Soil with high values for the sum of exchangeable bases occupies 84% of the whole; this indicates that most of the soil in the Area contains much clay of the 2:1 type, which has high holding capacity for plant nutrients. Since this type of clay shrinks appreciable by drying, efficient drainage might lead to good soil structure when some moisture decrease occurs in the soil with this type of clay.

Table 2.3.3 Soil Fertility

	pH	Sum of Cations 1)	Exchangeable 1) (%)		
			Ca	Mg	K
Low	21	0	0	3	4
Medium	65	16	14	29	59
High	14	84	86	68	37
	Solubility 2)				
	P	Zn	Mn	Fe	Cu
Low	20	71	4	2	4
Medium	41	18	56	22	80
High	39	11	40	76	16
	Ca/Mg	Ca/K	Mg/K	(Ca + Mg)/K	
Unbalance (low)	13	0	7	0	
Balance	45	13	50	20	
Unbalance (high)	42	87	43	80	

(Note) 1) me/100ml 2) g/ml

However, 20% of the soil is low in phosphorous, and 71% is low in zinc. Moreover, the absorption of potassium through plant roots is heavily affected by the balance between K and other cations, especially Ca and Mg existing together. Thus potassium deficiency in crops would be apt to occur, because more than 80% of the soil is ranked in the unbalanced range, caused by the high supplying powers of Ca and Mg in the soils of the Area.

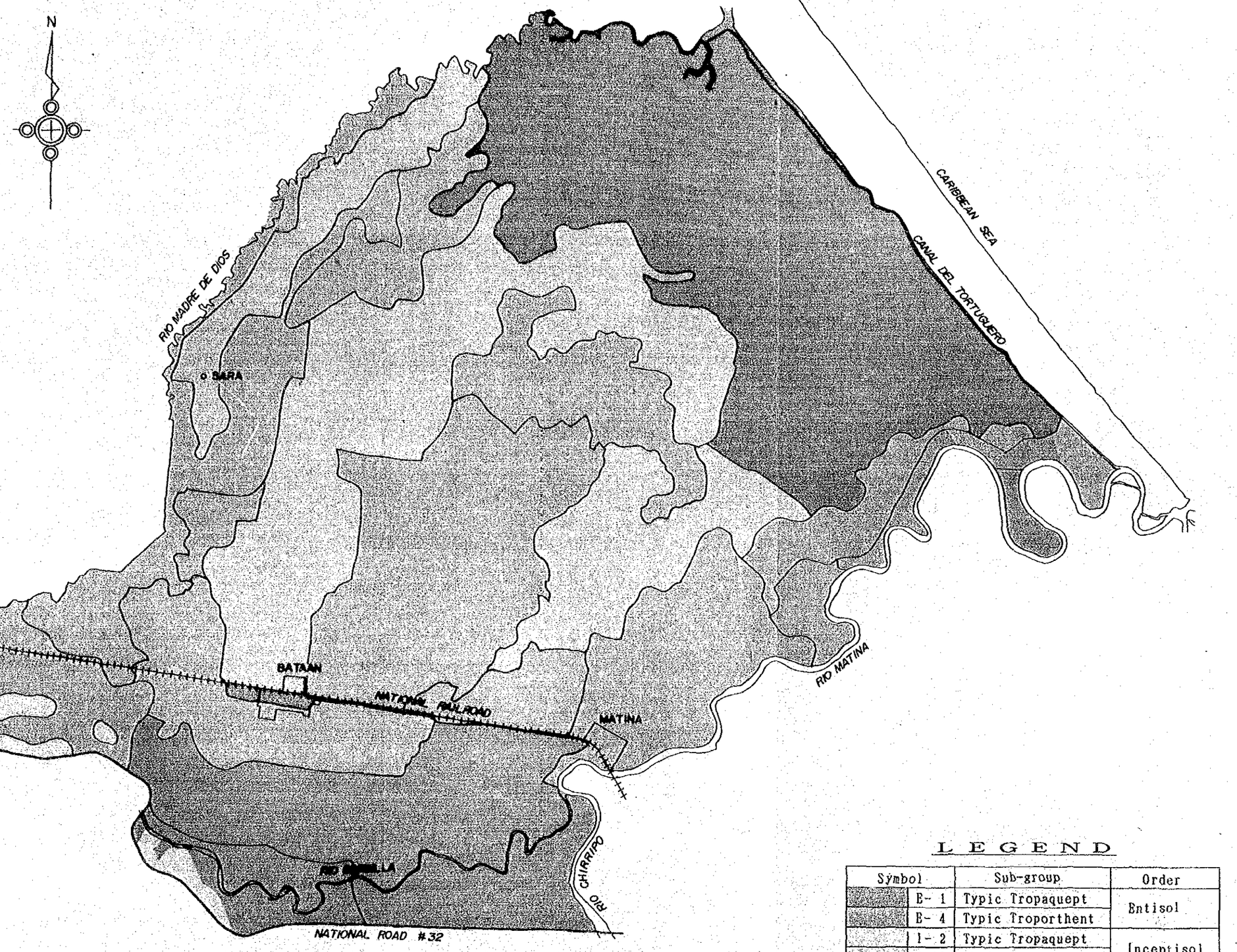
2.3.2 Soil Classification

The kinds of soil obtained by the survey are classified based on the USDA Soil Taxonomy method as shown in Table 2.3.4. The distribution of the soil series thus obtained is shown in Fig. 2.3.1. The explanation of the soils in the text below is conducted with the symbols in the table.

Table 2.3.4 Soil Classification

Order	Sub-Order	Great group	Sub-group	Family	Series (Association)	Area ha	Area %
Entisol	Aquent	Tropaquent	Typic Troporthent (E-4)	Dondi-Davao (a)	Dondi Matina (a-1) Davao (a-2)	2,495	12.8
			Typic Tropaquent(E-1)	San Juan (e)	San Juan, Gosche (e-1,-2)	4,585	23.5
Inceptisol	Aquept	Tropaquept	Aeric Tropaquept (I-16)	Barra-Lola-Santa (b)	Barra Matina (b-1) La Lola (b-2) Santa Marta (b-3)	5,300	27.2
				Margarita-Veintisiete-Goschen (c)	Margarita (c-1) Veintisiete Millas (c-2) Goschen (c-3)	2,750	14.1
			Typic Tropaquept(I-2)	Berta (d)	Berta (d-1,-2)	4,080	20.9
Ultisol	Humult	Palehumult	Oxic Palehumult(U-1)	-	-	290	1.5

( ) : Symbol



L E G E N D

Symbol		Sub-group	Order
	E- 1	Typic Tropaquept	Entisol
	E- 4	Typic Troporthent	
	I- 2	Typic Tropaquept	Inceptisol
	I-16	Aeric Tropaquept	
	U- 1	Oxic Palehumult	Ultisol

Fig. 2.3.1 General Soil Map

1) Classification of Higher Categories

The classification is conducted according to the materials issued by MAG. Most soil in the Study Area is in the very early stages of soil formation, classified as the Entisol and the Inceptisol. Only about one percent of the whole belongs to the Ultisol, a much more progressed state in the soil formation process.

Since the soil is generated from abundant excess water and tropical temperature, the soil is classified with "Aqu (Water)" and "Trop (tropical)" in the subdivision from the sub-orders to the sub-groups.

The Entisol, the youngest soil, is divided into two sub-groups, the E-1 and E-4. For both, the typical effects of moving soil moisture on the soil layers are barely evident because the newly deposited materials are repeatedly transported by frequent flooding.

In the Inceptisol, an in underdeveloped soil, the greatest factor affecting the formation of characteristic horizons seem to be behavior of the excess moisture in the soil bodies under the condition of the Area. Somewhat clear effects of the air appear in the profiles of the I-16 group, caused by moderately good drainage, while in the I-2 group, which has poor drainage, typical effects of the excess water such as a dead water increase and lower the air content.

The soil in the Ultisol has older parent materials and the leaching under the tropical rain-forest climate is much more advanced than in the soil of other two orders. It is deficient in plant nutrients such as the exchangeable bases, and thus it is hardly used for arable land. Moreover, this occupies only about one percentage of the whole, the classification in the lower categories was omitted.

2) Classification in Lower Categories

For this classification, the factors, directly affecting plant growth are chosen as the main criteria. The most important one

would be the quantity of excess moisture in the soil.

Therefore, the main differences between each series and each family of soil are the soil colors, quantities and clearness of iron and manganese mottles, and soil structure appearing on the profiles, resulting from the drainage conditions.

The elevation, micro-topography (depression or elevation), soil texture, quantity of mixed volcanic ash, groundwater table and stratification in the sub-soils are mentioned as the main factors affecting these things. Accordingly, based on their synthetical considerations, the series (may be series association in some cases) and the family were classified, putting some similar series together.

Family a

The soil, distributed on relatively higher land of about 10 m to 20 m elevation, and on natural dikes along the main rivers, suffered very little from inundations, has deep groundwater table of more than one meter and the best drainage in the Area.

Both the upper (about 30 cm in depth) and lower layers (about 30 cm to 100 cm in depth), are of rather high brownish colors, and of strongly developed structures with much porosity but very few mottles of iron and manganese. This soil family is used for the typical upland fields, and is hardly affected at all by excess water, especially the dead water in the soils.

A-1 series: The soil texture is silty clay loam with a deep available layer.

A-2 series: The texture is less clayey, silty loam, with the shallow available layer of 50 cm in depth due to an existence of stones.

Family b

Most soil in the natural dike and elevated lands, distributed widely in the Area, suffered lightly from inundations and have

groundwater tables of nearly one meter. Although the drainage is good next to the family a and is brownish on the whole and has well developed structures, the effects of the water appear in the profiles with the mottles of iron and manganese. The state of drainage seems to worsen in the order of b-1, b-2 and b-3, and the development of structures is the same. The b-2 series is distributed in higher places of 40 m to 50 m elevation, and rich in manganese mottles. As for the texture, although clayey to loam is observed for most soil of the b-1 and b-2 series, silty loam is dominant for b-3.

Family c

The soil is distributed on land of about 5 m to 15 m of elevation. It suffers from moderate inundation damage, has about 50 cm to 1 m depth of groundwater, is grayish to greenish white in color, and has increased clearness for mottles of iron and manganese and less developed structures, all of which indicate the remarkable effects of the dead water in the soil. The state of drainage seems to be worse in the order of c-1, c-2 and c-3. As for the texture, clay loam to silty clay loam predominates for the c-1 and c-2 series, while for the c-3 it is clay to silty clay. Thus, increasing clay content together with increasing volcanic ash seems to cause imperfect drainage of this series.

Family d

This soil, distributed on relatively low land of 3 m to 7 m elevation, has about 0.5 to 1 m depth of groundwater, and suffers from severe inundation damage. It has clearly worse drainage than the family c and has greenish colors in both the upper and lower layers showing the remarkable affects of the dead water in the soil.

As compared with the family c, the contents of clay and volcanic ash increase generally in the surface soils. Although this family seems to be classifiable into at least two series depending on the mix of volcanic ash, their distributions have not been estimated, so they are shown as a series of association.

Family e

The soil distributed on the low land with less than 5 m elevation suffers the most severe effects of inundations, has less than 0.5 m depth of groundwater, and has the most clayey texture and poorest drainage in the Area. It shows the distinct affects of the dead water in the soil, having gray horizons of blue grayish color not only in the sub-soil but also in the surface soil in some cases, and undeveloped structures such as wall surface are predominant. This family also seems to be classifiable into at least two groups depending on the mixed quantities of the volcanic ash in the surface soil. However, since their distribution have not been identified, the series is mentioned as an association of these groups.

2.3.3 Classification of Land Use Capability

According to the results of the soil survey, the main natural limiting factors for the land use capability in the Area seemed to be inundation, drainage, level of groundwater and depth of the available layer. Therefore, the classification of the land use capability was conducted on these items based on the criteria of the USDA method (Annex C Table C.7.1). The classified results are shown in Table 2.3.5 and their distributions are in Figure 2.3.2.

Class I : This class corresponds to the soil having almost no limitation for the land use. However, at present, since almost all the land of the Area seems to suffer from some damage of inundation, this class does not exist in the Area.

Class II : This class corresponds to soil that has some limitations in terms of the kinds of plants for cultivation or that require moderate control for land use.

Among those limiting factors, inundation is a common factor to all soil in this class. For the series a-2, the another factor is shallow depth caused by stones in the sub-soil, and for the series except the series a-1, that

is drainage condition.

The soil in this class is most suitable for farmland in the Area. It covers 9,925 ha, 51% of the whole. The limiting factors are not so severe, and the land could fit into I-class except for the series a-2 from which it is impossible to remove the stones. With adequate measures to deal with the negative factors, this could become highly suitable land for cultivating common upland crops and fruit trees.

Class III: The soil possess serious limitations for farmland use. The series c-3 in this class covers 620 ha 3% of the whole. Although at present, cultivation would be limited to plants with endurance to wet conditions, such as rice and certain kinds of pasture grasses and trees, this land class could be graded up to the class II with adequate measures.

Class IV : This class is marginally suitable for farmland at present. It corresponds to series d and covers 4,080 ha which is 21% of the Area. Even plants that have high endurance to wet conditions can hardly grow at present, land use for grazing grassland and forestry might be more feasible. With appropriate measures, the farmland could be improved to correspond to the class III.

Class V : This class includes soil having shallow groundwater level and poor drainage. It is very difficult to improve, but is in little danger of erosion. It could be used only for grassland and forestry. No soil corresponding to this class exists in the Area.

Class VI: Owing to the very severe limitations, the soil in this class is virtually unsuitable for farmland, and could be used only for pastures and forestry. The U-1 group, corresponding to this class, is of about 290 ha in area, and occupies 1.5% of the whole.

Class VII: Although the main factors are also inundation, drainage and groundwater level, their intensity is so extremely severe that the soil is not suitable for farmland but only for pasture, forestry and a habitat for wildlife. The family e soil corresponds to this class. It covers 4,585 ha 24% of the whole. As it would be almost impossible to find adequate economical measures, use as farmland is out of the question.

Table 2.3.5 Land Classification

Class	Soil Series	Limitation Factor	Area ha	Area %
I	-	-	-	-
II	a-1	h3		
	a-2	h3 h9	9,925	50.9
	b-1,b-2,b-3	h1,h2,h3		
	c-1,c-2	h1,h2,h3		
III	c-3	h1,h2,h3	620	3.2
IV	d-1,d-2	h1,h2,h3	4,080	20.9
V	-	-	-	-
VI	-	S9	290	1.5
VII	e-1,e-2	h1,h2,h3	4,585	23.5
Total	-	-	19,500	100.0

Limitation factor:

h1; drainage condition, h2; groundwater table,
h3; danger of flood, S9; stones mixed in soil

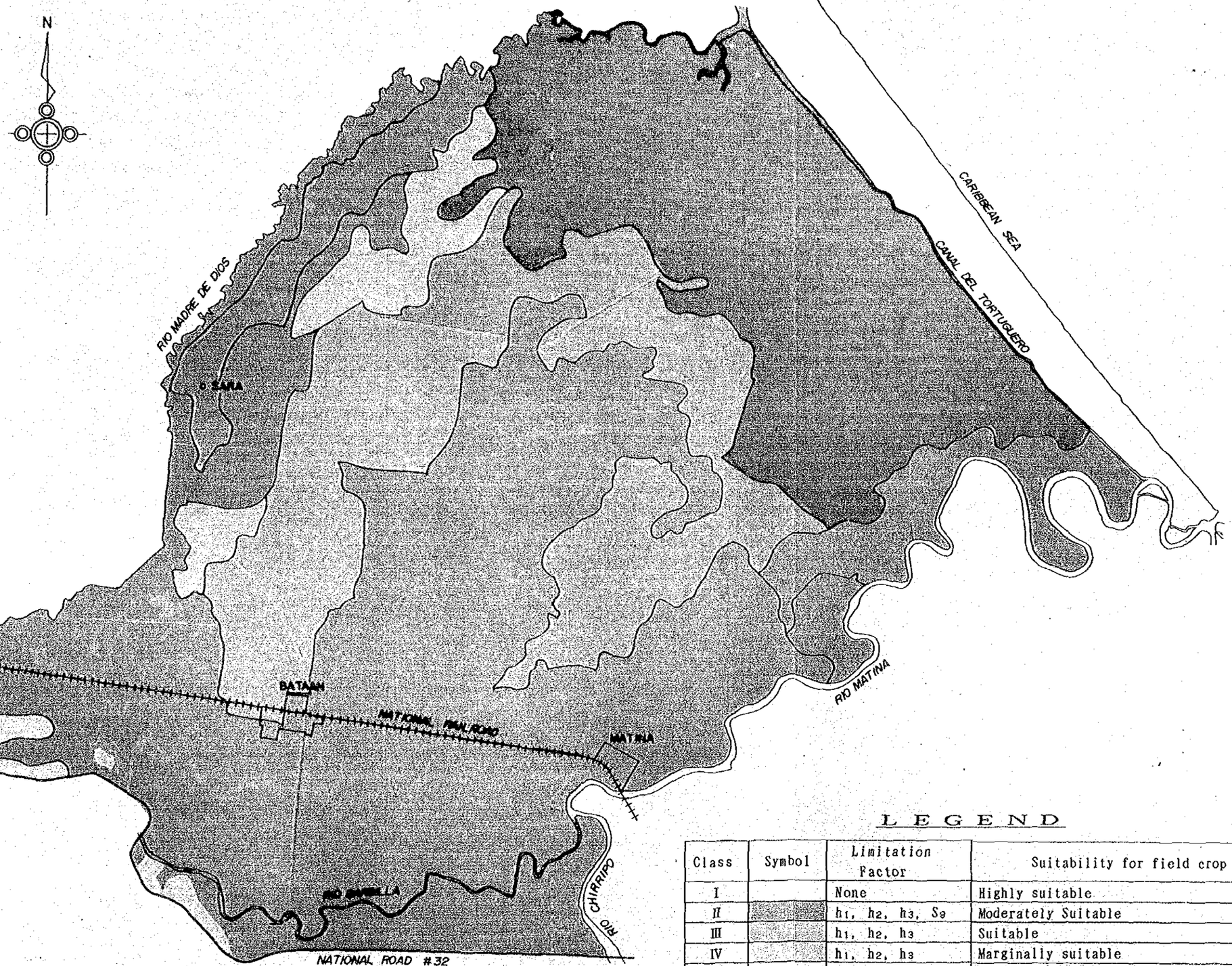


Fig. 2.3.2 Land Classification Map

LEGEND

Class	Symbol	Limitation Factor	Suitability for field crop
I		None	Highly suitable
II		h_1, h_2, h_3, S_9	Moderately Suitable
III		h_1, h_2, h_3	Suitable
IV		h_1, h_2, h_3	Marginally suitable
V		–	Suitable for pasture & forests
VI		S_9	Only available for forests
VII		h_1, h_2, h_3	Only available for pasture & forest

2.3.4 Soil Management

The thick wild grasses in fields makes rich organic matter for the surface soil, tending to increase moisture holding capacity of the soil. The imperfect drainage is unfavorable for upland crops. Therefore, an effective weeding is important for the land management, especially for the family c soil.

Generally, as the natural supply of P, Zn and K for plants in the Area is low, so adequate fertilization of these elements should be taken into consideration.

2.4 Drainage

2.4.1 Present Drainage System and Existing Drainage Canals

1) Present Drainage System

Most of the rain water in the Study Area is drained to the Caribbean Sea via small rivers and canals which branch out from the Canal del Tortuguero which runs in parallel to the sea. The present drainage systems in the Study Area consist of 20 drainage areas (Annex F Table F.1.1), and the drainage system which covers the largest area (191km^2) is that of Rio Madre de Dios.

The areas covered by Rio Matina, Rio Barbilla and Rio Chrripo, are divided into 11 drainage systems. The direct drainage area inside of the Area is 17.5km^2, which corresponds to 9% of the Area. The direct drainage area outside of the Area is 44.3km^2. (Fig. 2.4.1)

2) Existing Drainage Canals

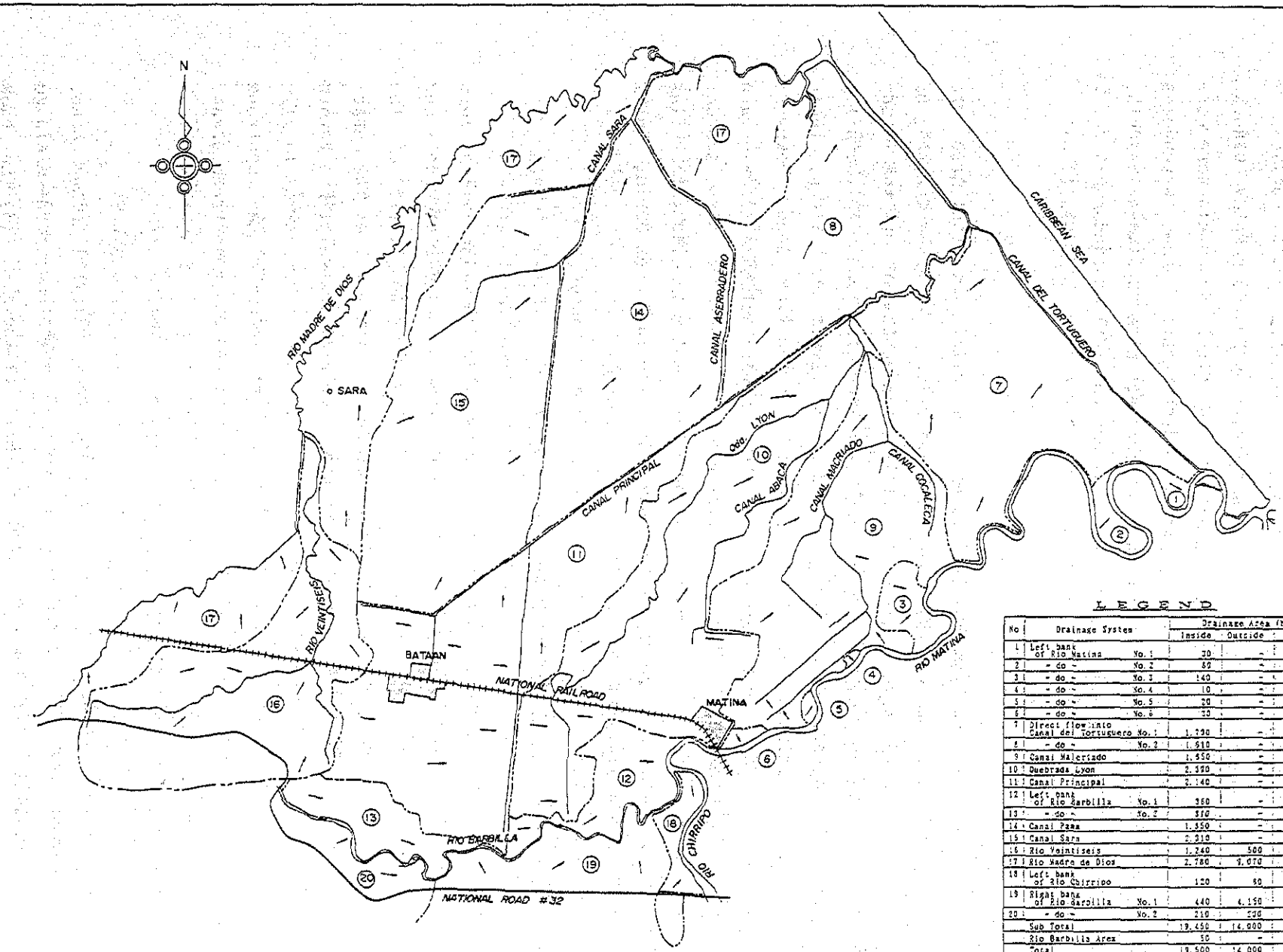
The existing drainage canals are as follows:

Principal drainage canals: Total length 60km
Small drainage canals : Total length 82km
Small and medium rivers : Total length 183km

The main drainage facilities in the Study Area are summarized as follows: (See Annex F F.1.1 to F.1.2)

(1) Principal Drainage Canals

Some canals were constructed by banana plantations. In the sections within and near the banana plantations, the canals have larger cross-sectional areas and are well maintained. The canals provide sufficient drainage capacity and the area near the drainage canals is well drained. Nevertheless, the further the canals are from the banana plantations, the smaller the cross-sectional areas become, and since these canals are not well maintained, the drainage capacities are insufficient.



LEGEND

No	Drainage System		Drainage Area (ha) Inside	Outside	Total
1	Left bank of Rio Matina	No. 1	30	-	30
2	- do -	No. 2	80	-	80
3	- do -	No. 3	140	-	140
4	- do -	No. 4	10	-	10
5	- do -	No. 5	20	-	20
6	- do -	No. 6	30	-	30
7	Direct flow into Canal del Tortuguero	No. 1	1,730	-	1,730
8	- do -	No. 2	1,510	-	1,510
9	Canal Malcriado		1,550	-	1,550
10	Quebrada Lyon		2,580	-	2,580
11	Canal Principal		2,140	-	2,140
12	Left bank of Rio Barbilla	No. 1	360	-	360
13	- do -	No. 2	330	-	330
14	Canal Pasa		1,550	-	1,550
15	Canal Sara		2,310	-	2,310
16	Rio Veintiseis		1,240	500	1,740
17	Rio Madre de Dios		2,780	9,070	11,850
18	Left bank of Rio Chirripo		120	80	200
19	Right bank of Rio Barbilla	No. 1	440	4,150	4,590
20	- do -	No. 2	210	530	410
	Sub Total		19,450	14,000	33,450
	Rio Barbilla Area		50	-	50
	Total		19,500	14,000	33,500

Fig. 2.4.1 Present Drainage System

(2) Small Drainage Canals

These canals were once constructed by banana company plantations and/or by settlement farmers. Since the canals were constructed without taking into consideration the surrounding conditions, they do not provide sufficient drainage capacity and the area near these canals is not well drained.

(3) Small Rivers

The two comparatively large rivers within the Study Area are Rio Madre de Dios and Rio Veintiseis. The upper reaches of both rivers are on the hills lying southwest of the Study Area. Both rivers meander across the flat land. In the hilly areas, since the gradients of the rivers are steep, their drainage capacities are large. On the flat land, however, the rivers meander and their cross-sectional areas are smaller. Other smaller rivers within the Area also meander and their cross-sectional areas are smaller. Thus, the flat area is poorly drained and vulnerable to floods during heavy rainfall.

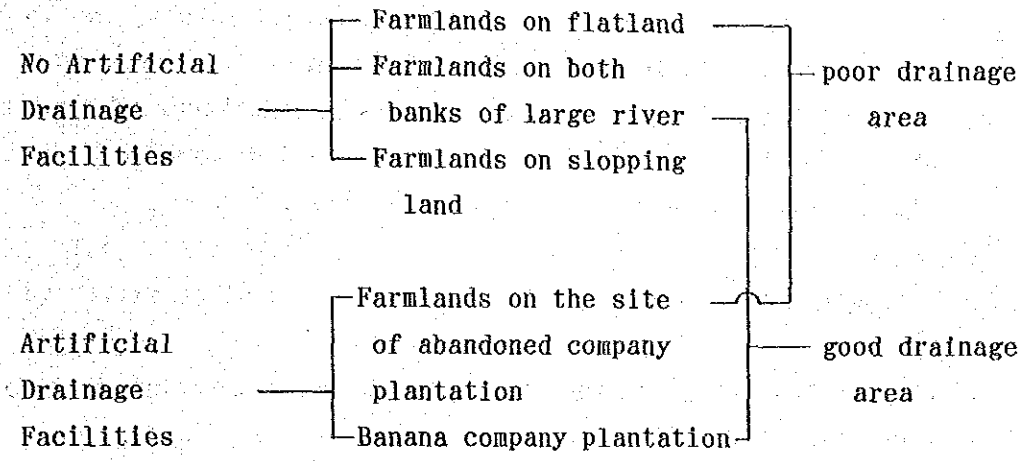
(4) Drainage Capacity of Canals and Rivers

The drainage capacities of the major drainage facilities were surveyed and calculated. The drainage capacities of canals and rivers are shown in Annex F Table F.1.3 and those of the bridges and closed conduits in Annex F Table F.1.4. The capacities are compared with probable flood discharge with a return period of 5 years. The study indicated that, while the facilities have sufficient drainage capacities in the upstream areas, they do not have in the midstream and downstream areas.

2.4.2 Present Drainage Conditions of Farmland

Floods occur often during periods of heavy rainfall in the Area, except for (1) the banana plantation area which has good drainage facilities, (2) the hilly area southwest of the Area, (3) the bank area downstream of Rio Matina, and (4) the Luzon settlement area. In

the poorly drained areas, the groundwater table reaches almost to the surface in the rainy seasons. The existing drainage conditions of the Area can be classified as follows:



1) Conditions of Inundation

(1) Farmland with Poorly Drained on Flat Land

In the farmland which has no drainage canals, rainwater stays once temporarily on the ground surface and then is drained to via small rivers and canals. Since the drainage facilities except those of the banana plantations do not have sufficient capacity, the farmland is often inundated. In extreme cases, farmland is inundated several times a year and left inundated for a few days each time this occurs.

The larger rivers, namely, Rio Matina, Rio Barbilla and Rio Chirripo, often overflow in the rainy seasons, causing the farmland to be even further inundated.

Analysis of flood conditions with probable flood discharge with a return period of 5 years was made for the left-hand bank area (18,700 ha) of Rio Matina and Rio Barbilla. The analysis indicated that the areas where floods of 30cm or more in a ponding depth occur are primarily in the midstream and downstream parts of the Study Area and the total flooded area is calculated to be 8,820 ha, including the unexploited virgin forest areas. The

depth of ponding water differs by area, ranging from 0.3 m to 1.0 m. (see Annex F F.2.2)

(2) Farmland with Good Drainage

The banana plantation areas, the farmlands on the downstream bank areas of Rio Matina, the hilly areas lying southwest of the study area, and the Luzon settlement area are well drained and are not flooded even in the rainy seasons. (Annex F F.2.1)

2) Conditions of Groundwater Tables

Groundwater tables of the Study Area were surveyed by investigating wells and soils.

(1) Farmland with Poor Drainage on Flatland

In the rainy season the groundwater table is not lower than GL-30cm.

(2) Farmland with Good Drainage

A) Farmland on the downstream bank areas of Rio Matina

The groundwater table is GL-1.0m in the rainy season and GL-3.0m in dry season. The groundwater table is affected more by the river water level than by the rainfall.

B) Farmland on sloping areas

The groundwater table is GL-1.5m in the rainy season and GL-3.0m in the dry season.

C) Banana plantations

The wet/dry conditions of end drainage canals (1.0m deep) were investigated. The investigation indicated that the groundwater table throughout the year will be approximately GL-1.0 to GL-1.5m.

2.4.3 Area with Poor Drainage

The poorly drained areas are classified into seven classes (Class I - VII) for the Master Plan, based on topography, presence/absence of artificial drainage facilities, groundwater tables in the rainy season, and interview with farmers. Class I - IV denote the poorly drained areas and Classes V - VII the well drained areas. (see the Master Plan Report, 3.8.3).

The areas of Classes I, V, VI and VII were able to be classified by referring to the results of field surveys and to 1/10,000 topographic maps. The areas of Classes II - IV, however, did not lend themselves to classify referring only to the results of field surveys and topographic maps. Therefore, they were classified by referring also to the results of drainage analysis with probable flood discharge with a return period of 5 years (see Annex F F.2.3.1). The classification of drainage conditions is as shown in Table 2.4.1. The result of classification of the Study Area into Classes I - VII is as shown in Figure 2.4.2.

The classified areas are as shown in Table 2.4.2. The total of the poorly drained areas in the Area is 11,670 ha(excluding the permanent swampy areas of Class I, which are 3,340 ha in total).

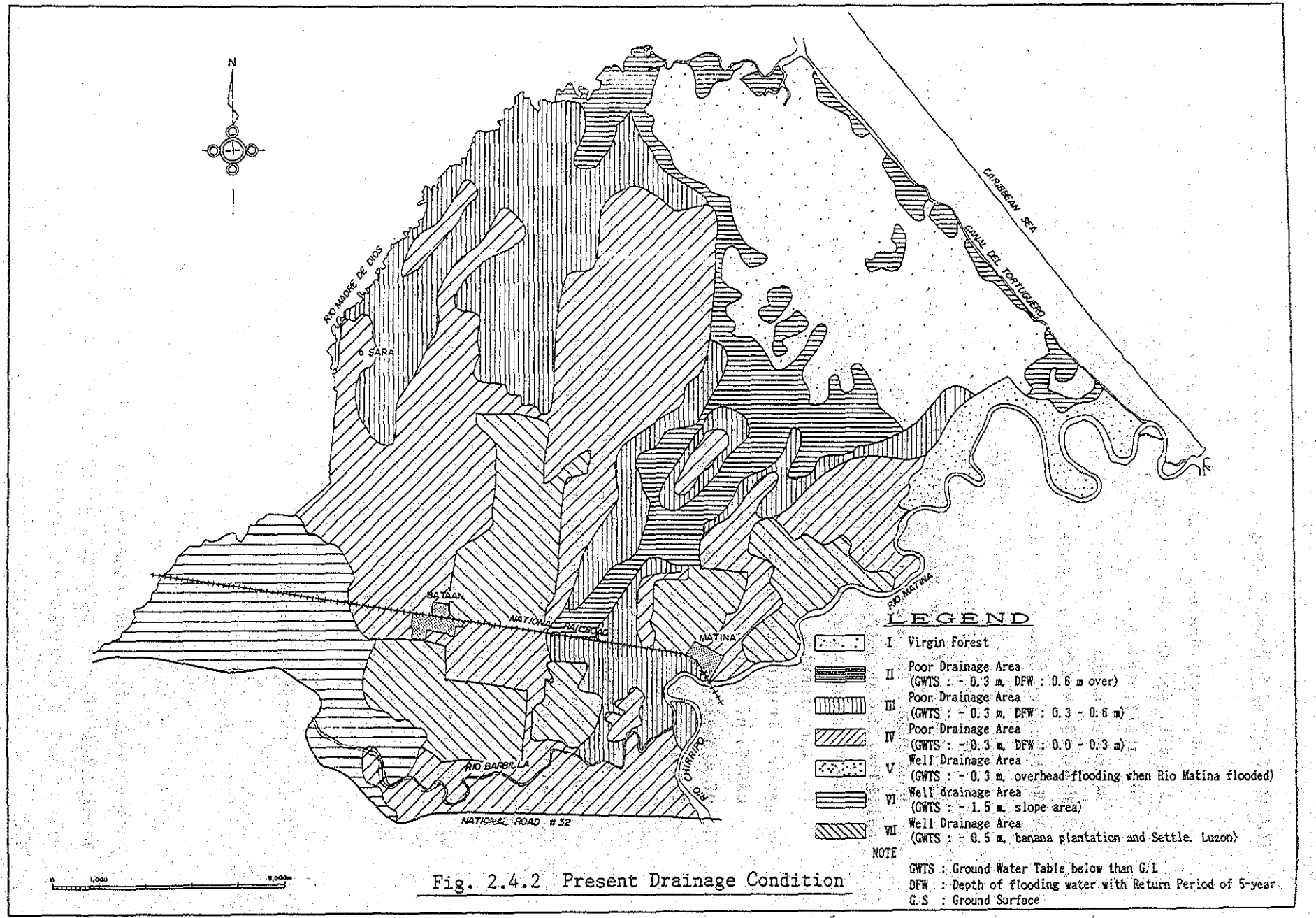


Fig. 2.4.2 Present Drainage Condition

Table 2.4.1 Present Drainage Situation

Facilities	Major Division	Ponding Depth in Flood Time (Return Period of 5 years)	Groundwater table during the rainy	Classification	Drainage Condition
No. Drainage Facilities	Permanent swamp		GL-0.3m	I	
	Farmland	more than 0.6m	GL-0.3m	II	Poor drainage area
		0.3 - 0.6m	GL-0.3m	III	
		less than 0.3m	GL-0.3m	IV	
	Farmland on the right banks of Rio Matina		under GL-1.0m	V	Good drainage area
	Farmland on sloping land		under GL-1.5m	VI	
Existing Facilities	Site of abandoned plantation	0.3 - 0.6m (Luzon)	under GL-1.5m	VII	
		0.3 - 0.6m (Sara)	under GL-0.3m	II - III	Poor drainage area
	Banana plantation		under GL-1.5m	VII	Good drainage area

Table 2.4.2 Area According to Drainage Condition

Unit: ha

Permanent Swamp	Poorly Drainage Area				Good Drainage Area				Others	Total
I	II	III	IV	Sub-total	V	VI	VII	Sub-total		
3,380	1,960	3,480	6,230	11,670	350	1,170	2,070	3,590	860	19,500

(Note) - Luzon settlement 110 ha is included in class VII.
- Other means the area of villages and institutes.

2.4.4 Inundation of Low-Lying Area

Water from rainfall in the Area and that which has overflowed from large rivers is drained to the sea via small rivers, existing canals and farmland. Water which is not drained remains on the low-lying area, causing inundation. The conditions of inundation referring to probable flood discharge with a return period of 5 years is as mentioned below. (see Annex F F.2.3.1)

1) Maximum flood level : EL 1.86m
2) Flood period (EL 1.00m or more): 49 hrs

2.5 Floods

2.5.1 Occurrences of Floods

In 1970, serious floods occurred three times, namely, in January, April and December, badly damaging some parts of the Area. The floods were of a 35 years probability according to the flow records of Rio Pacuare.

After 1970 also, many floods occurred although they were not heavy. In 1980, Rio Barbilla overflowed at south of Davao. In 1982, Rio Chirripo overflowed at a downstream location of Route 32. Rio Matina overflows every year at midstream and downstream.

The latest flood occurred in January 1988. The flood was caused by overflow of water from Rio Matina, Rio Barbilla and Rio Chirripo, inundating the farmland of the Area. The overflowing sections of the rivers found by field survey are shown in Annex F F.3.2.

2.5.2 Causes of Floods

The drainage capacities of the rivers were confirmed by employing the result of field survey and a non-uniform flow calculation. The capacities were compared with a probable flood discharge with a return period of 5 years (Table 2.5.1).

According to the results, the drainage capacity of the upstream area of Rio Barbilla and Rio Chirripo is larger than the probable flood discharge with a return period of 5 years.

However, the drainage capacities at the midstream and downstream areas of Rio Matina and Rio Barbilla and at the downstream area of Rio Chirripo are less than the probable flood discharge with a return period of 5 years (capacity for handling 13% - 73% for the probable discharge), indicating that the capacities of the rivers are insufficient. These insufficient drainage capacities of the rivers are the cause of the floods.

Table 2.5.1 Drainage Capacity of River

River	Location	Drainage Capacity (Q1) (m^3/s)	Flood Discharge with a Return Period of 5 years (Q2) (m^3/s)	Q1/Q2
Matina	Upperstream	300	2,248	0.13
	Middlestream	850	2,248	0.38
	Downstream	500	2,248	0.22
Barbilla	Upperstream	550	528	1.04
	Middlestream	350	528	0.66
	Downstream	100	528	0.19
Chirripo	Upperstream	1,800	1,760	1.02
	Downstream	1,300	1,760	0.74

(More details in Annex F F.3.1)

2.5.3 Damages Caused by Floods

Floods caused by Rio Matina, Rio Barbilla and Rio Chirripo cause damage mainly to the eastern half of the Study Area. The depth of inundating water is estimated to be 0.3 to 0.7 m and may differ by location. (Annex F F.3.2.1)

2.6 Land Use

2.6.1 Present Land Use

In the Study Area, there are 4,120 ha of farmland used for perennial crops such as banana and cacao and 4,340 ha of farmland used for annual crops such as rice. The present land use is characterized by many abandoned banana and cacao plantations, virgin forests along the Canal del Tortuguero and grasslands.

The present land use ascertained by field survey is tabulated in Table 2.6.1 and its distribution is shown in Fig. 2.6.1.

Table 2.6.1 Present Land Use

Classification	Area (ha)	Ratio (%)	Remarks
Annual Crop Land	4,340	22.3	Including 810 ha of fallow land
Bananas	1,960	10.1	Enterprise, Cooperative
Cacao	1,540	7.9	
Plantains, Coconuts	620	3.2	
Pasture	3,510	18.0	
Virgin Forest	3,380	17.3	Along the Canal del Tortuguero
General Forest	1,740	8.9	
Abandoned Plantations	1,550	7.9	Banana and Cacao
Others	860	4.4	
Total	19,500	100.0	

(Note) Others include urban areas, roads, canals and institutes' lots.

The land category distribution by elevation is presented in Table 2.6.2.

Table 2.6.2 Land Use by Elevation

Unit: ha

Classification	Elevation (m)					
	0-2	2-4	4-6	6-10	Over 10	Total
Annual Crop Land	30	520	860	1,640	1,290	4,340
Bananas	-	-	70	780	1,110	1,960
Cacao	-	40	360	280	860	1,540
Plantains, Coconuts	80	170	60	120	190	3,510
Pasture	300	540	750	1,010	910	3,510
Virgin Forest	2,520	860	-	-	-	3,380
General Forest	110	500	230	170	730	1,740
Abandoned Plantations	-	230	290	600	430	1,550
Others	70	60	60	110	560	860
Total	3,110	2,920	2,680	4,710	6,080	19,500

(Note) Others include urban areas, roads, canals and institutes' lots.

As mentioned above, most of the agricultural land in this Area lie at an elevation of 4 m and over; the rest are virgin forests. Specially, the area with an elevation of 4 m and under is not suited to farming due to very poor drainage. This area is also undeveloped owing to a long distance from National Route 32.

2.6.2 Land Tenure and Holding

Most of the Study Area are the IDA'S settlements and banana plantations of private enterprises as shown in Table 2.6.3. Most of the land is private; small portion is national land (See Annex D Fig. D.2).

Table 2.6.3 Classification of Land Tenure and Holding

Unit: ha

Private Land				National	Urban Area	
IDA Settlements	Banana Plantations	Others	Total	Land	Others	Total
9,930	1,960	6,070	17,960	1,040	500	19,500

Source: Data of IDA and JAPDEVA

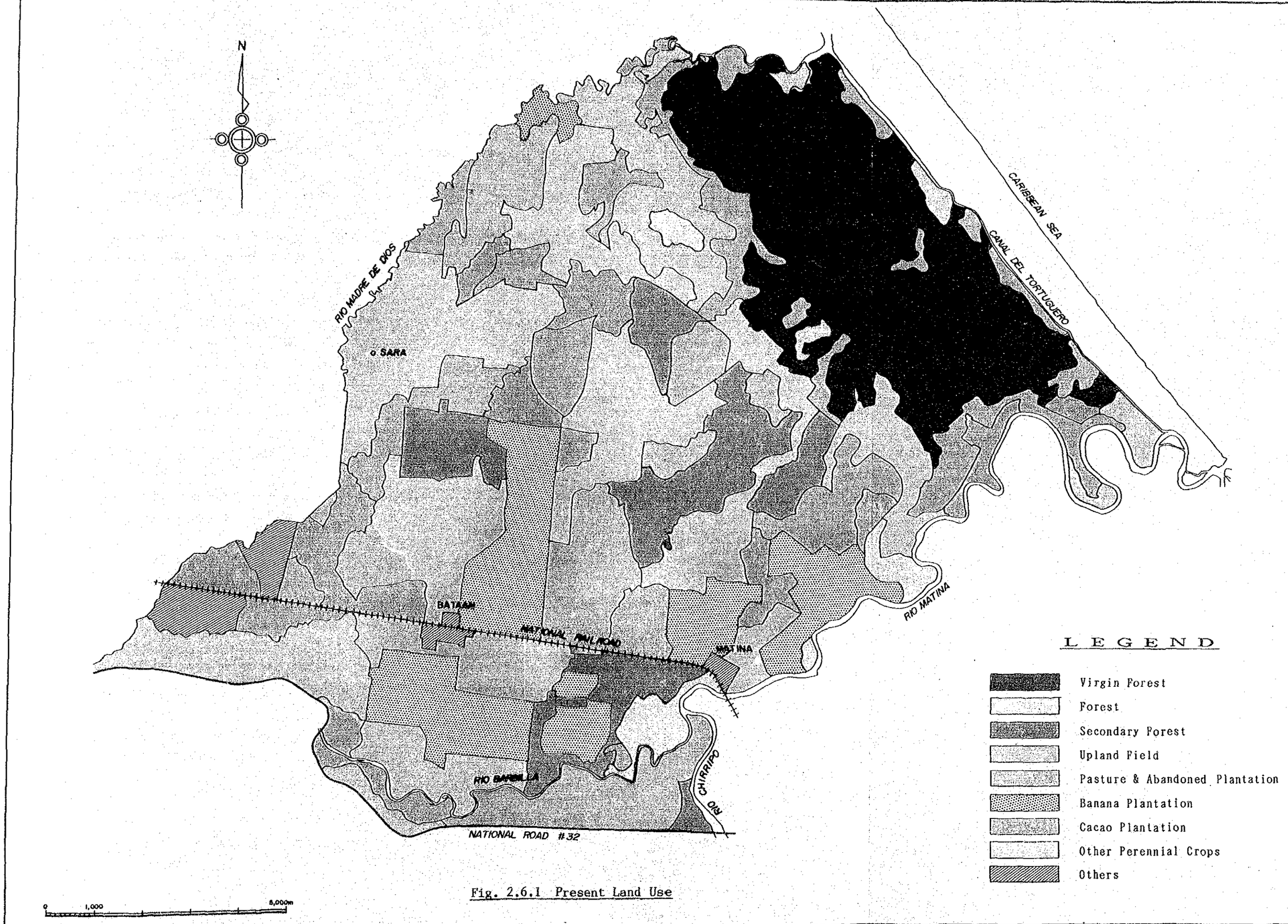


Fig. 2.6.1 Present Land Use

2.7 Agriculture

2.7.1 General

Major perennial crops in the Area are bananas, cacao and coconuts. Upland field rice is the main annual crop. The Area has an advantage of being situated relatively near Limon port, which is the biggest trading port, and linked to the capital San José by the National Road. The agricultural conditions including favorable climate enable farmers to make year-round cultivation of the major crops mentioned above.

However, insufficient drainage of the agricultural land is the major obstacle hindering expansion of the cropping area and increase of agricultural production.

2.7.2 Farming Pattern

1) Number of Farm Households and Average Land Holding

The total number of farm households in the Study Area based on the IDA and MAG farm management surveys is shown in Table 2.7.1.

The total number of farm households in the Study Area is 1,822 and the average land holding per farmer is 8.7 ha. More than 80% of the total number of farmers are small-scale farmers owning less than 12 ha of land. They are mostly the IDA settlement farmers.

At present, 1,127 of the settlement farmers, or 62% of the total farm households, are distributed in the sixteen areas.

Although the land holding per settlement farmer differs depending on the settlement land, the average land holding per farmer is 8.8 ha.

Table 2.7.1 Number of farm household

Land holding (ha)	Nos. of farm household	(%)
Less than 12	1,517	83.2
12 - 40	216	11.9
40 - 100	68	3.7
100 - 200	5	0.3
More than 200	16	0.9
Total	1,822	100.0

Source : (1) IDA : Registro de Asentamiento 1986
Asentamiento Bataán Necesidades 1988
(2) MAG : Program de Trabajo para 1987.
(3) MIDEPLAN: Censos de Población 1984.

2) Farm Management Scale and Land Use Intensity

The present average cropping area per farmer is estimated as 3 ha, which is obtained from calculating the total cropping area excluding banana plantations in the Study Area. At present, the farmers make use of only about 30% of their average land holding (average 8.7 ha). The farm management survey shows that the intensity of land use, farming types and agricultural productivity of farmers differ by the land holding scale.

Table 2.7.2 Land Use Intensity

Farm Scale	Small-Scale			Medium-Scale		Large-Scale	
Farm	A	B	C	A	B	A	B
(1) Land Holding Area (ha)	10.0	8.0	3.0	20.0	30.0	120.0	200.0
(2) Cropping area (ha)							
Cacao	2.5	0.1	-	-	5.0	-	-
Coconuts	-	-	0.3	-	-	-	-
Plantains	0.1	-	0.2	-	-	-	-
Rice 1st.	0.4	3.5	-	3.5	-	100.0	-
2nd	-	-	-	1.0	-	100.0	-
Maize	-	0.2	-	0.4	-	-	-
Kidney beans	-	0.1	-	0.1	-	-	-
Tuber crops	-	0.1	-	0.1	-	-	-
Pasture	-	-	-	1.0	-	-	200.0
Total	3.0	4.0	0.5	6.0	6.0	200.0	200.0
(3) Fallow Land (ha)	7.0	4.0	0.5	15.0	24.0	20.0	0.0
(4) Land use Intensity (%)	30.0	50.0	20.0	30.0	20.0	170.0	100.0

(Note) According to the results of farm management survey.

Table 2.7.2 presents the land use intensity per farmer and typical farming type corresponding to the farm management scale and the summary is as follows:

(1) With the increase in farm scale, the farmland tends towards monoculture and higher utilization rate because of the smaller proportion of fallow land. This is because large-scale farmers have greater funds and are thus in a position to carry out measures against flood and poor drainage, resulting in higher land use intensity. On the other hand, for small scale farmers, it is difficult to acquire funds to improve drainage.

(2) The planting of such perennial crops as cacao, plantain and coconuts is centered on small-scale farmers. In particular, most of the plantain and coconuts are produced by farmers owning less than 3.0 ha of land.

(3) Medium- and large-scale rice producing farmers also produce maize and kidney beans. All the crops except for rice, however, are produced only for the farmers themselves, and are not marketed.

2.7.3 Agricultural Production

1) Present Cropping Area of the Major Crops and its Production

The present cropping area in the Study Area is 6,870 ha. Table 2.7.3 shows the breakdown of the cropping area for major crops, and their yield and production.

As shown in this Table, about 80% of the cropping area is used for bananas, cacao and rice; in particular, rice covers 40% of the total cropping area.

Table 2.7.3 Cropping Area and Production

Crop	Area (ha)	%	Yield (ton/ha)		Production (ton)
1. Perennial crops:				1/	
Bananas	1,180	16.8	43.3	(43.4)	51,100
Cacao	1,540	24.4	0.25	(0.3)	390
Coconuts	320	4.4	2.2	(3.6)	700
Plantains	300	4.3	5.5	(10.5)	1,650
Sub-total	3,340	49.9	-	-	-
2. Annual crops:					2/
Rice	2,900	41.1	3.0	(3.3)	17,400
Maize	350	5.0	1.2	(1.7)	420
Kidney beans	40	0.6	0.5	(0.7)	20
3/Tuber crops	240	3.4	6.0	(6.8)	1,440
Sub-total	3,530	50.1	-	-	-
Total	6,870	100.0	-	-	

(Note) 1/ National average yield
2/ Double cropping
3/ Tuber crops means taro and yam

(Source) (1) ASBANA, Revista de la ASBANA, 1987.
(2) C.N.P., Agro-Tecnico, 1986
(3) SEPSA, Comportamiento de las Principales Actividades Productivas del Sector Agropecuario, 1987
(4) JICA Agricultural Farm Management Survey 1988

The average unit yield of the major crops with the exception of bananas in the Study Area is generally less than that of the national average. Total production of cacao, bananas and coconuts covers a large percentage of the national production, being 16%, 85% and 6% respectively. Rice production also covers a relatively large percentage, but the annual production varies according to the fluctuating rice market.

The Government has been encouraging increases in agricultural production of bananas, cacao, plantain, coconuts and tuber crops for export, and maize and kidney beans for domestic market, by establishing the "National Production Plan" (Plan Nacional de Producción) for an area including the Study Area and aiming for the year 2000. The national production plan focuses on increasing agricultural production by expanding the cropping area through higher intensity of land use, changing the kinds of crops cultivated and improving the unit yield of the crops.

2.7.4 Agricultural Technique

As shown in Table 2.7.3 the average unit yields of the major crops excluding bananas in the Study Area are generally less than that of the national average. Productivity is considerably low for small-scale farmers, but large and medium-scale farmers who receive extension services from MAG have high yield exceeding the national average. The difference of the unit yield by the scale of farmers is caused by the difference in drainage conditions and in the agricultural techniques such as the working system and the input material for agricultural production as described below;

1) Cropping Season

The present cropping pattern in the Study Area is shown in Fig. 2.7.1. The Area has a high temperature and plentiful rain all year round and the agricultural circumstances make year-round cultivation possible.

Rice-growing farmers with drainage facilities have an established practice of double cropping of upland field rice by direct seeding so the cropping period is stable. In the double cropping system, it is the common practice to seed in mid-April and mid-October and harvest in mid-September or mid-March. Nevertheless, small-scale rice farmers have big variations in cropping periods according to the varying rainfall patterns. The resulting irregularity forces them to depend on the ratooning, causing a reduced yield.

Monoculture or continuous cropping is generally used for annual crops, rather than crop rotation. Perennial crops are devoted to the monoculture with a exception of multiple cropping such as the coconuts and plantains.

The experimental fields at Guapiles and MAG adjacent to the Area have attained a high yield by establishing a rotation crop system covering rice, corn and kidney beans or soybeans. For the improvement of agricultural productivity, it is essential proposition to stabilize the cropping period and an appropriate rotation crop system at the same time.

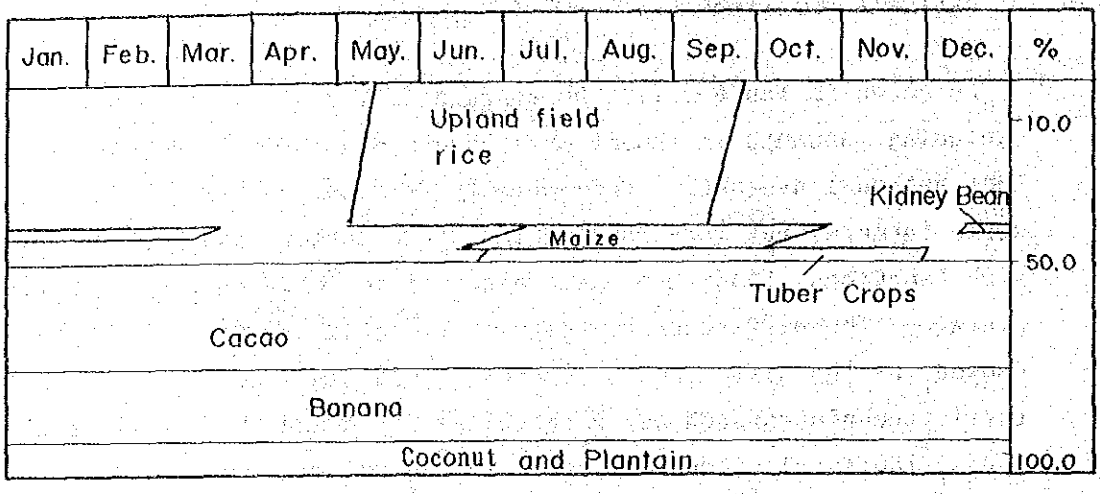


Fig. 2.7.1 Present Cropping Pattern

2) Farm Working System

In the Area, large-scale rice farmers employ an agricultural mechanization system covering all processes ranging from tilling, leveling, feeding, spreading agricultural chemicals and harvesting. On the other hand, bananas are grown by a corporate plantation system with all processes integrated from planting to harvesting and distribution. This agricultural working system contributes not only to the intensive land utilization and high yield but also to an improved and stabilized product quality.

In contrast, the only machines that small-scale farmers use are rented tractors in the rice-harvesting season, and most of their agricultural work depends on manual labor. In view of the dependence on family labor, both the planting area and farm size are restricted by the family work force. Also, they face the following harvesting problems.

a. Peak labor requirement due to the concentration of the harvesting period.
b. Decreased yield from missing the favorable harvesting period.
c. Increased moisture ratio of crops and decreased quality of crops because of insufficient drying.

3) Materials for Agricultural Production

In the Area guaranteed seeds prepared by the C.N.P. and hybrid seeds are used for major crops. There is no large difference in sowing density between the MAG's recommendation and actual practice of the farmers, regardless of farm scale. Direct sowing is liable to lead to compact planting, which is often the cause of falling plants and outbreak of disease and insects. Input of fertilizer and agricultural chemicals, on the other hand, varies with the farm scale, and the difference input results difference in yield. Table 2.7.4 shows input of production materials by farm scale of rice and cacao farmers.

Currently, because of flooding and poor drainage, the effect of fertilizer in the Area is very low. However, when the drainage improvement plan is implemented, the aggregate structure of soil and environment for the growth of the crops will improve, as seen in large-scale and experimental farms in the Study Area. As the ability of crops for absorption of fertilizer rises, a remarkable increase in yield may be expected.

Table 2.7.4 Comparison of Input of Materials for Agricultural Production

Farm scale	Rice farmer			Cacao farmer		
Item	A	B	C	A	B	C
(1) Cropping Area (ha)	5.0	8.0	10.0	10.0	10.0	60.0
(2) Yield (t/ha)	1.5	2.5	5.0	0.5	0.1	1.0
(3) Variety	CR.1113	CR.1113	CR.1113	-	-	UF
(4) Sowing density (Kg/ha)	90	110	150	900 unit	800 unit	1,100 unit
(5) Fertilizer (kg/ha) (N.P.K. 10-30-10)	10	60	140	65		125
(6) Disease and pest control (l/ha)	0	4	8	3.5	0	10
(7) Weed control (l/ha)	0	0.25	0.5	0	0	2.0
(8) Extension services	-	MAG	-	MAG	-	Agro Bataan

(Source) (1) JICA, Farm Management Survey, 1988.
(2) MAG, C.N.P., El Cultivo de Plátano con Sombra Temporal de Cacao, 1987.
(3) B.N.C.R. Costo de Producción
Comisión Interbancario de Avios, 1987.

2.7.5 Livestock

The Study Area has 3,500 ha of pasture land, which is equivalent to about 30% of the total agricultural land. Most is found in the low-lying and poor drainage areas, and is natural pasture. Since the cattle (Cebu-kind) are left in pasture to graze, the productivity of cattle breeding is low and the average weight of cattle for sale per head is 0.2 to 0.25 tons. The total number of cattle in the Study Area is approximately 2,200 head, of which 570 head are provided for sale. (Censo Agropecuario MAG 1986)

Stock raising except for beef cattle is not performed. Only domestic fowls are bred for chicken and eggs.

2.8 Agricultural Economy

2.8.1 Farm Household Economy

There are no data on farm household economy in the Study Area, so it was analyzed based on the result of the farm management survey of 30 small and medium scale farmers. The result of the farm management survey is shown in Annex E, Table E.5 and is summarized in the following table.

Table 2.8.1 Summary of Farm Management Survey
(Average of 30 farm households)

Number in family	: 5.2 persons (Maximum 9, Minimum 1)
Number of family laborers	: 1.8 persons
Land holding area	: 11.3 ha (*9.8 ha)
Cropping Area	: 3.9 ha (*4.2 ha)
Cultivation land intensity	: 35.0 % per year (*42.0)
Income of Farm Household (Gross Income)	: 182,000 ¢ per year (US$2,650)
Agricultural Income	: 82,000 ¢ per year
Non-agricultural Income	: 100,000 ¢ per year

(Note) (*) means average of IDA'S settlement farmers.

1) Of all the farm households covered by the survey, 20 were IDA settled farm households. The largest land area owned by the households was 55.0 ha and the smallest, 3.0 ha. The average area of their land is 11.3 ha.

2) About one third of the owned land is not cultivated. The reason for this low land utilization rate, as confirmed by the study team, is the poor drainage system and the shortage of farming funds.

3) The annual average income (gross income) of each farmer is estimated at 182,000 colons (about US$2,650). The income from outside jobs, however, accounts for the greater portion of the farmers' income, and reaches about 55% of their gross income.

4) Their income and expenditure balance out at 3,800 colons (US$ 55) credit per month. Without the income from outside jobs their economy would collapse.

5) The main part time jobs are laboring in banana plantations, large-scale rice-growing farms and cattle properties in and near the Area.

2.8.2 Marketing of Agricultural Products

Bananas, a dominant crop in the Study Area, however, are marketed largely through the U.S. private enterprises or the Asociación Bananera Nacional (ASBANA), which collects packed bananas for export and some of them are marketed directly to the domestic market.

The Area in Matina and Bataan mainly produces bananas, cacao, plantains, rice and tuber crops (including vegetable fruits). The marketing of these agricultural products is as follows:

1) Bananas

The banana plantation areas and production in the Area are shown in Annex H Table H.2.8.1. The FOB Moin price corresponds with New York market prices, (see Master Plan Report Annex H Table H.4.1), is growing steadily from US$3.40 per box in 1982 to US$3.90 in 1987.

2) Rice

The rice produced is sold by the farmers individually to the rice

mill in Bataán. Most of the rice collected by the millers or middlemen is brought to the markets in San José, the center of domestic consumption. Most of the rice produced in Costa Rica is consumed domestically and the surplus, if any, is exported to Panama and Mexico. The public quoted prices are described in item 3.5.2 "Agricultural Marketing" of the Master Plan Study Report.

3) Cacao

Harvested dried cacao seeds are all taken by chocolate processors in San José, and the chocolate products are made and marketed domestically. A little less than 30 percent of the total cacao production is exported. The processor buys directly at the farm and the farm gate prices range between 90 to 100 colones/kg of 9 to 15% moisture content cacao beans.

4) Others

Tuber crops, plantains and coconuts are also exported from the Limon port by private enterprises at Matina.

Costa Rica exports tuber crops mainly to the United States. The rough breakdown is 75% for the U.S., followed by United Kingdom, Netherlands and Puerto Rico at about 5 to 6% each. These four countries take 92% of all tuber crops exported from Costa Rica. Miami and New York are the main consuming cities of tuber crops. The average export price of taro in the San José market was US$520 per ton in 1986 (Master Plan Report, Annex H Table H.2.8.7).

2.8.3 Post harvest facilities

The present condition of post harvest facilities for bananas, cacao, rice and tuber crops produced in the Study Area is as follows:

Post-harvest facilities for bananas are owned by U.S. private banana plantation or banana cooperatives and these producers harvest agricultural products from their own farms and then ship them for processing, such as washing, disinfecting, quality selection and packing.

Rice post-harvest work such as collection and milling depends on the rice millers or middlemen. There is only one major rice mill in the Area with a milling capacity of 36 quintals(1,656 kg) per hour. This mill can store 6,000 tons.

Cacao post-harvest work consists of fermentation and drying. Some farmers have all-weather type drying facilities, but, these facilities are very old and mostly damaged. Cacao farmers usually dry the cacao on the ground under natural conditions in a small space in front of their houses. It is difficult to dry harvested seed to less than 15% of moisture content because of the plentiful rainfall. Sometimes, produced seeds are spoiled due to high moisture content.

For the tuber crops, post harvest facilities are only managed by corporations. They collect, wash, grade, pack and finally export the products by container line. Farmers themselves have no post-harvest facilities.

2.9 Agricultural Organization

2.9.1 Agricultural Supporting Services

In the Study Area, the following 13 organizations provide agricultural supporting services to the farmers.

Main Agricultural Supporting Services

(1) MAG : Ministry of Agriculture and Livestock
(2) IDA : Agrarian Development Institute
(3) SBN : National Bank System
(4) JAPDEVA : Board for Administration of Ports and Development of the Atlantic Basin
(5) BANDECO : Banana Development Company
(6) ASBANA : National Banana Association
(7) CATIE : Investigation and Education Center for Tropical Agriculture
(8) INA : National Vocational Training Center
(9) CNP : National Production Council
(10) MOPT : Ministry of Public Construction and Transport

(11) INS : National Insurance Institute
(12) INFOCOOP : National Cooperative Fomentation Institute
(13) Municipalidad : Matina Municipal

The purposes of their activities include extension of agricultural techniques, cropping experiments and agricultural credit, but each organization works independently without close cooperation (See Annex H Table H.2.8.10).

Organizations aimed at extending agricultural techniques are MAG, IDA, SBN, JAPDEVA and BANDECO. The following shows the farmers and crops targeted for agricultural extension.

Table 2.9.1 Farmers and Crops Covered by Agricultural Extension Services

Organization	Farmers	Crops
MAG	All farmers in the Area	Rice, cacao, plantains
IDA	Settlement Farmers	Rice, Bananas, Coconuts, Plantains
JAPDEVA	Farmers receiving JAPDEVAS' support services	Cacao, Plantains Coconuts
BANDECO	Banana Development Company	Bananas

With the exception of BANDECO, all the organizations engaged in extending agricultural techniques suffers from a shortage of experts and supporting materials. At MAG's Bataán extension office (Oficina de Extension Agricola en Bataán), for instance, three extension workers are in charge of 20,000 ha (more than 2,000 farm households), forcing their extension work to be less detailed.

Though each farm household is earnest to improve the farm management, the activity of the other agricultural supporting organization is stagnant because of inactivity of agricultural production due to the poor drainage and flooding damage in farmland.

There are two planting experimental stations at ASBANA and CATIE in the Area. ASBANA experimental station stresses experimental planting and seed production aimed at improving export plants and pest control.

CATIE, on the other hand, is engaged mainly in pest control, plant improvement tests and seed production. In Guapiles, adjacent to the Area, Costa Rica University and MAG's La Rita Agricultural Experimental Station conduct planting tests of annual crops and perennial crops such as cacao and pepper.

As mentioned above, there exist a number of organizations in and around the Study Area for improving and extending agricultural techniques. If the techniques owned by these organizations are utilized positively, it will help improve and extend the agricultural techniques in the Area toward the future.

2.9.2 Farmers' Organizations

The major farmers' organizations in the Area are farmers' cooperatives and consumers' cooperatives.

There are five farmers' cooperatives in the Area. The two cooperatives handle the production and management of banana plantations, including processing facilities for grading, washing and packing. Other three cooperatives, take charge of the production and selling of plantains, cacao and fruit as well as supply of production materials such as fertilizer, pesticides, etc.

On the other hand, the three consumers' cooperatives are involved in supermarket activities in the town centers. These consumers' cooperatives handle agricultural products and general foods such as groceries. All members of the farmers' cooperatives invest capital in common funds. Profits are distributed among the members. Details of the cooperatives are shown in Annex H Table H.2.8.9.

Moreover, an association for village improvement exists in each village, and their main purpose is to plan for villages having insufficient facilities. The associations hold general meetings, discuss their problems and submit petitions to the government.

2.10 Land Consolidation

2.10.1 General

Few properties are provided with farm roads and terminal drainage canals. Inspection of the present state of the land consolidation indicates that almost no land in this Area has been improved. This means that only approx. 700 ha of the land has been comparatively well improved and the others have scarcely been improved.

Terminal drainage canals and farm roads must be provided for the farm land, because, even if the drainage and road improvement project is implemented without the consolidation of the above facilities, effective results cannot be expected. Thus land consolidation in the Area is needed.

Consolidation conditions of the farmland in settlement land are almost the same as those of the other farmland.

2.10.2 Land Consolidation Condition

The typical examples of the farmland that has been comparatively well improved, and not improved at all are as follows:

1) Sara district

The district has been comparatively well improved. Most of the farms are rectangle. Almost all farmlands, excluding some blocked areas, are provided with farm roads. The farmland currently used is positioned in an area with good drainage. It accounts for approx. 40% of this district. The remaining approx. 60% is not cultivated and is covered with grass due to poor drainage conditions. Such areas are often found in the southern part of this district.

2) North Bataán district (including Goschen, Santa Marta, and Damasco)

The farmland in this district is not improved at all. Since the farmland is not adjusted and the plots are not uniform, most of farmlands distributed to settlers does not even have an admission passage. Many settlers who are provided with farmland in this district leave their farmlands as grassland or forest.

2.11 Settlement Project and Rural Villages

2.11.1 Settlement Project

In 1965 IDA started the Settlement Project in the Study Area. There are presently 16 settlement areas with 9,930 ha of land and 1,127 settlement households. Land family averages 8.8 ha (see Annex I).

The settlement areas are mostly located in the central part of the Study Area. IDA, the executive organization of the Settlement Project, constructs 6 m wide gravel roads in the settlement areas so that each field faces the road. This development method was not strictly adhered to during the early stages of the Settlement Project. The fields are of varied shapes.

As a general rule, settlers are obliged either to live on or near their land; therefore, most villages in the settlement areas are of a scattered type.

IDA is currently pressing forward with the Settlement Project throughout the country. However, in the Area there is insufficient land, so no new settlement plan is scheduled.

2.11.2 Rural Villages

Some of the rural villages in the Area are developed in the vicinity of railroad stations and along the railroad tracks. Some are

developed around banana plantations. There are old rural villages and newer scattered type villages in the settlement areas.

For the most part, villages can be classified into the following three types: the street-side type; the colony type; and the scattered type.

The street-side and the colony type villages of the Area have developed in the southern part where the national road, rail-road, and banana plantations have already been developed. In the central and northern settlement areas where no development progress has been made, the scattered type villages are predominant.

Assuming that each scattered type village encompasses an area having a 1.5 km radius, there are 32 villages in the Area; 10% of the street-side type, 25 % of the colony type, and 65 % of the scattered type.

2.11.3 Public Facilities in Rural Villages

The conditions of the water supply and sewage facilities in the rural villages are described in this section.

1) Conditions of Water Supply Facilities

Deep wells, from 40 to 50 m deep are used as the water source in most colony and street-side type villages. Water pumped up into elevated tanks is distributed to each household.

In scattered type villages, the majority of farm households use water from shallow wells 3 to 5 m deep for drinking purposes. A small number of farm households use rainwater or river water for drinking.

The water in shallow wells less than 3 m deep and located near toilets, household sewers, or livestock pens is mostly contaminated. The water from these wells must be boiled before drinking. Rainwater and river water must also be boiled if it is used for drinking.

2) Conditions of Sewage Facilities

At present, there is no public sewerage installed in the Study Area. In Bataán, however, a sewerage installation plan is progressing under AYA (Instituto Costarricense de Acueductos y Alcantarillados). This plan does not include the construction of a sewage treatment facility. The plan calls for installing sewer pipes only. Sewers will be drained through the pipes into the existing drainage; thus water contamination problems may arise after completing the sewerage.

Even though the area's annual rainfall is high (3,500 mm/year), it is not known whether or not the rainwater will be able to dilute the sewage to a safe level. It will be necessary, therefore, to observe the water quality periodically.

2.12 Social Infrastructure

2.12.1 Education

There are eleven 6-year primary schools, one middle school and one high school instituted in Bataan under the compulsory education system. The problem they face is a shortage of teachers and teaching equipment and materials. To make up for this shortage, the primary schools are opened to children on two shifts in the morning and afternoon. Moreover, the school attendance rate is as high as 90%.

2.12.2 Public Medical Facilities

Bataán and Matina have public health centers belonging to the Welfare Ministry. Further, Bataán has one mobile medical clinic and one dental clinic, and one free clinic belonging to a social insurance foundation. Additional medical facilities in the Area include three educational and nutritional clinics for babies and small children.

The problem with these medical facilities is a shortage of staff and medical equipment.

2.12.3 Roads

There are four main roads in the Area: Route 32 forming a southern boundary of the Area, and its branches extending to the major towns of Matina, Bataán and Veintiocho Millas. In addition, roads along the railroad extend to the large communities of Sara, Goschen, Santa Marta, Luzon and Cuatro Millas. There are also farm roads near the settlements of Sara, Santa Marta and Bataán. They extend only a short way.

The distances of these roads are shown below.

Route 32	15.7km
Roads with effective width of 6m or more	9.8km
Roads with effective width of 4m or more but less than 6 m	42.5km
Roads with effective width of less than 4m	37.6km
Farm roads	17.2km
Total	122.8km

Out of the roads extending from Route 32 toward the major towns in the Area, two roads cross Rio Barbilla. Both are narrow and use existing bridges of halted railway and are not in good condition. Rio Madre de Dios forming the northern boundary of the Area has three directly crossing points. At Veintiocho Millas, upstream, there is no bridge. At Sara at some distance down from Veintiocho Millas, there is a bridge of a halted railway. It is, however, closed to vehicles. Only the bridge at Goschen downstream of the river can be used to link Perla in the adjacent area.

Since there are only a few bridges crossing large rivers in the Area and the boundaries, and these are in poor condition, people must use Route 32 to reach adjacent areas.

In addition, there are bridges and culverts at points where roads cross small and medium-size rivers and drainage canals. Most of the facilities comprise wooden bridges and concrete pipes. The sectional area of these culverts is so small that they become a bottleneck, and

often cause water to stagnate at the time of flooding.

2.12.4 Public Transportation

National railroad runs almost parallel to Route 32 in the Area. There are three stations at Veintiocho Millas, Bataán and Matina in the Area. There is only one two-way train service every day between San Jose and Limon and two two-way services between Guacimo and Limon. With the development of other transpor-tation means such as bus and trailer truck, the railroad has lost its importance to some degree.

Bus service is available to adjacent areas including Limon and Siquirres and to Goschen and Santa Marta within the Area.

2.12.5 Electricity and Communications

1) Electricity

Electric power is supplied to most residential houses in the Area. Only a small number of farm houses dotted in the depth of Santa Marta, the northwestern part of Cuatro Millas and Goschen are not yet to be supplied with electric power. The work for power distribution for these places is under way.

2) Communications

Automatic telephone service is available in urban areas of Bataan, Matina and Veintiocho Millas and corporate banana plantations. However, only a very small number of households in the rural districts have telephones. About the only telephones available in such areas are at grocery stores or the like in each community.