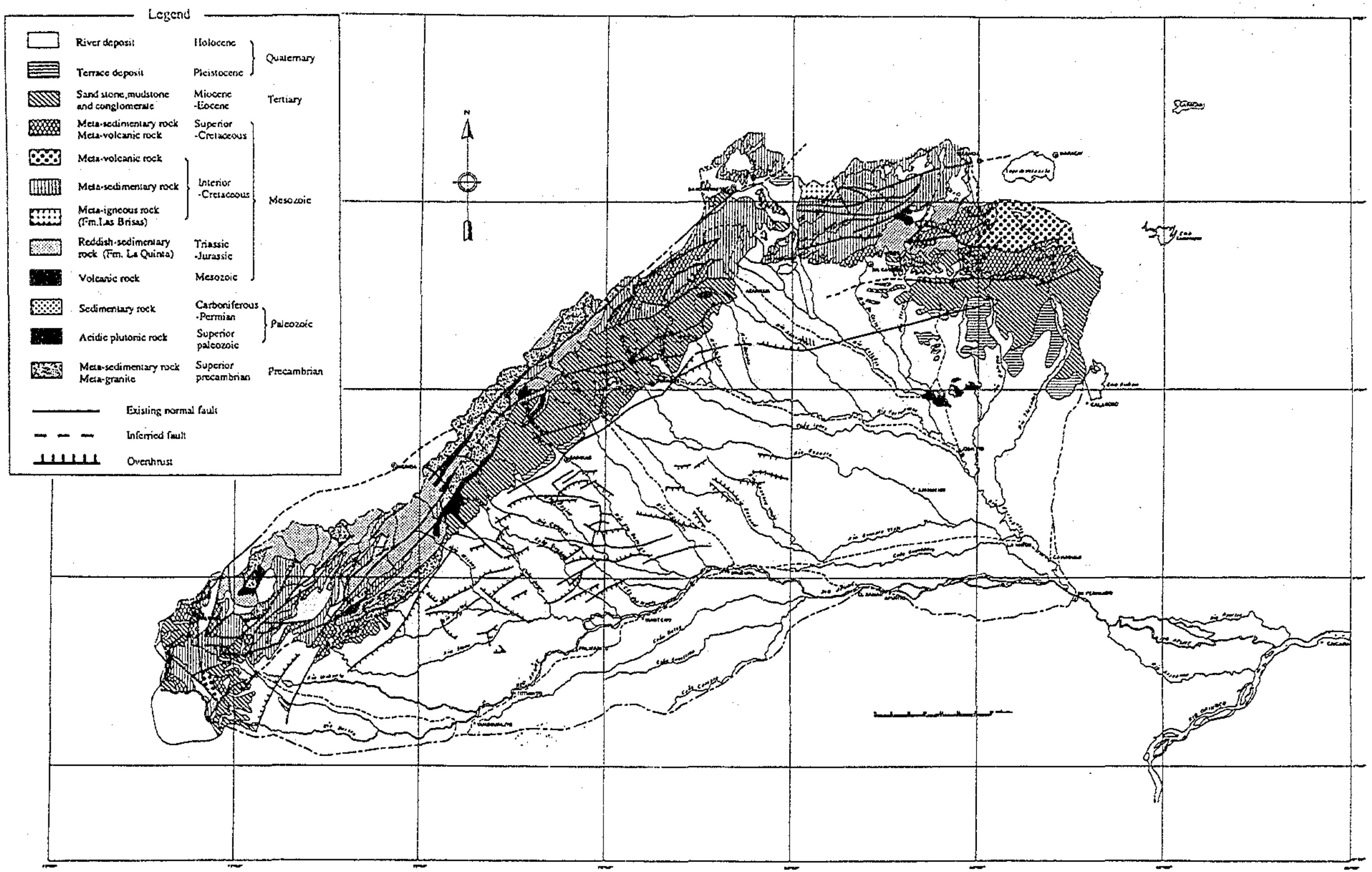


Fig. 2.2.1 Geological Map of Apure River Basin

THE REPUBLIC OF VENEZUELA
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OF THE APURE RIVER BASIN
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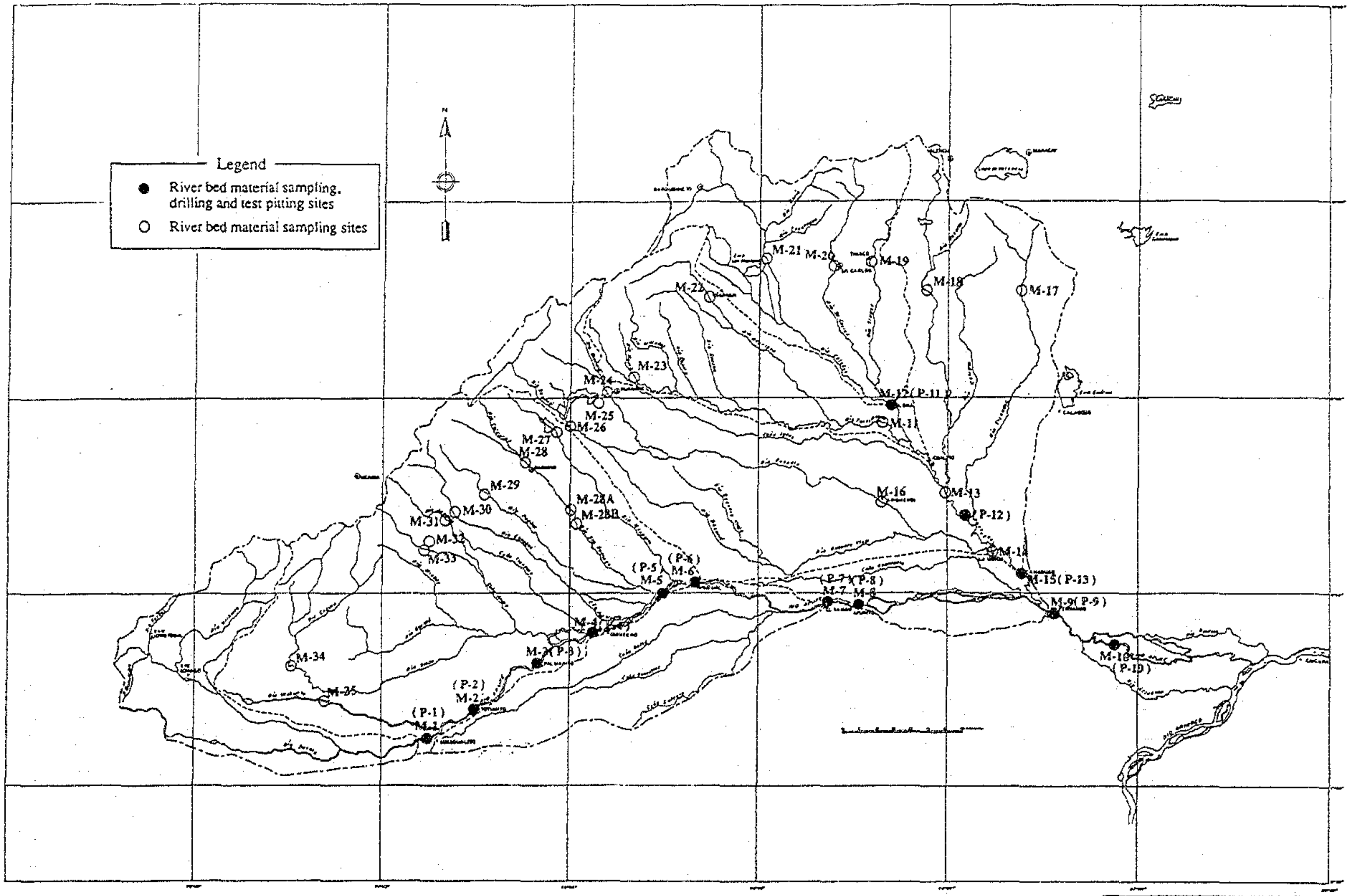

Fig. 3.1.1 Material Investigation Sites in Apure River Basin

THE REPUBLIC OF VENEZUELA
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OF THE APURE RIVER BASIN

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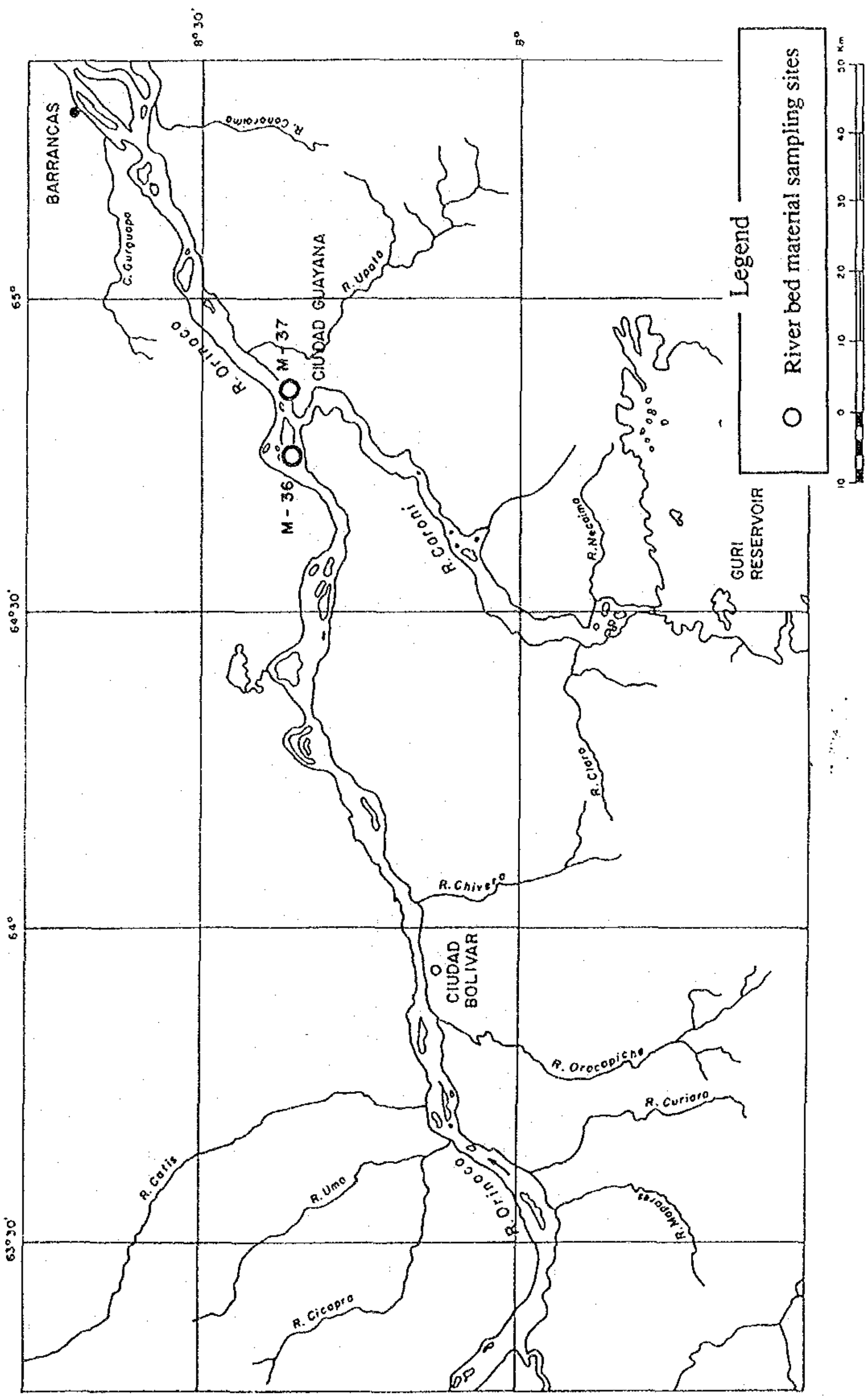

Fig. 3.1.2 Material Investigation Sites in Orinoco River

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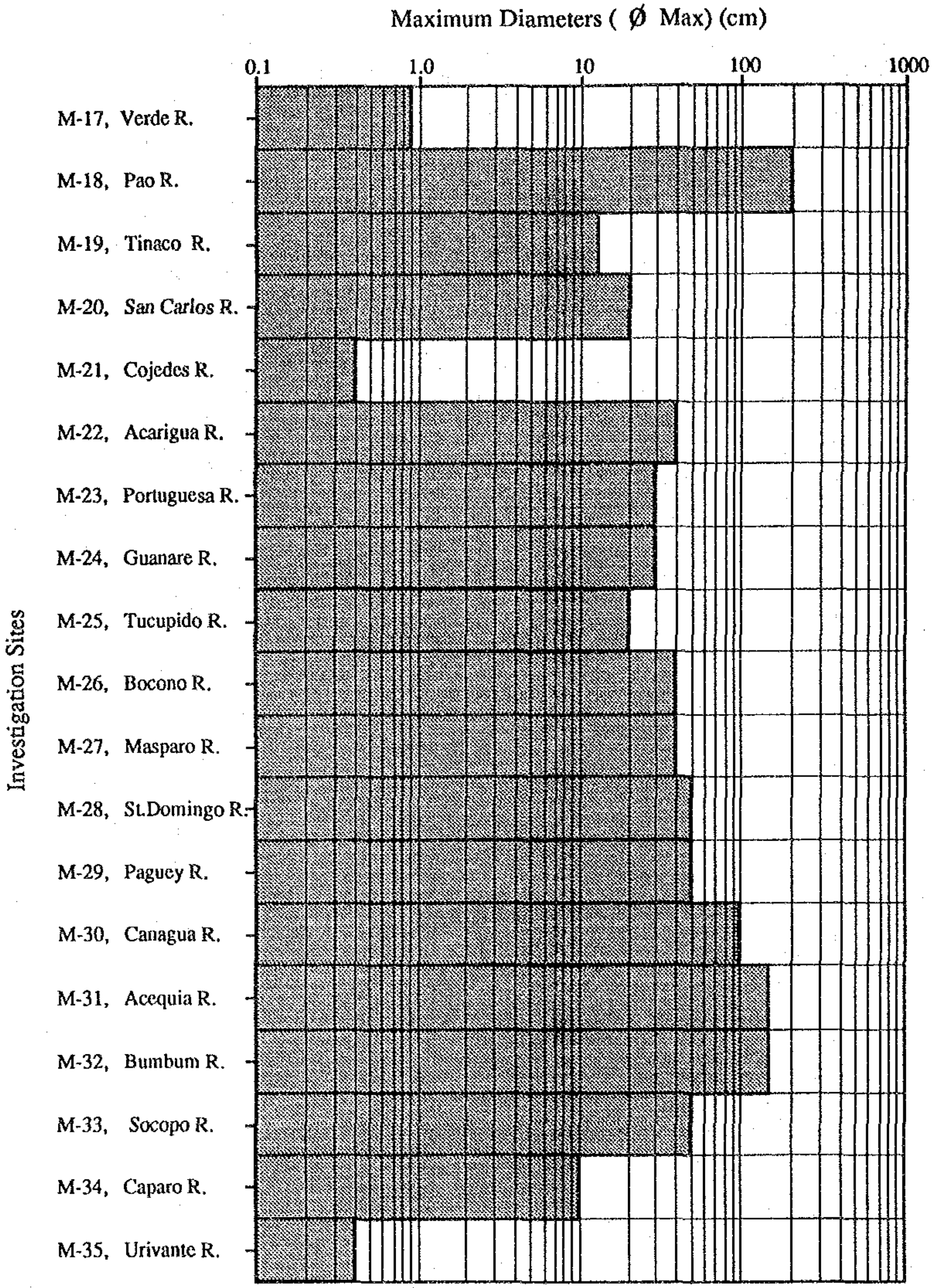

Fig. 3.1.3 Maximum Diameters of River Bed Materials at Foot of Mountains

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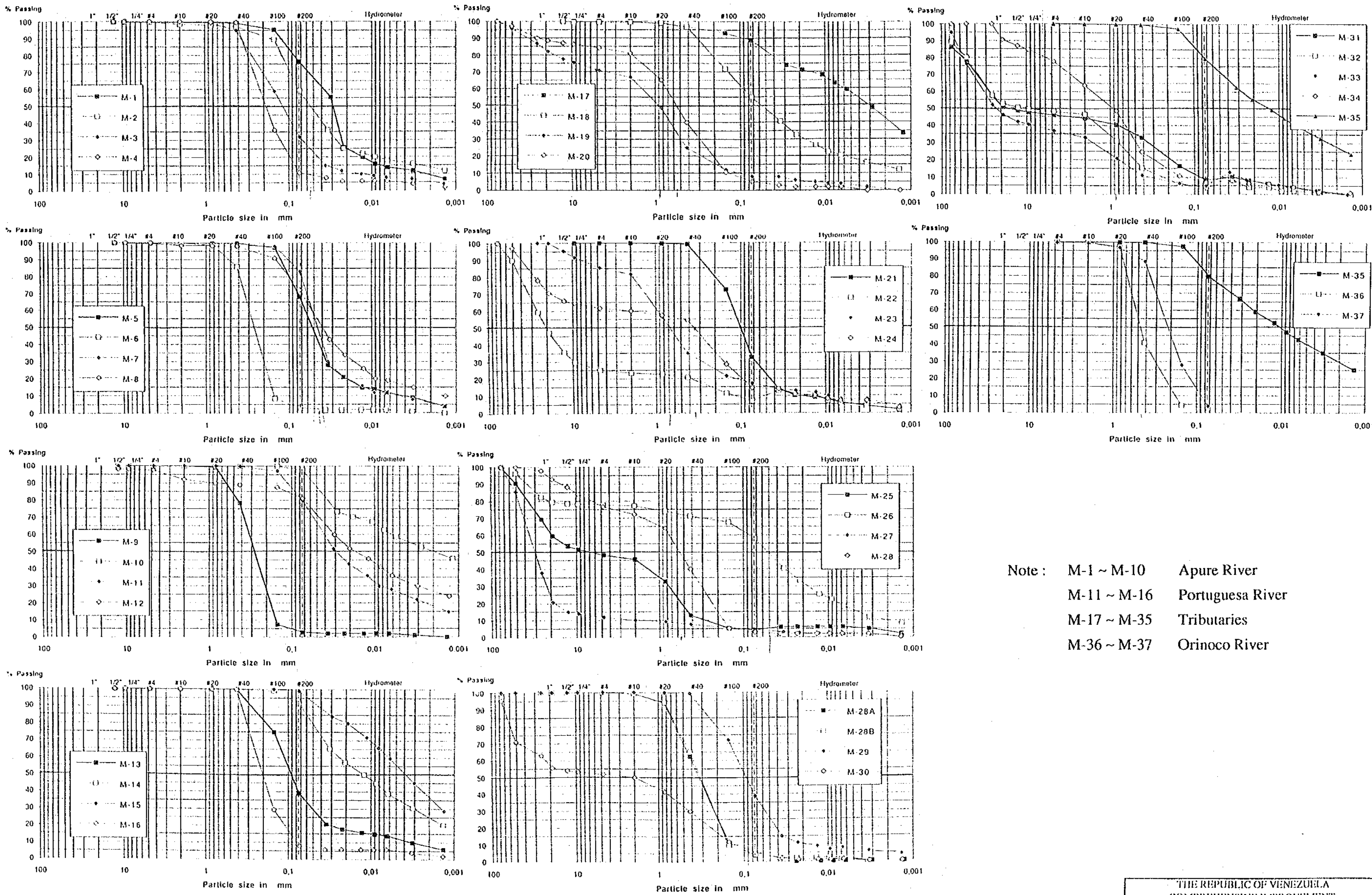

Note :		
	M-1 ~ M-10	Apure River
	M-11 ~ M-16	Portuguesa River
	M-17 ~ M-35	Tributaries
	M-36 ~ M-37	Orinoco River

Fig. 4.2.1 Grain Size Distribution of River Bed Materials

THE REPUBLIC OF VENEZUELA
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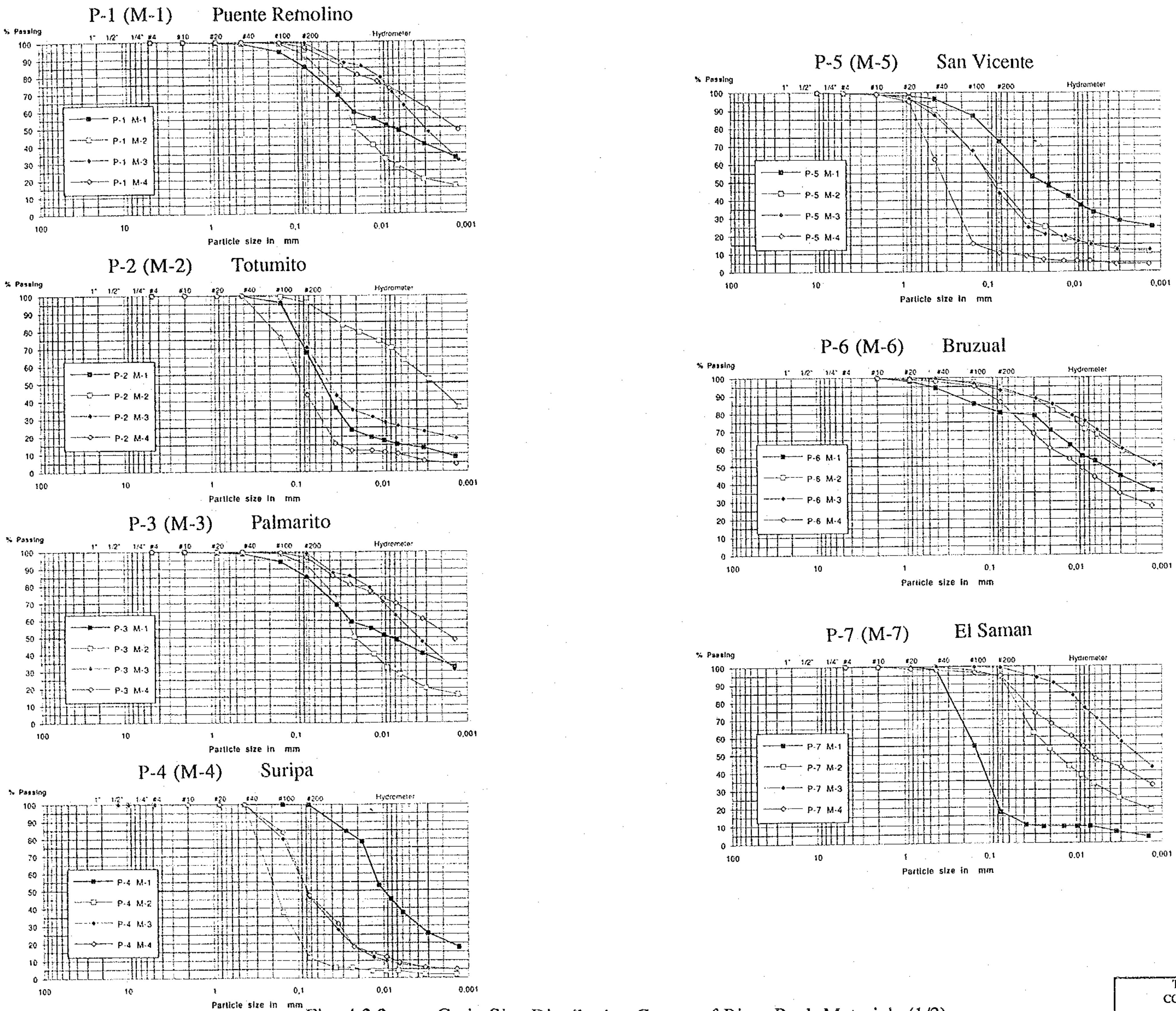

Fig. 4.2.2 Grain Size Distribution Curves of River Bank Materials (1/2)

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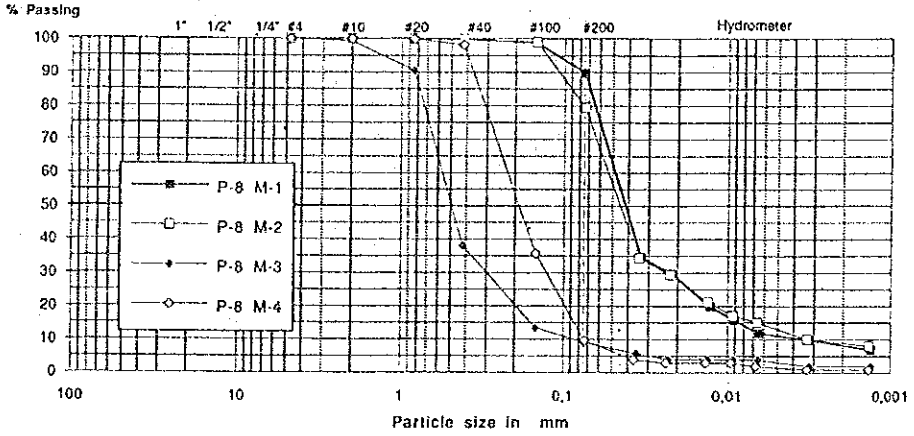
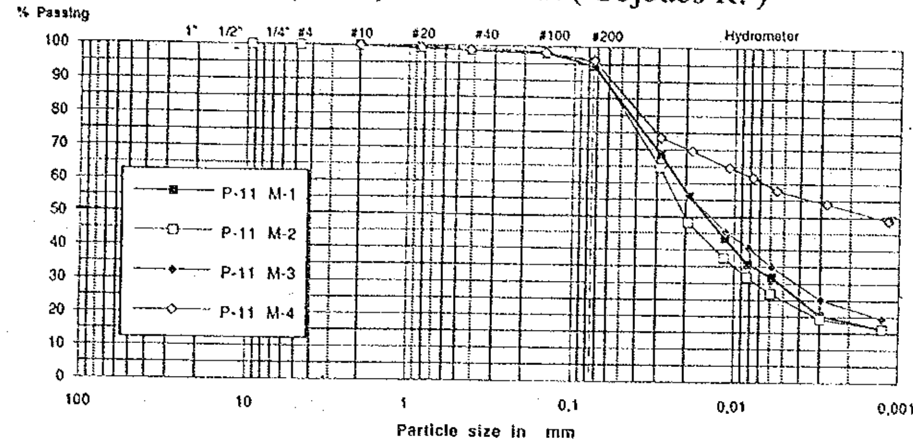
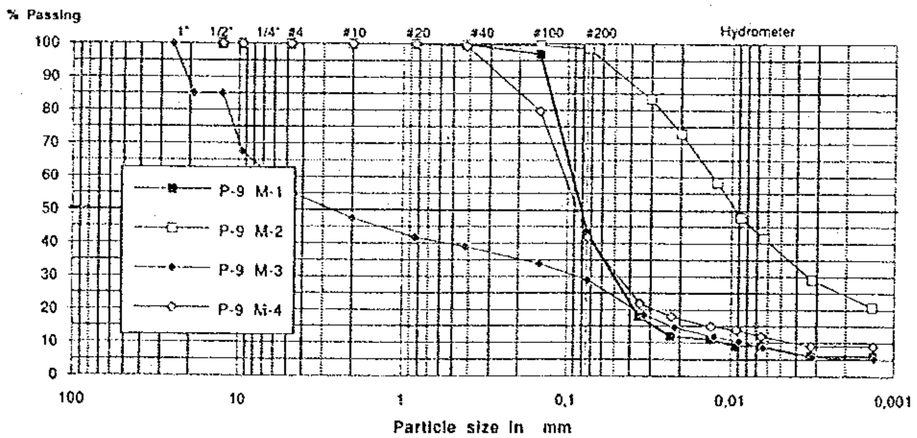
P-8 (M-8) Apurito



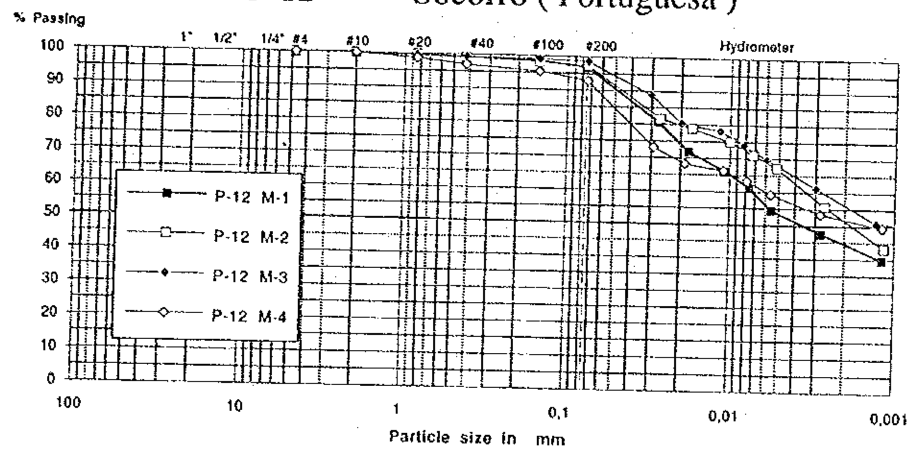
P-11 (M-11) El Baul (Cojedes R.)



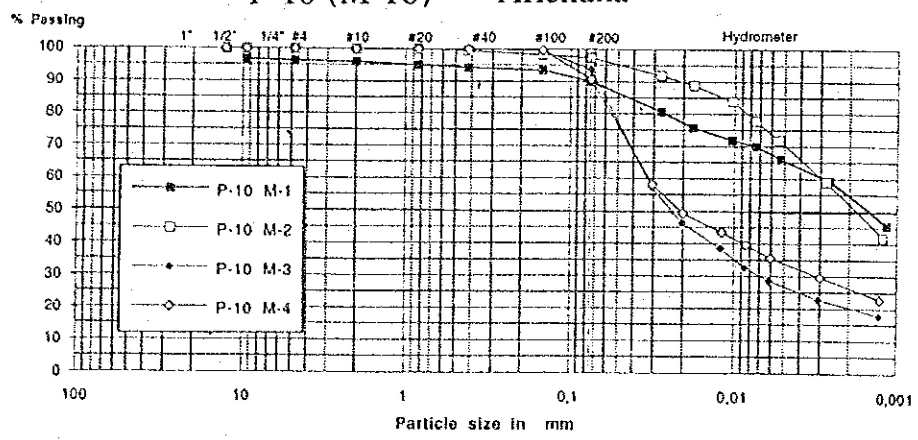
P-9 (M-9) San Fernando



P-12 Socorro (Portuguesa)



P-10 (M-10) Arichuna



P-13 (M-15) Camaguan (Portuguesa)

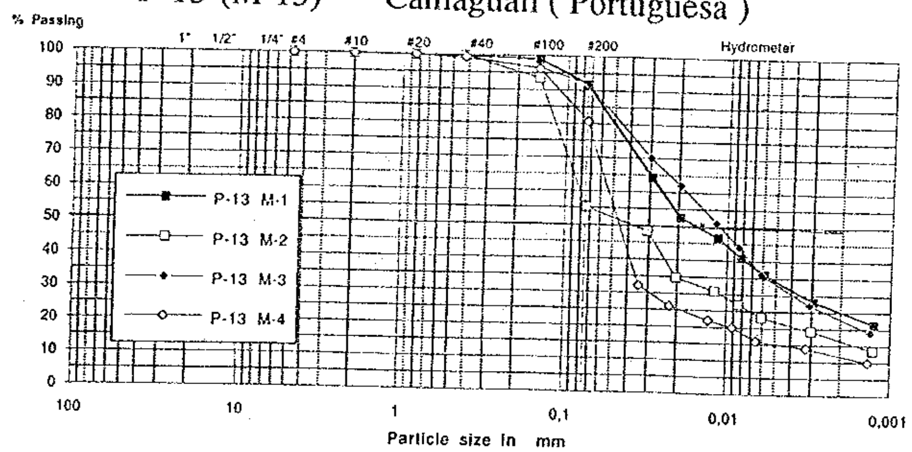


Fig. 4.2.2 Grain Size Distribution Curves of River Bank Materials (2/2)

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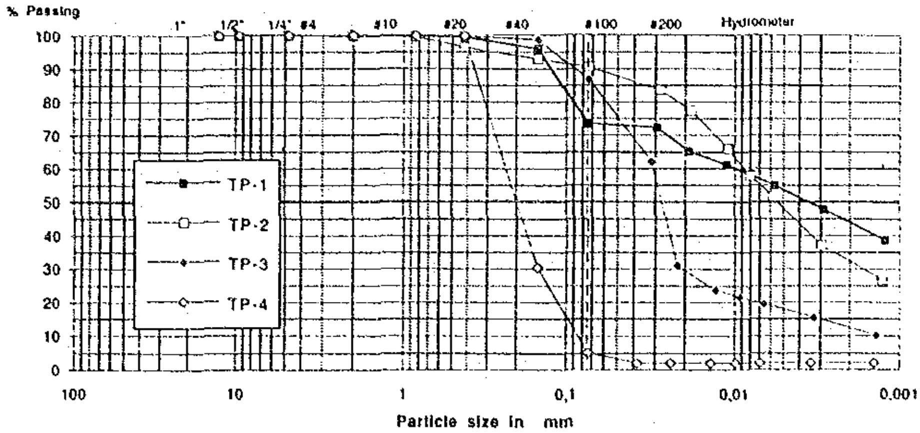
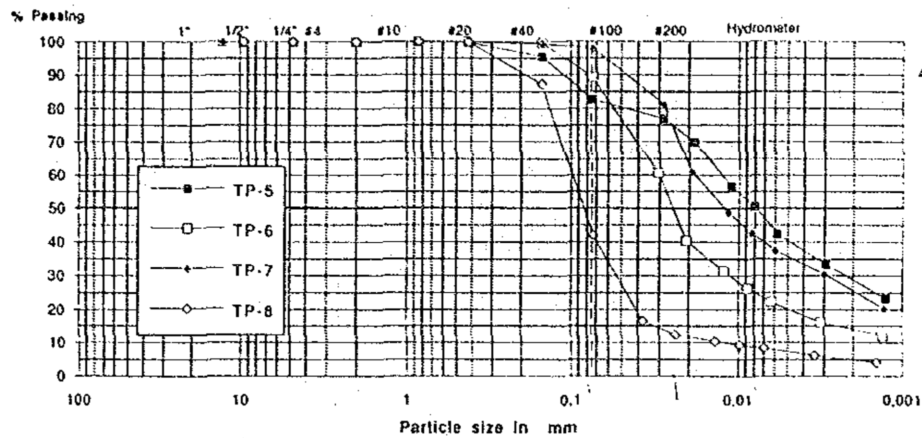
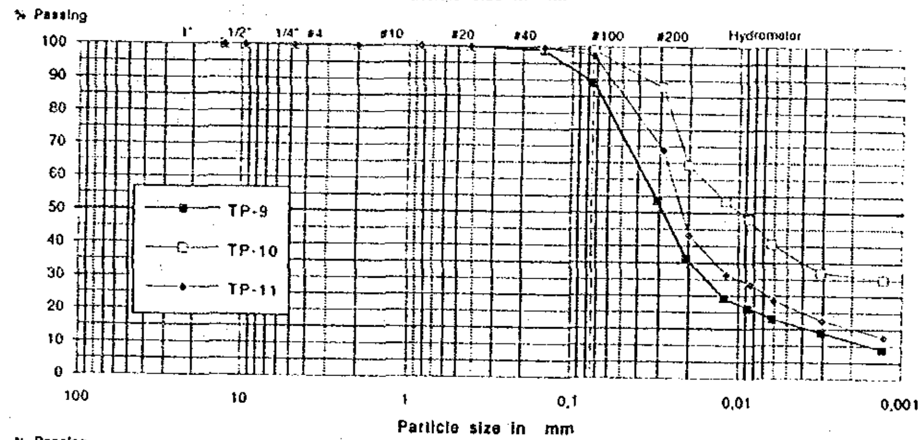


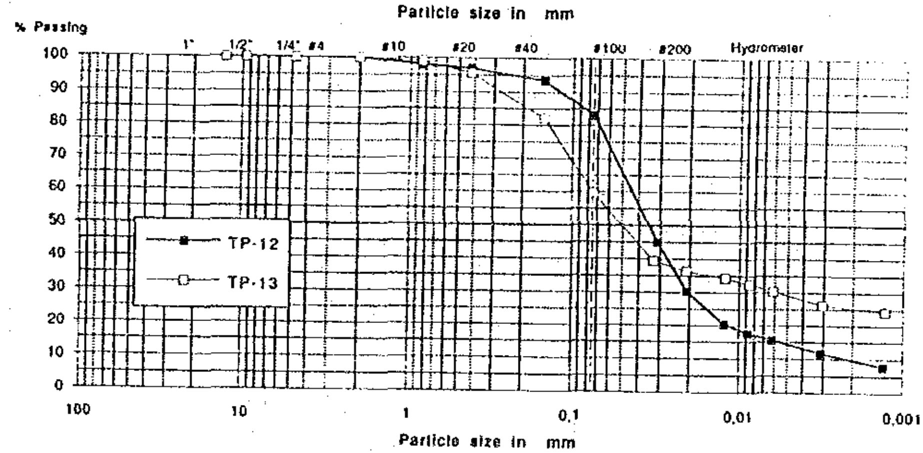
Apure River



Apure River



Apure River & Portuguesa River (TP-11)



Portuguesa River

Fig. 4.2.3 Grain Size Distribution Curves of Embankment Materials at Other Tributaries

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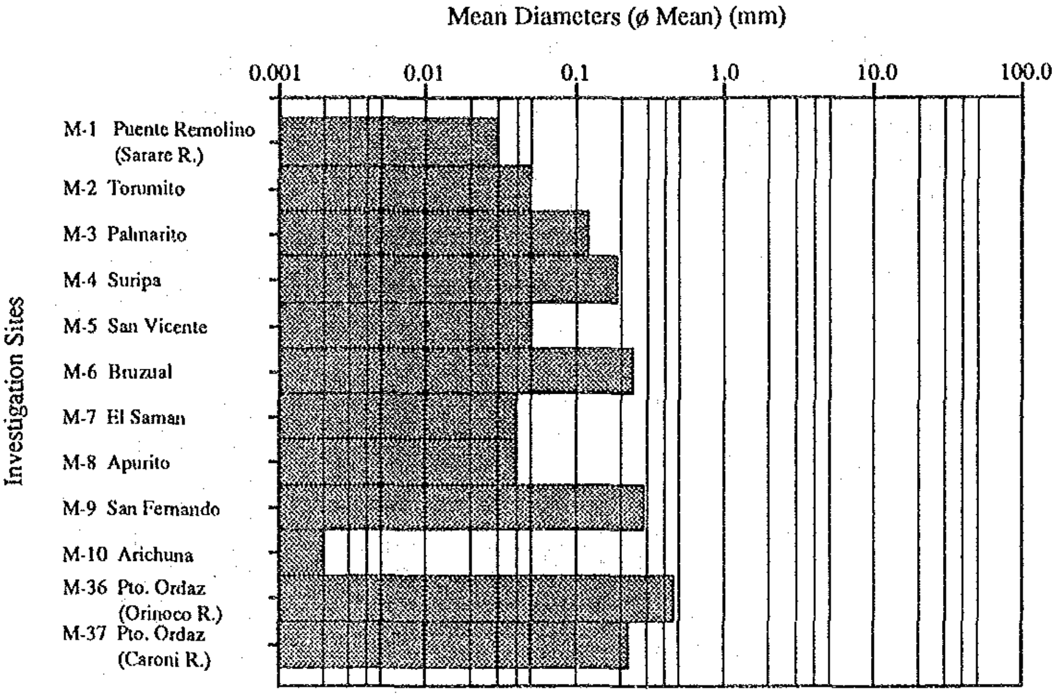

Fig. 4.2.4 Mean Diameters of River Bed Materials of Apure River and Orinoco River

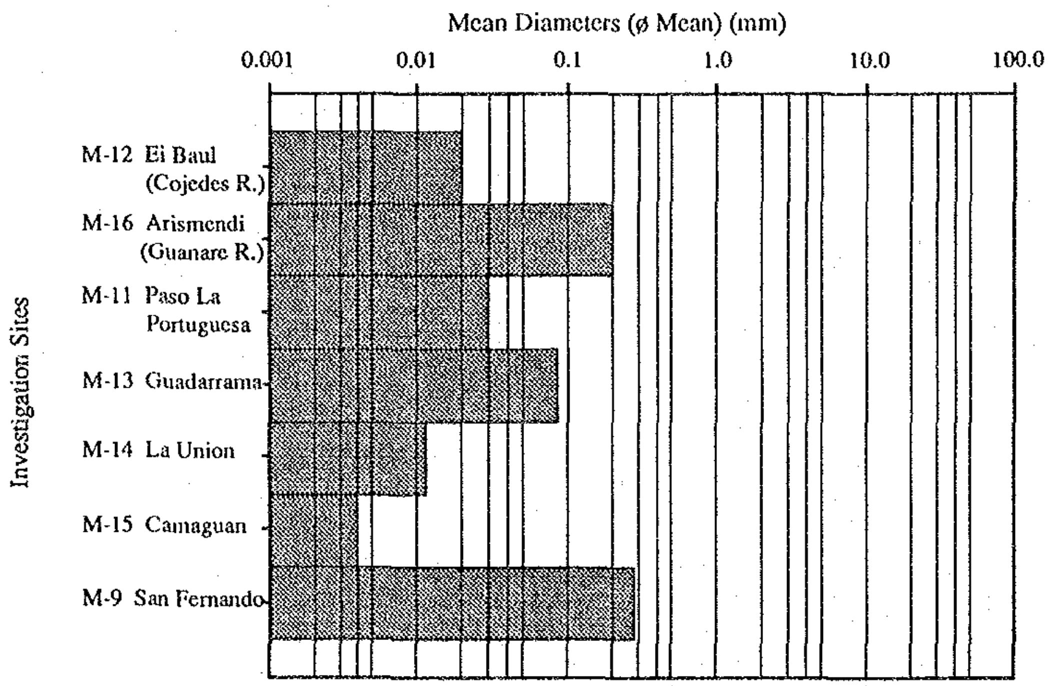

Fig. 4.2.5 Mean Diameters of River Bed Materials of Portuguesa River and Apure River

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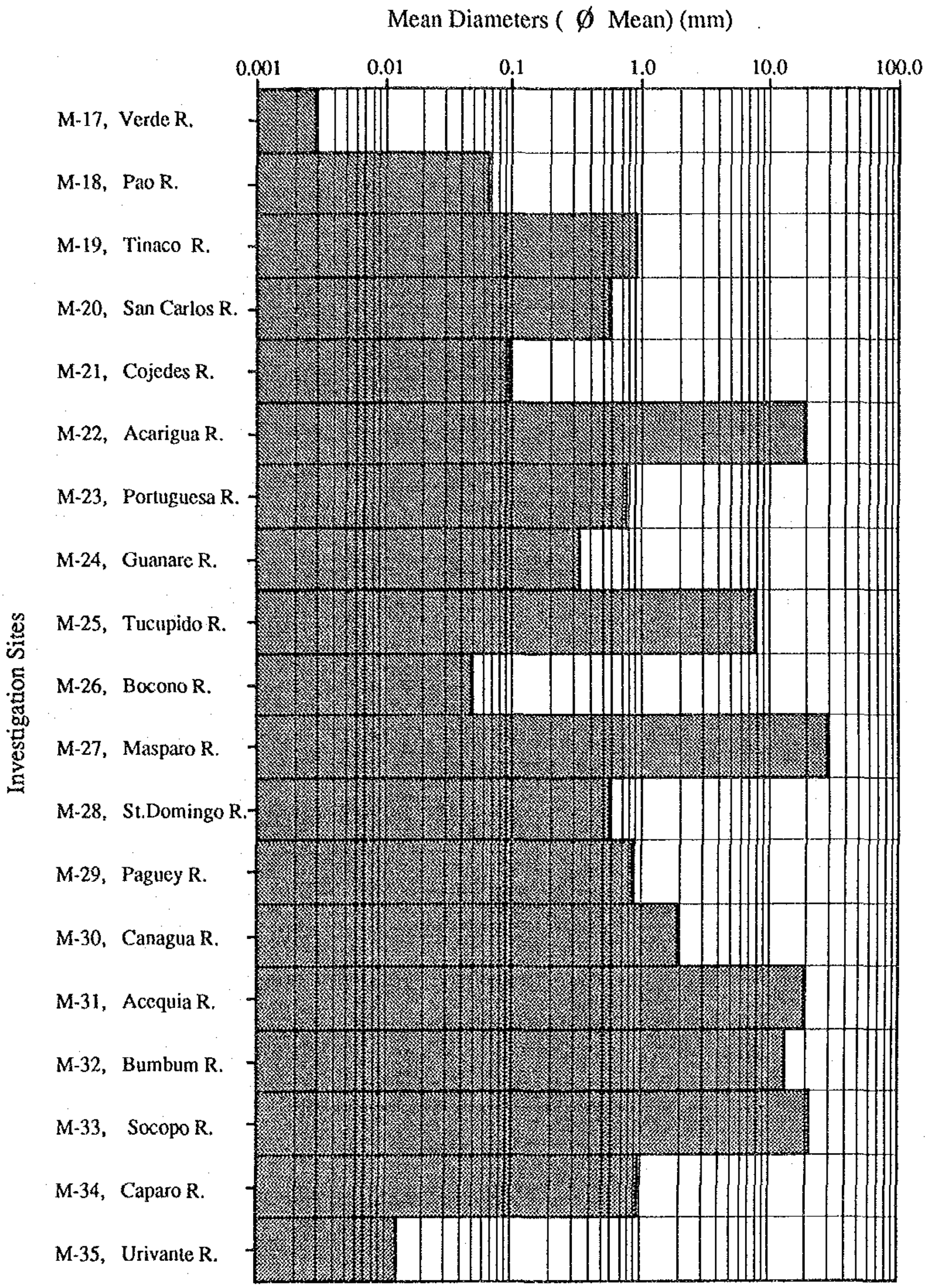

Fig. 4.2.6 Mean Diameters of River Bed Materials at Foot of Mountains

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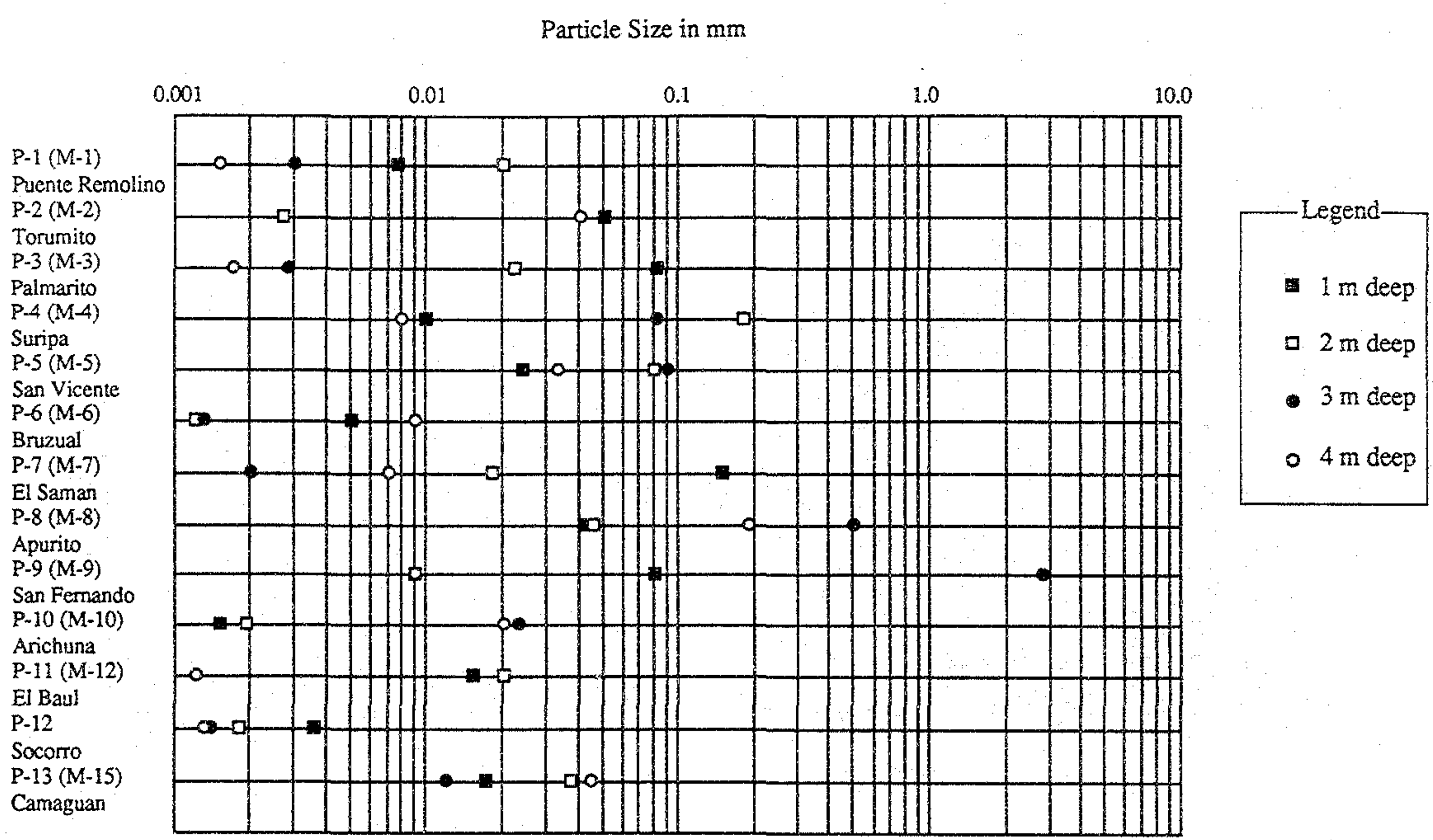

Fig. 4.2.7 Mean Diameters of River Bed Materials

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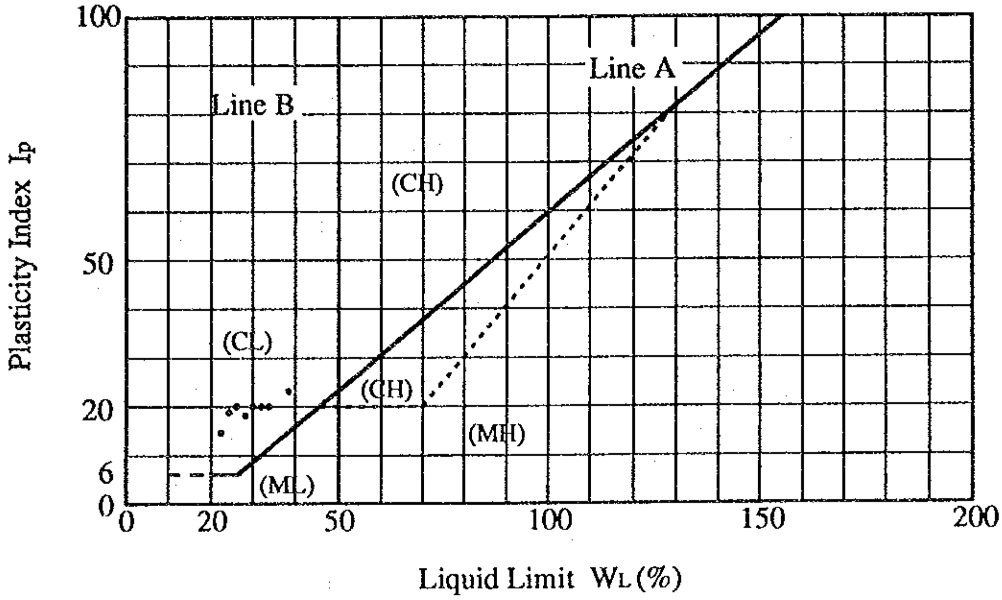

Line A : $I_p = 0.73(W_L - 20)$
Line B : $W_L = 50$

Fig. 4.2.8 Plasticity Chart

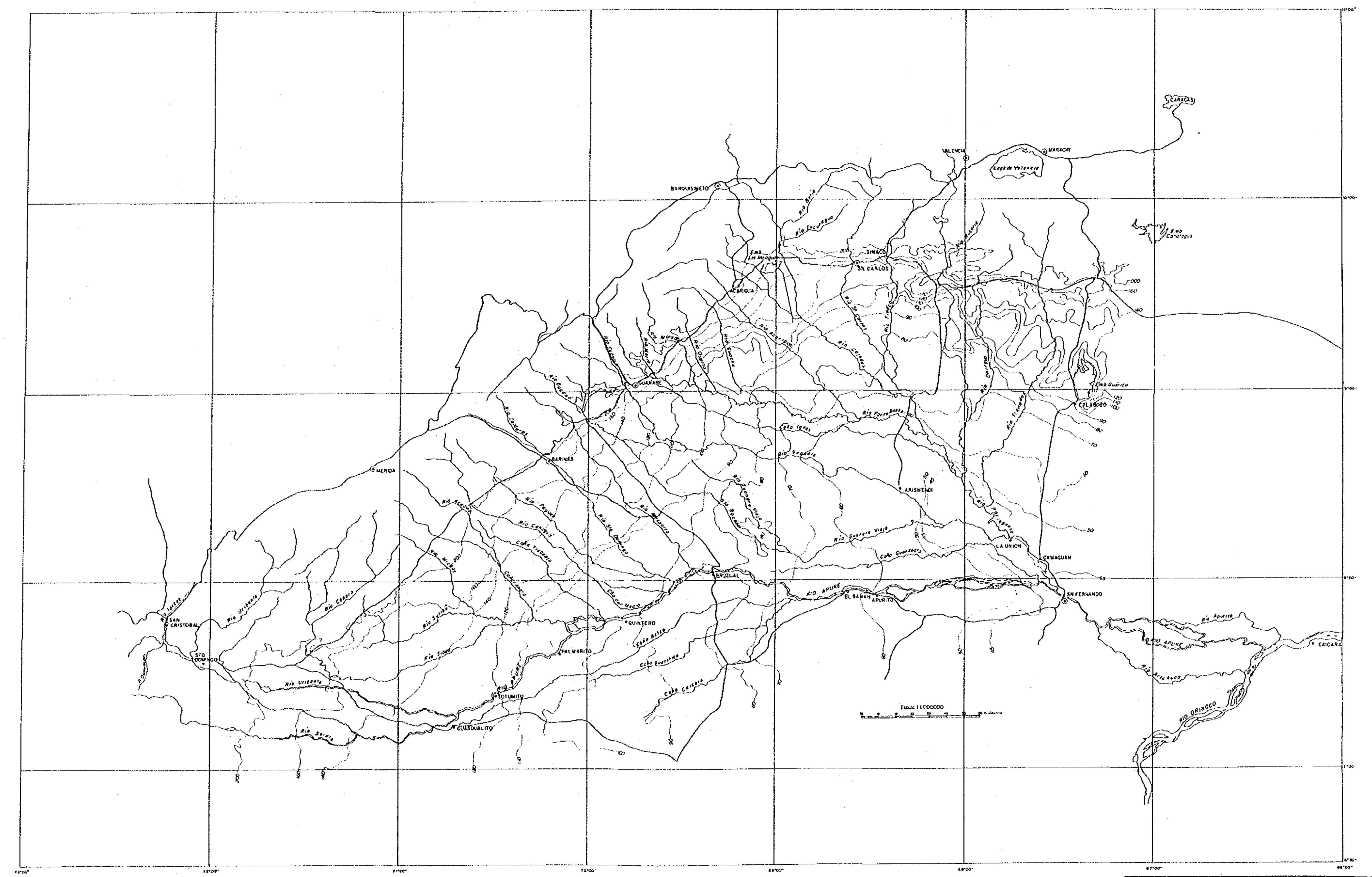

Fig. 5.1.1 Contour Line Map of Apure River Basin

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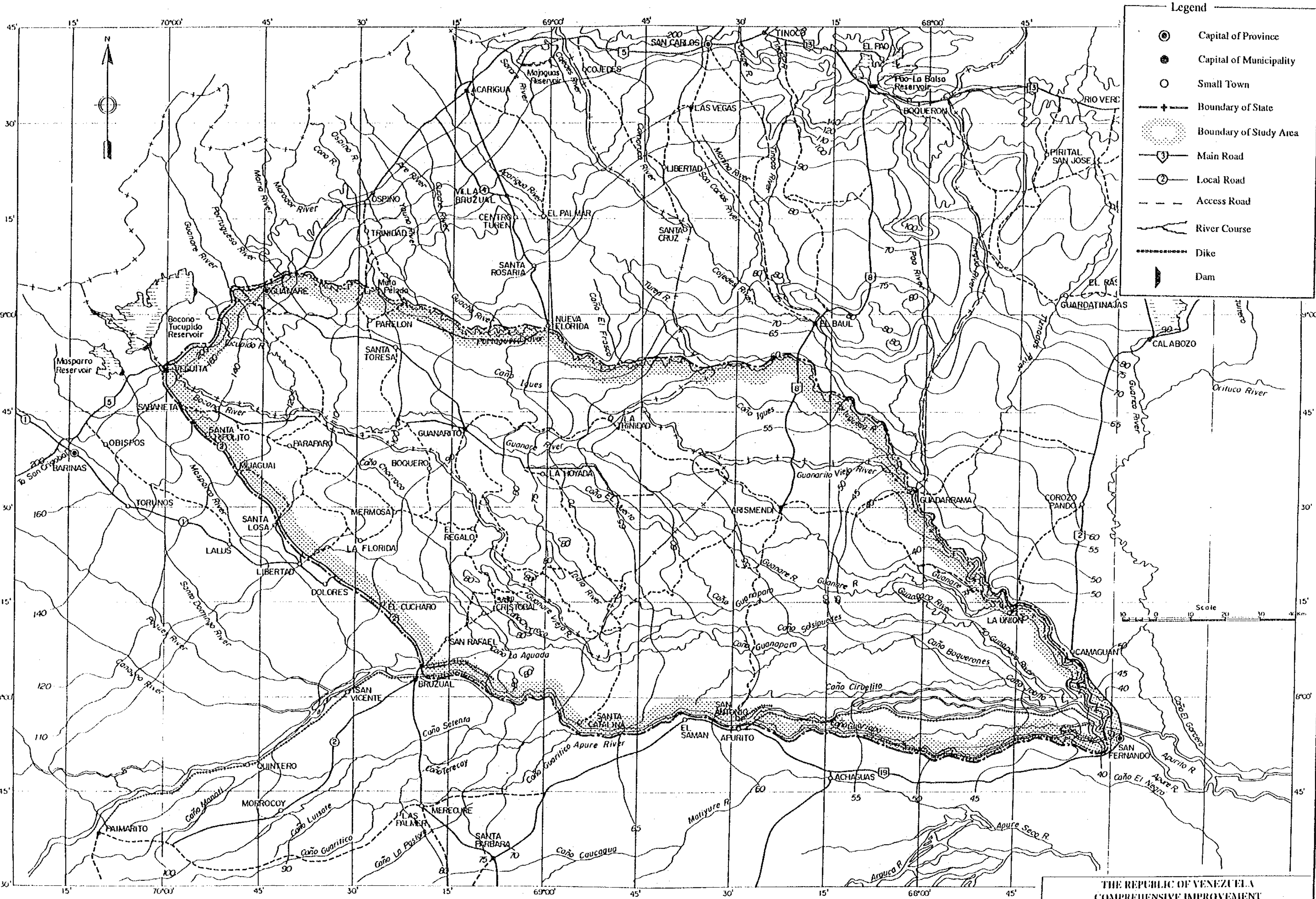

Fig. 5.1.2 Contour Line Map of Flood Management Study Area

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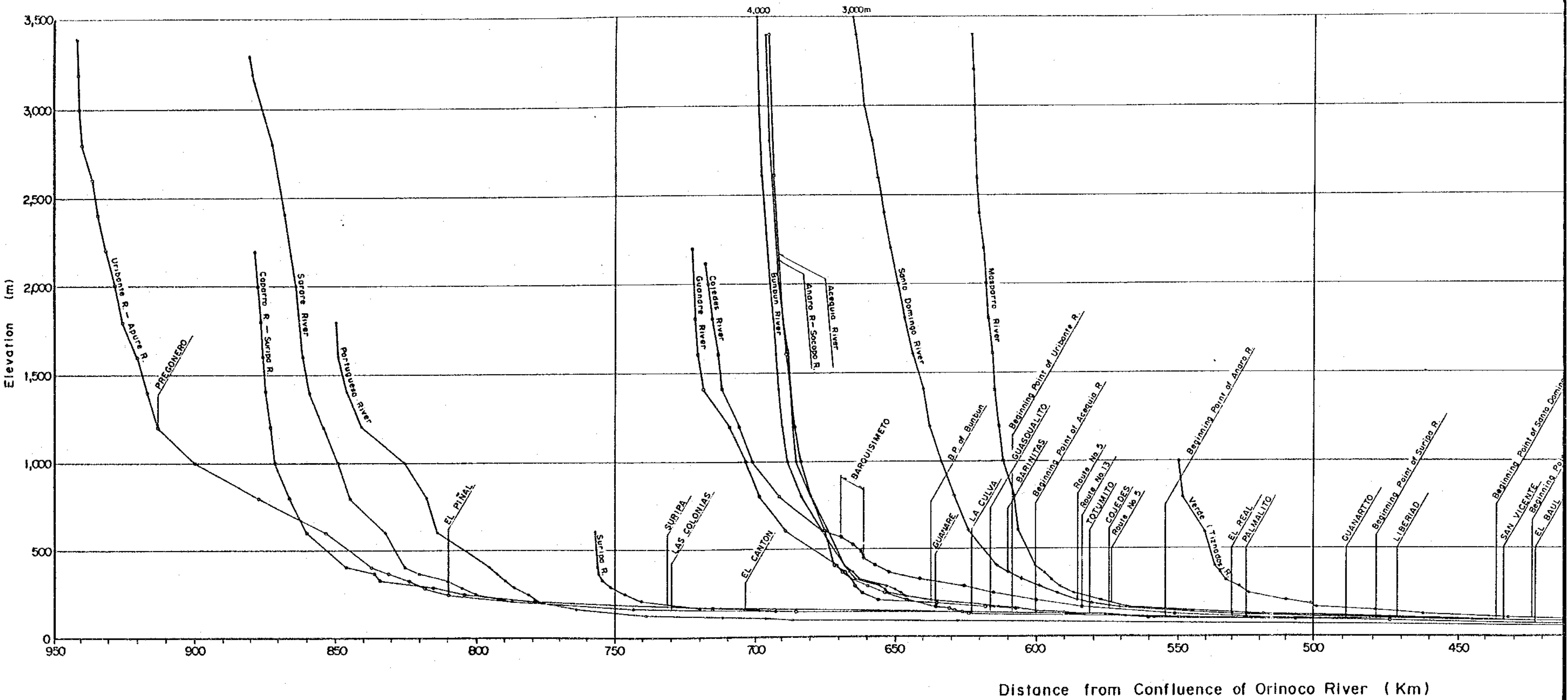

Fig. 5.1.3 River Profiles of Apure River Basin

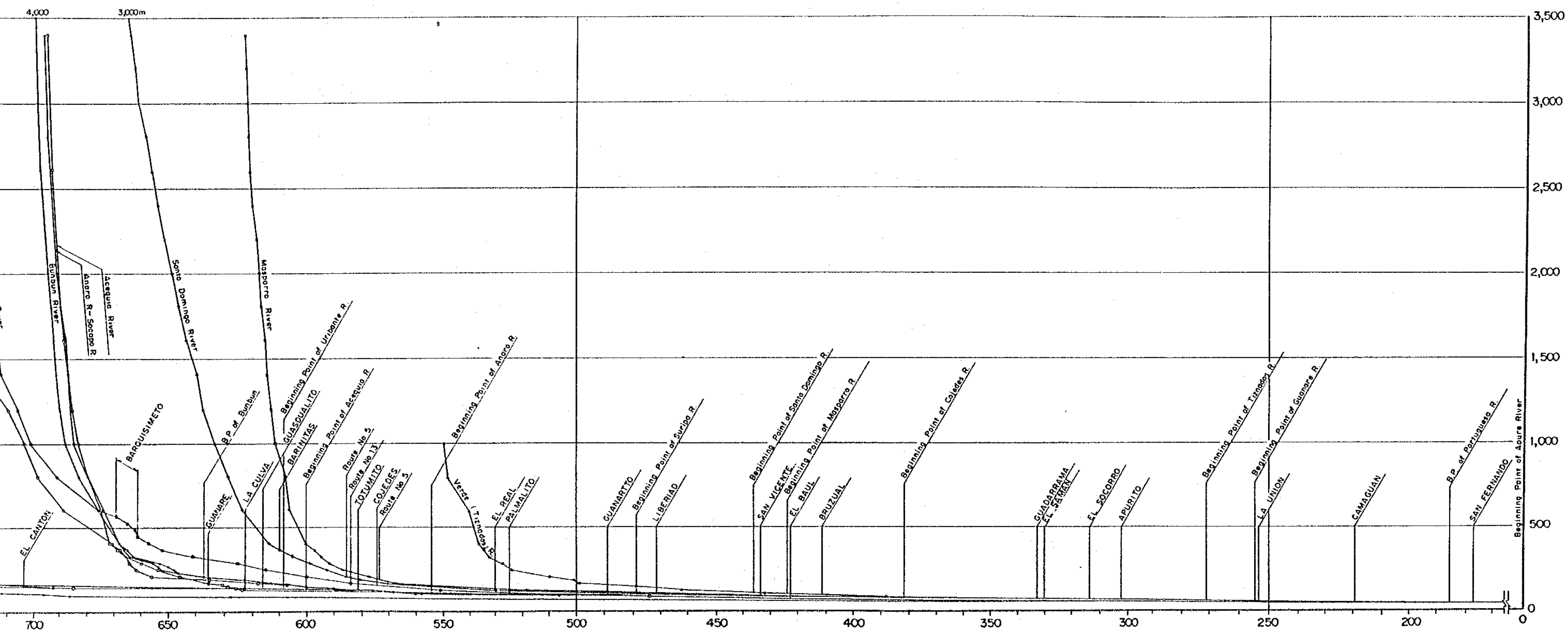

Fig. 5.1.3 River Profiles of Apure River Basin

THE REPUBLIC OF VENEZUELA COMPREHENSIVE IMPROVEMENT OF THE APURE RIVER BASIN
JAPAN INTERNATIONAL COOPERATION AGENCY

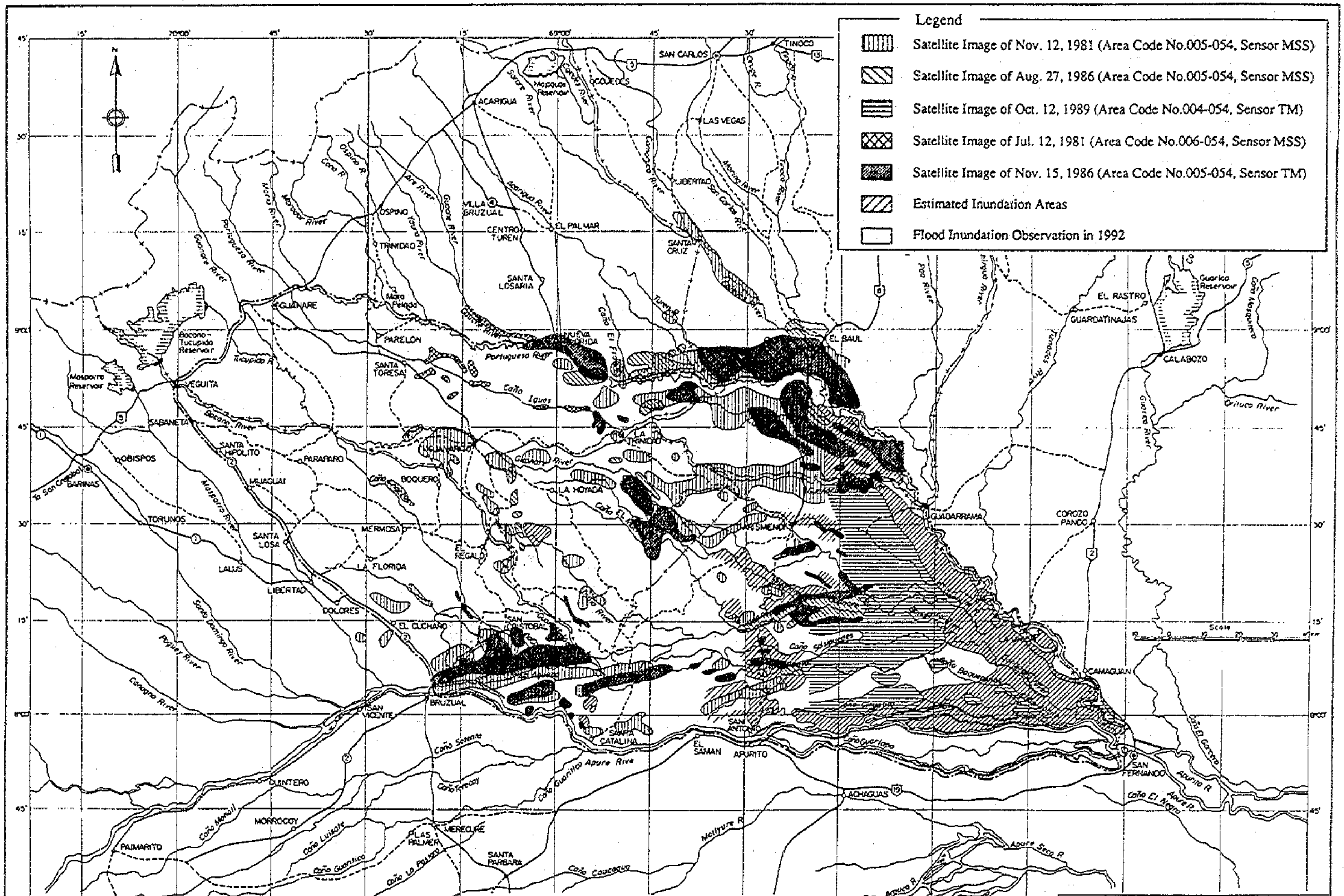

Fig. 5.1.4 Inundation in Rainy Season

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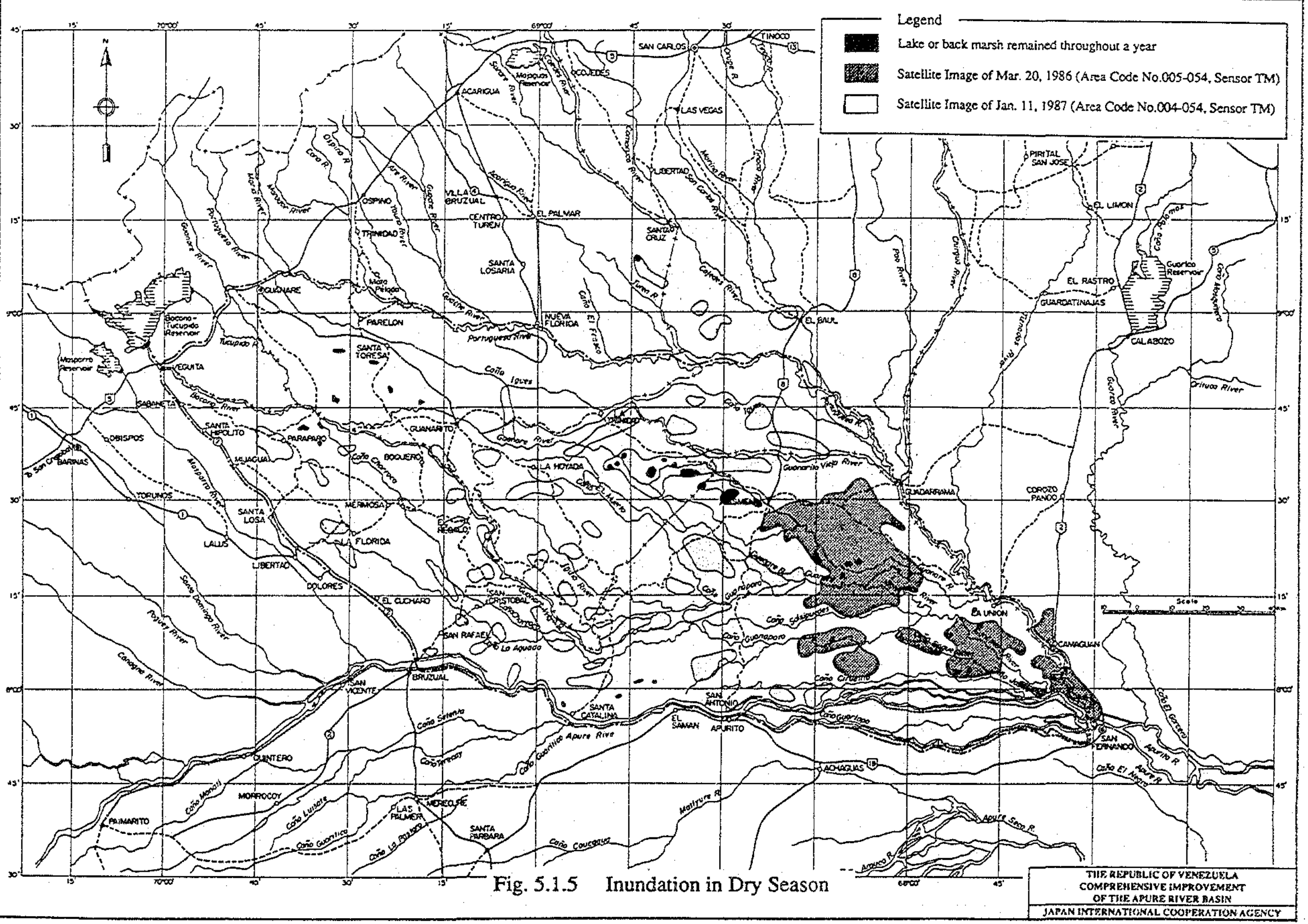
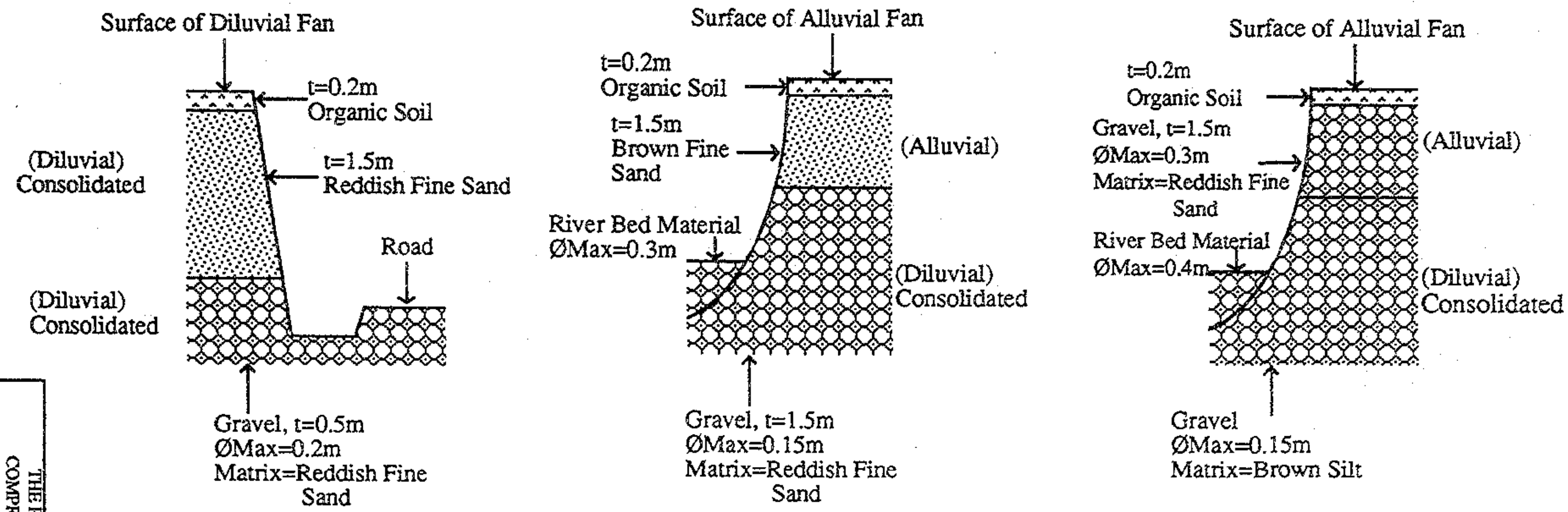


Fig. 5.1.5 Inundation in Dry Season



(1) Bocono River (Route 5)

(2) Portuguesa River (Route 5)

(3) Acarigua River (Route 5)

Fig. 5.2.1 Geological Profile of Fan Deposits

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Fig. 5.2.2 Geological Profile of Apure River

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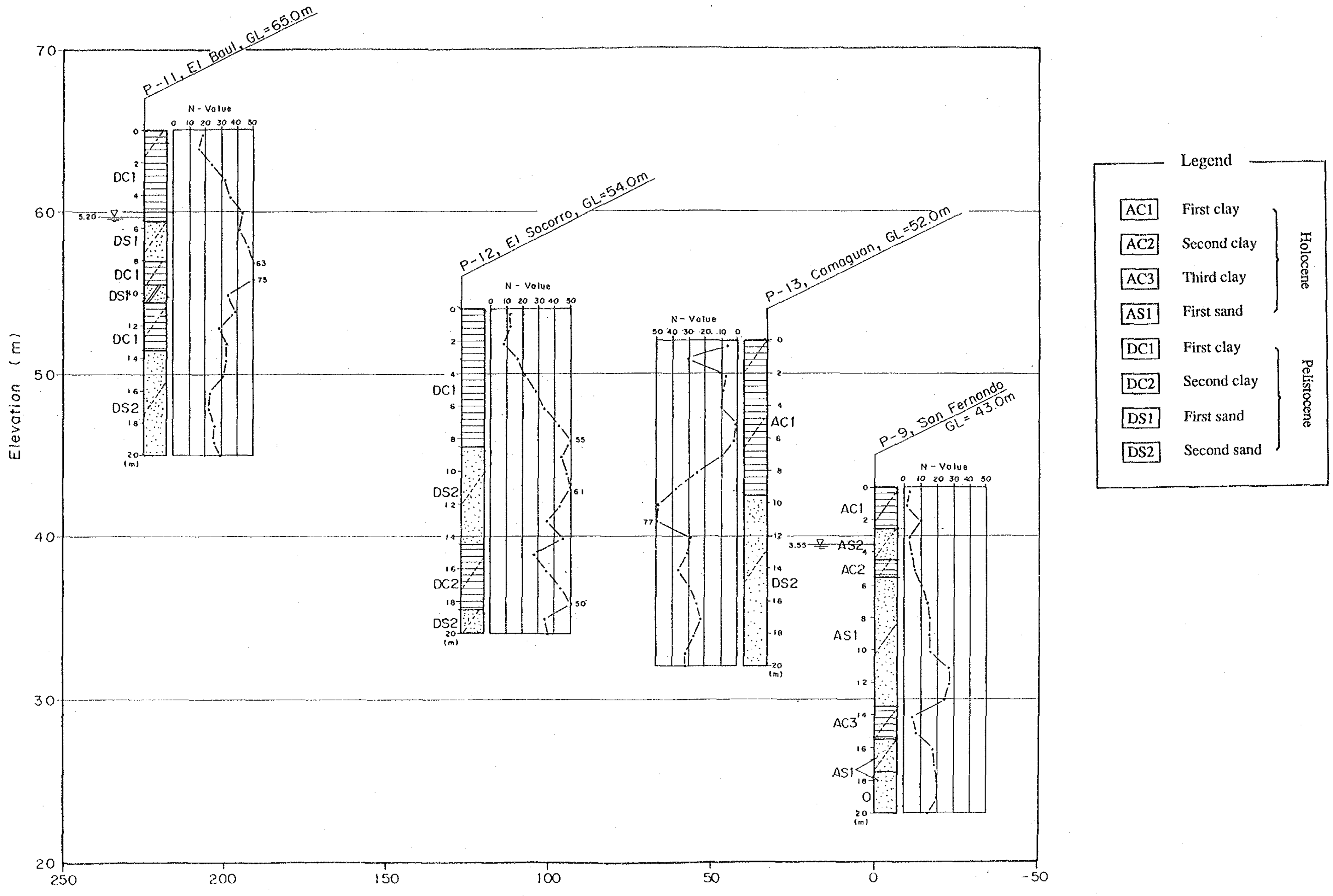

Fig. 5.2.3 Geological Profile of Portuguesa River

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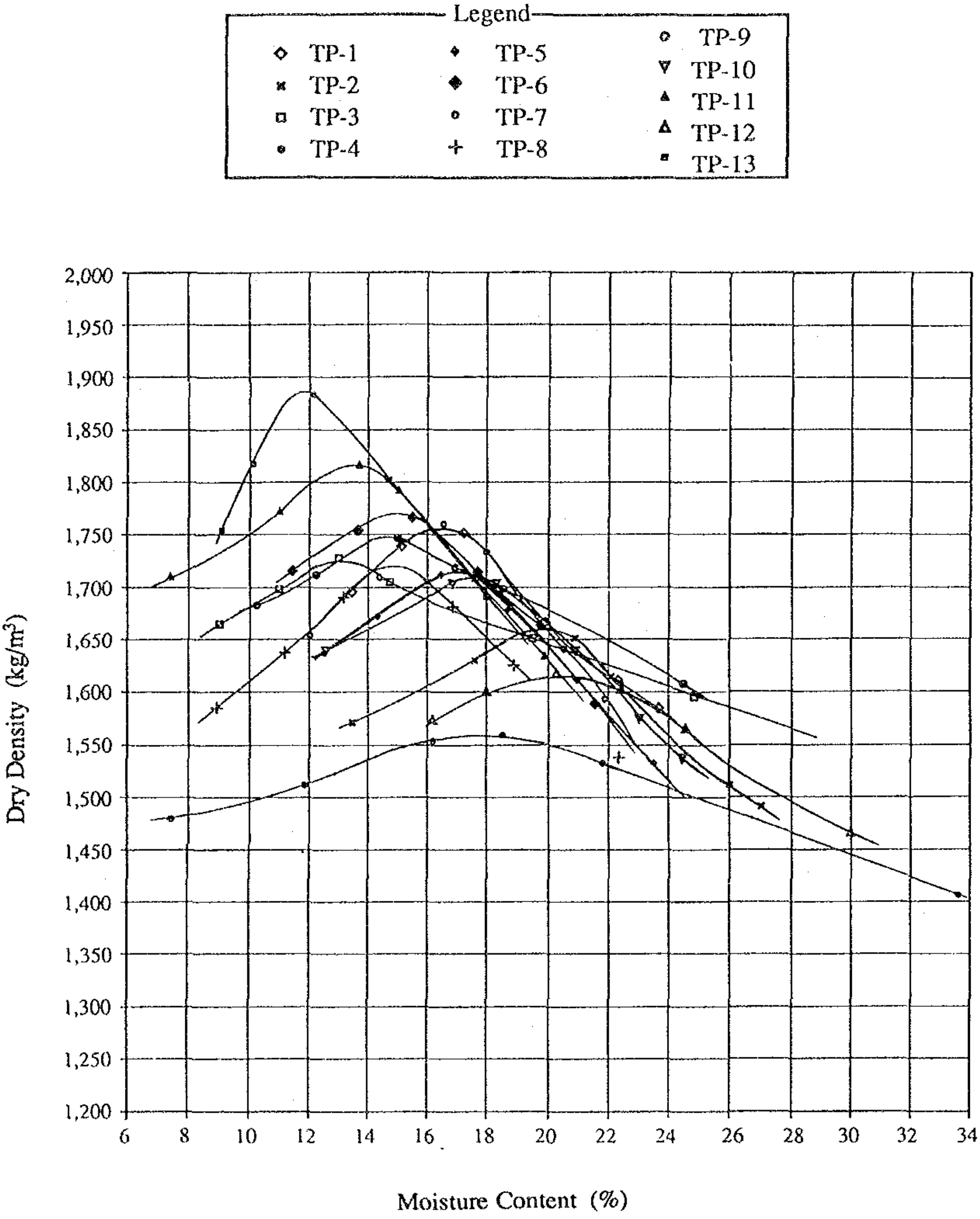

Fig. 6.1.1 Relation between Moisture Content and Dry Density

THE REPUBLIC OF VENEZUELA
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JAPAN INTERNATIONAL COOPERATION AGENCY

PART-C

AGRICULTURE AND LAND USE SURVEY

STUDY ON COMPREHENSIVE IMPROVEMENT OF THE APURE RIVER BASIN

FINAL REPORT

VOLUME III : SUPPORTING REPORT
PART-C : AGRICULTURE AND LAND USE SURVEY

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I. INTRODUCTION

This section present the results of agriculture and land use survey carried out as a component of the Study on Comprehensive Improvement of the Apure River Basin. The survey mainly consists of the collection and analysis of existing data and information related to land use and agricultural development within the study area. Field reconnaissance survey was also carried out during the study period. The basic concepts for land use and agricultural development stated herein are based on the analysis of the collected data and information.

Venezuela is a country blessed with vast natural resources such as oil and other minerals, agricultural land and water resources. Little attention was given for agricultural development during the wealthy times of high oil's prices. The agricultural production was highly subsidized and of low productivity. Venezuela depends largely on import for satisfying its national demand on food and fibers of agricultural origin. Approximately 67% of the food demand is satisfied by imported agricultural products. Large amounts of money is expend annually for importing agricultural products. Present agricultural production and future targets are presented in Table 1.1.1.

Targeted volumes of agricultural production were established by the Ministry of Agriculture. The land areas that should be put into production are estimated based on the production targets. The target cropping area by states is estimated making correlation of the present output of agricultural production in each state. Targets for agricultural land area of main crops in the states of the study area are presented in Table 1.1.2.

The land area that should be dedicated for rice production in the year 2010 is more than 5 times of the land area under rice cultivation at present. Also, for other main crops the planting area for the year 2010 should be at least twice of the area planted of each crop at the present.

Extensive land areas are dedicated for livestock production, however the present level of productivity of cattle breeding is very low. The production of milk in the entire country was estimated at 1,573 million liters in 1986, while the national demand was 2,980 million liters for the same year. These data indicate deficit in milk production of about 47 % of the national demand. The increase in milk production in the last few years was estimated at 2.8 % per annum, while the demand increased at about 5.7 % annually. To satisfy the national demand of milk and meat, total area and unit yield should be increased substantially. It is estimated that for the year 2000 the area dedicated for cattle breeding should be about 3.5 million ha and the unit yield should increase twice of the present yield level.

The new agricultural policy is targeting to achieve a sustainable and accelerated growth of the out-put from the agriculture and livestock production sectors. Land area and productivity must increase for achieving the targets. The objectives of the national agricultural development plan indicate that the country's production should be enough for satisfying the national demand and for exporting competitive agricultural produces.

Out of the total country's land area of approximately 91.65 million ha, 7.83 million ha are suitable for agricultural production and 27.77 million ha are suitable for livestock production. A large percentage of the land suitable for agriculture and livestock production is located within Barinas, Portuguesa and Cojedes states where the study area is located. The study area presents high potential for achieving sustainable and accelerated increase in agricultural and livestock production, thus contributing to attaining the national targets. Potential land use for agriculture and livestock production is presented in Table 1.1.3.

II. STUDY AREA

2.1 Location and Topographic Characteristics

The Study area is located between 7° 50' and 9° latitude north and 67° 30' and 70° 30' west longitude. It is bounded to the North by national road no. 5 and Portuguesa river, to the East by Portuguesa river, to the South by Apure river, and to the West by the country road no. 2. It is within the Venezuelan region known as the Western Plains. The study area includes part of three States of Barinas state comprising approximately 57 % of the total study area, Portuguesa state 36 % and Cojedes state about 7 %.

The study area is a large plain of approximately 21,000 km^2. The land elevation varies from 40 m to 160 m above sea level. The land topography is flat within its different geomorphologic units; the slopes are mostly of less than 1 %, being in some areas as low as 0.2 %. The general land form is wavy, with succession of concave and convex land units.

2.2 Climate

The most important feature of the climate in the study area is the rainfall distribution pattern. The rainy season occurs from May to October. During this period about 85% of the total annual rainfall occurs. November and April are considered as transition months between dry and rainy seasons. The dry season is from December to March. There are some variations in rainfall pattern within the study area. In the south-east, the average annual rainfall is about 1,250 mm and the dry season period is 5 to 6 months long, while in the north and west part the average annual rainfall is about 1,650 mm and the dry season is 4 to 5 months long. Also, there are large variation in the amount of rainfall from year to year at one site. The highest amount of rainfall recorded in Sabaneta is 1,913 mm, while the lowest recorded annual rainfall at the same site is 971 mm.

There are very small monthly variations in the average temperature and amount of sunshine within the study area. The coolest month is August with mean monthly temperature of 24°C. March is the hottest month with mean temperature of 27.8°C. The relative humidity during the dry season is about 80 %. The annual total amount of surface water evaporation varies in the range of 1,700 to 2,300 mm. The monthly pattern of rainfall and evaporation distribution is shown in Table 2.2.1, which represents the northern part of the study area. There are significant site's differences in amount of rainfall within the study area and therefore the water balance varies with site.

2.3 Land and Water Resources

2.3.1 General Characteristics of Soils

In the study area there is a very complex pattern of soil type distribution. Soils of good quality are generally in association with soils of poor quality. A large percentage of soils in the study area is classified as Chromusterts and Pellusterts Great group of the Vertisol Order. The soil are lying on flat or concave topography. The soil texture is very fine with high clay content. These soils often have high bulk density because of the fluctuation in ground water level, which causes swelling and shrinking of the clay. Both surface and internal drainage are very slow. In addition to the flooding problem, the high clay contain and poor drainage condition are the main constraints for the potential agricultural use of land with these type of soil (MARNR, 1979).

The second most abundant soil type is association of Inceptisol/Mollisol, Inceptisol/Alfisol and Mollisol/Alfisol. The most common Great group of Inceptisol is the Ustropept. The most common Mollisol Great group is Haplustoll. Tropaqualf is the most common soil Great group of Alfisol Order. The soil in general are of fine texture, Clay loam or Silt loam. The internal drainage varies from moderately well to imperfect. The soils have deep profiles. In general the soils are of moderate to good natural fertility. The soil pH varies mostly in the range between 5.5 and 8.0. There is no problem of soil salinity or alkalinity in the area (MARNR, 1979).

Entisol Order occurs in less extent, mainly along some rivers courses. These soils are of coarse texture, high permeability, rapid internal drainage, and moderately low natural fertility.

2.3.2 Land Classification and Potential Agricultural Land Use

Part of the land in the study area (Guanare-Masparro Project) is classified as land with very high production potential. Those areas are ranked at the highest priority for agricultural development at national level. Most of the good quality lands are distributed all over the study area, and intercalated with lower quality lands.

MARNR (1979) made a land classification study at reconnaissance for the Western Plans; the entire study area is included in that land classification. The land classification was done following a modified version of the US Department of Agriculture classification system. The land in the study area is classified as shown in Fig. 2.3.1 and Table 2.3.1.

Under "Present condition" there is no land area classified into class I because of the long dry season that limits the possibility of making an intensive land use. The lands of class IIc have minimum limitations and are considered highly suitable for all the crops usually grown in the study area. The only important limitation for the intensive agricultural use of these land class is the long dry season. Because of the long dry season, the possibility of obtaining two or more harvest in a year under rainfed condition is very limited. Irrigation is required for assuring intensive use of these lands. Most of this land class would be classified as class I after irrigation is provided. The most common soil types in these land class are associations of Ustropepts/Haplaustolls. There is no drainage problem affecting this land class.

The lands classified as class IIIs_2d have mostly Tropaqualf soil, of clay texture, moderately low permeability, and have drainage problems which are moderate constraints for the intensive agricultural use. The potential use of these lands, after solving the flood and drainage problems, are limited to some crops such as rice, cotton, sesame, and sugar cane. Crops such as corn, sorghum, beans, bananas, pineapple could be grown during the dry season, applying special agronomic management practices.

Lands of class IVs_2d and IVd present severe constraints for the agricultural use because of the clayey soils and poor internal drainage. The recommended use for this land class is for rice, sugarcane and improved pasture for intensive livestock production. Lands of classes V and VI, subclass s_2d present very severe constraints for agricultural use, only rice and some improved pasture might be grown successfully in these lands classes.

Semi-detailed studies have been carried out in some parts of the study area. MARNR (1991) carried out the study named "Integral Drainage Program for the Western Plains, Morphology and Land Use Potential". That study was done in the area bounded by Bocono river-Guanare river and the Guanare-Guanarito road, comprising 153,467 ha. In the area named inter medium basin of the Portuguesa river comprising 110,000 ha and in the area between Portuguesa river and caño Igues, comprising about 130,000 ha. According to the data included in the respective reports, the land area with potential for agricultural use might be summarized in Table 2.3.2.

Within the study area there is the Guanare-Masparro project which comprises an area of approximately 500,000 ha, part of which has been classified as one of the country's best quality land for agricultural use. The potential land use reported by the Ministry of Agriculture for Guanare-Masparro project area is shown in Table 2.3.3. It is necessary to carry out more detailed studies on land use potential before the implementation of any agricultural development project.

Frequent flooding and poor drainage conditions are the main constraints limiting the potential land use in the study area. Regarding to the solution of the drainage problem, the land of the study area have been classified as follows. In about 45 % of the total study area the drainage problem is considered of relatively easy solution. The solution of drainage problem is moderately difficult for 25 % of the total area and 30 % of the total area is considered of very low possibility for solving the drainage problem.

2.3.3 Water Resources

There are six large rivers and many small water courses running along the study area in north-west to south-east direction. The river discharge follows the rainfall pattern. The rivers carry large amount of water during the rainy season causing flood in large areas, but the river discharges decrease significantly during the dry season. Difficulties in satisfying needs of the small irrigated areas sometimes occurs due to low water levels during dry season.

There are three dams constructed in the upper part of Masparro, Bocono, and Tucupido rivers, just upstream of the study area. Those water reservoirs are used for irrigating very small portion of the study area. There are plans for constructing several other dams in the upper part of rivers that influence the water resources of the study area.

There are important underground water resources underlying a large percentage of the study area. MARNR (1979) reported that the aquifers in some parts of the study area might yield between 150,000 to 310,000 m^3/km^2/year. In some part of the study area underground water is being used for irrigation purpose.

2.4 Land Use

2.4.1 Present Land Use

The present use of land in the study area is classified as follows: 8 % of the total area for agricultural purpose; 7 % for improved pasture; 45 % by natural grass and bushes, mostly used for extensive livestock production; 30 % by forest; 2 % by marsh and water bodies; and 8 % in other uses including buildup areas. Present land use is shown in Fig. 2.4.1.

The land area being used at present for agriculture purpose is still very low although a large percentage of the study area is highly suitable for intensive agricultural use. As it has been pointed out, the reduced present agricultural land use is because no measures have been taken to alleviate the constraints caused by floods and poor drainage. The present land use for agricultural production is low both in extension and use intensity. Land is used extensively for livestock production, but with low productivity.

The present agricultural land use in the study area is mostly concentrated within the Guanare-Masparro project, which comprises a total area of approximately 500,000 ha. According to the data given by the Ministry of Agriculture, at least 70 % of the land in Guanare-Masparro project is suitable for agricultural use. But until now, the maximum percentage of the Guanare-Masparro area been used for agriculture in a year is about 24 % of the total project area. Almost all the agricultural production in Guanare-Masparro area is under rain-fed condition. Present agricultural land in the study area is shown in Tables 2.4.2 and 2.4.3.

Within the study area there is an important economic activity based on land use for extensive livestock production. The livestock is mostly fed on natural pasture without improvement of the natural land condition.

2.4.2 Use Intensity of Agricultural Land

Only one harvest is made annually in most of the agricultural land within the study area. The main constraints limiting a more intensive use of the land are the flood and drainage problems. Other important constraints are lack of irrigation infrastructure and the ineffectiveness of the existing irrigation system to guarantee water supply during the dry season, the untimely availability of agricultural credit and the limited availability of machinery for land preparation and crop harvesting.

2.4.3 Target for Land Use on Intensive Agricultural and Livestock Production.

The Republic of Venezuela depends on import for satisfying about 67 % of the national demand for food products. The national government has declared high priority for the need for increasing the self-sufficiency level of agricultural food and fiber produces. It is recognized by the national authorities that the country is urgently in need for the development of its agricultural sector.

The available land resources and the projection of future agricultural land use in the states of the study area was analyzed by the UNELLEZ and CIDIAT ("APUROQUIA" 1983). The analysis takes as starting point the land area under present agricultural use and assumes an optimum annual increase of agricultural land use of 6 %. The APUROQUIA's analysis was made assuming that the land will be used without solving the present constraints of flood hazard and poor drainage. But, in the same report it is stated that "The present limited use of agricultural land is due to the fact that no measures have been taken to alleviate the damages caused by floods and poor drainage."

If the flood hazard and drainage constraints are not solved, even a conservative prospect for future land use can no be achieved.

For the purpose of the present study it is assumed that the flood and poor drainage problems will be solved. The expected land use for intensive livestock production as a important economic activity within the study area is also considered here. Estimates of future land use area are presented in Table 2.4.4.

The estimated area increase of agricultural land use are in accordance with the target established in the "Orderly Land Use Planning" of Barinas state, which said that for the year 2010 they will be using 60 % of the land suitable for intensive agriculture.

2.4.4 Constraints for Agricultural Land Use

The main constraints affecting the agricultural development in the study area may be divided into physical constraints and institutional constraints. The main physical constraint is the one derived from the combination of the land geomorphology and soil texture characteristics of the area. Because of these two characteristics, a large percentage of the study area is subject to frequent floods, and presents poor drainage condition. It has been estimated that approximately 30 % of the study area have almost no possibility for solving the drainage problem.

The main institutional constraints are:

a) No existence of a clear and consistent agricultural development policy and objectives.
b) Little coordination between the different official agencies related to the agricultural development sector.
c) Insufficient agricultural supporting services (extension and agricultural credit services)

2.4.5 Present Cropping System

The present cropping system in the study area is mostly under rain fed condition. The area under irrigation is still a small percentage of the potentially irrigable land. The level of input used in farming activities varies largely depending upon farmer economic capability. Normally, there is a direct correlation between farm size and farming input level; large farm owners have greater input capability, while small farmers usually are lacking of agricultural support services such as extension service, agricultural credit, agricultural machineries, etc.

Farming activity is very unstable under present conditions. The planted areas are often partially or totally lost due to floods and drainage problems.

2.4.6 Crop Adaptability to the Study Area

A large number of tropical crops can be grown within the study area. The major limitations for successful crop production are the flood and poor drainage condition. A large percentage of the area is suitable only for those crops that can withstand clayey soil type and high soil water content.

The main crops grown under present conditions are corn, sun flower, sugar cane, cotton, rice, sorghum, beans, cassava, tobacco and some vegetables. Other crops that might be successfully grown in the area are cocoa, oil palm, and coconuts.

2.4.7 Present Cropping Pattern and Intensity

The cropping pattern is very erratic due to the low development condition and scarce agricultural supporting services available in the study area. At present there is no clear fixed cropping pattern. Although cropping pattern plans have been prepared by the agricultural extension service, rarely those planned cropping pattern can be achieved. Because of the said limitation affecting the agriculture in the study area, normally the actual cropping pattern is two or three months later than the planned one.

The cropping intensity in the study area is low. Generally only one harvest is obtained per year in present agricultural land area. Commonly large percentage of the agricultural land area can not be planted because of the hazardous conditions prevailing in the area. Present cropping pattern is shown in Fig. 2.4.2.

2.4.8 Proposed Cropping Pattern and Intensity

The agricultural land in the study area might be used in a intensive and continuos basis. Two or more harvests of annual crops might be obtain per year, but an optimum cropping pattern and high intensity can be achieved only after eliminating the main constraints that at present are affecting the agricultural development. The proposed cropping pattern and intensity are shown in Figs. 2.4.3 and 2.4.4.

2.4.9 Present Crops Yields and Expected Yield Increase After Flood Management and Land Improvement

The crops yields obtained under present conditions in the study area vary from low to very low. There is high potential for increasing the yield of all crops. The expected yield increase, after eliminating the constrains affecting the agriculture, varies from 50 % to more than 100 % for the different crops. The present crop yield and expected yield after land improvement are listed in Table 2.4.5.

2.4.10 Livestock Production Under Present Condition

Livestock production is an important economic activity in the study area. The livestock production under present conditions is mainly under extensive production systems. Large areas of land covered with natural grass are used for livestock grassing. The present ratio of livestock heads per land unit is about 0.3 head per ha. This ratio could be ten times greater if improvement is made in land conditions.

The frequent flood occurring in the area is cause of serious loss of the livestock industry. The livestock owners need to move the herds to safe places during the rainy season. The main losses occur in the process of moving the herds in the flooded areas to outside.

Flood control works will be stimulus for large increase in both area and productivity of the livestock industry within the study area. It is estimated that land use for growing improved pasture will increase from the present level of approximately 150,000 ha to almost 600,000 ha in the year 2010. At the same time the animal load ratio will increase from 0.3 heads per ha to 3 heads per ha in the same period. Others benefits of flood control on livestock production such as reduction in mortality and faster weight increase need to be evaluated.

2.4.11. Existing Infrastructure in the Study Area

The study area is lacking all type of infrastructures required for supporting the development of agricultural production. Structures of flood control, drainage, road, irrigation, etc. are all urgently required for improving agricultural production and improving the living condition of farmers in the area.

2.4.12 Basic Concept for Agricultural Development

In formulating the basic concept for agricultural development in the study area, special concern was put on minimizing the negative effects on the environment. The proposed land use plan considered not only the production potential of the land after flood control mitigation and nation's production targets, but also the compatibility of proposed uses with the environment of the area. At least 30 % of the area to be protected by flood mitigation measures is planned to remain in natural forest condition for environmental concern.

The proposed land use in the areas to be protected with flood mitigation measures is as follows:

Protected area A : In this area predominate soil of heavy texture, and the land presents relatively poor drainage condition, mostly land class IV and less area of class III; Because of this physical condition, the proposed land use for protected area A is mostly for rice cultivation and, intensive livestock production with "Apure Module" type of structures for water management. The protected area comprises approximately 205,500 ha. It is estimated that out of this total physical area, about 102,700 ha will be effectively available for the proposed use; 72,900 ha for rice cultivation and 26,800 ha for Apure type module.

Protected area B: This area includes lands of class III, IV and II in less extent. The proposed crops are cotton and rice. Smaller area is proposed for intensive livestock production with the development of Apure Module type of infrastructure. The protected area comprises approximately 164,500 ha. It is estimated that out of this total physical area, about 82,300 ha will be effectively available for the proposed use; 50,000 ha for rice cultivation and 32,300 ha for cotton cultivation.

Protected area C : At this stage of the study all the area is considered for intensive livestock production with the development of "Apure Module type of structure for water management. In the area predominate land of classes IV and V with relatively poor drainage condition. More detailed study is required for assessment of the land, water and the environment of this area. The present human intervention in this area is low. The area protected by the proposed dike comprises about 135,800 ha, out of which approximately 68,000 ha will be effectively available for the proposed use of Apure type module.

The proposed land use is considered to be initially under rain-fed condition and to carry out studies for drainage and irrigation developments are proposed. The estimate made indicates that drainage and irrigation development would produce high economic benefits.

The "Apure Module" type of structure is proposed here based on their comparative potential for increasing the productivity of livestock production. According to data presented by MAC (1986), the livestock supporting capacity might increase as much as ten times from present level of 0.3 cattle heads per ha to a level of 3 heads per ha. Still there are some aspects not well known such as the economic benefit and management problems. More investigation is required to clarify the advantage of "Apure Module." Potential and Proposed land use are shown in Figs. 3.4.5, 3.4.6 and 3.4.7.

The present study for flood mitigation aims to solve one of the main constraints affecting the agricultural development in the area. Expansion of the agricultural frontiers, increase in crop yield and increase in farming intensity are expected to occur after the implementation of flood mitigation measures. The flood mitigation measures will contribute to the achievement of national and states' objectives of food self-sufficiency and exporting of agricultural produces.

The basic concept for agricultural development in the Study area includes:

- Expansion of the agricultural frontier within the study area
- Intensification and stabilization of agricultural production
- Intensification, diversification and stabilization of livestock production

To take full advantage of the high potential for agricultural development in the study area, besides the flood mitigation measures, other actions not included in the scope of the present study should be dealt with in subsequent studies. Subsequent studies should tackle the drainage and irrigation constraints, the need for agricultural supporting infrastructures and services, and the institutional constraints.

The agricultural development plan for the study area should include:

- Implementation of flood mitigation measures
- Master plan study for drainage, Irrigation and supporting Infrastructure development
- Study on improvement of agricultural supporting institutions and services.

TABLES

Table 1.1.1 PRESENT AGRICULTURAL PRODUCTION AND FUTURE TARGETS

(Unit: ton)

Crops	Production in 1982	Production in 1991	Production Target for the Year 2010	Required Increase Over 1991 Level
Corn	546,000	1,024,589	1,980,000	1.93
Rice	617,000	610,508	3,209,700	5.26
Sorghum	314,000	615,088	1,521,000	2.47
Plantain	431,000	558,022	1,512,000	2.71
Banana	900,000	1,214,847	2,160,000	1.8
Frijol	10,000	14,726	183,000	12.4
Beans	22,000	36,723	122,000	3.32
Soybean	---	9,107	856,800	94.08
Sesame	53,000	45,072	180,000	3.99
Cotton	39,000	71,876	320,000	4.45
Peanut	14,000	4,778	120,000	25.1
Palm Oil	---	5,885	50,000	8.50
Sugar Cane	4,820,000	7,066,033	11,249,900	1.59

Source: MAC, 1991, UNELLEZ, 1983

Table 1.1.2 TARGETS FOR AGRICULTURAL LAND AREA OF MAIN CROPS IN THE STATES OF THE STUDY AREA

(Unit: ha)

State / Year	1995	2000	2005	2010
PORTUGUESA				
Rice	353,017	436,597	520,178	603,758
Corn	167,314	199,607	231,901	264,196
Sorghum	135,276	166,444	195,612	225,779
Cotton	22,722	28,931	35,140	41,348
Sesame	228,470	265,089	301,711	338,330
Black beans	5,492	6,894	8,294	9,695
Sugarcane	13,576	15,298	17,021	18,744
Total	925,867	1,118,860	1,309,857	1,501,850
BARINAS				
Rice	41,461	54,388	67,316	80,243
Corn	34,773	41,852	48,932	56,011
Sorghum	101,504	131,798	157,093	182,388
Cotton	41,076	49,312	57,547	65,782
Black beans	3,591	4,516	5,441	6,365
Banana	13,238	16,201	19,164	22,127
Total	235,643	298,067	355,493	412,916
COJEDES				
Rice	52,931	61,281	69,632	77,982
Corn	31,096	37,337	43,658	49,944
Sorghum	26,615	31,135	35,654	40,174
Cotton	2,778	3,470	4,161	4,854
Total	113,420	133,223	153,105	172,954
Grand total	1,274,930	1,550,150	1,818,455	2,087,722

Source: UNELLEZ, 1983

Table 1.1.3 POTENTIAL LAND USE FOR AGRICULTURE AND LIVESTOCK PRODUCTION

Item	Nation (ha)	% of Nation	Portuguesa (ha)	% of Portuguesa	Barinas (ha)	% of Barinas	Cojedes (ha)	% of Cojedes
Agriculture	7,905,195	14.36	974,546	64	994,069	28.2	262,195	17.8%
Agriculture and/or livestock	9,280,617	16.85					69,349	4.7
Livestock	18,420,569	33.46	448,006	30	1,351,912	38.4	550,565	37.35
Forest	19,457,160	35.33	90,667	6	1,317,580	37.4	591,850	40.15

Source: MARNR, 1983

Table 2.2.1 MONTHLY AVARAGE RAINFALL AND EVAPORATION IN THE STUDY AREA

(Unit: mm)

Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Rainfall	22.7	12.1	20.8	94.9	181.1	278.1	256.6	188.5	140.3	144.5	93.4	29.7
Evapotranspirat	181.5	286.3	249.8	206.9	133.7	112.7	118.5	137.9	126.3	136.6	126.2	144.4
Potent. Evapotr.	145.2	165.1	199.8	165.5	107.0	90.2	94.8	110.3	101.1	109.3	100.9	115.5
Soil Water	0	0	0	0	74.1	200.0	200.0	200.0	200.0	200.0	192.5	106.6
Water deficit	15.8	152.9	179.0	70.5	0							
Water excess	0	0	0	0	0	54.1	161.8	78.1	39.2	35.2	0	0

Source: CIDIAT, 1991

Table 2.3.1 LAND CLASSIFICATION OF THE STUDY AREA

Land Class	Present Condition Area (ha)	Present Condition % of total	With Project Area (ha)	With Project % of total	Constraints for Intensive Use
I and II	604,800	28.8	636,300	30.3	Flood and Irrigation
III s_2d	214,200	10.2	266,700	12.7	Flood, Drainage and Irrigation
IVs_2d	65,100	3.1	151,200	7.2	Flood, Drainage and Irrigation Clayey soil texture
V and VI s_2d	1,003,800	47.8	835,800	39.8	Flood, Drainage and Irrigation Clayey soil texture
Others	210,000	10.0	210,000	10.0	Flood and Drainage
Total	2,097,900		2,100,000	100.0	

Source: MARNR, 1979

Table 2.3.2 SUITABILITY CLASSIFICATION OF LAND IN THE STUDY AREA

Land Class	Potential Use
I	No land restriction for any crop adapted to the climate
IIc	All crops; Restricion only in use intensity; Without irrigation only one harvest per year is possible.
$IIIs_2d$	Most crops adapted to the climate might be grown with good management. Increase costs.
$I Vs_2d$	Rice, Cotton, Surghum
Vs_2d	Rice and Livestock
VIs_2d	Livestock, forest

Source: MARNR 1979

Table 2.3.3 RESULT OF SEMI-DETAILLED LAND CLASSIFICATION WITHIN THE STUDY AREA

Land Class	Area (ha)	% of Reported Area	Recommended Crops
1c	67,840	17.2	Corn, Sorghum, Sesame, Bean, Banana, Tobacco, Sunflower, Rice, Sugarcane, Vegetables
2.1c	160,499	40.8	Rice, Sugar cane, Cotton, Bananas
3.1c	10,966	2.8	Corn, Sorghum, Sunflower, Bean, Tobacco,
Subtotal for Agric.	239,305	60.8	
Total reported area	393,487	100.0	

Source: MARNR, 1991

Table 2.4.1 LAND USE POTENTIAL IN GUANARE-MASPARRO PROJECT AREA

Potential Land Use	Area (ha)	% of total	Limitations
Intensive and diversified agriculture	173,170	40	No limitation
Intensive agriculture	57,750	13	Minor limitation due to fine texture
Rice, Sugar cane, and Improved Pasture	111,240	25	Drainage problem, very fine texture
Pasture for intensive livestock production	72,540	17	Drainage problem, very fine texture
Rain fed agriculture and Pasture	20,180	5	Coarse soil texture

Source: MAC, 1990

Table 2.4.2 PLANTED AREA IN GUANARE-MASPARRO PROJECT

(Unit: ha)

Crop/Year	1985	%	1986	%	1987	%	1988	%	1989	%
Corn	19,316	17.8	38,515	43.6	38,430	36.0	40,300	35.0	45,112	37.7
Rice	25,404	23.4	8,431	9.6	3,250	3.0	6,012	5.2	6,683	5.5
Sorghum	41,342	38.1	12,208	13.6	5,600	5.3	4,400	3.8	5,317	4.4
Sugar cane	8,000	7.4	12,100	13.7	12,900	12.1	13,200	11.5	12,100	10.0
Sunflower	0	0.0	0	0.0	18,300	17.1	28,400	24.7	24,651	20.4
Sesame	3,000	2.8	4,120	4.7	11,500	10.8	5,800	5.1	2,355	2.0
Cotton	9,270	8.5	11,450	13.0	12,900	12.1	11,250	9.8	17,126	14.1
Cassava	650	0.6	1,200	1.3	2,000	1.9	2,460	2.1	3,540	2.9
Beans	1,500	1.4	241	0.3	1,860	1.7	3,200	2.8	4,169	3.4
Total	108,482		88,265		106,740		115,022		121,053	

Source: MAC, 1990

Table 2.4.3 FARM LAND BY DISTRICT WITHIN THE STUDY AREA

(Unit: ha)

District	Corn	Cotton	Sesame	Sun-flower	Sorghum	Sugar-cane	Rice	Beans
Guanare	10,460	935	1,215	6,115	3,680	17,533	1,905	730
Guanarito	12,100	500	2,086	10,708	4,750		4,366	390
Alb. Torre alba	4,595	1,016	622	733	248		845	456
Rojas	6,703	1,476	505	2,590	385			60
Sosa	3,885	3,259	218	772	95			65
Arismendi								55
Total	37,743	7,186	4,646	20,918	9,158	17,533	7,329	1,756

Source: MAC, 1991

Table 2.4.4 ESTIMATES OF LAND USE AFTER FLOOD MANAGEMENT PROJECT AND DRAINAGE AND IRRIGATION PROJECTS

(Unit: ha)

Year	Land Use for Intensive Agricultural Production		Land Use for Intensive Livestock Production	
	6% Increase	8% Increase	6% Increase	8% Increase
1992	200,000	200,000	150,000	150,000
1995	238,180	251,900	178,650	188,960
2000	318,740	370,200	239,080	277,640
2005	426,400	543,900	319,940	407,940
2010	570,800	799,200	428,160	599,400

Source: UNELLEZ, 1983, and own calculation based on available data.

Table 2.4.5 EXPECTED CROP YIELD INCREASE

Crop	Present Yield Level (kg/ha)	Expected Yield (kg/ha)	Increase (%)
Corn	1,500	3,000	100
Rice	3,000	5,000	67
Sorghum	1,700	3,000	76
Banana	7,500	16,000	113
Beans	460	1,000	117
Soy bean	Not planted	2,000	
Sesame	600	900	50
Cotton	1,240	2,000	61
Peanut	1,500	2,400	60
Oil Palm	Not planted	2,500*	
Sugar cane	65,200	95,000	46

Source: MAC, 1991 * Obtained Oil

FIGURES

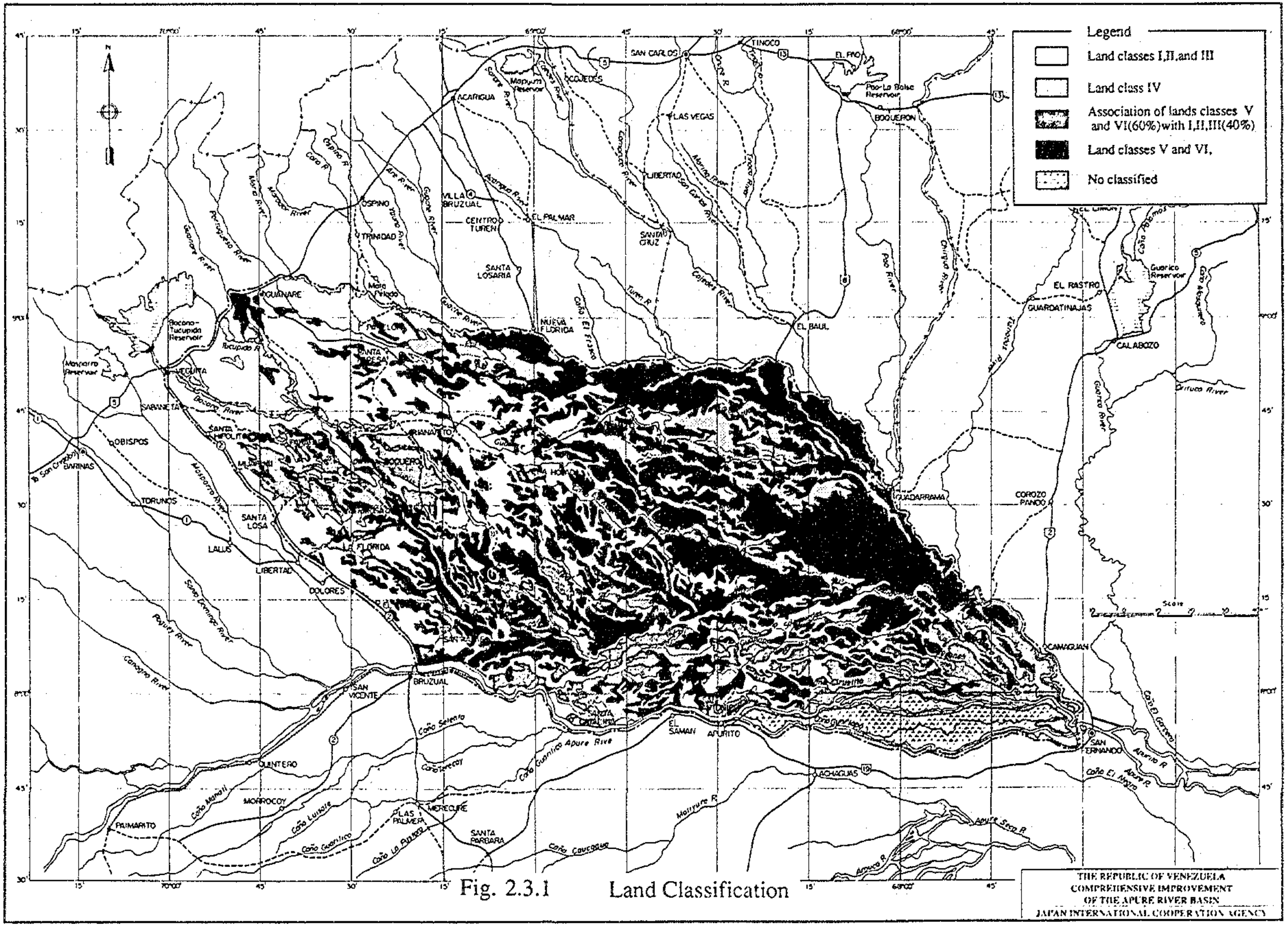

Fig. 2.3.1 Land Classification

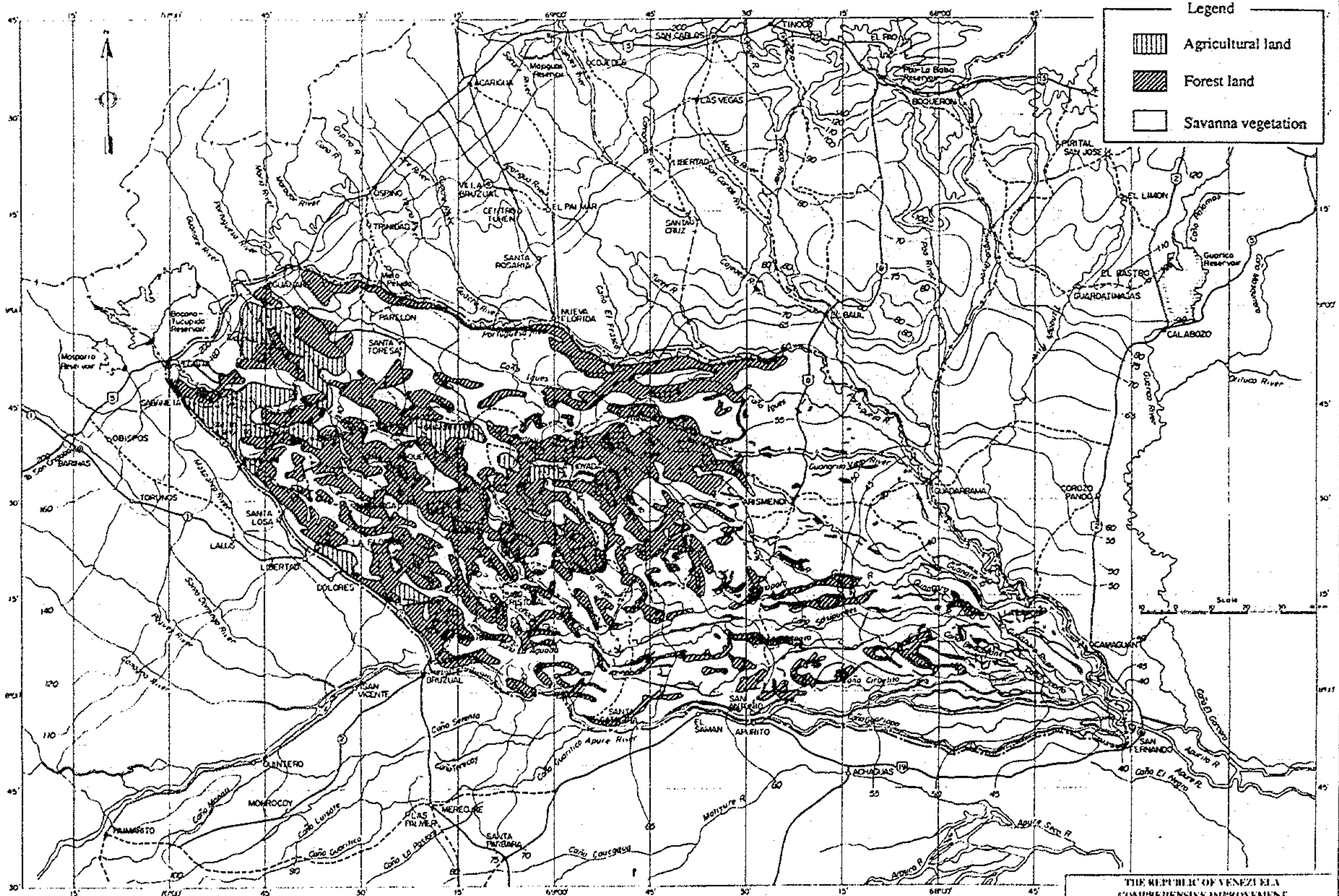

Fig. 2.4.1 Present Land Use

THE REPUBLIC OF VENEZUELA
COMPREHENSIVE IMPROVEMENT
OF THE APURE RIVER BASIN
JAPAN INTERNATIONAL COOPERATION AGENCY

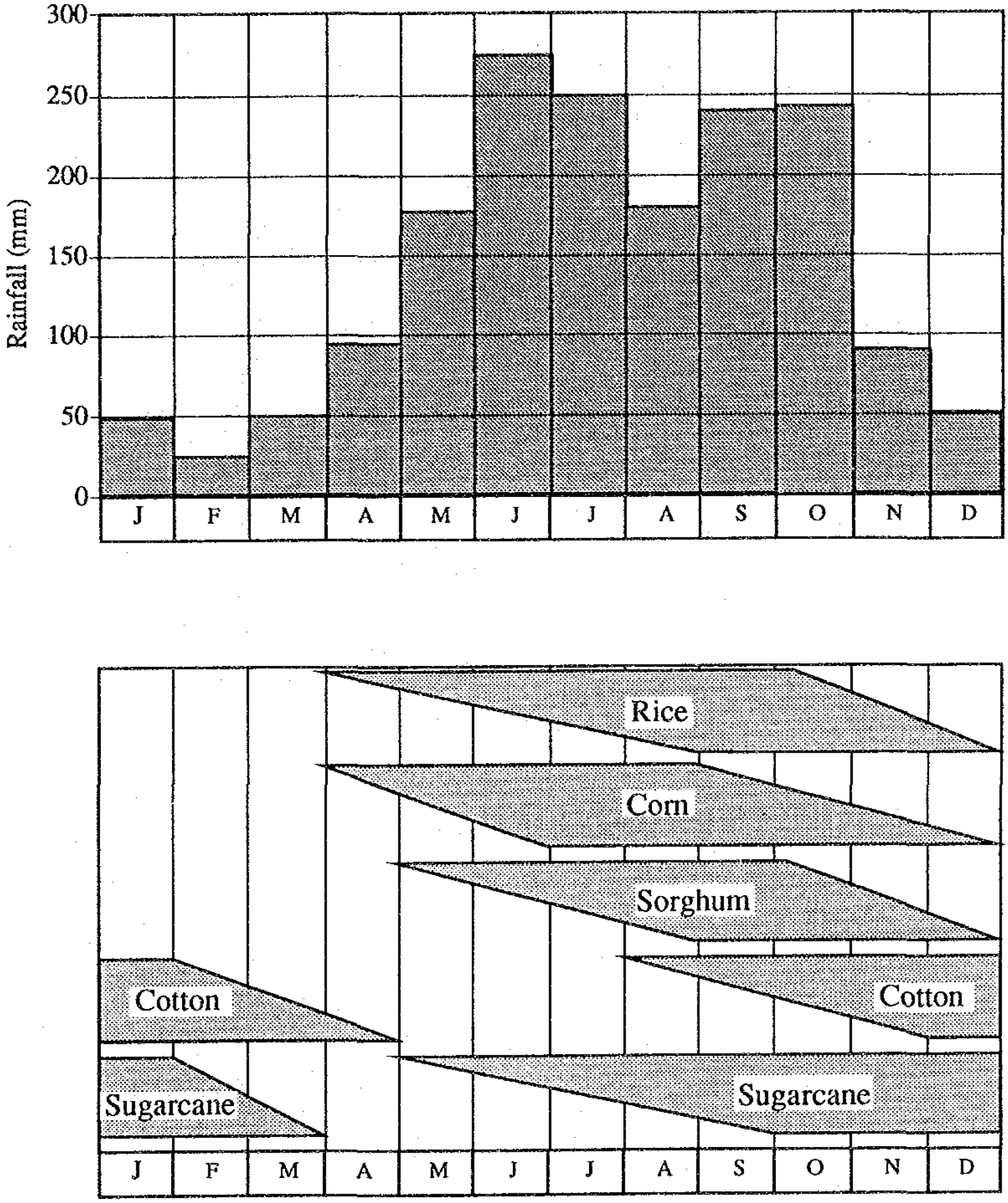

Fig. 2.4.2 Present Cropping Pattern

THE REPUBLIC OF VENEZUELA
COMPREHENSIVE IMPROVEMENT
OF THE APURE RIVER BASIN
JAPAN INTERNATIONAL COOPERATION AGENCY

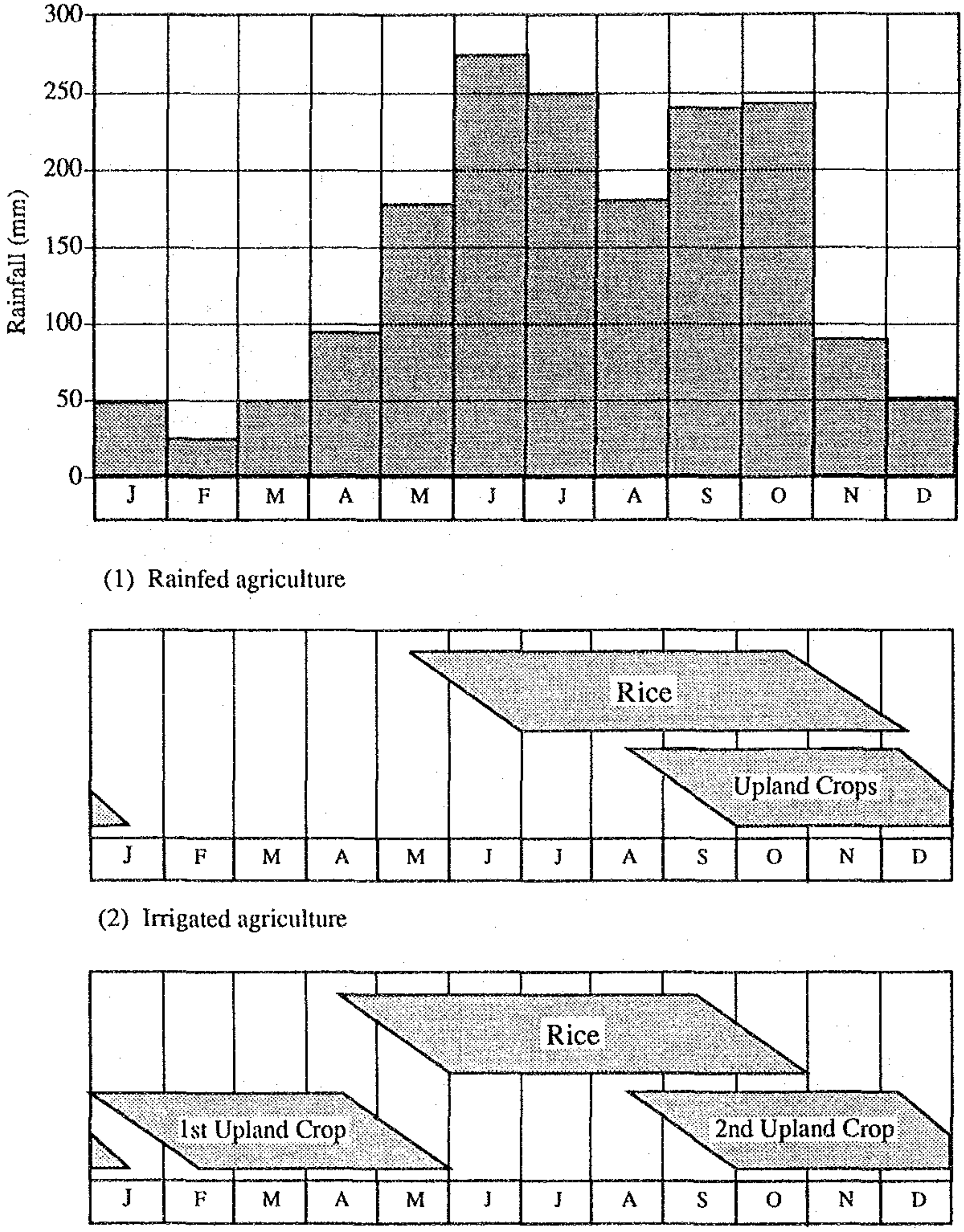

Fig. 2.4.3 Proposed Cropping Patterns

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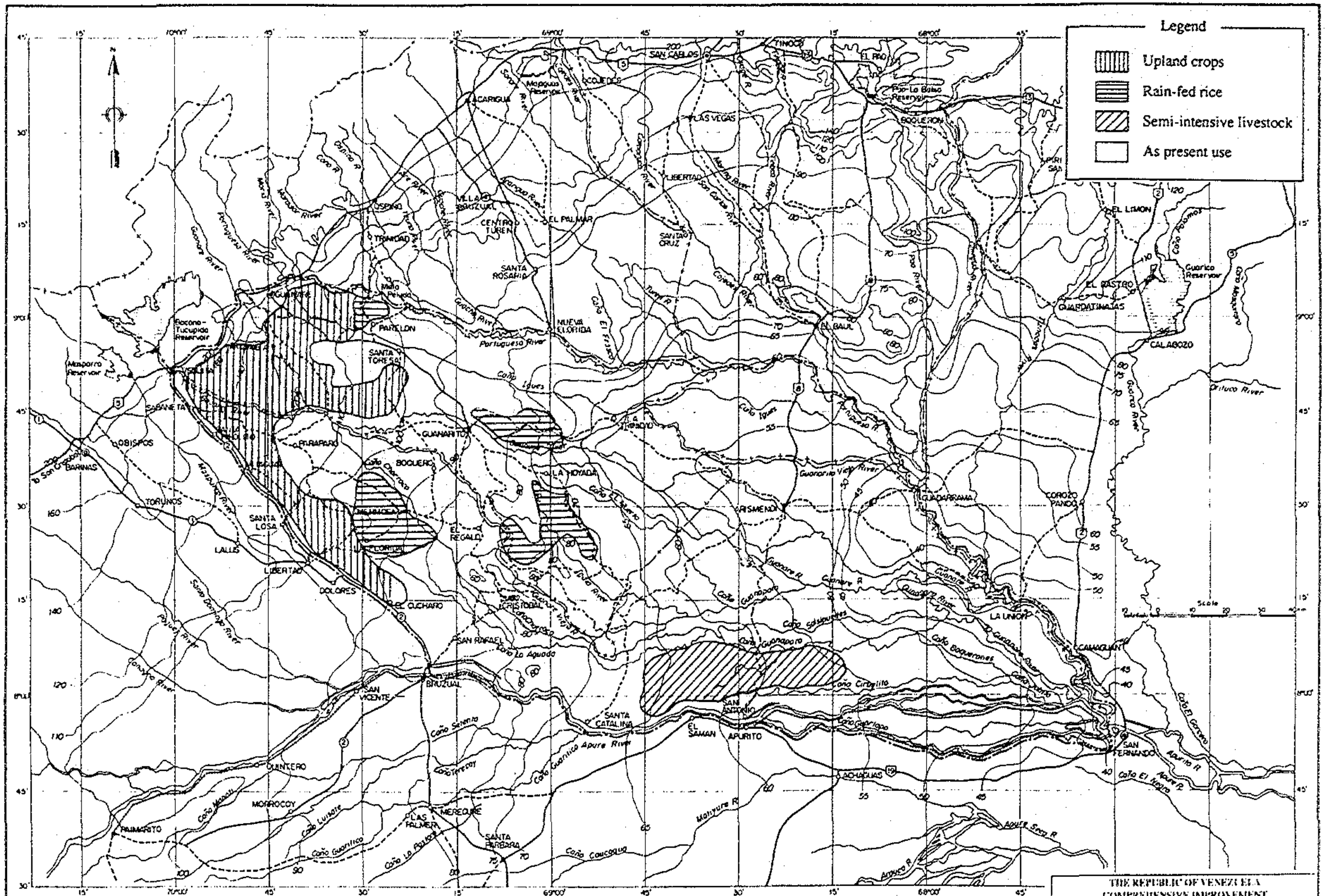

Fig. 2.4.4 Potential Land Use Without Project

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