CHAPTER 5 CIRCUMSTANCES OF THE SURVEY AREA

5.1 Outline

5.1.1 Location

The survey area adjacent to Yacyreta Dam is located at 27°10' - 27°20' south latitude and 56°25' - 57°10' west longitude, where is swampy zone along the right bank of Parana River about 300km far from Asuncion, capital city of Paraguay, toward the south east.

The survey area is the verge of southeastern part of about 1,500,000 ha vast bog located at southwestern Paraguay where Parana River joins Paraguay River.

This area, in administrative division, stretches over both part of southwestern Itapua department and southern Misiones department throughout San Cosme y Damián of its east end into River Yabebyry of its west end and throughout santiago de las Misiones of its north end into Parana River of its south end, and it is about 150,000 ha wide area extending about 30km in latitudinal length and about 80km in langitudinal length.

5.1.2 Social factor

Comparing population density between Itapua and Misiones department, Itapua department has 15.2 person/km^2 and Misiones department has 10.1 person/km^2.

Villages and towns surrounding the survey area are San Cosme y Damián, Santiago de las Missiones, Ayolas and Yabebyry ets, which have a population of 3,000 - 5,000 each around where is dotted with farmers.

There is only one commercial city around this area, Encarnacion (44,500 population as of 1982, the third population of paraguay), capital of Itapua department, about 160km for away.

For transportation from Capital Asuncion to this area, national road route 1 (Asphalt ic pavement 7m width) is available as far as Encarnacion and then access road as construction road of Yacyreta Public Corporation from km.260 on the national road to Ayolas has completed (305km far away from Asuncion).

For airport falility, 1,850m long runaway of asphalt pavement was already completed for construction of Yacyreta Dam and it is controled by the army. But regular air service is not yet open as there is no gas station.

5.1.3 Circumstances around Yacyreta Dam site

Yacyreta island and the local office of Yacyreta Public Corporation and its neighborhood are controlled by the army, besides, traffic is restricted, passersby are checked and some areas need a pass of the army in advance, because Parana River, international river between Paraguay and Argentina, is cut off to construct dam.

Some facilities for dam construction are being constructed around Ayolas office of Yacyreta Public Corporation. There are housings for staff and the persons concerned with the construction, clinic, gymnasium, pool, soccer fields, tennis fields and community center etc. Besides, Water supply and drainage are already prepared and electric current is also supplied by an independent power plant from 8.00 in the morning to 12.00 in the night. Moreover, there are some supermarkets and gas stations, and they form an urban district. The local office of Yacyreta Public Corporation is equipped with a wireless installation and telephone facilities, but copy of drawings etc, is not available there.

5.1.4 Topographical Features

The eastern verge and the southen verge of this area

a join hills on which national road route 1 extends. This hill area has uneven ridge between 100 and 150m high and the peak is 180m high. The ground configuration is changed remarkabley at EL 80 - 100m, zone of EL 80m and below forms a flat swamp and the swamp reached the right bank of Parana River at EL 60 - 70m. The south verge along Parana River is a slightly elevated natural embankment. The west verge extends to a flat Neembucu bog. About 95% of central swamp in this area is at EL 60 - 80m, and the central part is the shape of which is just like a plate, is always inundated.

There are 7 inflow rivers into this area, the flowed-in water to the area is stared once at central area and formed inundated zone. The largest outflow rivers from this area are Atinguy River and Yabebyry River, besides, small ones are Yaguary River and artificial drainage canels. All flow into River Parana.

The central inundated zone is divided by gravel road connecting San Ignacio to Yabebyry. As there are some canals at timber bridges connecting the central inundated zone to Neebucu great bog of the west, at present water flows to the west. But occasinally water flows into this zone from the west due to the relation of water level between Paraguay River and Parana River.

An area concerned with this area is about 2,600 km .

5.1.5 Meterological Circumstances and Others

This area belongs to the most rainly zone in Paraguay, and annual mean rainfall is about 1,600mm. Moreover, this area belongs to subtropical climate, annual mean temperature is 21°C, monthly mean temperature of January, the hottest month in a year, is 26°C and monthly mean temperature of June and July, the coldest month in a year, is 16 C.

Kinds of soil texture are Planosols, Regosols and Gleysols.

Soil along Parana River is sandy soil, the farther to the north, the more clayey and at the foot of hills sandy soil turns clayey soil.

For the present condition of land utilization, it is used mostly for pasture except partial uses as paddy field or upland field. Nearly 40% of this area from central part as far as the west verge is always inundated at 1-5m depth and mostly covered with grasses. Therefore, this area is not utilized yet for agriculture.

This area is dotted with forests along rivers at slightly elevated places. The total are with forests is about 7,000 ha.

5.2 Farming

5.2.1 Farm

The present farming conditions in the towns and villages of the departments concerned with in survey area is described based on the census in 1981. First, Itapua Department the number of farming families is 30,396 and average farming area per farm is 31 ha. The distribution of farms by the farming class is as follows; the class of 10 - 50 ha occupies 40%, the class 5 - 10 ha occupying 25% and the class 1 - 5 ha with 19%. The above three classes occupy 84%. On the other hand, for area distribution by the farming class, the class of 10 - 50 ha of the mode stratum uses 29% of total agricultural land the class of 50 - 200 ha uses 26%, the class of over 1,000 ha uses 21% of total area. The above three classes occupy 76% of total agricultural land in Itapua Department.

On the other hand, there are 9,147 farming families in Misiones Department, and the average farming area per farm is 72 ha.

In the distribution of farms by farming class, the class of 1 - 5 ha occupies 35%, next, the class of less than 1 ha is 19%, following these, the class of 5 - 10 ha is 18%. The farms of above three classes form 72% of total farming families in Misiones Department. In the area distribution by farming class, however, the upper class of 1,000 ha holds 68% of total area, and the class of 200 - 1,000 ha holds 16%. These two classes possess 84% of the total area of agricultural land in Misiones Department. This differs markedly from Itapua Department in that most of the agricultural land is held by the large farmers.

The number of farmers in the survey area, 5 villages, is 3,867, and the average farming area per farm is 59 ha. In the distribution of farms by farming scale, the class

of 1- 5 ha occupies 26%, the class of 5 - 10 ha is 23%, the class of 10 - 50 occupies 22%. In the area distribution of farming scale, the upper class of over 1,000 ha hold 62% of total area and the large farmers, adding the class of 200 - 1,000 ha with 18%, possess over 80% of total agricultural land.

There are, especially, large farms around Santiago in Misiones Department and Gral Delgando in Itapua. (Table 5-1, 2)

Table 5-1 Number of Farming Families by Farming Scale in The Survey Area

(%)

Department, town and village	Total	Landless	Less than 1 ha	1 - 5	5 - 10	10 - 50	50 - 200	200-1,000	Over 1,00 ha
Itapua	30,396(100)	1	6	19	25	40	8	1	0
Misiones	9,147(100)	2	19	35	18	18	5	2	1
Total	39,543(100)	1	9	23	23	35	7	1	1
Gral Delgado	1,198(100)	2	20	22	34	18	2	1	1
San Cosme	966(100)	0	14	30	25	27	3	1	0
Ayolas	472(100)	2	23	24	12	28	7	3	1
Santiago	711(100)	8	18	22	15	21	8	5	3
Yabebyry	520(100)	-	26	33	13	16	8	3	1
Total	3,867(100)	2	20	26	23	22	4	2	1

Source: Cenco Nacional Agropecuario - 1981 - Paraguary

Table 5-2 Area Distribution by Farming Scale in The Survey Area

(%)

Department, town and village	Total	No landless	Less than 1 ha	1 - 5	5 - 10	10 - 50	50 - 200	200-1,000	Over 1,00 ha
Itapua	933,324(100)	-	0	2	7	29	26	15	21
Misiones	654,859(100)	-	0	1	2	6	7	16	68
Total	1,588,183(100)	-	0	2	5	19	18	15	41
Gral Delgado	46,042(100)	-	0	2	8	9	4	10	67
San Cosme	24,567(100)	-	0	4	8	21	11	21	35
Ayolas	30,506(100)	-	0	1	2	9	9	25	54
Santiago	94,628(100)	-	0	0	1	4	7	16	72
Yabebyry	33,072(100)	-	0	2	2	6	12	23	55
Total	228,815(100)	-	0	1	3	8	8	18	62

Source: Cenco Nacional Agropecuario - 1981 - Paraguay

5.2.2 Cultivated Crops

Annual crops cultivated in Itapua and Misiones Departments are shown in Table 5-3, 5-4. In Itapua Department soybean cultivation occupies the greatest part of agricultural land, 61.8% of the total area in the department, followed by corn of 16.4%, cotton of 8.9%, wheat of 8.3%, cassava of 6.8% and paddy rice of 2.7%. In Misiones Department corn cultivation occupies the greatest position, 26.4% of total agricultural land followed by cotton of 25.6%, paddy rice of 11.6%, soybean of 11.5%, wheat of 10.2% and cassava of 6.6%. These 6 crops are the core of the cultivation in both department.

As for the total cultivated area of annual crops in Paraguay, 25% of total agricultural land for annual crops in Paraguay is part of these two departments, moreover, 21% belongs to Itapua Department. In the cultivated area by annual crops, these two departments perform 67.6% of all paddy rice cultivation, 57.0% of wheat cultivation, 50.6% of soybean cultivation. It is a fact that these two departments are the core of the annual cultivation of crops in Paraguay. In the increase of cultivated area of the main anuual crops mentioned above (except cassava which is mainly for self consumption), the percentage of increase (compared with 1975) is 230% in soybean, 200% in cotton, 190% in wheat, 160% in corn, 130% in paddy rice. On the other hand, the increase in yield, compared to 1975 is 250% in soybean, 210% in wheat, 180% in corn, 170% in cotton, and 110% in paddy rice. The cultivation of soybeans and wheat have particularly increased over the previous 5 years.

In the discussion of the fruit tree as permanent crops, pineapple has a great portion followed by banana and grapefruit. Furthermore, in comparison with fruit cultivation in Paraguay in general, the cultivation of

orange and grapefruit by grafting are excellent in Itapua Department. In Misiones Department the main fruit cultivated is banana followed by pineapple and grapefruit. In the cultivation of orange and grapefruit, seedings are better than grafting.

As for the transition of fruit production, the native varieties of banana have increased the most namely CARADE in banana, CAYENA in pineapple, LISA in pineapple and orange by grafting. (Table 5-5, 6)

Table 5-3 Cropping Area by Crops in Itapua and Misiones Departments

(1,000 ha, %)

Crop	Paraguay	Departments concerned related to development			Ratio to the country
		Itapua	Misiones	Total	
Garlic	0.7(0)	0.3(0.1)	0.0(0)	0.3(0.1)	42.9
Alfalfa	4.7(0.3)	0.7(0.2)	0.2(0.3)	0.9(0.2)	19.1
Cotton	312.5(19.5)	28.1(8.9)	18.3(25.6)	46.4(11.9)	14.8
Pea	4.1(0.3)	0.4(0.1)	0.1(0.1)	0.5(0.1)	12.2
Paddy rice	22.0(1.4)	8.6(2.7)	8.3(11.6)	16.9(4.3)	76.8
Upland rice	8.1(0.5)	0.8(0.3)	0.4(0.6)	1.2(0.3)	14.8
Sweet potato	14.1(0.9)	1.0(0.3)	0.7(1.0)	1.7(0.4)	12.1
Sugar cane	35.5(2.2)	2.1(0.7)	1.7(2.3)	3.8(1.0)	10.8
Onion	4.0(0.2)	0.4(0.1)	0.1(0.1)	0.5(0.1)	12.5
Miscellanious peas	15.7(1.0)	3.1(1.0)	0.2(0.3)	3.3(0.9)	21.0
Corn	357.7(22.0)	52.1(16.4)	18.8(26.3)	70.9(18.2)	20.1
Cassava	126.4(7.9)	21.5(6.8)	4.7(6.6)	26.2(6.7)	20.7
Peanut	23.9(1.5)	1.9(0.6)	0.3(0.4)	2.2(0.6)	9.2
Potato	1.0(0)	0.1(0)	0.0(0)	0.1(0)	10.0
Porot bean	79.1(4.9)	6.0(1.9)	3.5(4.9)	9.5(2.4)	12.0
Soybean	360.3(22.6)	196.1(61.8)	8.2(11.5)	204.3(52.5)	56.7
Sorghum	6.9(0.4)	0.1(0)	0.1(0.2)	0.2(0.1)	2.9
Tobacco	20.5(1.3)	0.4(0.1)	0.2(0.3)	0.6(0.2)	2.9
Castor oil plant	23.5(1.5)	-	0.4(0.6)	0.4(0.1)	1.7
Wheat	52.3(3.3)	26.4(8.3)	7.3(10.2)	33.7(8.7)	64.4
Cropping area total	1,467.6(91.5)	350.1(110.3)	73.5(102.9)	423.6(108.9)	28.9
Are of agricultural land	1,604.2(100.0)	317.4(100.0)	71.4(100.0)	388.8(100.0)	24.2

Source: Encuesta Agropecuario Por Nuesteo

(Note) The copping ratio is obtained by dividing the cropping area with the agricultural land.

Table 5-4 Transition of Cropping Area and Production in Main Crops

(1,000 ha, 1,000t, %)

	Crop	1975			1980			Ratio to in 1975
		Itapua	Misiones	Total	Itapua	Misiones	Total	
Cropping area	Cotton	11.1	5.6	16.7	20.0	13.3	33.3	199.4
	Paddy rice	6.1	7.1	13.2	8.2	8.5	16.7	126.5
	Corn	35.0	11.0	46.0	54.8	18.4	73.2	159.1
	Soybean	85.5	18.6	104.1	232.0	11.0	243.0	233.4
	Wheat	8.4	5.5	13.9	20.8	5.8	26.6	191.4
Yield	Cotton	12.2	5.4	17.6	19.3	10.9	30.21	171.4
	Paddy rice	19.8	15.8	35.6	22.5	16.1	38.6	108.2
	Corn	53.7	13.3	67.0	94.2	25.6	119.8	178.8
	Soybean	124.2	25.4	149.6	361.1	18.2	379.3	254.4
	Wheat	5.7	3.5	9.2	18.8	0.5	19.3	209.8

Source: Encuesta Agropecuario Por Muesteo - 1980 -

Fig. 5-1 Cropping Pattern for Main Crop

According to extension office

Crop	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Amount of Seeding	Yield
Soybean	Weeding Prevention for direase and insect		Harvest							Seeding Weeding		Prevention for direase and insect	kg/ha 60	kg/ha 1,600
Wheat					Seeding Fertilizing		Weeding Prevention for direase and insect			Harvest			120	1,200
Corn			Harvest						Seeding				15 - 20	2,500
Tomato	Prevension for direase and insect		Harvest						Seeding Prevention for direase and insect				0.5	30,000
Melon	Harvest							Seeding	Prevention for direase and insect Transplanting			Harvest	2	100,000
Onion			Seeding Prevention for direase and insect	Transplanting					Harvest				0.5	6,000
Potato	Harvest							Planting Prevention for direase and insect				Harvest	800 1,000	10,000
Green Pepper								Seeding and transplanting	Prevention for direase and insect			Harvest	0.5	8,000
Cassava							Planting Harvest				Prevention for direase and insect		32 2,500	15,000
Cotton	Prevention for direase and insect	Harvest								Seeding Prevention for direase and insect	Fertilizing Weeding		25	1,600
Sunflower	Harvest						Seeding			Prevention for direase and insect		Harvest	7	1,400
Rice	Weeding			Harvest						Seeding Fertilizing		Weeding	120 150	4,500

Table 5-5 Number of Fruit Trees Planted

(1,000 trees, %)

	Paraguay	Department concerned			Ratio to the country
		Itapua	Misiones	Total	
Banana					
ORO	9,069.2	246.9	736.1	983.0	10.8
CARADE	15,238.7	1,295.3	853.4	2,148.7	14.1
Native varieties	711.1	172.8	16.4	189.2	26.6
Grapefruit					
Seeding	853.7	55.0	27.2	82.2	9.6
Grafting	235.2	50.1	2.3	52.4	22.3
Orange					
Seeding	6,900.5	587.2	336.0	932.2	13.4
Grafting	2,326.7	492.6	46.1	538.7	23.2
For juice	104,168.8	34.4	92.8	127.1	0.0
Pineapple					
ABACACHI	44,146.2	1,253.8	90.5	1,344.3	3.0
CAYENA LISA	14,158.0	640.6	115.9	756.5	5.3

Source: Encuesta Agropecuario Por Muesteo - 1979 - MAG

Tabe 5-6 Transition of Fruit Planting

(1,000 trees, %)

	1975			1979			Ratio to the country
	Itapua	Misiones	Total	Itapua	Misiones	Total	
Banana							
ORO	246	722	968	247	736	983	101.5
CARADE	892	615	1,507	1,295	854	2,149	142.6
Native varieties	85	5	90	173	16	189	210.0
Grapefruit							
Seeding	50	25	75	55	27	82	109.3
Grafting	40	2	42	50	2	52	123.8
Orange							
Seeding	566	325	891	587	336	923	103.6
Grafting	458	42	500	493	46	539	107.8
For juice	30	92	122	34	93	127	104.1
Pineapple							
ABACACHI	1,168	67	1,235	1,254	90	1,344	108.8
CAYENA LISA	337	63	400	641	116	757	118.1

Source: Encuesta Agropecuario Por Muesteo

5.2.3 Farming Conditions

The crop cultivation and farm management seen from the standpoint of farming scale are described in this section. The common characteristic in farm management of both departments is that the stock raising for beef cattle is main farm operation by the large-scale farms of over 1,000 ha. The farms also cultivated soybean and wheat by established mechanization system. In Itapua Department middle class farmers with 50 - 1,000 ha mainly cultivates soybean and wheat added stock raising for the economic stability of farm management. In the farms of 50 - 200 ha, the main crops cultivated are soybean and wheat and in the farms of 5 - 50 ha the main crop is cotton instead of soybean and wheat. Stock rasing is hardly ever seen. Petty farmers with 1 - 5 ha cultivate mainly cotton, and corn, cassava are produced for own consumption. There is a big difference in the cultivation system between Itapua and Misiones Department. In Misiones Department, the main farm operation is stock raising of beef cattle even in middle class farms, in which soybean and wheat are hardly ever cultivated. Small farmers with 1 - 50 ha cultivate mainly cotton as a cash crop, and corn, cassava for own consumption.

As mentioned above, in Itapua Department, middle class farmers form the core of agriculture cultivating soybean and wheat mainly in addition to paddy rice, fruit and stock raising. On the other hand in Misiones Department stock raising of beef cattle is the main industry. Differences are seen between large scale and petty farmers.

In contrast, it is a common characteristic that paddy rice cultivation is popular, totally 17,000 ha in both Departments, because of easy water supply from tributaries

of Parana River and flat topographical conditions. Recently paddy rice cropping is introduced by large and middle scale farmers.

Table 5-7 Cropping Ratio by Farming Scale in Single Year Crops and Number of Feeding Cattles

	Cropping area						Number of feeding cattles	
	Cotton	Sugar cane	Soybean	Wheat	Tobacco	Total	Cattle	Pigs
	%	%	%	%	%	%	Heads	Heads
Itapua	(3.6)	(0.2)	(21.7)	(3.6)	(0.0)	(29.1)	(8.6)	(5.5)
Less than 1 ha	11.3	0.3	3.2	0.3	-	15.1	2.0	1.7
1 - 5	20.1	0.5	9.5	0.1	0.1	30.3	2.4	3.2
5 - 10	13.7	0.4	11.9	0.4	0.1	26.5	2.6	4.4
10 - 50	6.7	0.3	15.9	2.4	0.0	25.3	6.7	6.8
50 - 200	1.0	0.1	49.4	6.9	1.0	58.4	19.6	9.1
200 - 1,000	0.2	0.1	21.4	7.3	-	29.0	87.2	11.7
Over 1,000 ha	0.0	0.0	1.0	0.1	-	1.1	1,048.1	11.7
Misiones	(1.4)	(0.1)	(0.3)	(0.1)	(0.0)	(1.9)	(42.8)	(2.7)
Less than 1 ha	7.9	0.5	-	-	-	8.4	4.4	1.3
1 - 5	24.8	0.5	0.1	0.0	0.1	25.5	4.7	2.2
5 - 10	20.7	0.6	0.0	0.0	0.1	21.4	11.8	3.1
10 - 50	8.5	0.3	0.3	0.0	0.0	9.1	20.5	3.7
50 - 200	1.8	0.1	0.1	-	0.0	2.0	71.3	4.3
200 - 1,000	0.2	0.0	0.8	0.3	-	1.3	285.9	4.6
Over 1,000 ha	0.0	0.0	0.2	0.1	-	0.4	1,831.9	5.8
Towns and villages Concerned	(1.9)	(0.1)	(0.1)	(0.1)	(0.0)	(2.2)	(36.3)	(3.3)
Less than 1 ha	-	-	-	-	-	-	-	-
1 - 5	4.9	0.2	-	-	0.0	5.2	4.7	1.2
5 - 10	19.7	1.5	0.0	(0.0)	0.0	21.3	11.4	4.0
10 - 50	9.9	0.7	0.2	-	0.0	10.8	20.2	4.7
50 - 200	1.2	0.0	0.0	-	0.0	1.3	75.1	5.2
200 - 1,000	0.5	0.0	0.5	0.3	-	1.3	281.1	5.6
Over 1,000 ha	0.0	0.0	-	0.0	-	0.1	1,248.2	8.2

Source: Canco Nacional Agropecuario - 1981 - Paraguay

(Note) 1. The cropping ratio is obtained by dividing the classifies by scale for each crop by the total farm area.
2. Number of the feeding cattle is obtained by dividing the total number of cattles by the number of farms classifies by scale.

5.2.4 Production Cost and Profit of Main Crops

Production cost and profit of the main crops are shown in Table 5-8. The production cost of the 6 main crops in both departments are as follows; 105,300 Gs/ha in cotton, 64,000 Gs/ha in cassava, 64,100 Gs/ha in paddy rice, 46,800 Gs/ha in corn 40,900 GS/ha in soybean, 34,100 Gs/ha in wheat.

Net profit per ha is 36,800 Gs in cotton which is the highest followed by cassava and paddy rice, and the profit ratio to the gross profit in wheat is 28.25 which is highest followed by 25.9% of corn, 25.5 of soybean, 25.0% of cassava and paddy rice. In the comparison of the average production cost in Paraguay and in Carmen del Parana (Itapua Department), the production cost in Carmen del Parana is 114,360 Gs which is 1.8 times the average in Paraguay. Excess production cost is due to fertilization, weeding, insecticide, drilling, operation and maintenance. Net profit of paddy rice production is 48,140 Gs which is 2.1 times the average, and the profit ratio to the gross profit is 29.6%. This is due to high yield, of 6,500 kg/ha. (Table 5-9)

The profit of soybean and wheat is 55,000 Gs/ha in soybean and 46,800 Gs/ha in wheat in accordance with the data of verbal investigation in Japanese immigration areas such as Alto parana, Chavez and Fram. (Table 5-10)

Table 5-8 Production Costs and Profits of Main Crops
(Per hectore)

Crop	Yield per ha	Production cost	Net profit	Gross profit	Cost per Kg
(Annual crop)	Kg	1,000 GS	1,000 GS	1,000 GS	GS
1. Soybean (fertilized)	2,000	40.9	14.3	55.2	27.58
2. Corn (semi-mechanized)	3,800	46.8	16.4	63.2	16.64
3. Cotton (fertilized, semi-mechanized)	3,000	105.3	36.8	142.1	47.36
4. Cassava (fertilized)	25t	64.3	22.5	86.8	3,470t
5. Wheat (fertilized Itapua)	1,600	38.2	13.4	51.6	32.25
6. Paddy rise (semi-mechanized)	3,000	64.1	22.4	86.5	28.82
7. Porot bean (fertilized)	900	34.1	11.9	46.0	51.16
8. Garlic (fertilized)	6,000	119.1	41.7	160.8	26.80
9. Peanut (fertilized)	2,000	49.5	17.3	66.8	33.43
10. Potato (fertillzed)	10,000	103.2	36.1	139.3	13.93
11. Sorgum (fertilized)	1,800	40.2	14.1	54.3	30.14
12. Tobacco (fertilized)	1,800	101.4	35.5	136.9	76.08
13. Tomato	60,000	729.2	255.2	984.4	16.40
14. Green pepper	20,000	185.6	65.0	250.6	12.52
15. Onion	5,500	101.0	35.3	136.3	24.80
(Perennial crops)	Bunch				Bunch
Banana (fertilized)	13,600	285.9	100.0	385.9	28.32
	Piece				Piece
Orange (improved)	725,000	1,976.8	691.9	2,668.7	3.68
Grapefruit (fertilized)	650,000	1,129.7	395.4	1,525.2	2.34
Pineapple (fertilized)	50,000	455.3	159.3	614.6	12.29

Source: Cuentas Culturales - 1981-1982 - MAG

Table 5-9 Production Cost and Profit of Paddy Rice (Per ha)

	Native system (Semi-mechanized, no fertilization) Paraguary		Large mechanized system (Mechanized, fertilization) Corman del Parana		
			Expense		
	Expenses	Detail of operation	Machinery rental	Machinery owned	Detail of operation
	GS		GS	GS	
1. Land readjustment	19,015	Cultivation (twice), Crushing (4 times) Leveling,making footpaths Tractor (86 HP), plow, Harrow, Rastra	21,500	18,500	Cultivation (twice), Crushin (4 times) Tracter (110 HP) (Arado, Harrow, Rastra)
2. Field arrangement	-		1,000	1,000	Cleaning irrigation canal
3. Seeding	7,500	Tractor (seeds), seeds 120 Kg	13,800	12,500	Tractor (seedes,harrow, leveles, tiepelle) seeds 120 - 130 Kg (Cica-8)
4. Fertilization	-		14,500	15,500	Base fertilizes Simultaneous work with sowing Additional fertilization 50 Kg (Urea)
5. Weeding	7,600	Weeding by hand	10,600	11,100	Spraying weed removes 2-4-D (first time - 7 l, Second time - 2 l)
6. Water control	7,600		8,000	8,000	Pumping water (machine 4,000, worker 4,000)
7. Eliminating insects	-		5,500	6,500	Spraying insenticide (once)
8. Harvest	16,700	Reaping, Threshing, Packing in bags, Combine 120 bags (used for three years)	20,000	18,200	Reaping, Threshing, Packing in bags, Combine 120 bags (used for three years)
9. Soil analysis	-		1,000	1,000	
10. Others	13,235	Land cost, Management expenses, Interest, etc.	* 22,830	* 22,060	Land cost, Management expenses, Interest, etc.
Total	64,050		118,730	114,360	
(Reference)	Kg		Kg	Kg	
Yield	3,000		6,500	6,500	(6,000 - 7,000)
	GS		GS	GS	
Gross profit	86,467	3,000 x 28.82 GS/Kg	162,500	162,500	6,500 x 25 GS/Kg
Net profit	22,417		44,000	48,140	

(Note) 1. For the native system refer to Cuentes Culturales - 1981/1982 - MAG
2. For large mechanized systems, based on the field survey (1980/1981) by MAG. SEAG production cost is calculated, then other expenses are added.
3. In Garman Del Parana Cica-8 occupies 70% of cropping rice varieties.

Table 5-10 Profits of Soybean and Wheat (Per hectore)

1981 - 1982

Farm No.	Location	Soybean				Wheat			
		Cropping area	Yield	Cost per Kg	Gross profit	Cropping area	Yield	Cost per Kg	Gross profit
		ha	Kg	GS	GS	ha	Kg	GS	GS
1.	Alto Parana	550	2,000	27	54,000	300	1,500	35	52,500
2.	Chavez	330	2,000	26	52,300	330	1,800	30	54,100
3.	Yguazu	200	2,700	26	70,200	170	1,000	30	30,000
4.	Fram	163	1,950	27	52,500	135	1,480	33	48,900
5.	Chavez	160	1,810	25	45,300	160	1,310	31	40,700
6.	Chavez	90	2,010	26	52,300	115	1,100	33	36,200
7.	Fram	53	2,500	27	68,800	50	1,800	33	60,100
8.	Chavez	50	1,800	25	45,000	50	1,740	29	50,500
9.	Chavez	30	2,100	27	57,600	10	1,200	33	39,600
Accumulated average		181	2,080	27	55,100	147	1,470	32	46,800
(Reference) Average in colony									
Chavez (31 farms)		74	1,780	25	44,500	71	1,460	31	45,260
Fram (141 farms)		63	1,630	27	44,000	54	1,260	31	39,200
Alto Perana (228 farms)		62	1,970	25	48,700	22	1,140	33	37,600

(Note) 1. The data by farmhouses are based on the hearing investigation.
2. (In reference) average in colony is calculated in accordance with the data by JICA Encarnacion Branch.
3. Data from Sep. 1981 to Aug. 1982 are applied.
4. Since the average yield in colony is obtained by dividing the sold amount by the cropping area, it has been calculated slightly low.

5.2.5 An Outline of Farming Condition by Verbal Investigation

Farming conditions of the survey area. The outline of the result of verbal investigation in the survey area is as shown in Table 5-11. The Bolf farm as an advanced example of cultivating paddy rice is described as follows, [An outline of the management in Bolf farm] (Located at San Cosme y Danian, Itapua Department).

Mr. Bolf, who was born in Czechoslovakia, started to cultivate paddy rice in Uruguay in 1943.. He has cultivated paddy rice for about forty years, moving to the present location in 1959. His land is approximately 17,000 ha, in which 600 ha is used for paddy rice cultivation, 60 ha for sorghum, and 700 ha for improved posture. The other land is grassland utilized for grazing.

The farm has approximately 13,000 head of beef cattle. The farm also has a grain silo (2,500 tons) and a warehouse. A rice cleaning mill is being operated in Encarnacion.

Normally, the personnel working at the farm is about 40, but this increases to 50 - 60 persons at peak times such as during paddy rice harvesting. (About 80% are employed in cultivating paddy rice).

The facilities for farming consist of an office and storage houses for farm machines and implements and a pumping station which was constructed on the right bank of Parana river in 1962.

One steam engine, three diesel engines and one compact generator were installed in the pumping station, from which the irrigation canal of 3,000m (earth canal) runs up to farm.

Agricultural machinery owned is as follows:

Small tractors	10 (old-fashioned)
Medium tractors	6 (Italian-made)
Large tractors	4 (Argentine-made)
Combine harvester	8

Other machines: Disc harrows, levelers, "tiepellor", etc.

* Furthermore, the farm is planning to purchase large tractors of about 220 PS.

The paddy rice variety planted is mostly Cica-9 of Indieca, which is itself used for seed

The volumn of seeds sown is about 110 kg/ha for granule Cica type and about 130 kg/ha for the Italian large grain type, furthermore the yield of rice in 1982 was 4,000 kg/ha in paddy. According to Mr. Bolf, if the fertilization, weeding and insect elimination in this farm were supervised, it might be possible to yield of 5,000 - 6,000 kg/ha.

Most of the rice produced is sold to a trader in Asuncion at the price of 40 Gs/kg, however, the price of the rice coming from the farm's cleaning plant is 75 Gs/kg. The quality of the rice produced by this farm is higher than that of the rice produced by other farms and it is being sold at a higher price.

A rough estimation of the production cost is 80,000 GS/ha, and supposing all production is sold in Asuncion, the yield of 3,000 kg/ha is necessary to meet the cost of the production. Thus, no profit is realized it yeild is not over 3,000 kg/ha.

The rotation system between the paddy rice and pasture is shown below, its purposes are to obtain high quality pasture and to restore fertility to the earth.

Paddy rice	→ Paddy rice	→ Grazing pasture	→ Grazing pasture	→ Grazing pasture
(1st year)	(2nd year)	(3rd year)	(4th year)	(5th year)

The tilling is performed by large machines, and the fertilizing is done using 150 - 160 kg/ha of base fertilizer consisting of (N. 9: P30: K30). As a test case, 40 - 50 kg/ha of urea is used as an additional fertlizer. Also, elimination for reduems diseases and harmful insects is performed. Approximately 13,000 head of beef cattle are being raised and 2,500 head of beef cattle are sold every year.

General cropping pattern in Itapua and Misiones Department is shown in Fig. 5-2 and it's characteristics are described as follows.

1. Intercropping: Soybean, cassava and cotton are cultivated between corn.
2. Nature method used for corn drying one.
3. Within the farmer's lot, vegetables, fruits (orange, banana, etc.) are cultivated for the farmer's own consumption.

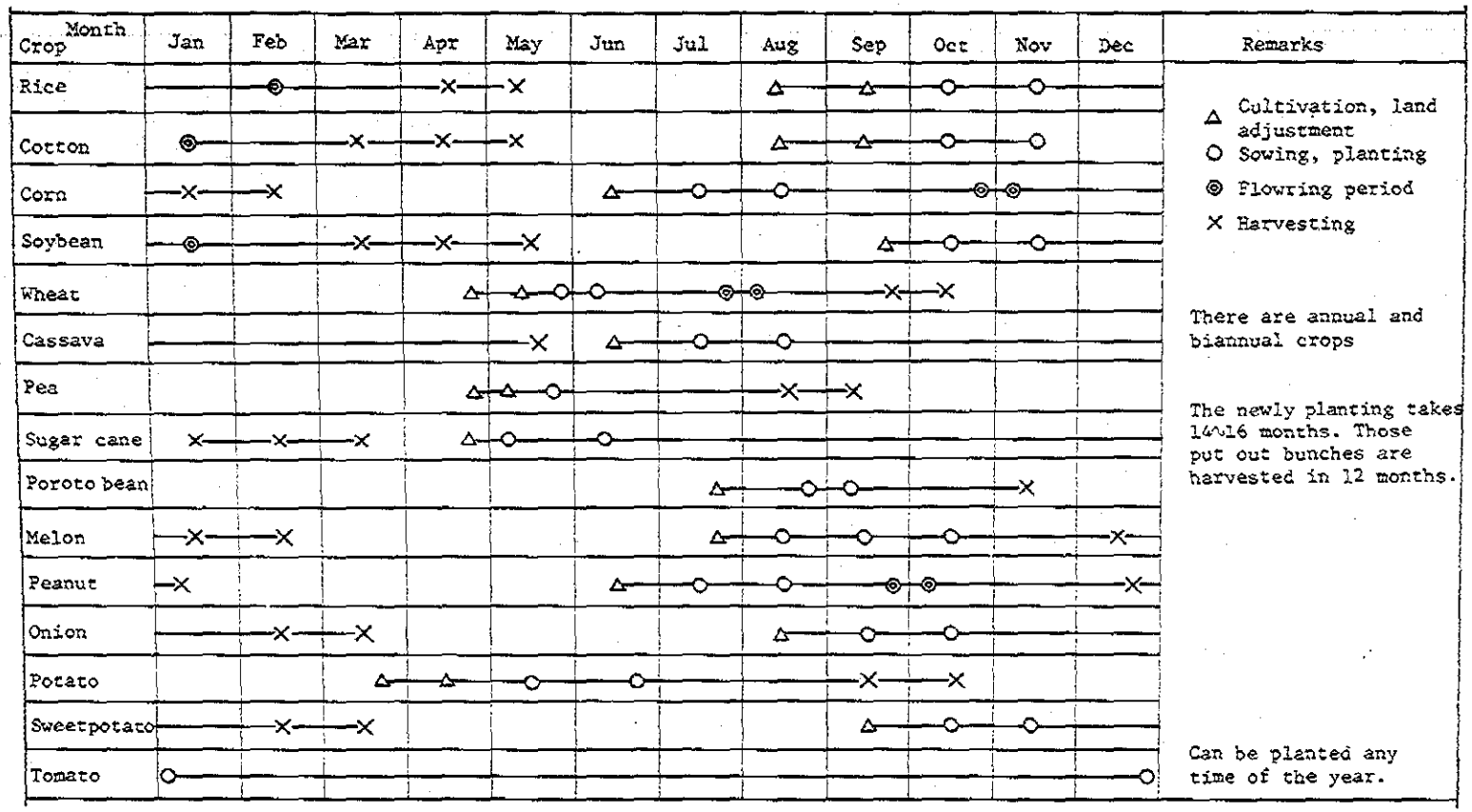


Fig. 5.2 Cropping Pattern in the Survey Area
(Itapua, Misiones Department)

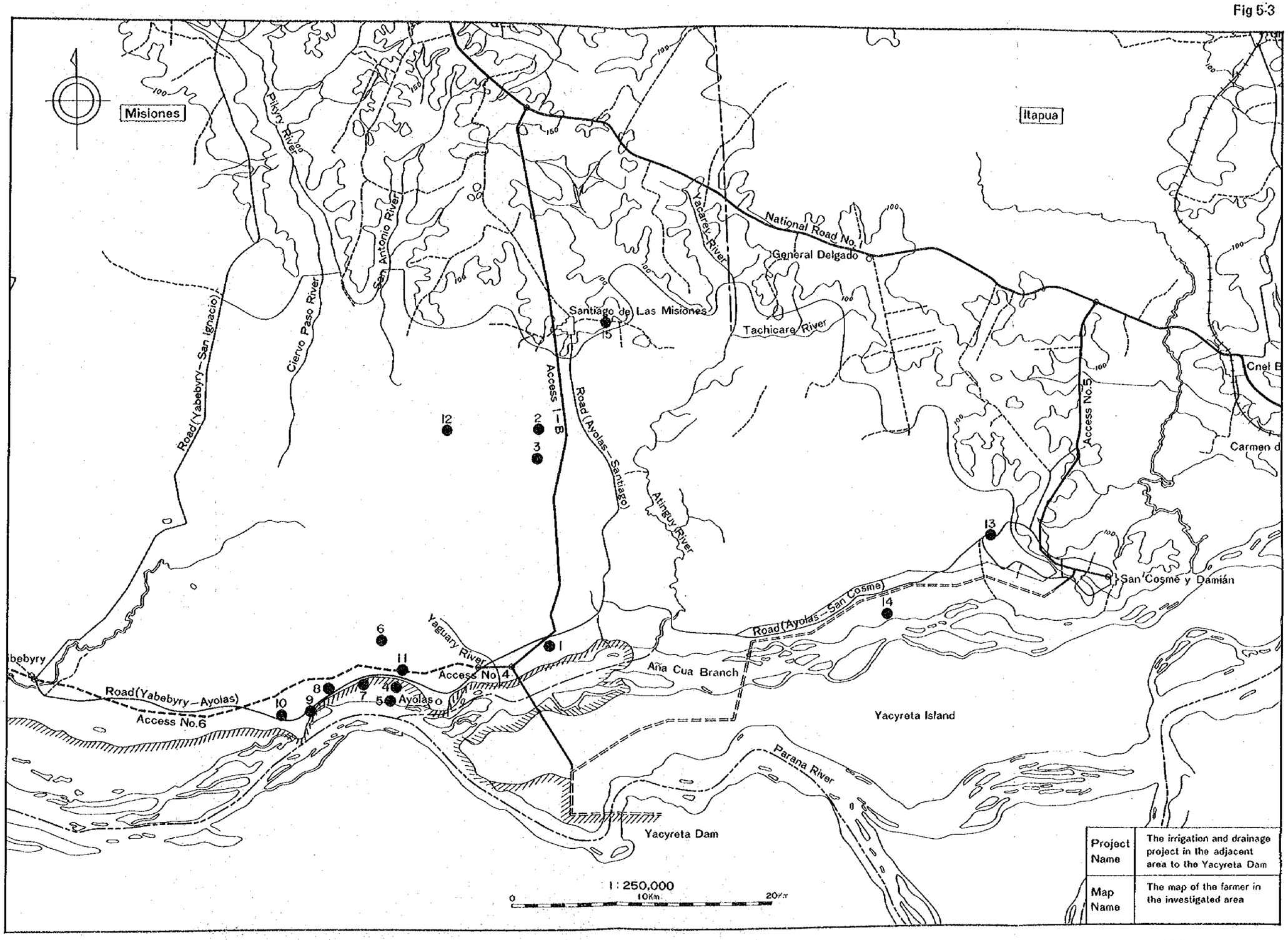

Misiones
Itapua
Pikyry River
San Antonio River
Ciervo Paso River
Road (Yabebyry – San Ignacio)
Yacarey River
National Road No. 1
General Delgado
Santiago de Las Misiones
Tachicare River
Access I – B
Road (Ayolas – Santiago)
Atinguy River
Access No.5
Cnel B
Carmen d
San Cosme y Damián
Road (Ayolas – San Cosme)
Yaguary River
Access No. 4
Aña Cua Branch
Yacyreta Island
Road (Yabebyry – Ayolas)
Access No.6
Ayolas
Parana River
Yacyreta Dam
1 : 250,000
0
10Km
20Km
Project Name
The irrigation and drainage project in the adjacent area to the Yacyreta Dam
Map Name
The map of the farmer in the investigated area

Table 5-11 Out line of Harving Survey Farm Management in the Survey Are

Number	Location	Area of ownership (ha) Agricultural land for cultivation	Pasturage and others	Total	Number of feeding cattles	Crop planting	Gross income from farming	Remarks
					Head, wing	ha	1,000 GS	
1.	San Cosme	600	11,000	17,000	Beef cattle 13,000	Paddy rice 600	149,000	
2.	"	-	8,000	8,000	" 5,000	-	16,000	
3.	Ayolas	-	7,750	7,750	" 1,000 Horse 80 Sheep 120	-	4,000	Old people households
4.	Santiago	10	7,000	7,010	Beef cattle 3,000	Paddy rice 10	9,300	
5.	Ayolas	-	2,200	2,200	" 1,100 Sheep 250	Cassava 35	5,500	
6.	"	6	1,514	1,520	" 700 " 700	Corn 3, red bean 1 Cassava 1	7,000	Partnership (brothers)
7.	"	-	249	249	" 300		1,000	
8.	"	-	220	220	Milk cows 10 (5 gives milk)	-	2,000	
9.	"	8	120	128	Beef cattle 210 Horse 10	Corn 5, Cassava 3	1,200	
10.	"	7	16	23	Beef cattle 10	Corn 2, Cassava 1 Cotton 3, red bean 2	Cotton 180	
11.	"	-	15	15	" 16		-	Public service personnel
12.	"	3	10	13	-	Corn 0.5, Cassava 0.3 Red bean 0.5	-	Fisherman
13.	"	6	1	7	Beef cattle 8	Corn 4, Cassava 1 Red bean 1	-	Store-keepers
14.	"	7	-	7	" 12, Chicken 50	Corn 2, Cassava 1 Cotton 3	Cotton 75	
15.	"	2	-	2	-	Corn 1, Cassava 0.5 Cotton 0.5	Cotton 37	Migration in 6 months ago

(Note) Servey term period: (1982.12.13 - 1983.1.14)

(Reference) Number of farms investigated 15

Livestock	Over 1,000 ha	5	
	50 - 1,000 ha	3	
Stock farming rice	Over 1,000 ha	1	(Bolf Farm)
Cotton (cash crop)	5 - 50 ha	5	
(for his consumption)	Less tan 5 ha	1	

5.3 Land Utilization

5.3.1 Topography

The survey area is located in the southernmost of Paraguay (27° South latitude), and forms the low land along the Parana River flowing in the southern verge of the area.

It is surrounded by the hilly zone of San Cosmey Damián in the east and in the north by the gentle hills around Santiago. In the west the boundary is set by the road connecting Yabebyry to San Juan Bautista.

The area along the Parana River is the gentle flat land with abundant sandy soil, but around the center of the survey area away from the river, the land is lower than the area along the river and the bog expands largely in the east-west direction.

5.3.2 Agricultural land and Pasturage

This region has a topography of very gentle hills as a whole. This topography is classified into five categories in the local society. 1) Alto 2) Bajo 3) Bañado 4) Estero 5) Pantano

Each category has its topographical characteristics, and is considered to be affecting greatly on the vegetation and crop types.

(1) Alto (Hilly area)

This is so-called hilly land, and Alto in this region has gently and greatly undulating eroded valleys, whose wave length is 2-4 km and elevation difference ranges from 20-100 m. The bottom of the undulation often becomes the marsh land. The hilly land from the northern section to the eastern section of the survey area is classified as Alto. The area is well drained and can be made for an attractive agricultural land.

The most part of the agricultural land for cultivation lies in the similar topographical conditions.

(2) Bajo (Low lying land)

This area lies below the hilly land and adjoins the marsh land. It has a gentle slope but not as steep as that in the hilly land. The area is well drained due to this slope, and always dry. The forest land with large diameter trees often lies in this area, and the forest concentration in the survey area is located in this area. It is also suitable for the agricultural land because of its gentle undulation and good drainage.

(3) Bañado (Dry marsh land)

This area is the flat land lying below the low-lying land. Since the very gentle flat land lies extensively, the drainage is not favorable and it is often flooded during rainfalls. In the survey area the considerable portion is classified as this. The flood condition can be eliminated by providing the drain, and it is utilized as the pasturage or the paddy field.

(4) Estero (Low marsh land)

This area has the more extensive flat land than Bañado, and is covered with water all the time. However, the area can become a dry land with a spell of the good weather. The central portion of the survey area falls into this category, and it has water plants such as Piri, Guajo, or Estadana. The condition is unfavorable due to the poor drainage, however, Estero in this region has the sandy soil and is considered to be usable as the agricultural land with the drainage improvement.

(5) Pantano (Bog land)

This area is more wet than the marsh land, and is constantly covered with water and never dries up, therefore, the bottom has accumulated mud. There is very little in the survey area, but this is said to be seen in the piraar region down the Parana River. In addition, the area with further more wet condition is called Laguna (Bog land, Pond).

In the survey area, Bajo (Low lying land), Banado (Dry marsh land) and Estero (Low marsh land) of the above category occupy the most area. The boundary between the dry marsh land and the low marsh land is not clear and always shifting.

Entering from the hilly hinterland lying to the north-east and to the north of the survey area, we can see the transition from the low-lying land to the dry marsh land.

In this region, since the slope is comparatively gentle, the drainage improvement was carried out with excavation of the drain canal 1-2m wide and about 50cm deep.

As far as the pasture is concerned, most are the native species (Natural), and in some farms, improved pasture such as Pangola glass, Setaria, were seen. In addition, as a part of the pasturage some farmers have introduced the rice field. After 2 - 3 rice croping, the land was used for the pasturage again. In this case, in the improved the native species of pasture has been growing without seeding, and the improved pasturage land seems to have more 50% cattle feeding capacity (1 - 1.5 ha/head) compared with the capacity before improvement.

The improved pasturage will decrease the cattle feeding capacity after 3-4 years due to the weed. Then the land will be used for the paddy field again.

The area along the road connecting Ayolas to Yabebyry has the sandy soil, and is well drained. In this area, besides the corps for farmer's are cultivated such as cassava, cotton, corn, consumption barley and wheat.

5.3.3 The marsh land and the bog land

The central portion of the survey area has the water covered area lying in the east-west direction about 10 km away from the Parana River. Around the area crossing the Atinguy River the width is about 5 km, and the width becomes wider as going to the west. Then around the area crossing Yabebyry River the width becomes about 10 km. This is equivalent to the low marsh land (Estero). However, the extent is changing constantly, and affected by the precipitation condition and the weather conditions. At the time of the actual site survey, it was after a spell of the good weather, and the usually water-covered area was in the state of dried-up condition in some cases.

In this region the topography is gentle, and the hydraulic gradient is very little. The precipitation condition in the survey area is not uniform due to the vastness of the area. Therefore, the water seems to flow from the area with greater precipitation to the area with smaller precipitation. Besides, according to the survey from the airplane, the water surface was not clearly identified probably because of the water plant on the water. However, there were some independent places. Therefore, the water in this area can be considered to be diminished due to the evaporating action by the strong sun and the water plant rather than flowing out.

5.3.4. Land ownership

In the survey area, the hearing survey from farmers was conducted for the purpose of grasping the outline of the area. The total area owned by the farmer surveyed this time reached 111,000 ha. This is equivalent to approximately 70% of the total survey area.

Farmers surveyed this time are in many cases comparatively large farmers. This survey result is not necessarily indicating the actual land ownership conditionin the area, however, the condition that 96% of the area is owned by the large land owners of more than 1,000 ha, corresponds with the delay of the efficient land use because in this area the pasturage has great acreage due to the extensive marsh land in the area.

There are many residents not surveyed this time along the Parana River, and there seems to be many illegal settlers among them. This may require a further investigation.

Table 5-12 Land ownership by farming scale (1981)

	Paraguay		Itapua Department		Misiones Department		The survey area		
	Area (1,000 ha)	%	Area (1,000 ha)	%	Area (1,000 ha)	%	Area (1,000 ha)	%	Number of farmers
Less than 1 ha	18.9	0.1	1.2	0.1	1.1	0.2	0	0	0
1 ∿ 5 ha	229.3	1.1	19.8	2.0	9.7	1.5	2	0	1
5 ∿ 10 ha	497.3	2.4	65.5	7.0	12.5	1.9	14	0.1	2
10 ∿ 50 ha	1,439.0	7.0	269.3	28.8	37.0	5.6	51	0	3
50 ∿ 200 ha	1,020.7	5.0	241.0	25.8	45.5	6.8	128	0.1	1
200 ∿ 1,000 ha	1,663.3	8.1	135.6	14.5	102.7	15.7	4,260	3.8	6
More than 1,000 ha	16,665.3	81.5	200.9	21.5	446.3	68.2	107,170	96.0	20
Total	20,425.6	100	933.4	100	654.8	100	111,625	100	33

Remarks: In accordance with 1981 fiscal year census.

The figure for the survey area is based on the hearing from 33 farmers. (January, 1983)

5.4 Meteorology and Hydrology

5.4.1. Meteorological and water level observatories

(1) Existing meteorological observatories

In Encarnacion, San Juan Bantista and Yacyreta Island which are main cities around the survey area, the meteorological observatories were built by department of meteorology, Ministry of National Defence and they are controlled and obserbed by stuff of this agency. In addition, Yacyreta Public Corporation set up 5 more meteorological observatories in Santa Rosa, Ayolas (both Misiones department), Gral Delgado, San Cosmc y Damián, Carmen del Parana (three above Itapuá department) in Jun. 1981, and the observation is being carried out by local people entrusted by the department of meteorology, Ministry of National Defence. The locations of these 8 meteorological observatories are shown in Fig. 5-3. Moreover, the result of the on-site investigation on observation instruments in each meteorological observatory is shown in Tab. 5-13.

(2) Newly set up meteorological observatories

The existing meteorological observatories are located in southwestern part of the survey area and encicle the area.

Considering that there are not instruments for meteorological observation except pluviometer in Yabebry Station and water gauge will be newly installed there, a new meteorological observation instrument is installed for this investigation in Yabebry Station. Therefore, it was made possible to connect meteorological observatories with network.

Observation instruments consist of pluviograph, evaporimeter, sunshine recorder, windvane and anemometer.

Moreover, pluviograph was set up near where water gauge installed (say later), too.
Fig. 5-3 shows locations of these newly established meteorological observatories. However, the newly set up meteorological observation instruments are being managed by Ayolas office of Yacyreta Public Corporation.

(3) Existing water level observation station
There are 4 recording water gauges set up by Yacyreta Public Corporation around the survey area, however, there is only one recording water gauge to us for our survey in River Atingury (at the bridge over this river along a road connecting Ayolas to San Cosme y Damian).

(4) Newly set up water level observatory
Large part of this survey area is located in Neembuch bog. Therefore, newly 3 recording water gauges will be installed, one each in Pickury River (pluviometer is also installed) and Yacarey River (Pluviometer is also installed) which both are inflow rivers to Neembuch bog and last one in Yabebyry River which is outflow river[1/] from Neembuch bog to Parana River, as it is necessary to analyze water balance of survey area for making this development plan.
Moreover, the survey area is divided into 3 parts by access road starting from a middle point between San Ignacio and Delgado along national road No. 1 and road connecting San Ignacio to Yabebyry.
Along two roads said above, some bridges and box culverts are built and they work as connection pipes, therefore water levels of three divided bog can be observed to rise and fall linked together.

1/ : Relatively big rivers among outflow rivers from Neembuch bog in the survey area to Parana River are Yabebyri River and Atingury River. As recording water gauge was already installed in Atingury River by Yacyreta Public Corporation, water gauge will be installed in River Yabebyry only.
Therefore, in order to observe fluctuation of water level and flow direction of bog and collect data for analysis of water balance in the survey area, newly 8 graduated water gauge were installed, three along access road and five along road connecting San Iguacis to Yabebyry. Ayolas office of Yacyreta Public Corporation is observing with these instruments, however, useful data is not yet collected so far as the instruments were just installed recently. In any case, they will bring about a lot useful data for future investigation.
Fig. 5-3 shows locations of recording water gauges and graduated water gauges.

5.4.2 Collection of existing data of meteorology and hydrology.

Meteorological station of the department of meteorology, Ministry of National Defence meteolorogical observation of Paraguay. Data collected by each meteorological observatory are sent to the head quater of the department of meteorology, Ministry of National Defence, where they are arranged by hand and taken charge of in each meteorological observatory.

Therefore, it takes long time to arrange data. Moreover, our data collection of meteorological observatories in Encarnacion, San Juan Bautista and Yacyreta have

been stopped since 1980 because data have not been arranged from 1980 on. 1/ Data of meteorological observatories in Santa Rosa, Gnal Delgado, Carmen del Parana, San Cosme y Damián and Ayolas which were recently set up have been arranged by Yacyreta Public Corporation. Accordingly, data from Jun. 1981 (starting observation) to Jul. 1982 could be collected.

Meteorological data collected in this investigation are shown in Tab. 5-14 with every meteorological observatories.

1/ : Data collected in each meteorological observatories are once sent to the department of meteorology, Ministry of National Defence, the head office of which forwards this data to Yacyreta Public Corporation, where they are arranged. Finally, the arranged data are sent back to the department of meteorology, where they are taken charge of.

As mentioned in (1), data observed in three meteorological observatories under the direct control of the department of meteorology, Ministry of National Defence can be regarded as the existing data around the survey area.

Linking these three observatories, nearly all the survey area can be covered.

Moreover, observation is being carried out continuously for more than 20 years in these three observatories. Among them, meteorological observatory in Encarnacion is the most important in order to seize meteorological character of the survey area for reasons below.

1) This observatory is located nearest the survey area
2) The observated data seem the representative amounts in the right bank of Parana River

3) Observation term is more than 40 years.

4) Observation system is excellent and observation items were filled up.

For future investigation, however, it is necessary to collect meteorological data observed in meteorological observatories set up by Yacyreta Public Corporation and meteorological observation set up for this investigation, and to make an effort to seize meteorological character of the survey area by making clear quantitatively correlation among meteorological phenomena of Encarnacion, San Juan Bautista and Yacyreta.

(2) Collection of hydrological data

i) Water level record

Water level observation of Atingury River is carried out by local people entrusted by the department of meteorology, Ministry of National Defence of the Pentagon. The observer checks up and maintains regularly (at every noon) and confirm the working condition of instruments. Water level records of Atingury River from Aug. 1981 to Oct. 1982 were obtained from Yacyreta Public Corporation.

ii) Flow discharge record

Flow discharge record and H-Q curve of Atingury River were obtained from Yacyreta Public Corporation (see Fig. 5-4)

Moreover, flow discharge observations were carried out 4 times in Atingury River and 2 times in Yabebyry River during this investigation (see Tab. 5-15)

(3) Meteorological phenomena

Paraguay belong to subtropical zone, and has continental climate because it is a landlocked country.

A year is divided generally into summer season and winter season, meanwhile, there are short spring seasons and autumn.

Spring:	Sep. ∿ Oct.	2 months
Summer:	Nov. ∿ Mar.	5 months
Autumn:	Apr. ∿ May	2 months
Winter:	Jun. ∿ Aug.	3 months

i) Temperature

Tab. 5-16 shows annual mean temperature (maximum, minimum, mean) from 1971 to 1980 (10 years) in meteorological observatories of Encarnacion, San Juan Bantista and Yacyreta (under the department of meteorology, Ministry of National Defence) around the survey area.

For meteorological observatory in Encarnacion, annual mean temperature is 20.7°C, maximum temperature 32.0°C in Jan. and minimum temperature 10.3°C in Jun.

Generally a range of temperature is very wide, for example maximum temperature in summer may be over 40°C and minimum temperature in winter may be under 0°C. Moreover, even maximum temperature in winter may be over 30°C. (see Tab. 5-17)

ii) Humidity

Tab. 5-16 shows monthly mean humidity in meteorological observatories of Encarnacion, San Juan Bautista and Yacyreta from 1971 to 1980 (10 years). Himidity of meteorological observatory in Encarnacion is in the range between 73∿83%. Generally humidity in summer is rather low, 73∿80% and humidity in winter is rather high, 79∿

82%. For annual tendency, humidity is the lowest in November when summer starts and gradually gets higher. Through June into July, humidity reaches point, after that gradually get lower.

iii) Evaporation

Tab. 5-16 shows monthly mean evaporation in meteorological observatories of Encarnacion and Sun Juan Bantista from 1971 to 1980 (10 years).
Evaporation in meteorological observatory is the largest, 3.2 ∿ 3.6 mm/day through November into January.
Maximum evaporation in a year is 3.6 mm/day (111.1 mm/month) in December and minimum one is 1.7 mm/day (51.5 mm/day) in June.
Annual total evaporation is 852.9 mm/year, which is a half of annual precipitation.
Such evaporation were observed by balance type evaporimeter, therefore, it is necessary to attend to the observed values with instrument screen.
In Encarnacion, large type evaporimeter (diameter 1.2 m) is set up 50 cm high on the ground, where an observation have been made since July 1981.
Tab. 5-18 shows the observed values of evaporation by balance type evaporimeter and large type evaporimeter in Encarnacion from Aug. 1981 to Dec. 1982.
According to this Fig., it is obvious that evaporation by large type evaporimeter is two and half times as much as one by balance type evaporimeter is two and a half times as much as one by balance type evaporimeter.
Anyway, it is necessary to collect more data because observation term is very short and data

is few so far.

iv) Rainfall

Tab. 5-19 shows month rainfall in Encarnacion, San Juan Bautista and Yacyreta from 1971 to 1980 (10 years).

Annual mean rainfall in Encarnacion is about 1,700 mm, and this region belongs to a high rain area. A range of annual rainfall is wide, over 1,000 mm.

Namely, maximum rainfall from 1971 to 1980 is 2,154.2 mm in 1973, and minimum one is 1,098.0 mm in 1978. Besides, it is observed that fluctuations of annual rainfall are sharp as rainy year and little rain year occur one or two year cycles so far.

Regarding distribution of monthly rainfall, it is relatively much in summer and little in winter. Monthly mean number of rainfall days is 8 days/month, and rainfall every month is nearly same amount. Accordingly, this region is in the climatic zone where dry season can not be distinguished from rainy season.

v) Frost

Tab. 5-20 shows monthly mean number of frosting days in Encarnacion, San Juan Bautista and Yacyreta from 1971 to 1980 (10 years).

Generally frost in each meteorological observatory is extremely few, but in Encarnacion, it frosts approximately 6 days through May into September

vi) Duration of sunshine

Tab. 5-20 shows monthly duration of sunshine in Encarnacion, San Juan Bautista and Yacyreta from 1971 to 1980 (10 years).

Annual mean duration of sunshine in Encarnacion is 2,443.4 hours. Regarding distribution of seasonal duration of sunshine, it is much in summer season, 47% (1,154.4 hours) and little in winter season, 21% (517.2 hours).
Moreover, regarding distribution of monthly duration of sunshine, monthly mean duration in summer season is the largest, 230.9 hours/month and one in winter season is the smallest, 172.4 hours/month. Spring (195.1 hours/month) and autumn (190.8 hours/month) can be regarded as the turning season.

vii) Wind direction and wind velocity
Tab. 5-21 shows monthly mean wind velocity in Encarnacion, San Juan Bautista and Yacyreta from 1971 to 1980 (10 years).
Annual mean wind velocity in Encarnacion is 5 knots (approximately 2.6 m/sec), and seasonal fluctuation is a little.
Moreover, mean wind direction in Encarnacion is nearly fixed throughout a year, namely it can be seen that eastwind is the prevailing wind as wind direction of NE or E amount to 40% and next, winddirection of S or SE amount to 24% (see Tab 5-22).

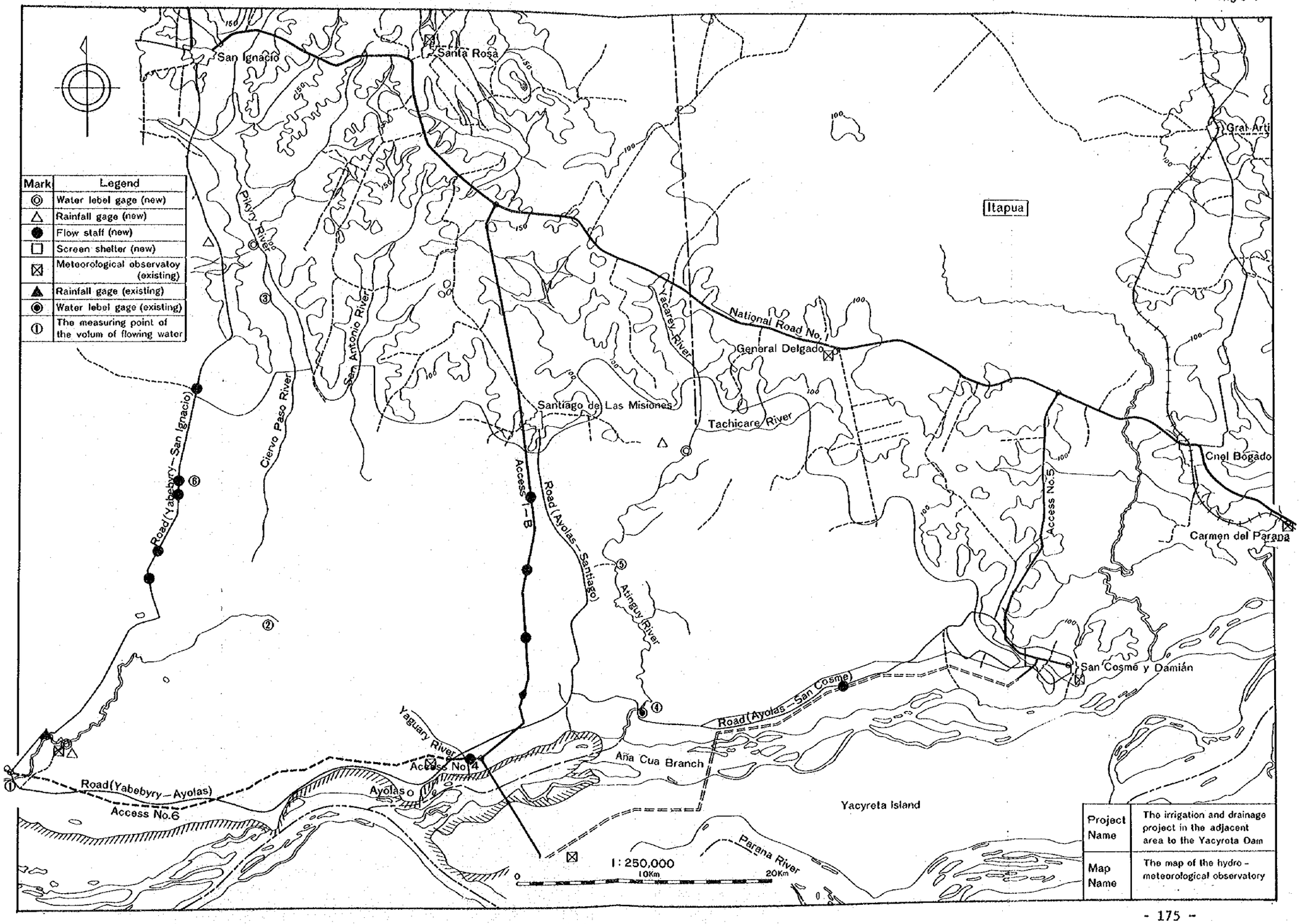
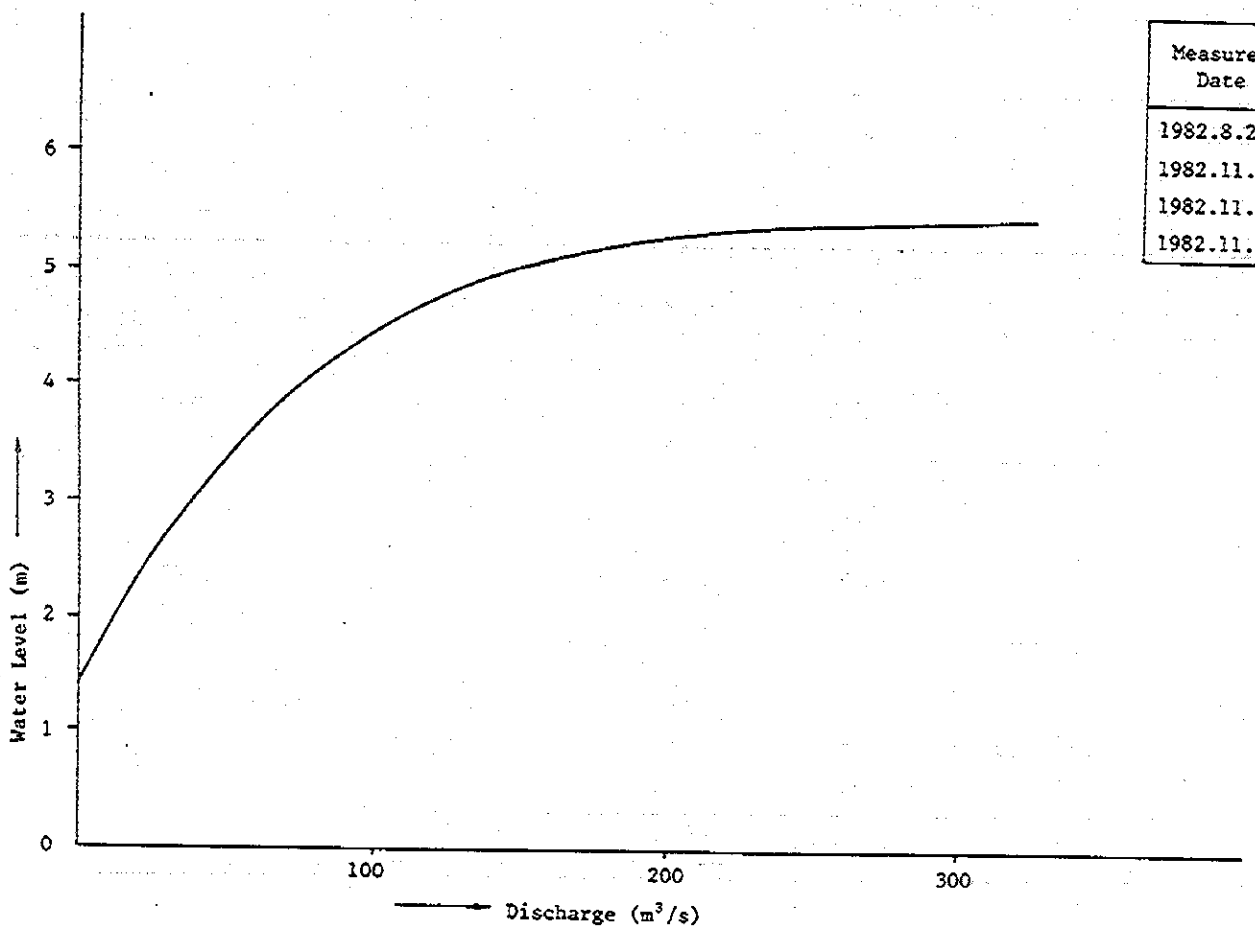

Mark
Legend
Water lebel gage (new)
Rainfall gage (new)
Flow staff (new)
Screen shelter (new)
Meteorological observatoy (existing)
Rainfall gage (existing)
Water lebel gage (existing)
The measuring point of the volum of flowing water
San Ignacio
Santa Rosa
Pikyry River
San Antonio River
Ciervo Paso River
Yacarey River
National Road No. 1
General Delgado
Itapua
Gral. Arti
Santiago de Las Misiones
Tachicare River
Cnel Bogado
Carmen del Parana
Road (Yabebyry – San Ignacio)
Road (Yabebyry – Ayolas)
Access No.6
Access No.1 – B
Road (Ayolas – Santiago)
Atinguy River
Access No.5
San Cosme y Damián
Road (Ayolas – San Cosme)
Yaguary River
Access No.4
Aña Cua Branch
Ayolaso I/o
Yacyreta Island
Parana River
1 : 250,000
0
10Km
20Km
Project Name
The irrigation and drainage project in the adjacent area to the Yacyreta Dam
Map Name
The map of the hydro – meteorological observatory

Table 5-13 List of observation instruments in meterological observatory

Observatory	Rainfall	Temperature·Humidity		Wind	Atmospheric pressure	Evaporation	Duration of sunshine	Remarks
		Max. and min. temperature	Hygrometer					
Encarnacion	Pluviograph (float type)/ cylindrical pluviometer Both equipped	Fuess type thermometer/ thermograph Both equipped	Ventilated hygrometer/ hygrograph Both equipped	Vane anemometer/ Robinson type anemometer Both equipped	Barograph/ mercury barometer Both equipped	Large type evaporimeter/ balance type evaporimeter Both equipped	Campbell-Stockes sunshine recorder	8 times a day, observed
San Juan Bautista	Same as above	Same as above	Same as above	Vane anemometer	Same as above	Balance type evaporimeter	Same as above	8 times a day, observed
Yacyreta	Same as above	Same as above	Same as above	Same as above	Same as above	No observed	No observed	6 times a day, observed
Santa Rosa	Same as above	Fuess type thermometer	Ventilated hygrometer	No observed	No observed	Same as above	Same as above	3 times a day, observed
Gnal. Delgado	Cylindrical pluviometer	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
Carmen del Parana	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
San Cosme y Damián	Pluviograph/ cylindrical pluviometer Both equipped	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
Ayolas	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above

Table 5-14 List of Meteorological Data Collected and Station

Station	Location		Organization	Collected data	Observation Terms	Remarks
Encarnacion	South Latitude West Longitude Elevation	27°19'45" 57°50'55" 91.6m	Meteorological department, Ministry of National Defense	Barometric pressure, Temperature, Humidity, Wind direction, Wind velocity evaporation, Rainfall, Duration of sunshine	1940.1∿1980.12	Except Jan.∿Feb. in 1940
San Juan Bautista	South Latitude West Longitude Elevation	260°40'12" 57°09'06" 125.7m	"	"	1955.7∿1980.12	
Yacyreta	South Latitude West Longitude Elevation	27°24'00" 56°27'00" 86m	"	Barometric pressure, Temperature, Humidity, Wind direction, wind velocity, Rainfall	1963.3∿1980.12	Except Jul.∿Dec. in 1964 Dec. 1967
Santa Rosa	South Latitude West Longitude	26°53'15" 56°50'55"	Yacyreta Public Corporation	Temperature, Humidity, Rainfall	1981.6∿1982.7	
General Delgado	South Latitude West Longitude	27°07'05" 56°23'52"	"	"	"	
Carmen del Parana	South Latitude West Longitude	27°13'38" 56°05'30"	"	"	"	
San Cosme y Damian	South Latitude West Longitude	27°18'59" 56°19'44"	"	"	"	
Ayolas	South Latitude West Longitude	27°23'27" 56°48'22"	"	"	"	



Measured Date	Water Level (m)	Discharge (m^3/s)
1982.8.2	1.36	0.4
1982.11.7	5.24	188.3
1982.11.13	4.30	93.3
1982.11.15	3.96	75.2

Fig. 5-5 Q-H Curve of Atinguy River

Table 5-15 Discharge Measurement

Name of River	Measured Date	Cross Section Area	Velocity of Flow	Discharge	Measuring Method	Measured Place
		m^2	m/s	m^3/s		
Yabebry	1982.12.15	72.4	0.56	40.4	Current-meter	1 in drawing
"	1983.1.21	16.7	0.58	9.7	"	"
"	1983.1-28	19.4	0.50	9.7	Float method	"
"	1983.1.18	3.2	0.81	2.6	"	2 in drawing
Pikyry	1983.1.19	28.6	0.49	14.0	"	3 in drawing
Atinguy	1982.12.15	57.1	0.13	7.5	Current-meter	4 in drawing
"	1983.1.20	2.3	0.20	0.5	Float	5 in drawing
Marsh crossing the San Ignacio ∿ Yabebyry road	1983.1.19	3.0	0.14	0.4	"	6 in drawing

Table 5-16 Monthly Average Temperature, Average Humidity and Evaporation

(Unit: °C, %, mm)

Station	Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Encarnacion	Maximum average temperature	32.0	31.7	30.3	27.0	23.7	21.8	22.6	22.7	25.2	27.4	29.1	31.2	27.1
	Minimum average temperature	20.3	20.1	18.9	14.0	11.9	10.3	11.0	10.9	12.6	14.7	16.2	18.9	15.0
	Average temperature	26.0	25.6	24.1	20.0	17.3	15.7	16.3	16.5	18.7	20.9	22.7	25.1	20.7
	Average humidity	75	79	80	80	83	82	80	79	75	75	73	74	78
	Evaporation	89.5	75.4	72.2	65.4	53.7	45.2	57.1	59.0	77.0	78.0	83.9	96.5	852.9
San Juan Bautista	Maximum average temperature	32.5	32.2	30.8	27.8	24.6	22.8	23.1	23.3	25.6	27.6	29.5	31.7	27.6
	Minimum average temperature	21.3	21.2	19.8	16.3	13.6	11.8	11.9	12.0	14.0	16.1	17.8	20.0	16.3
	Average temperature	26.6	26.2	24.6	21.2	18.3	16.4	16.7	16.9	19.2	21.6	23.3	25.8	21.4
	Average humidity	68	69	72	71	76	76	73	72	67	66	66	66	70
	Evaporation 1/	98.7	79.2	72.9	65.1	58.9	40.7	68.6	71.9	96.6	104.2	113.7	115.0	985.5
Yacyreta	Maximum average temperature	32.2	31.8	30.3	27.0	23.6	21.6	22.1	22.0	24.7	27.0	28.6	31.1	26.8
	Minimum averate temperature	21.0	20.8	19.7	15.5	13.1	11.1	11.3	11.7	13.4	15.7	17.2	19.8	15.9
	Average temperature	26.3	25.9	24.5	20.8	18.0	15.9	16.2	16.6	18.7	21.2	22.9	25.4	21.0
	Average humidity	74	75	77	76	80	80	77	77	72	73	71	72	75
	Evaporation	-	-	-	-	-	-	-	-	-	-	-	-	-

Data of Meterological Department, Ministry of National Defence

Term of statistics: 1971～1980 (10 years)

Notes: 1/ : term in statistics:1971～1974 (4 years)

Table 5-17 Monthly Maximum and Minimum Temperature

(Unit: °C)

Station	Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Encarnacion	Maximum temperature	40.5	39.4	38.2	35.0	33.0	31.0	32.4	33.4	36.0	37.2	36.6	38.4	40.5
	Minimum temperature	11.0	11.6	5.4	2.4	-1.7	-3.8	-3.8	-2.0	0.0	3.0	7.0	8.6	-3.8
San Juan Bautista	Maximum temperature	39.0	39.4	38.6	36.0	34.0	32.2	33.2	34.2	37.2	38.0	37.0	38.4	39.4
	Minimum	13.2	11.0	9.6	6.0	2.0	2.0	0.0	1.2	1.6	6.4	9.2	9.4	0.0
Yacyreta	Maximum	38.9	39.2	38.2	36.8	33.4	31.2	32.0	33.2	36.4	38.4	37.2	40.5	40.5
	Minimum	13.8	12.2	6.8	5.2	-1.0	-1.0	-1.4	1.4	3.0	6.6	9.2	10.7	-1.4

Data of Meterological Department, Ministry of National Defence
Term in statistics: 1971～1980 (10 years)

Table 5-18 Comparison between Evaporations Measured by Balance Type Evaporimeter and Large Type Evaporimeter

Encarnacion

(Unit:mm)

Date	Aug. 81	Sep.	Oct.	Nov.	Dec.	Jan. 82	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Remarks
Large type evaporimeter	115.5	106.5	184.6	170.1	209.5	240.1	150.5	158.3	106.3	91.5	75.1	96.0	108.6	115.7	168.8	153.2	170.8	Total '82 1,634.9mm
Balance type evaporimeter	62.2	45.2	66.8	49.2	62.3	96.5	58.2	57.0	61.2	49.9	29.6	47.0	49.5	51.8	71.0	52.1	71.9	695.7mm
Large type/balance type	1.86	2.36	2.76	3.46	3.36	2.49	2.59	2.78	1.74	1.83	2.54	2.04	2.19	2.23	2.38	2.94	2.38	Average 2.47

Date of Meteorological Department, Ministry of National Defense

Table 5-19 Monthly Rainfall and Days of Rainfall (Average)

(Unit: mm, days)

Station	Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Encarnacion	Rainfall	156.1	137.6	150.7	118.8	144.6	136.5	95.4	125.3	141.4	178.9	140.2	170.1	1,695.6
	Days of rainfall	9	7	8	7	7	8	8	8	7	9	9	8	95
San Juan Bautista	Rainfall	189.5	108.7	164.9	121.4	122.4	109.6	79.4	108.1	91.9	198.9	188.8	160.8	1,644.4
	Days of rainfall	10	7	8	7	7	7	6	7	6	9	8	7	89
Yacyreta	Rainfall	130.8	130.5	131.7	121.7	124.3	129.4	90.5	108.9	107.9	164.0	140.2	135.7	1,515.6
	Days of rainfall	8	6	7	6	6	7	7	7	5	8	8	7	82

Data of Meterological Department, Ministry of National Defence

Term in statistics: 1971 ~ 1980

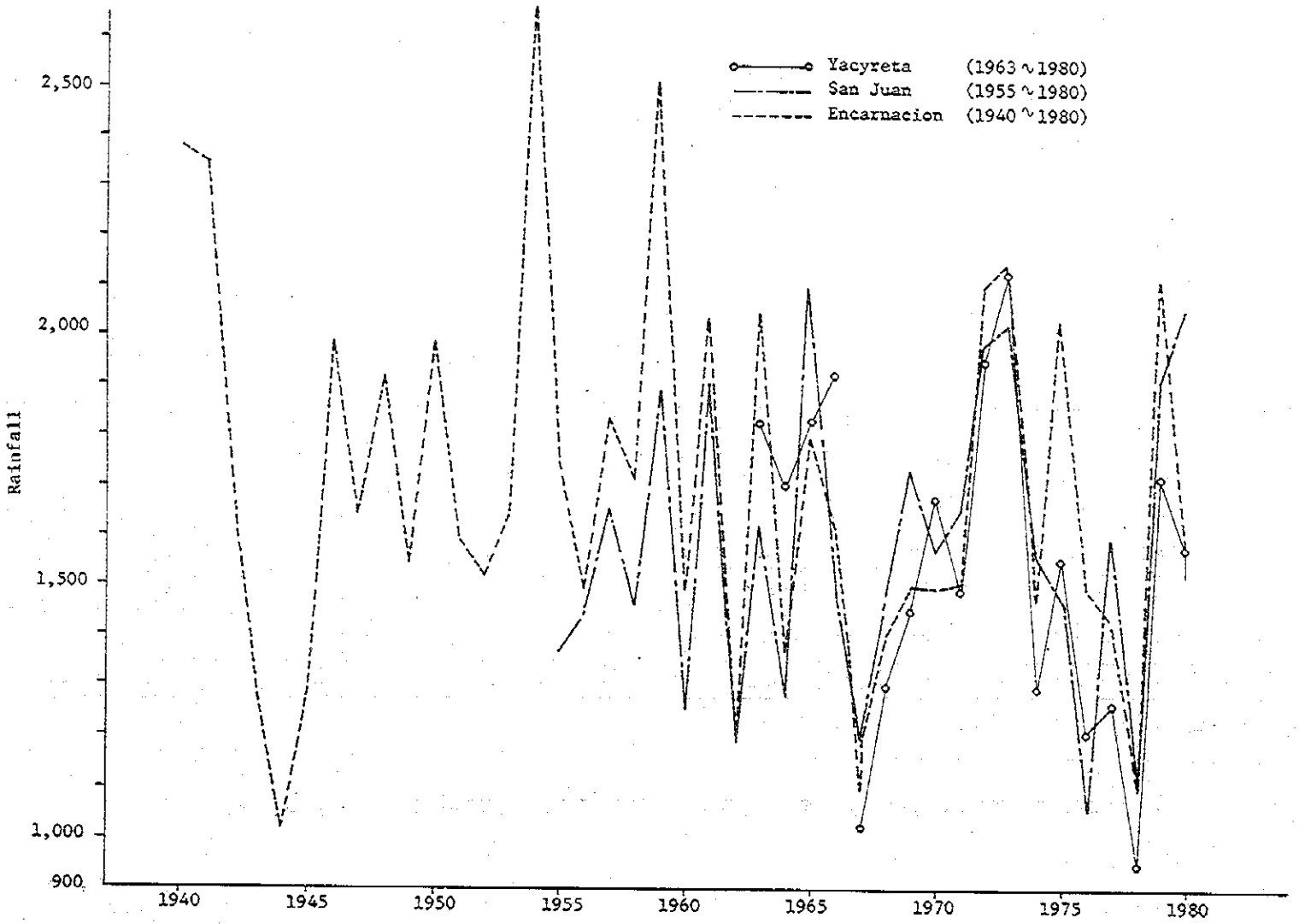


Fig. 5-6 Annual Rainfall

Table 5-20 Duration of Sunshine and Frosting Days (Average)

Station	Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Encarnacion	Duration of sunshine 1/	244.2	241.3	183.1	211.8	169.8	166.6	171.5	179.1	172.8	217.4	219.4	266.4	2,443.4
	Frosting days	0	0	0	0	0.9	2.7	1.6	0.9	0.2	0	0	0	6.3
San Juan Bautista	Duration of sunshine 2/	252.4	222.9	216.2	205.0	190.6	173.9	164.0	173.1	205.5	215.7	248.8	248.6	2,516.7
	Frosting days	0	0	0	0	0.1	0.2	0.4	0	0	0	0	0	0.7
Yacyreta	Duration of sunshine	-	-	-	-	-	-	-	-	-	-	-	-	-
	Frosting days	0	0	0	0	0.1	0.1	1.1	0.1	0	0	0	0	1.4

Data of Meterological Department, Ministry of National Defence

Term in statistics: 1971∿1980 (10 years)

Notes) 1/ : Term in statistics: 1975∿1980 (except 1978 and 1979 because no observed)
2/ : Term in statistics: 1975∿1979 (5 years)

Table 5-21 Monthly Mean Wind Velocity

(unit: Knot)

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Encarnacion	5	5	5	4	4	5	5	5	5	5	6	5	5
San Juan Bautista	5	5	5	5	5	6	6	6	7	7	6	6	6
Yacyreta	6	6	5	5	6	6	7	7	7	7	7	6	6

Data of Meterological Department, Ministry of National Defence

Term in statistics: 1971∿1980

1/ : 1 knot (=0.51 m/sec)

Table 5-22 Monthly Mean Wind Direction

(unit: %)

Wind Direction \ Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
N	7	6	4	3	4	4	5	5	4	2	4	5	4
NE	34	27	23	21	27	29	31	21	26	22	21	26	26
E	15	13	15	16	11	15	12	8	13	15	16	14	14
SE	7	11	11	8	8	8	6	9	13	9	9	12	9
S	11	13	15	15	12	11	12	18	15	20	19	17	15
SW	4	6	5	5	5	4	5	5	6	8	6	6	5
W	2	1	1	1	1	2	2	2	1	1	2	2	2
NW	2	3	2	1	1	1	2	3	1	1	2	2	2
C	18	14	24	30	31	26	25	29	21	22	21	16	23

Data of Meterological Department, Ministry of National Defence

Term in statistics: 1971∿1980 (10 years)

5.5 Irrigation and Drainage

5.5.1 Irrigation

Only paddy fields of the Bolf farm located at the southeastern part of the survey area are comprehensively irrigated. Moreover, there are a few farmers who are introducing irrigation systems on a small scale to paddy fields by stemming small rivers by embankments 2∿3 m high and taking water into small canals through timber water gates. The Bolf farm is cultivating paddy rice every year over an area of 500∿600 ha. A pumping station is set up on the right bank of Parana River, where water is pumped up about 12 m and used for irrigation. The details of the pumping station on the Bolf farm is as follows.

Intake location	Right bank of Parana River nearby San Cosme y Damián		
Construction data:	Completion, December 1962 extension 1982		
Equipments:	Small generator	1	
	Steam engine	1	(fuel: wood)
	Diesel engine	3	
	Pump	4	(Capacity 400 l/sec/pump)

Two of the four pumps are always running during the irrigation period, and the total pumping capacity is 800 l/sec. The pumping height of these pumps is 11.5 m from the water level of Parana River. The pumps run 24 hours a day for 60∿70, and occasionally 90 days in the year. By mean of the 1982 extensions, there is a Bolf farm total of 1,200 ha which can be irrigated as paddy fields on the Bolf farm. The channels from the pump to as far as 50 m point are made of concrete and those beyond 50 m are made of earth.

The total length of the main canals is about 20 km and the canal from the pumping station to the 14 km point is a trapezoid shaped earth canal with the upper end 11 m wide, the lower end 8 m wide, and 1.4 m in depth.

The Bolf farm is introducing a crop rotation system. Accordingly, the total canal length is rather long in comparison with the area of paddy field. The upper part of the farm is irrigated by setting up a secondary pump along the way.

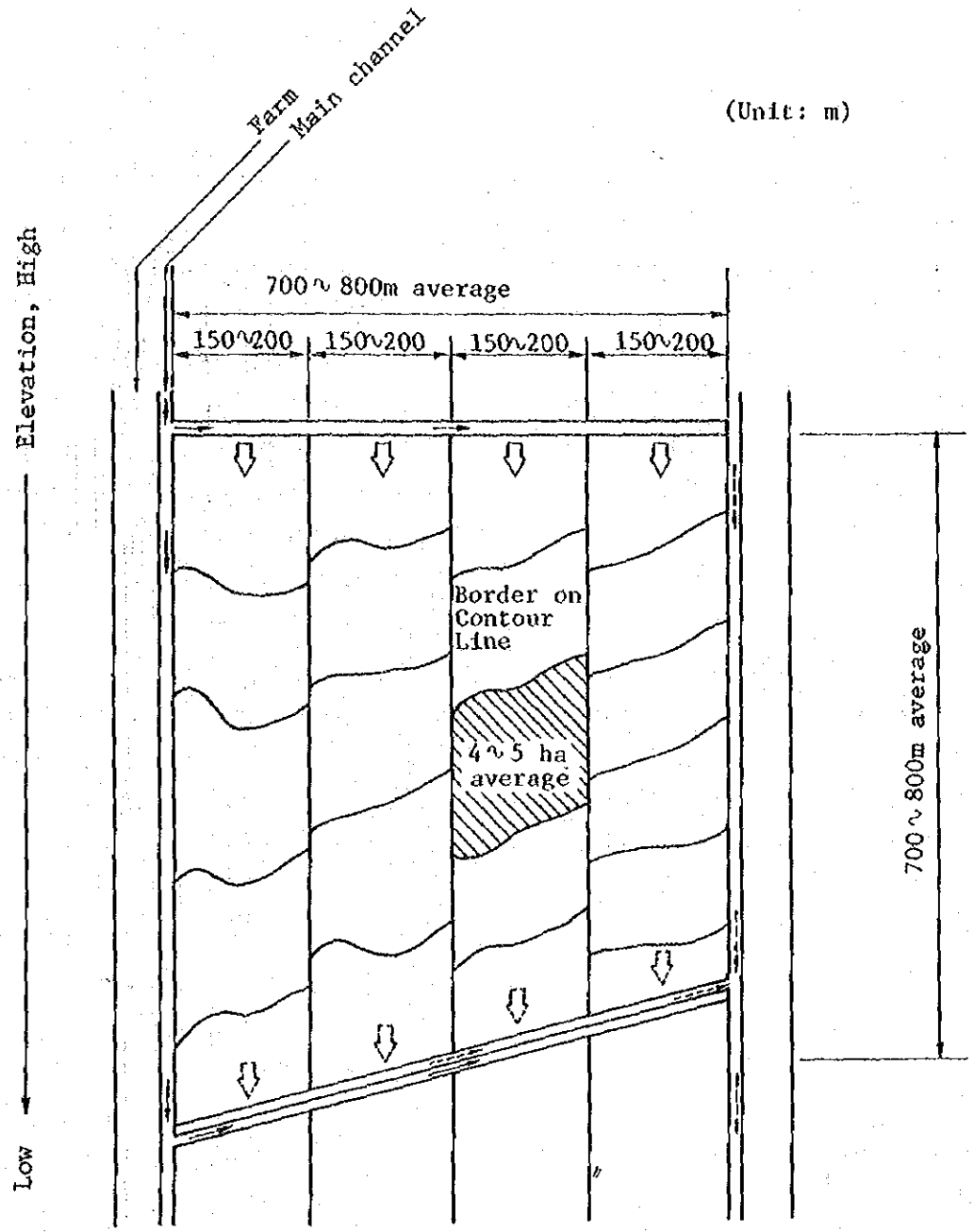
The paddy fields are square-shaped with an area of 800 m × 800 m (64 ha) on average, and there are canals along the roads on the upper parts of the fields. Large blocks of 800 m × 800 m are divided by straight footpaths crossing the contour lines at right angles at 150∿200 m intervals. Moreover, these long fields are divided by footpaths parallel to contour lines at 4∿5 ha unit so that the difference of elevation between the small plots is 4∿8 cm.

After direct sowing on dry paddy field (drill seeding), footpaths are made by a footpath-maker. Footpaths parallel to the contour lines are made by levelling.

In irrigation, water is taken from the main channels and distributed to long plots, by mean of plot to plot irrigation. As there is no intake facility, channels are stemmed by earth moved by bulldozers. Overall water management in this farm is carried out by simple wooden water gates installed with 500 mm diameter concrete pipes at outlets to the outside of the paddy fields.

Fig. 5-7 and Fig. 5-8 show sketchs of the paddy fields on the Bolf farm.

In addition to the water pumped up from Parana River, the Bolf farm is uses water from other small rivers. The irrigation requirement of a paddy field is about 2 ℓ/sec/ha.



* Difference in Height between Paddy Fields, 4∿8 cm.
If calculated using the standard type, the field 'slope' is 0.02∿0.04.

Fig. 5-7 Field Diagram in Bolf Farm

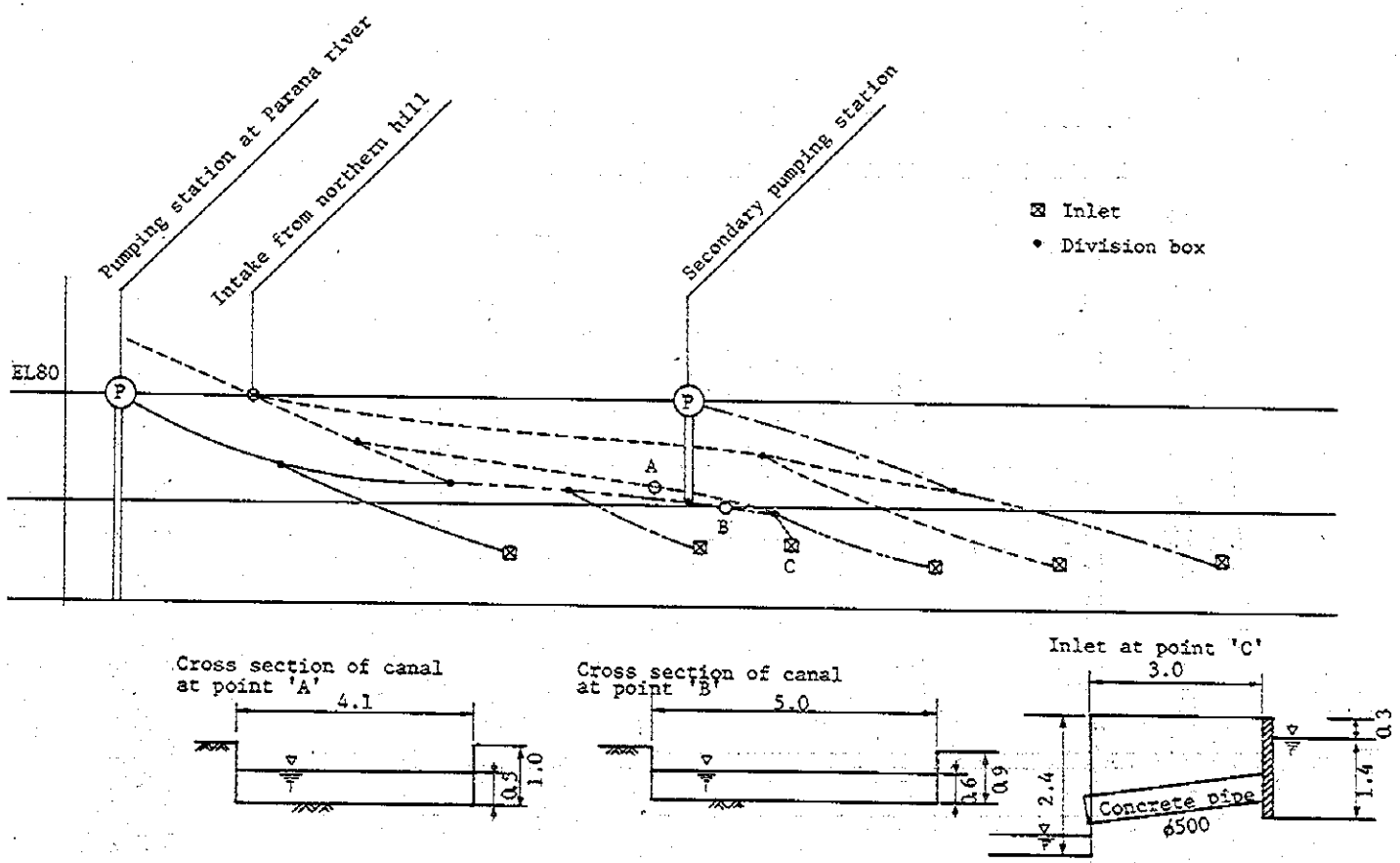


Fig. 5-8 Irrigation and Drainage Diagram in Bolf Farm

5.5.2 River situation

The survey area is broadly divided into a west part and an east part by the access road (1-B) which streches south north through a central part. There are two rivers, the Atinguy River 10 km to the east from the access road and the Yabebyry River 35 km to the west from the access road.

These two rivers are the main drainage rivers of the survey area to Parana River. In addition, there is one samll river, the Yaguary River, in the central area and several artificial drainage canals, which are cut off by a slightly high natural embankment along the Parana River in the eastern area near San Cosme y Damián.

The inflow rivers from the southern hill zone are (in order from the east), the Aúary River, and the Tachicare River which is the upper stream of the Atinguy River, Yacarey River, Yacúguy River, San Antonio River and the Pikyry River. However, most of the rivers disappear on their way from the hill zone to inundated areas to form swamp zones. The flow capabilities of inflow rivers are low in the river channels which spread about 1 km long as far as natural meadows with a water depth of 50∿70 cm.

Drainage rivers from this area are natural rivers which zigzag. The bed slopes of the Yabebyry River and the Atinguy River are 1/2,000∿1/3,000 but they are easily flooded as the slopes become gentle at river mouths and the flow capabilities are low. This area is often damaged by the rising water level of river mouths with the flooding of the Parana River (As most of the catchment area belongs to Brazil, this area is flooded without regard to rainfall in this area), because this area is a flat ground adjacent to Parana River.

The total length of the Yabebyry River is about 60 km, starting from the inundated zone of the central west part of this area, and empties into Parana River. This river is 30 m wide at the timber bridge on the road connecting Ayolas to Yabebyry and 8 m wide at the riverhead at a point 30 km from the timber bridge.

The total length of the Atinguy River is about 30 km, running in the central western part of this area from the north towards the west and emptying into the Parana River. This river is 25 m wide at the timber bridge of the road connecting Ayolas to San Cosmey Danián and 15 m wide at a point 20 km up from the this bridge.

The Pikyry River, which is the largest of the inflow rivers to the area, is 11 m wide, and 2.5 m deep around the inflow point to the inundated zone. Its discharge is 14 m^3/sec. About 1 km wide of this river is always in a flood condition at a depth of 0.5∿0.7 m and flowing at a velocity of 0.1 m/sec.

5.5.3 Present drainage system

The present drainage system of this area is divided into four, artificial drainage lines and Atinguy River line (both of which are on the east of the access road (1-B)), the Yaguary River line of the south side of central area and the the Yabebyry River line occupying most of the east part. However, part of water of the inundated zone of the Yabebyry River line connects with Neembucú bog spreading on the east side through the north-south road connecting San Ignacio to Yabebyry. Presently water flows out to the west side through some small rivulets. But occasionally water may flow into this area due to changes of water levels between the Parana River and the Paraguay River.

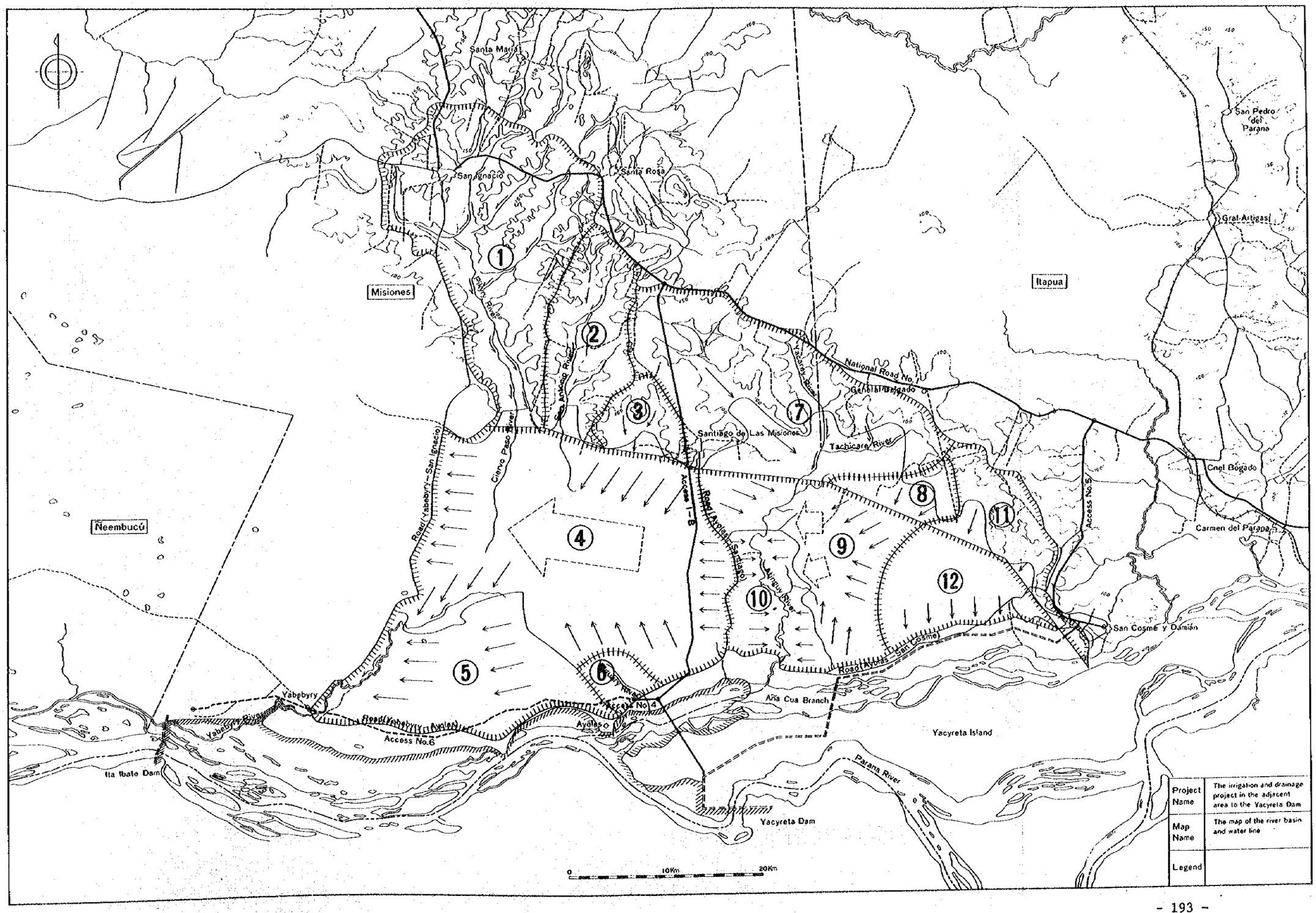

Santa Maria
San Ignacio
Santa Rosa
San Pedro del Parana
Gral Artigas
Misiones
Itapua
Neembucú
Piray Rivers
San Ignacio River
Cierva Paso River
Road (Ybabebyry – San Ignacio)
Access I-B
Road (Ayolas – Santiago)
Uruguay River
National Road No. 1
Gral Bruguez
Tacuara River
Santiago de Las Misiones
Tachicare River
Cnel Bogado
Access No.5
Carmen del Parana
San Cosme y Damián
Road (Ayolas – San Cosme)
Access No.4
Ayolas
Añá Cua Branch
Yacyreta Island
Ybabebyry
Ybabebyry River
Road (Ybabebyry – Ayolas)
Access No.6
Ita Ibate Dam
Parana River
Yacyreta Dam
0
10Km
20Km
Project Name
The irrigation and drainage project in the adjacent area to the Yacyreta Dam
Map Name
The map of the river basin and water line
Legend

Table 5-23 The River Basin Area Record

Drainage line	Rivers	Number	The rivers basin area (mm^2)	Explanation
The Yabebyry River	The Ciervo Paso River The Pikyry River	1	415	The hill areas in San Ignacio
	The San Antonio River	2	153	The hill areas neighboring in the east of No. 1
	The Yacú Guy River	3	59	The hill and Vale areas neighboring in the east of No. 2
	The flooded area	4	631	The flat areas including in the flooded area in the upper Yabebyry river
	The direct flowed area	5	262	The flat areas neighboring in the east of the Yabebyry river
	Sub-total		1,520	
The Yaguary River		6	38	The flat areas in the north of Ayolas
	The Yacarey River The Tachicare River	7	403	The hill areas shut in by access road and route 1
	Artificial Zanja	8	52	The hill areas neighboring No. 1
The Atinguy River	The flooded area	9	227	The flat areas in the upper Atinguy river and the flooded area
	The direct flowed area	10	103	The flat areas in the middle and lower Atinguy river
	Sub-total		785	
Artificial Drainage Line	The Auary River	11	108	The hill areas neighboring No. 1
	The direct flowed area	12	140	The flat areas including in The Bolf Farm
	Sub-total		248	
	Total		2,591	

The total catchment area of rivers related to survey area is an area of 2,690 km^2 and there is watershed around the national road route extending on the hill zone of the north side from the north-west toward the south-west.

Table 5-23 shows the catchment area of each block and the inflow rivers etc. Fig. 5-9 shows the result of flow in the area on the basis of field reconnaisance and verbal reports. It is necessary to observe inflow discharge from the catchment area ④ through a road connecting San Ignacio to Yabebyry, discharge of inflow from catchment area ⑥ to the Parana River and discharge of inflow from ⑫ to the Parana River in detail in future.

5.5.4 Damages due to inundation

This area is badly drained except for a small part. Accordingly, each farm made drainage channels (Zanja, 1∿3 m wide, 0.25∿1.5 m deep) 10∿20 years ago. But their flow capabilities have decreased because no maintenance has been carried out. Gravel, earth or grass fills the channels. Moreover, the field drainage channels are not prepared yet, therefore, drainage water is being discharged into others' meadows. Swamps and the inundated areas are covered with some plants, Guajo (2.5 m high), Piri (1 m high), Estadaná (0.7 m high) etc. and these become causes of ill drainage.

Table 5-24 shows the circumstances of damage due to inundation of this area and investigated by reports from 21 stock farms, Fig. 5-10 shows the location of these 21 stock farms. Circumstances of inundation investigated by the reports, field reconnaisances by jeep or horse, topographic maps (a scale of 1/10,000) Air photographs (taken in 1972 to a scale of 1/20,000) and a light aircraft etc. are shown in Table 5-25, and the location are shown in Fig. 5-10. According to Table 5-25 and Fig. 5-10, an inundated area is 58,000 ha and occupies 30% of whole area.

The inundated area is broadly divided into four blocks, shown in Fig. 5-11. Particularly Block 1 is such an important key to drainage planning that it occupies 25% of the whole area of 66% of the inundated area.

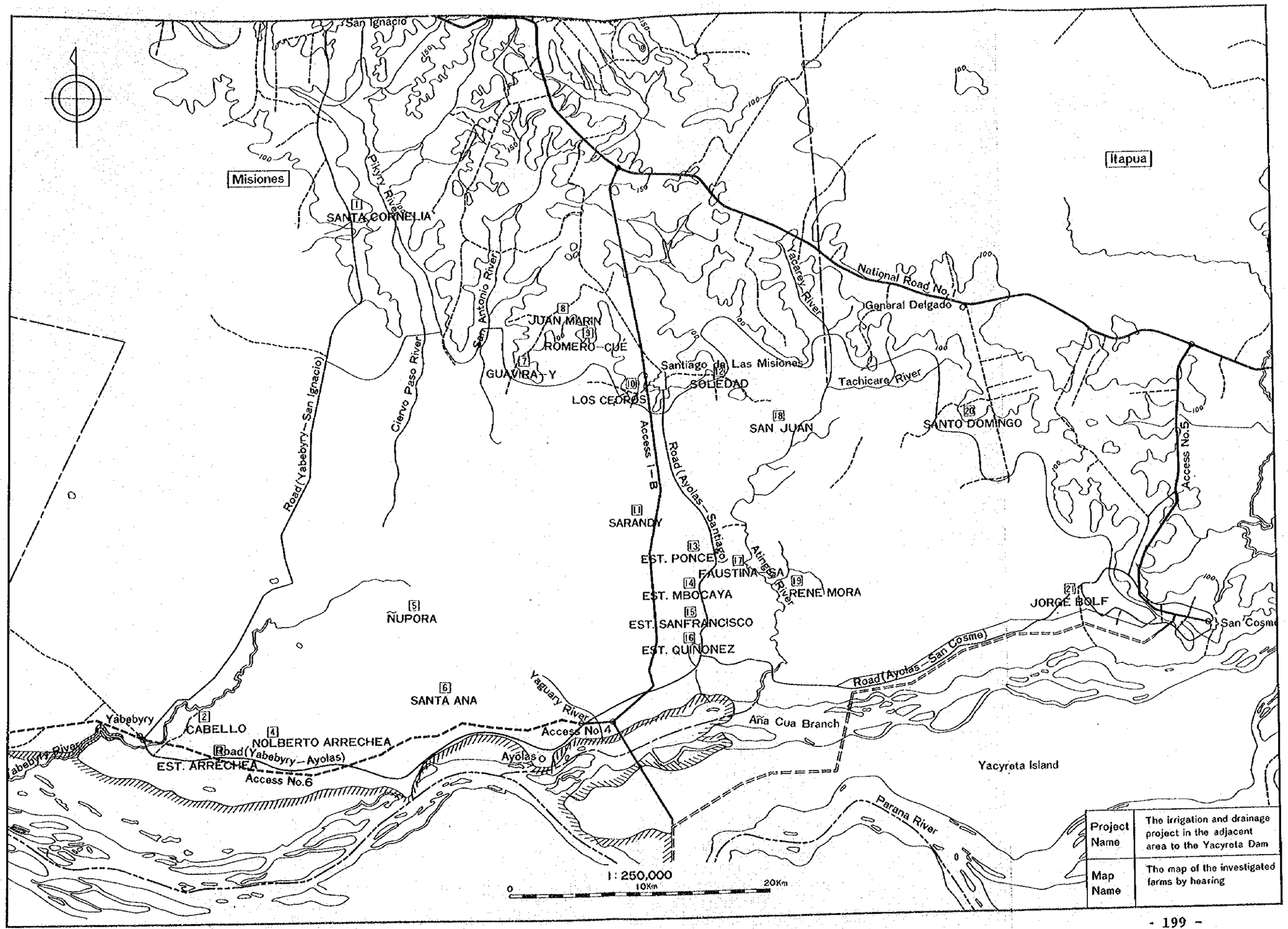
According to the verbal reports from the farms (Table 5-24), the submerged depth is 0.20 m ∿ 2.00 m. And there are some parts so deep that jeeps horses or even boats cannot go in. Moreover, according to the field hearings and photos taken in 1964, the central block 1 in the head stream of the Yabebyry River is over 4 m deep.

Naturally there are restrictions to this survey of the inundated area and depth,and it is necessary to in-investigate in the future in greater detail by helicopters, hovercrafts or mudmobiles.

5.5.5 Factors of ill drainage

38% of the whole area is always inundated and a large part is occationally submerged. According to the field survey, the factors are as follows.

1. There is no catch line of inflow water from neighboring highland.
2. Drainage rivers (Yabebyry River and Atinguy River) zigzag and the slope around the river month is gentle.
3. There is an impermeable layer (20∿30 cm underground through which little water percolates.
4. Drainage channels are not yet ready in the area and water flows naturally.
5. This area is a very flat with the central area being rather low and the Parana River side being rather high.


San Ignacio
Misiones
Itapua
Pikyry River
SANTA CORNELIA
San Antonio River
Ciervo Paso River
JUAN MARIN
ROMERO-CUÉ
GUAVIRA-Y
LOS CEDROS
Santiago de Las Misiones
SOLEDAD
Yacarey River
National Road No.1
General Delgado
Tachicare River
SAN JUAN
SANTO DOMINGO
Access No.5
Road (Yabebyry–San Ignacio)
Access I–B
Road (Ayolas–Santiago)
SARANDY
EST. PONCE
FAUSTINA
Atingasa River
RENE MORA
EST. MBOCAYA
EST. SANFRANCISCO
EST. QUIÑONEZ
JORGE BOLF
San Cosme
ÑUPORA
SANTA ANA
Yaguary River
Road (Ayolas–San Cosme)
Yabebyry
CABELLO
NOLBERTO ARRECHEA
EST. ARRECHEA
Rbad (Yabebyry–Ayolas)
Access No.6
Access No.4
Ayolas
Ana Cua Branch
Yacyreta Island
Parana River
1 : 250,000
0
10Km
20Km
Project Name
The irrigation and drainage project in the adjacent area to the Yacyreta Dam
Map Name
The map of the investigated farms by hearing

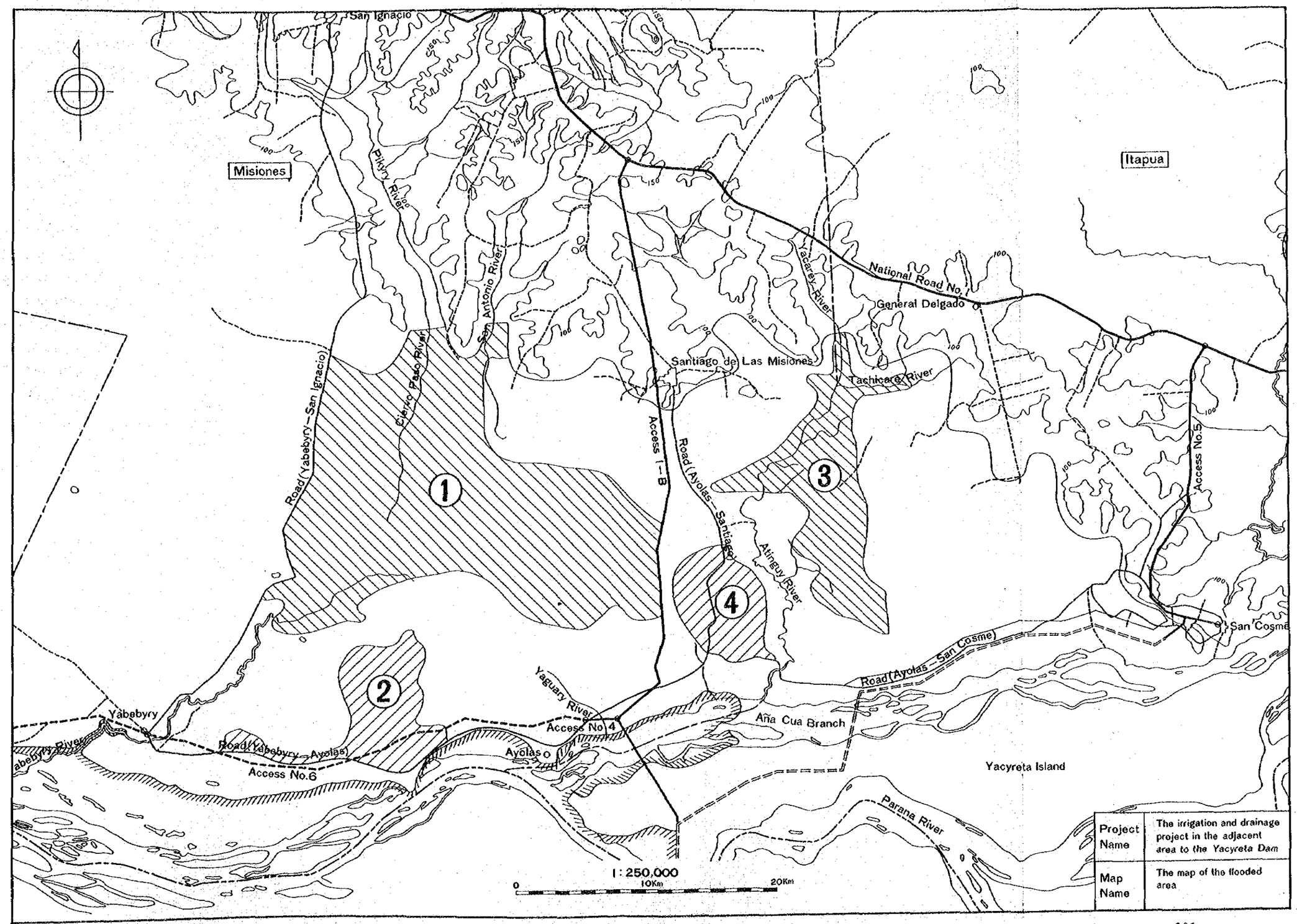

San Ignacio
Misiones
Itapua
Pikyry River
San Antonio River
Yacarey River
National Road No.1
General Delgado
Santiago de Las Misiones
Tachicare River
Access I-B
Road (Yabebyry–San Ignacio)
Cierro Paso River
Road (Ayolas–Santiago)
Atingui River
Access No.5
San Cosme
Road (Ayolas–San Cosme)
Yaguary River
Yabebyry
Yabebyry River
Road (Yabebyry–Ayolas)
Access No.6
Access No.4
Ayolas
Aña Cua Branch
Yacyreta Island
Parana River
①
②
③
④
1:250,000
0
10Km
20Km
Project Name
The irrigation and drainage project in the adjacent area to the Yacyreta Dam
Map Name
The map of the flooded area

Table 5-24 Hearing Record of the Flooding Damage

Name of Farm	Area of Farm	Usual Inundated Area	Depth of flooding	Notes
	ha	ha	m	
1. Santa Cornelia	12,500	8,500	0.25	
2. Cabello	1,800	360	0.50	
3. Est. Arrechea	950	0	-	
4. Nolberto Arrechea	7,000	1,300	0.60∿1.50	
5. Nupora	3,600	1,400	0.60∿2.00	
6. Santa Ana	7,000	1,000	0.50∿1.20	
7. Guavira Y	1,300	200	0.80	
8. Juan Marin	640	0	-	
9. Romero-Cue	8,000	5,000	1.00	
10. Los Cedros	1,400	0	-	
11. Sarandy	800	180	0.75	
12. Soledad	7,000	1,000	0.70	
13. Est. Ponce	600	420	0.80	
14. Est. Mbocaya	2,000	1,600	0.80	
15. Est. San Francisco	800	560	0.80	
16. Est. Quinonez	1,000	600	0.80	
17. Faustina-Sa	10,000	6,000	0.40∿0.45	
18. San Juan	2,000	500	0.70	
19. Rene Mora	3,300	1,300	0.20	
20. Santo Domingo	3,600	0	-	
21. Jorge Bolf	17,000	0	-	
Total	92,290	29,920		

Table 5-25 Record of the Flooding

Unit: (ha)

Total Area		Flooding Water Area		b / a (%)
Western part from access road	86,000	1	39,000	25.3
		2	6,000	3.9
Eastern part from access road	68,000	3	9,000	5.9
		4	4,000	2.6
Total	154,000	Total	58,000	37.7

Note) Total area ia defined in Chapter 6.

5.5.6 Probability

On the basis of meterological data for Enearnacion which was collected, the estimated rainfall, which forms the foundation of drainage plans and the annual maximum daily and yearly precipitation maximum rainfall for a continuous three days (for 41 years from 1940 to 1980) are entered into a probability sheet by means of the wibul plot method. The result is shown in Fig. 5-11. Table 5-26 shows the rainfall probability of the 2 years, 3 years, 5 years, 7 years, 10 years, 15 years and the 20 years, which were read into Fig. 5-11.

Table 5-26 Rainfall Probabilities (1/2 ∿ 1/20)

Item	1/2	1/3	1/5	1/7	1/10	1/15	1/20
Maximum Daily Rainfall in Year (mm.)	107	125	140	155	162	170	180
Maximum Rainfall over three consecutive days in year (mm.)	148	175	200	210	235	260	270

There is a recording water gauge established by Yacyreta Public Corporation in May 1981 at bridge of road connecting Ayolas to San Cosme y Danián, the downstream of Atinguy River. Fig. 5-13 and Table 5-27 show a comparision between the rainfall and the water level on the basis of the water level records and the rainfall data (already obtained up to July 1982) in meterological observatories of Santa Rosa and Gual Delgado. Rainfall in the survey area is supposed to reach the downstream of Atinguy River approximately after 10 days, however a detailed study is necessary to fix such matter in future.

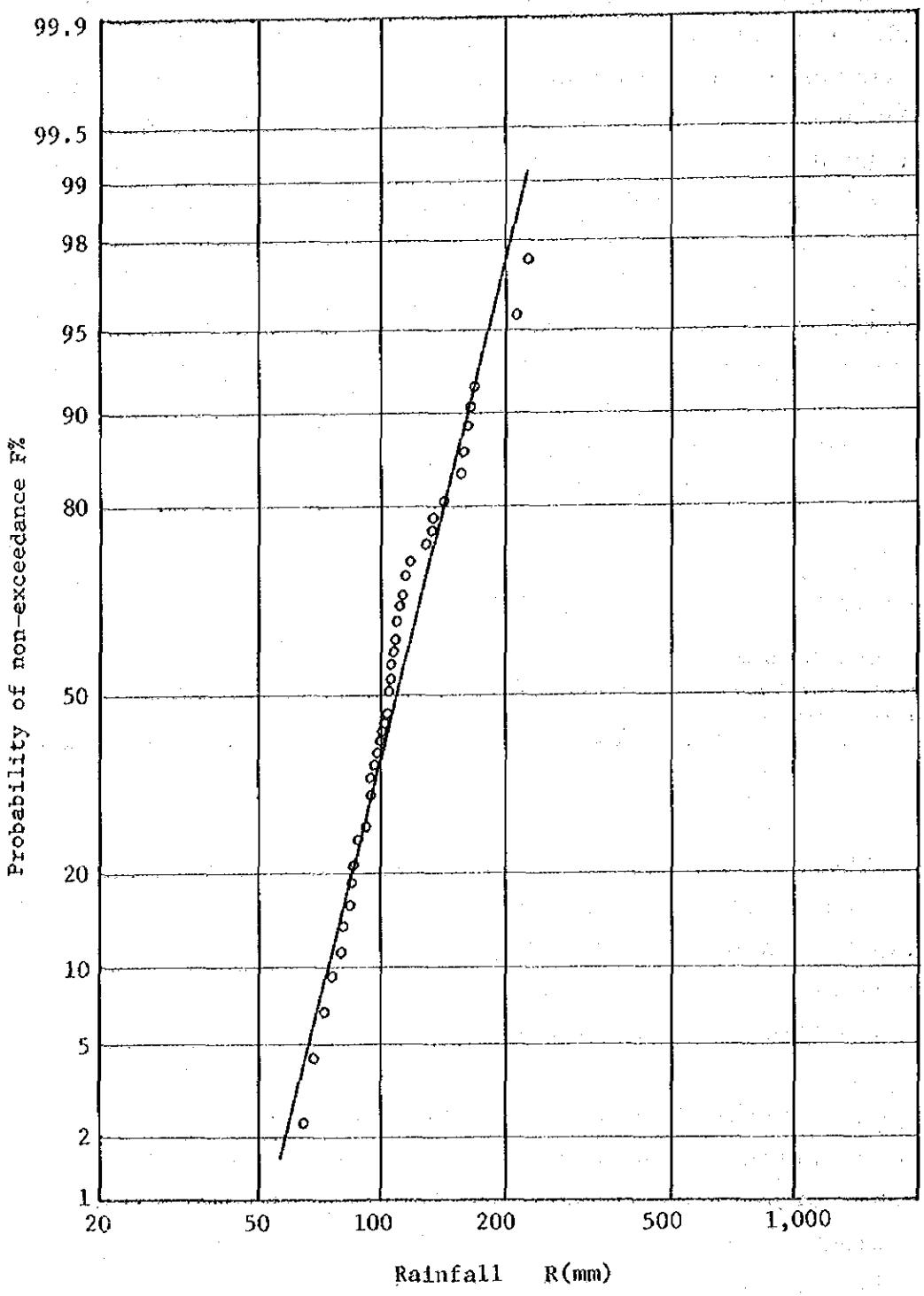


Fig. 5-12 Maximum Daily Rainfall in Year at Encalnacion

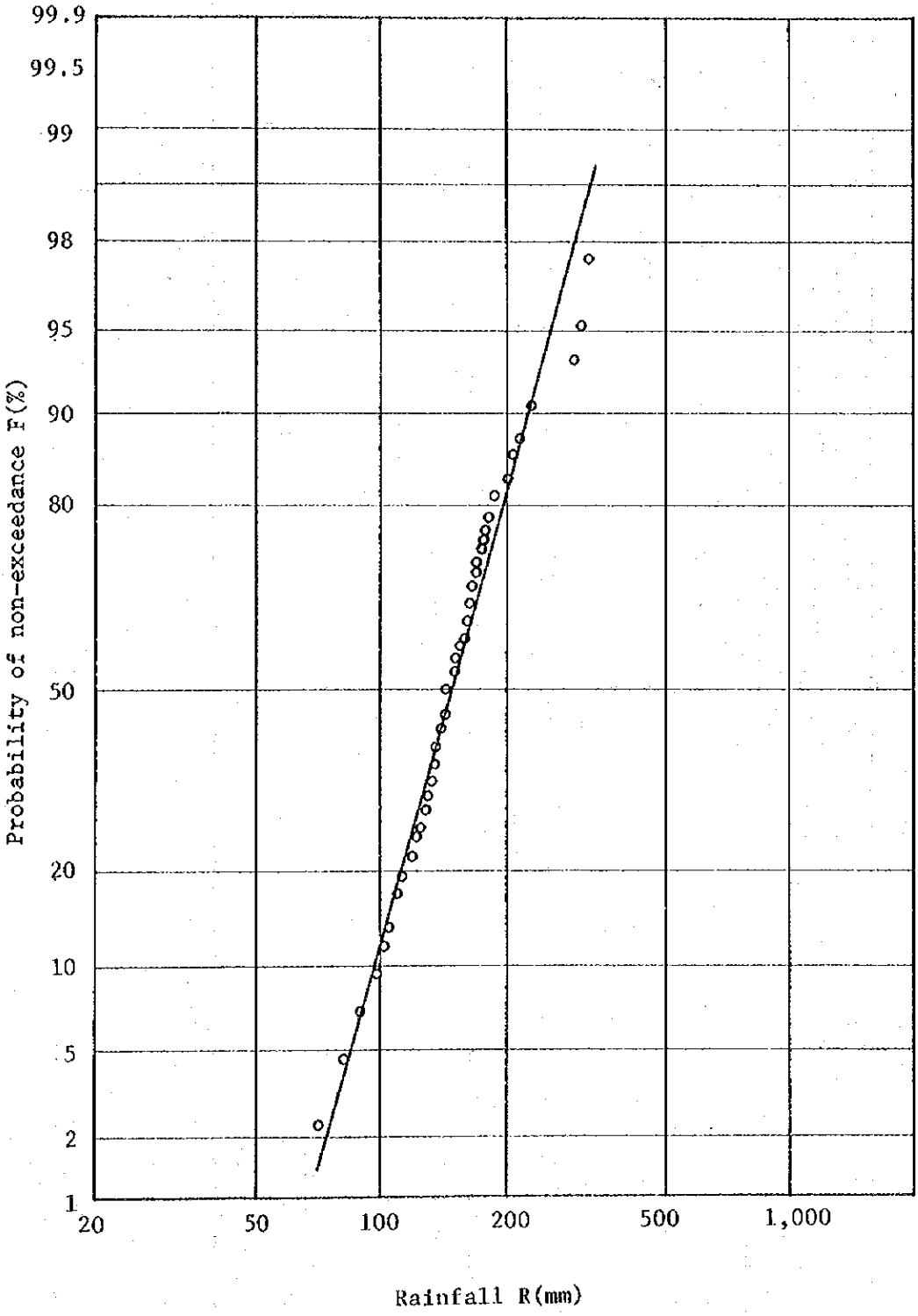


Fig. 5-13 Maximum Rainfall over 3 Conseutive Days in Year at Encalnacion Station

Table 5-27 Relationship between the Water Level of the Atinguy River and Daily Rainfall in Santa Rosa and General Delgado

Item \ Year, Month, Days	Jan. 1981			Aug.			Sep.			Oct.			Nov.			Dec.			Jan. 1982		
	1~10	11~20	21~31	1~10	11~20	21~31	1~10	11~20	21~30	1~10	11~20	21~31	1~10	11~20	21~30	1~10	11~20	21~30	1~10	11~20	21~31
Average Water Level of the Atinguy River over a 10-day Period (1)	-	1.52	1.37	1.35	1.39	1.34	1.30	1.38	1.72	1.49	1.54	1.64	1.58	1.59	1.60	2.18	2.32	2.55	2.39	2.38	2.10
Average Daily rainfall in a 10-days Period — Santa Rosa (2)	1.5	20	0	3	0	39.2	0.5	54.5	15.8	5.8	0.3	64.3	63.5	58.1	109	6.6	150	9	1.5	29	53.5
Average Daily rainfall in a 10-days Period — General Delgado (3)	3	13	0	8	0	18	0	64.5	10	1.5	0	62	68	13	55	26.7	50.5	0	0	5	26

	Feb. 1982			Mar.			Apr.			May			Jun.			Jul.			Aug.			Sept.		
	1~10	11~20	21~28	1~10	11~20	21~31	1~10	11~20	21~30	1~10	11~20	21~31	1~10	11~20	21~30	1~10	11~20	21~31	1~10	11~20	21~31	1~10	11~20	21~30
(1)	2.08	2.32	2.65	1.78	1.88	2.42	2.56	2.18	2.26	1.66	1.63	1.57	1.83	2.44	2.63	2.48	2.41	2.65	1.82	1.69	2.00	2.41	2.63	2.42
(2)	64.5	163.1	41	2.3	16.7	54.7	30	63	1.7	0	116.5	0.8	111.7	65	6.5	0.8	43.4	19.1	-	-	-	-	-	-
(3)	37	160.5	82	4	22	39	0	112.5	0	0	67	0	113	81	3	0	12	24	-	-	-	-	-	-

	Oct. 1982		
	1~10	11~20	21~31
(1)	2.37	1.82	1.29
(2)	-	-	-
(3)	-	-	-

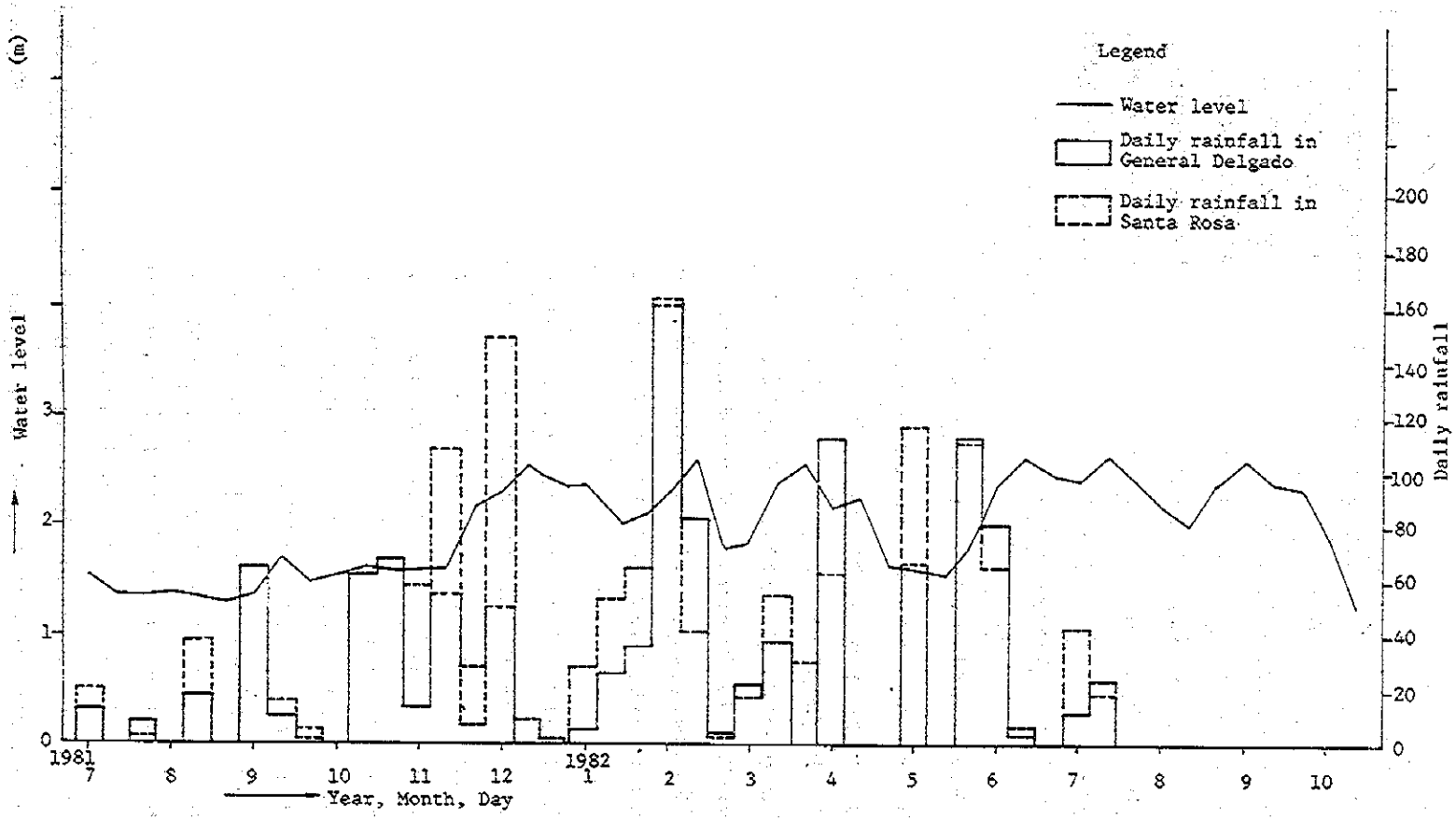


Fig. 5-14 Relationship between Water Level of the Atinguy River and Daily Rainfall in Santa Rosa and General Delgado

5.6 Soil

5.6.1 Brief

A report of the survey by Halza Dasociados and presented to Paraguay government in 1972 was obtained.

We conducted the Soil survey of the object district with the help of the Halza report and FAO-UNESCO planning reports. As an important part of the Halza report including a Soil map and a map describing the survey points was not available, the following survey of the next year is required for a complete analysis.

5.6.2 Main Contents of the Halza Report

The report covers an area of 229,000 ha which contains nearly all of our survey district. The area is shown in Fig. 5-15.

Planosols, Gliysols, Regosolo are the predominant soil types and there is some minor distribution of Red Yellow Podzolic soil. The description of each soil and soil capability were given as follows.

1) Planosols; Ill-drained clay soils are developed on flat lowland or bottomland. Owing to the poor permeability of the subsoil, Planosols are apt to be flooded during certain periods of the year. They are divided into the three subtypes of Mollic Planosols, Eutric Planosols (base saturation (V) > 50%), and Dystric Planosols (base saturation < 50%). Growable crops are restricted to the poorly permeable subsoil. Though surface water is drained relatively easily, the soil wetness does not improve. Fertility is at a medium level. Mollic Planosols in the surveyed area have a high water holding capacity and keep their soil moisture well, making agricultural practice easy even in the dry season.

2) Gleysols

III-drained soils with Gley layer developed due to the effect of water on flooded plains or bottom land. They are useful for rice cultivation and after drainage, for intensive horticulture. Humic Gleysols are dominant in the survey area.

3) Regosols

Very young soils with slight evidence of soil development. Regosols with a depth over 2.5m were found in the survey area. The texture is sandy with a high permeability and a poor water holding capacity so that land usage is limited to grassland or forests.

4) Soil capability classification

The report classifies soils using a USA - USDA capability classification system. USA - USDA system classifies the soil into 8 classes according to their usefulness for agricultural production.

Class I V are soils are good for the production of most crops if they are appropriately managed Class V - VI are soils which are good for fruit, vegetables or some specific crops with intensive management.

Class VII and VIII are soils where the land use should be limited to grassland or forest.

The USA - USDA Classification was slightly modified for better application to the survey area and is shown in Fig. 5-15.

The soils of the survey area were classified into classes III (small area), IV, V, VI (small area) and VII. Class III has a smaller freedom for crop choice compared with I or II and requires some special efforts for its management.

Class IV are good for rice or grass cultivation under natural conditions. Class V agrees with Humic Gleysols and Regosols which show quite a regular distribution.

Regosols with high permeability and low water holding capacity are good for trees (including fruit) and ranching.
For growing other crops, liming and irrigation are necessary.
Humic Gleysols having horizon A with a high organic content were divided into ones good for ranch or pasture land and those available for intensive agriculture, (according to drainage conditions).
Class VI has limits to its agricultural use because of excessive wetness and flooding. With appropriate treatment, it is good for rice cultivation.
Class VII could be improved to Class IV if the drainage efforts were successful.
This classification is presented in Table 5-28.
Table 5-29 shows the relationship between the crop suitability and the soil texture.

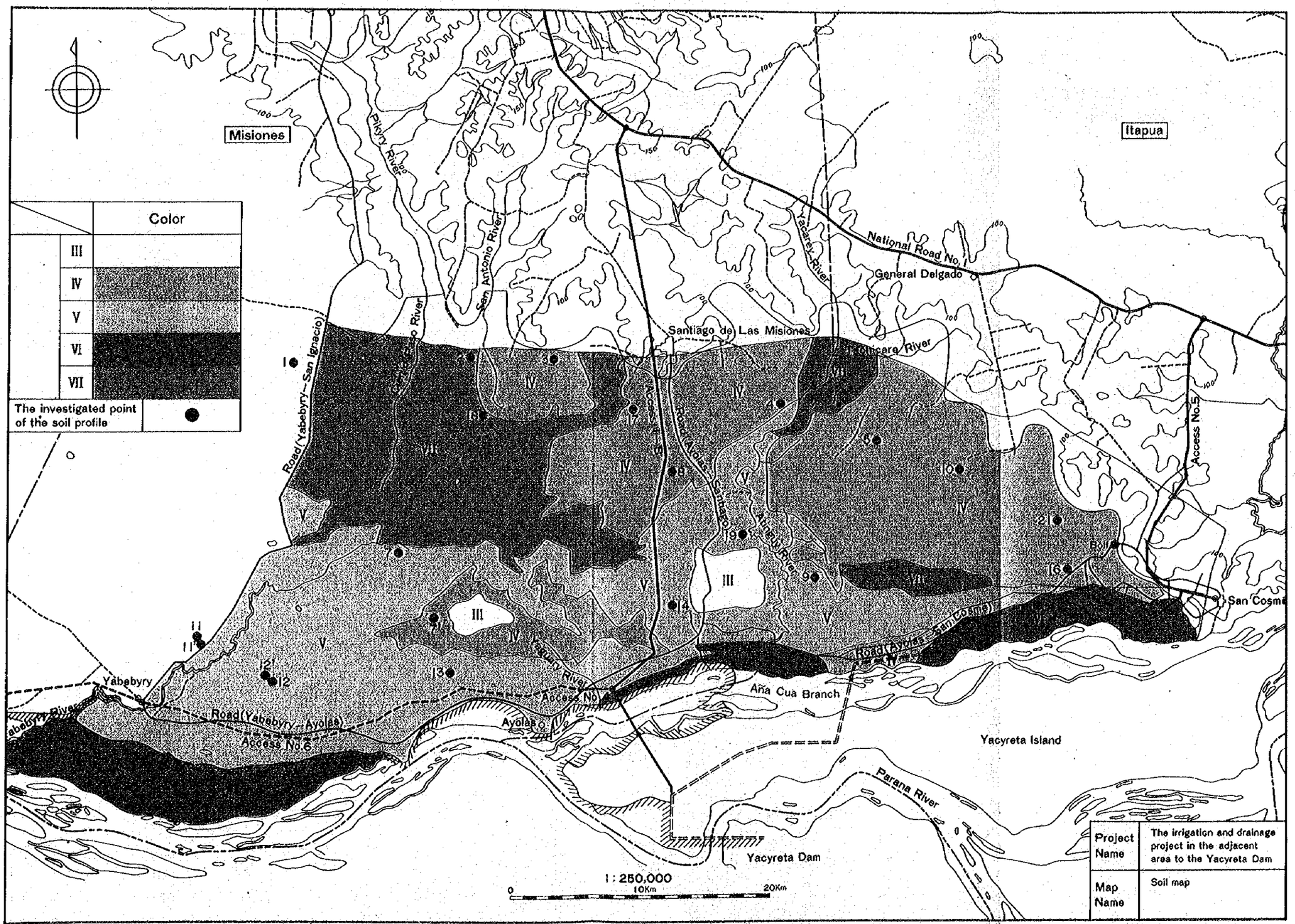
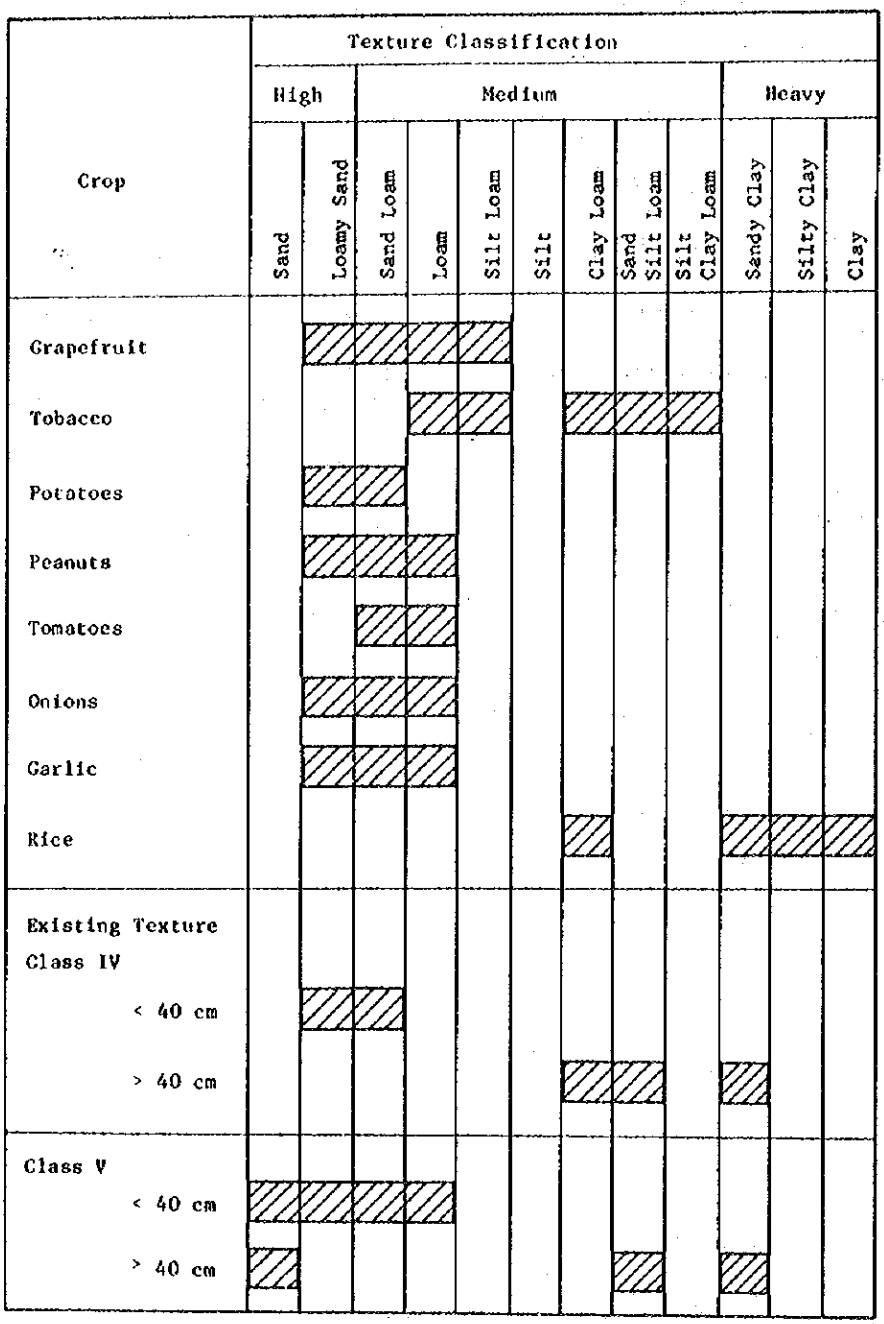

Misiones
Itapua
Color
III
IV
V
VI
VII
The investigated point of the soil profile
Pikyry River
San Antonio River
Yabebyry River
Yaguarey River
National Road No. 1
General Delgado
Santiago de Las Misiones
Ohicare River
Road (Yabebyry – San Ignacio)
Access No.1
Road (Santiago – Ayolas)
Access No.5
Yabebyry
Road (Yabebyry – Ayolas)
Access No.6
Ayolas
Feliciano River
Aña Cua Branch
Yacyreta Island
Parana River
Yacyreta Dam
1 : 250,000
0
10Km
20Km
Project Name
The irrigation and drainage project in the adjacent area to the Yacyreta Dam
Map Name
Soil map

Table 5-28 Land Capability Classification

Classes	Gross Area	Percent	Soils
III	1,000 ha	0.4 %	Red Yellow Podzolic
IV	70,000	34.0	Planosols
V	106,000	46.4	Gleysols Regosois
VI	10,000	4.4	Gleysols Regosois
VII	34,000	14.8	Planosol Gleysols
Total	229,000	100.0	

Table 5-29 Soil Texture Requirements



5.6.3 Soil Profile Study of the Survey District

1) Deciding the places for study

Based on the farm area map from the Halza report, we divided the survey district into north and south, and divided each part east - west into 4 parts. The places for study were set on the each intersection of the dividing lines (Fig. 5-15).

2) Methods and study items

The study was conducted from January 12 29, 1983. The study of the central part was limited to the places which were accessible by the ranch road and in cases where the appointed place was flooded, we studied a neighbouring place.

We added places where the ranch owners requested the study or with a high ground water table, into our survey plan.

A soil profile as deep as 1 m was studied at each place and supplementary observations of the surface soil to a depth of about 50 m were added at 4 points within a distance of 1 km from the place of study in each direction.

The study items were,

Horizon;	Divided by color, texture and structure,
Soil texture;	Identified according to international system,
Humus;	Identified by color and supplemental analysis,
Soil color;	Identified according to MUNSELL SYSTEM.
PH(KCI);	Measured by the simple method of Fujihira's equipment and by supplementary glass-electrodes,

Oxides precipitation;	Observed for morphology, freshness and content,
Gley mottling;	Observed by color.
Compactness;	Measured by Yamanaka's corn penetrometer,
Adhesiveness;	Measured by adhesiveness to finger and identified to high, medium, and low,
Permeability;	Judged by the texture, structure, porosity, compactness etc. and identified to high, medium and low,
Wetness;	Measured by the wetness felt by hand,
Root development;	Observed, measured and (ited by the amount of plant roots or length.

Though the content of gravel and the slope of the land were also studied, these would not limit the crop production of the ditrict so no comment was made.
Soil profiles were studied at 22 places and 69 soil samples were taken from 3 layers of each profile.
The analysis of these samples will be submited to the division of soil science of Asuncion University in the excution of 1983's survey.

3) Results of survey

The results of soil profile study were given in Table 5-30.
Though these results should be discussed by referring to Halza report, as mentioned above, the maps of the classified soils or the places studied by Halza were not available this year, so that our discussion is limited solely to the results of our own survey.

a) Planosols

Planosols are seasonally flooded and have a sandy bleached surface layer and illuvial clay layers in their subsoil.

Planosols in the district were divided into three groups, namely Mollic Planosols which has Mollic A Horizon; Dystric Planosols which had Ochric A Horizon and base saturation (V) under 50% and Eutric Planosols with base saturation (V) over 50%.

Mollic Planosols consist of two types. One has thick surface soil with a depth of over 20 cm and a B Horizon of relatively soft sandy loam or loamy sand. The other has hard pan of sandy clay or clay loam in the second layer with base saturation (V).

The results of the soil profile study of Planosols are given in Table 5-30 with the numbers of 3, 4, 5, 7, 8, 10, 15, 17 and 19. Detail study of Dystric Planosols and Eutric Planosols will be made with the result of soil analysis of next year.

b) Gleysols

Most Gleysols are distributed on low or bottom land and strongly affected by the ground water. The effect of water is evident at depths within 50 cm from the surface. The soil has the band or mottling of grayish blue with the co-existense of red or red-yellow mottling. Along the central road, on the ditch wall of Santiago side, large profiles of Gleysols were observed. Study place number 1, 2, 11, 13, 18 and 21 had the profile of Gleysols. Surface soil had the large content of humus. An exact

analysis of the humus content will be made next year.

Mollic Gleysols with Unbric A Horizon were also found.

c) Regosols

Regosols were light yellow sandy soils in which horizon was obscurely recognized. It was found at places number 12 and 14.

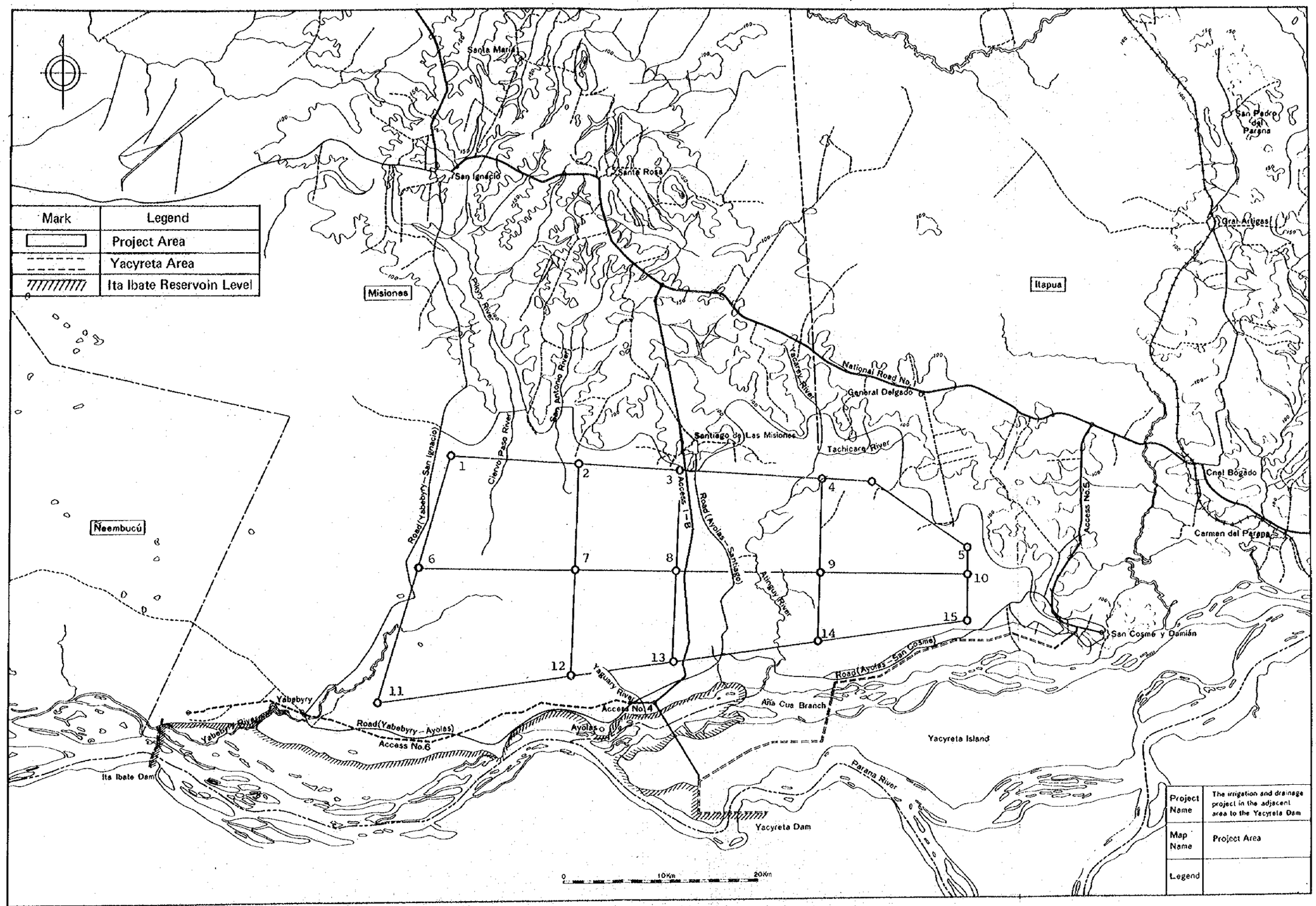

Mark
Legend
Project Area
Yacyreta Area
Ita Ibate Reservoin Level
Misiones
Itapua
Ñeembucú
Santa María
San Ignacio
Santa Rosa
San Pedro del Paraná
Gral. Artigas
Pirity River
San Antonio River
Cienvo Paso River
Yacaré River
National Road No.1
General Delgado
Santiago de Las Misiones
Tachicare River
Cnel Bogado
Carmen del Paraná
Road(Yabebyry – San Ignacio)
Access I – B
Road(Ayolas – Santiago)
Access No.5
Aiingay River
San Cosme y Damián
Road(Ayolas – San Cosme)
Yaguary River
Access No.4
Añá Cua Branch
Yacyreta Island
Yabebyry
Yabebyry River
Road(Yabebyry – Ayolas)
Access No.6
Ayolas
Ita Ibate Dam
Paraná River
Yacyreta Dam
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
0
10Km
20Km
Project Name
The irrigation and drainage project in the adjacent area to the Yacyreta Dam
Map Name
Project Area
Legend

Table 5-30 Results of Soil Profile Study

No.	Layer	Texture	Humus	Color	PH (KCl)	Existence of Oxides	Existence of Grey	Compactness	Adhesiveness	Water Permeability	Wetness (Ground water level)	Root distribution	Land use etc.
	cm		%	7.5YR		%		mm			cm	%	
	0 - 23	SL	10	2/1	5.8	-	-	23	L	M	Dry	70	
1	24 - 35	SCL	2	10YR 4/1	5.0	5	-	15	M	M	"	20	Ranch
	36 - 60	LIC	-	10YR 3/2	6.5	20	C	15	H	L	70	65	
	0 - 13	SL	5	7.5YR 6/2	5.5	-	-	30	L	H	Dry	80	Ranch
2	14 - 52	SIL	2	7.5YR 6/3	5.5	5		30	M	M	"	10	
	53 - 105	SIC	-	10YR 5/2	5.0	10	G	26	"	"	Semidry	53	
	0 - 8	CL	2	7.5YR 5/1	5.5	-	-	24	M	M	Dry	80	Ranch
3	9 - 48	SC	-	7.5YR 6/1	5.5	-	-	30	"	"	"	20	
	49 - 90	LIC	-	10YR 4/1	5.0	5	-	19	H	L	Semidry	50	
	0 - 16	CL	-	7.5YR 5/3	5.5	-	-	25	M	M	Dry	70	Ranch
4	17 - 55	SC	-	10YR 5/3	5.5	-	-	25	"	"	Dry	20	
	56 - 75	LIc	-	7.5YR 7/2	4.0	5	-	22	H	L	Semidry	50	
	0 - 34	CL	5	7.5YR 3/1	5.5	-	-	20	M	M	Wet	70	Ranch
5	35 - 44	SC		10YR 4/2	5.2	-	-	12	"	"	Semiwet	20	With ground water
	45 - 70	LIC		7.5YR 7/2	5.9	10	-	31	H	L	70	55 cm	

No.	Layer	Texture	Humus	Color	PH (KCl)	Existence of Oxides	Existence of Grey	Compactness	Adhesiveness	Water Permeability	Wetness (Ground water level)	Root distribution	Land use etc.
	cm		%	10YR		%		mm			cm	%	
	0 - 17	LIC	10	2/1	5.5	-	-	22	H	L	Dry	80	Ranch
7	18 - 45	CL	5	10YR 3/1	5.0	-	-	20	M	M	"	10	
	46 - 70	SCL	-	10YR 7/3	6.3	-	-	18	"	"	"	50 cm	
	0 - 12	SL	2	7.5YR 6/2	5.5	-	-	25	M	H	Dry	70	Ranch
7'	13 - 35	SIL	-	7.5YR 5/3	5.0	-	-	26	"	M	"	20	
	36 - 100	CL	-	7.5YR 5/4	5.0	5		23	"	H	"	55 cm	
	0 - 7	SL	-	7.5YR 7/3	5.5			26	M	M	Dry	80	Ranch
8	8 - 45	SCL	-	7.5YR 7/2	5.5			27	"	H	"	10	
	46 - 100	CL	-	7.5YR 4/2	5.0	15		26	"	M	"	43 cm	
	0 - 10	SL	2	7.5YR 6/2	5.2	-	-	23	L	M	Dry	80	Ranch
9	11 - 61	SIL	-	10YR 6/3	5.5	-	-	19	M	M	Dry	10	Ranch
	62 - 110	SL	-	7.5YR 5/2	5.0	5	-	17	"	"	"	57 cm	
	0 - 31	LIC	5	10YR 2/1	5.5	-	-	24	H	L	Dry	80	Rach
10	32 - 70	CL	2	10YR 7/1	6.0	5	-	28	"	"	"	10	
	71 - 110	SIC	-	10YR 5/1	4.5	5	-	21	M	M	120	50 cm	
11	0 - 13	SIC	2	7.5YR 5/2	5.0	-	-	15	M	M	Dry	80	Ranch

No.	Layer	Texture	Humus	Color	PH (KCl)	Existence of Oxides	Existence of Grey	Compact-ness	Adhesive-ness	Water Permea-bility	Wetness (Ground water level)	Root distribu-tion	Land use etc.
	cm		%	10YR		%		mm			cm	%	
11	14 - 24	SL	-	5/4	5.3	-	-	21	M	M	Dry	10	
	25 - 100	LIC	-	7.5YR 6/4	5.5	10	G	22	"	"	"	65 cm	
	0 - 17	SCL	-	7.5YR 6/3	5.5			21	M	M	Dry	70	Ranch
11'	8 - 40	CL	-	7.5YR 1/3	5.7			22	"	"	"	20	
	41 - 60	SIL	-	7.5YR 6/3	5.8	5	G	13	"	"	80	60 cm	
	0 - 5	CL	5	7.5YR 3/1	5.5			18	M	M	Dry	80	Ranch
12	6 - 26	SL		7.5YR 4/2	5.7	5		20	"	"	Semidry	10	Close to flooded Land
	26 - 45	LIC	-	5 YR 5/3	5.5	10	-	24	"	"	45	50 cm	Ranch
	0 - 15	SL	2	10YR 3/2	5.7	-	-	23	L	H	Dry	70	Ranch
12'	16 - 42	SIL	-	7.5YR 4/2	5.5	5	-	22	M	M	"	20	
	43 - 100	SL	-	10YR 5/2	5.8	10	-	23	"	"	"	58 cm	
	0 - 14	SL	2	10YR 5/2	5.5			25	L	H	Dry	80	Ranch
13	15 - 37	SICL	-	7.5YR 7/4	5.0	5		25	M	M	"	10	
	38 - 58	SCL	-	7.5YR 6/4	5.2	10		23	"	"	"	40 cm	
	59 - 100	LIC	-	10YR 6/4	5.3	20	G	18	H	L	Wet		

No.	Layer	Texture	Humus	Color	PH (KCl)	Existence of Oxides	Existence of Grey	Compactness	Adhesiveness	Water Permeability	Wetness (Ground water level)	Root distribution	Land use etc.
	cm		%	10YR		%		mm			cm	%	
	0 - 15	SL	2	5/3	5.8	-	-	20	L	H	Dry	70	Ranch
14	16 - 43	SL	-	10YR 4/3	5.5	-	-	16	"	"	-	20	
	44 - 60	SIL	-	10YR 4/6	5.6	-	-	13	"	"	-	10	
	61 - 93	SIL	-	7.5YR 4/6	5.6	-	-	13	"	"	93	75 cm	
	0 - 30	SL	5	7.5YR 4/2	5.6			25	M	M	Dry	70	Ranch
15	31 - 80	CL	-	7.5YR 6/1	5.7	-	-	23	M	M	"	20	Ranch
	81 - 100	SCL	-	7.5YR 7/1	5.5	-	-	26	"	"	"	80 cm	
	0 - 17	SC	8	10YR 6/1	5.2			16	M	M	Dry	80	Ranch
16	18 - 50	CL	3	10YR 4/2	5.8	5		13	"	"	Semidry	10	
	51 - 75	SIC	-	10YR 5/2	5.5	10		19	"	"	75	53 cm	
	0 - 17	SCL	5	10YR 4/2	5.0			22	M	M	Dry	80	Ranch
17	18 - 42	CL	3	10YR 6/2	5.7			22	"	"	"	10	
	43 - 72	SC		7.5YR 7/4	5.5	5		16	"	"	Semidry		
	73 - 100	CL		7.5YR 8/6	5.5	10		9	"	"	-	86 cm	
	0 - 15	CL	5	7.5YR 6/2	5.8			25	M	M	Dry	80	Ranch
18	16 - 50	CL	2	7.5YR 4/2	5.8			22	"	"	"	10	

No.	Layer	Texture	Humus	Color	PH (KCl)	Existence of Oxides	Existence of Grey	Compactness	Adhesiveness	Water Permeability	Wetness (Ground water level)	Root distribution	Land use etc.
	cm		%	7.5YR		%		mm			cm	%	
18	51 - 112	LIC		4/1	5.5	20	G	20	H	L	Dry	40 cm	
				10YR									
	0 - 44	SCL	3	4/2	5.8	-	-	16	M	M	Dry	70	Ranch
19				10YR									
	45 - 64	CL	-	5/1	5.8	-	-	15	"	"	"	20	Ranch
				7.5YR									
	65 - 100	LIC	-	6/2	5.9	5	-	12	H	L	"	90 cm	
				10YR									
	0 - 20	CL	5	2/1	5.7	-	-	20	M	M	Dry	90	Ranch
21				7.5YR									
	21 - 50	CL	2	6/2	5.2	-	-	23	"	"	"	37 cm	
				10YR									
	51 - 105	LIC	-	5/2	5.5	15	G	16	H	L	Semidry		

5.7 Rural and Agricultural Land Development

5.7.1 Regional road (Appendix Tab. 5-43, Fig. 5-2, 5-3, 5-4)

This area is broadly surrounded by four roads, and divided into an eastern and a western part by the access road to Yacyreta dam.

(1) National Road Route 1

This 370 km road from Asuncion to Eucarnacion is completely paved with asphalt. Part of this road directly related to this area is about 80 km in length from San Ignacio to a point about 19 km east of General Delgado where this road joins with the access road from San Cosme y Danián.

This road is 11.0 m in total width and 5.8 m in effective width and passes through the ridge of northern hills, whose elevation is 100~180 m from Santa Rosa to General Delgado.

(2) Access road No.5

This road which runs north-south along the eastern side of the survey area, is asphalt paved and about 26 km in length from San Cosme y Danián, bypassing the swamp, to the point where this road joins the National Road Route 1.

(3) Access road 1-B

This road runs north-south through the center of the survey area. This road has a length of about 45 km of asphalt pavement, which begins from Ayolas, gradually turns towards the north, from a point about 15 km east Ayolas, turns north and joins the National Road Route 1 on the eastern edge of Santiago.

This road is 17.5 km in total width and 7.0 m in effective width.

A road running from a point 6 km east of Ayolas towards Yacyreta Island is attached to this access road. There is a 300 m concrete bridge spanning the Parana

River on this attached road.
Moreover, a total of 57 boxculverts (Inner size 1.5 × 1.5 m, In-situ placed concrete(are located at 400 m intervals on the access road crossing the central swampy zone. Water flows very slowly toward the west at present.

(4) Access road, No.4, No.6 (Proposed road)
Access road No.4, No.6 are totally about 48 km in length (No.4 Ayolas-Ayolas Airport, No.6 Ayolas Airport-Guaira Cie), which is proposed to extent towards the west from Ayolas to Guaira Cie by way of Yabebyry.
In this connection, Ita Ibate equalizing dam will be constructed at Guaira Cie.

(5) San Igracio-Yabebyry line
This road runs north-south along the western verge of the survey area and is 60 km in total length, 10.0 m in whole width and 7.0 m in effective width. Moreover, part of this road from San Ignacio to Santa Rita goes through Northern hills (EL 90-150 m), and about 18 km from Santa Rita to Yabebyry goes through a bog. Nearly the entire length of the road is constructed with Orthic Acrisols as banking material, and the mechanical strength of soil is easily weakens due to water. Therefore, one day of rain causes traffic to stop for three days at least. A regular bus service is carried out on this road.

(6) Road along the Parana River
This road is about 83 km in total length from Yabebyry to San Cosme y Danián on a natural embankment of the Parana River. A regular bus service is operated on the 30 km sandy, unsealed road linking Yabebyry and Ayolas. This road passes on the timber bridge over the Yabebyry River. From Ayolas to the end of the

proposed line of Yacyreta Dam, the right bank of which is 25 km long the road is constructed of Orihic Acrisols and there is a concrete bridge spanning the Atinguy River on the road.
Division from Yabebyry to the end of the proposed line of Yacyreta Dam on right bank is 10.0 m in total width and 7.0 m in effective width.
About 28 km division along the proposed line of Yacyreta Dam was a temporary road for the construction of Yacyreta Dam and was paved with 20 cm of thick gravel on the subbase embanked with Orthic Acrisols. Therefore, transportation is possible even during rain. This road is 16.0 km in total width and 9.0 m in effective width.

(7) Old road along the access road
There is an old road from road along the Parana River to the National Road Route 1 by way of Santiago. Since access road 1-B was constructed this road is used mainly as a farm access road.

(8) The other roads
In addition to main roads mentioned above, there are roads from main roads to farms and farm roads. According to the field survey, most roads from main roads to farms are made of earth, namely Orthic Acrisols. Therefore, even jeeps can not pass after rain. The farm roads are made by earth, so vehicles do not run particularly well on this road.

(9) Remarks
The width of land which must be acquired for main roads is mostly three times as much as the whole width. Generally, the subbase of roads is made of Orthic Acrisols. These Orthic Acrisols are typical clayey laterites which do not contain humus and organic matter and which are easily soluble in water.

When Orthic Acrisols are used as embankment material, their mechanical strength weakens with rain. If a vehicle goes through such road during rain, wheel ruts remain on the surface and generally it is not easy for vehicles to run on the road because of unevenness. For such reason, it is essential to stop traffic on such roads after rain. When compared with gravel paving road such as that proposed for along the Yacyreta Dam, gravel pavement is much more effective.

From the standpoint of securing transportation after rain, it is necessary to consider selection of materials and gravel pavements in future plans.

5.7.2 Circumstances of agricultural land on the Bolf Farm

(1) Paddy field

According to field reconnaissance and on hearing the reports of farmers, information regarding fields is as follows.

Field arrangements are made by setting fire to plants, cultivating the surface by disc harrows and making level using a land leveler, while irrigation channels are made by machinery.

Fixed footpaths between plots are laid out at 150∿200 m intervals so that they meet contour lines at right angles. The long block divided by these footpaths is divided once again by small transverse footpaths at 4∿5 ha units from the upper part. These transverse footpaths are laid out parallel with contour lines.

A difference in this small plot of 4∿5 ha blocks is 4∿8 cm; both sides of a block are surrounded by parallel straight footpaths and curved transverse footpaths. The footpaths are made by a footpath maker and small transverse footpaths are also made by machine along contour lines. Farm roads to fields are laid out at

right angles to contour lines, which are embanked with surplus soil from farm drain making with almost no difference of elevation between fields and roads.
The manner of graving paddy rice is the direct sowing method where small curved foot paths are first made along contour lines after seeding and then the field is filled with water. Besides, agricultural chemicals are seldom used. Therefore, work after sowing is mainly water management so that the water depth is kept at 5 cm on the average up to the time of harvest.

After surface drainage at harvesting, large combines harvest the rice, which is in blocks 200 m wide and 700∿800 m long, over small footpaths, and all works are mechanized.

(2) Grassland

There are two types of grassland, which form natural pasture for grazing after setting fire to the virgine field as well as improved meadows.
Moreover, in the category of natural pasture grassland is divided into pastures remaining after the fields have been burnt off and those in the crop rotation system after paddy or sorghum has been planted for a few years. Every farmer said that the yield of rice in the rotation system was more productive.
The improved pasture is seldom used for hay and silage making. Accordingly, lean cattle are moved from natural pasture to improved pastures to gain weight and then returned to the natural pasture again.
The farm roads in the pastures are made from earth and are so narrow that cars can barely pass through. Therefore, horses are used for transportation within the pastures.

5.8 Environmental Conservation

5.8.1 Present condition of conservation of natural environment in Paraguay

The total area of Paraguay is 40,675,000 ha, of which forest land accounts for 51%, grassland for stock farming (mostly natural grassland) 42%, and agricultural land for cultination 4% (1979).

Change in land use in Paraguay

Table 5-31

(Unit : 1,000 ha)

	1974	1979	Increase or decrease (Δ) between 1974 and 1979	Rate of Increase or decrease between 1974 and 1979
	(59)	(51)		%
Forest	23,924	20,643	Δ3,281	13.7
Agricultural land for Cultivation	(2) 958	(4) 1,781	823	85.9
Grassland for stock farming	(37) 14,849	(42) 17,291	2,442	16.4
Water surface and others	(2) 944	(2) 960	16	1.7
	(100)	(100)		
Total	40,675	40.675	0	0

Note: Data from the Encuesta Agropecuaria per Muestreo (MAG).
Values in parentheses show percentage.

The change in land use during the five year period of 1974 to 1979 includes a decrease in the forest area by 3,280,000 ha, all which was converted to agricultural land for cultivation or grassland for stock farming.

By the enactment of the forest low in 1973, the Forestry Agency (Servicio Forestal Nacional) was established as an organization to take special authority and responsibility for the protection, improvement and rational utilization of renewable natural forest resources. The Forestry Agency is responsible for services related to forests, forestry, and forest industry, but at the same time a branch of the organization, the Department for the Protection of Forests, National Parks and Wild Life, establishes national parks, Protected forests, and forest reserves (forests protected from human interference) for the protection of endangered plants and animals (Because of the excessive commercial hunting and the hunting for pleasure in Paraguay, the numbers of armadillos, jaguars, wild pigs, and deer are decreasing.) and for the conservation of historical sites. The following are parks and forests which are already established.

National parks and natural protection areas in Paraguay

Table 5-32

(Unit : 1,000 ha)

Name	Location	Established Year	Area
1. Tinjunqúe National park, Reservation Forest (Animal protection)	Presidente Hayes	1966	280
2. Kuriy National Reservation Forest	Alto Parańa	1973	2
3. Ybycuí National Park	Paraguarí	1973	5
4. Saltos de Guairá National Park	Canendiyó	1973	1
5. Defensores Del Chaco National Park	Chaco	1975	780
6. Nacunday Protection Forest	Alto Paraná	1975	1
7. Jakui Protection Forest	Alto Paraná	1975	1
8. Caaguazú National Park	Caazapá	1973	6
9. Cerro Corá National Park	Amambay	1976	5
10. Teniente Agripino Enciso National Park	Nueva Asunción	1980	40

Note: Data from the Desarrollo Forestal Paraguay (FO Informe técnico 9)

In Itapua and Misiones Departments, National Park, Protection Forest, and Reservation Forests are not yet established.

Construction Plans of dams for large-scale hydro-electric power plants in recent years drove the country to emphasize the protection of wild life and the maintenance of fish resources in the areas to be submerged, as seen in the construction of Itaipu Dam, Yacyreta Dam and other planned dams. (Wild life protection plan related to the construction of Yacyreta Dam will be discussed in appendix.)

5.8.2 Agricultural development and environmental conservation

- Function of agricultural ecosystem for the environmental contervation -

Agriculture has the role of continuously and steadily providing food-essential for human life, but at the same time has a function of maintaining and conserving natural environment. Cultivated land, such as paddy fields, upland fields, pastures (including natural grasslands), natural rivers and irrigation canals, and properly distributed forests have the following functions within an agricultural ecosystem:

(1) Functions concerned with the atmosphere

a) Function of cleaning the atmosphere through photosynthesis of plants.

b) Function of forests to moderate wind speeds and climate.

(2) Function concerned with water

a) Function of vegetation to moderate surface runoff; function of paddy fields to prevent floods by the water storing capacity.

b) Function of cultivated lands and forests to

maintain ground water, to moderate shortage of water, and to nourish the head of a stream.

(3) Functions concerned with soils

a) Function of plant roots to bind soils, thus preventing soil erosion and land collapse.

b) Function of vegetation to prevent the washing-away of soil by rain, and to prevent soil from blowaway (wind erosion).

(4) Functions concerned with organisms

a) Function to protect organisms by providing a Place for rare animals and plants to live.

By the stabilization of the agricultural ecosystem which has the above-mentioned functions, agricultural production will be fully achieved and the long-term maintenance of the production will be expected. The project area is an undeveloped area which is mostly swamp land inundated with water all the time, except for scattered small forests and limited places used for paddy fields, upland fields and pastures. The integrated agricultural development project is a large-scale project for the conversion of this unused land to the agricultural land by constructing paddy fields, upland fields and pastures by means of irrigation and drainage canals, thus promising and efficient use of land and an increase in agricultural production. With the progress of the project, the maintenance of the present natural environment will become more difficult, However, by the construction of the foundation for the agricultural production and the creation of the above-mentioned stable agricultural ecosystem, it will be possible to realize the improved environment. In this respect, it should be said that the environmental preservation problem in agricultural development is different from that in an area to be submerged with the construction of a large dam.

For the quick and steady stabilization of the agricultural production efficiency, it is necessary to utilize the present vegetation as much as possible. It is also important to avoid the unnecessary removal and transportation of soil for the preparation of agricultural lands, roads and irrigation canals. For the stabilization of agriculgural ecosystem and for the maintenance of the agricultural production it is also essential to properly distribute forests in the agricultural land. As mentioned above, the role of forests is significant for the preservation of soils, i.e., for the prevention of soils from wash-away and blow-away, for the protection of agricultural crops and livestock by providing wind shelter forests and shade forests, and for the protection of people and farm houses by the surrounding groves. We consider that an appropriate combination of agricultural land and forests in the framework of a stable agricultural ecosystem is an efficient way of preserving the environment in the project area.

5.8.3 Present condition of forests in the survey area

In the servey area of 150,000 ha, forests cover only a small area of 7,000 ha (5%). These forests can be classified into the following three types in terms of the location of their distribution:

(1) Natural levees forest (Dique Natural),

(2) Gallery forest (Bosque du Galeria),

(3) Clustered small forest.

Natural levee forest is a forest stood along large rivers protecting river banks. In the survey area these are distributed along the right bank of Parana River with the width of a stand of 2 ∿ 4 km. The area of the Natural levees forest is 2,000 ha out of the total forest area of 7,000 ha.

Gallery forest are long and narrow forest stand, along

small to medium-sized rivers. It is seen along the Atinguy River and the Yabebyry River in the survey area. This type of forest exists along both banks of the Atinguy River from the upstream to the downstream portions. The forest is about 1,000 m-wide in the downstream area and narrows gradually upstream with the width becoming about 100 m in the extreme upper portions. On the other hand, Gallery forest is very scarce along the Yabebyry River and is visible only partially along the middle and the upstream portions. Thus, Gallery forest exists almost in a perfect condition along Atinguy River, but partially along the Yabebyry River. The possible reason as to why the Yabebyry River lacks a good stand of this type of forest are that the Yabebyry River is more liable to the flood damage and hence has more chance to be submerged or there may be some effect of the ground water or soils, or the forest had been felled in the past. A detailed study is necessary to determine whether this conjecture is right. The total area of the Gallery forest along the Atinguy and the Yabebyry Rivers is approximately 1,000 ha.

Clustered small forests are scattered in the swampland and in the natural grassland (including ranches) in the survey area. The largest cluster has an area of nearly 500 ha (only one place), but generally they are small with an area of one cluster being in the range between 1 and 10 ha. The total area of this type of forest is about 4,000 ha. The following several reasons for the clustered nature of small forests can be considered.

a) The land where these clustered forest are found form hills which look flat from a distance, so there is little effect on water in the flood season. Otherwise, the ground water level is low.

b) These forest areas are rocky and not suitable for agriculture and thus have been left unused; or they

were once used for agriculture but since left because of the unfavorable condition for agriculture and tree species regenerated.

For the exact answer a detailed study is again needed.

Area of each type of forest in the survey area

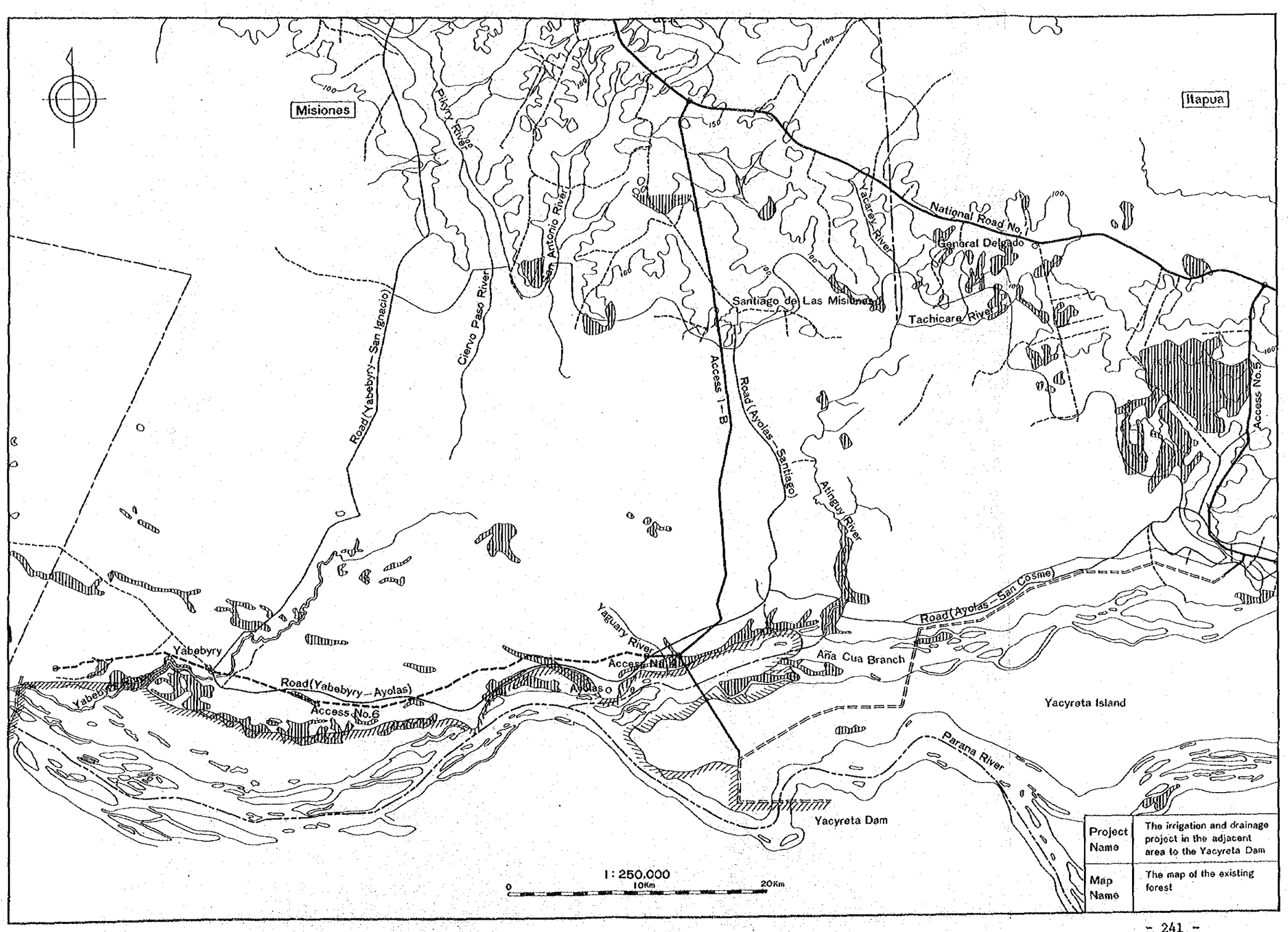
Table 5-33

Forest type	Area (ha)	Remarks
Natural levees forest (Dique Natural)	1,990	Forest between the southern border of the survey area and the right bank of the Parana River
Gallery forest (Bosque de Galería)	1,060	
Ciustered small forest	4,030	
Total	7,080	

Note: Calculated from the 1:50,000 scale map

Thus, the total forest area in the survey area accounts for only 5% of the total area and most trees have low economic values as lumber and hence has no value for timber management. However, from the standpoint of the land conservation, the large scale forest and the gallery forest along river banks like natural levee forest prevent breaking and transportation of the ground from the banks and nourish water resources and thus play a very important role.

In addition to these comparatively large forests there are groves which are closely related to the life of local people. There are always trees around houses in the survey area and the surrounding areas. These trees are essential to moderate wind speed and to provide shades for the people to rest under. They are planted trees as well as natural trees with tall wide canopies, including Eucaliptos, Chivatos, Paraisos and Jacarandas.


Misiones
Itapua
Pikyry River
San Antonio River
Ciervo Paso River
Road (Yabebyry – San Ignacio)
Access 1-B
Road (Ayolas – Santiago)
Yacarey River
National Road No.1
General Delgado
Santiago de Las Misiones
Tachicare River
Access No.5
Atinguy River
Road (Ayolas – San Cosme)
Yaguary River
Access No.4
Añá Cua Branch
Yacyreta Island
Yabebyry
Yabebiry
Road (Yabebyry – Ayolas)
Access No.6
Ayolas
Parana River
Yacyreta Dam
1 : 250,000
0
10Km
20Km
Project Name
The irrigation and drainage project in the adjacent area to the Yacyreta Dam
Map Name
The map of the existing forest

5.8.4 Forest administration and agricultural development

(1) Forest law

The forest law was enacted and Forestry Agency was established in 1973 in Paraguay and only a short time has passed since the start of its forest administration. The objective of the forest law says that "the rational utilization and management of forest and forest lands in Paraguay shall be executed for the benefit of the public", and further says that "it is the public duty to protect, maintain manage, improve and rear forest resources" (the first clause, forest law), thus emphasizing the public value of forests. The basic objective (the second claus) includes the protection, management, expansion, renewal and rational utilization of forest resources and the incorporation of forest management in the economic plan at the national level interpreting the forest as a place for the production of lumber, thus stressing the strengthening of forest productivity and at the same time the role of forest for the conservation of lands, e.g., catchments and farm lands, by preventing soil erosion.

For the attainment of the above objectives the clauses 4 through 7 of the forest law states that the forest and forest lands are to be classified into the following three groups:

a) Production forest (a forest feasible to produce a regular profit under a certain management),
b) Protection forest (a forest used for the adjustment of water resources, conservation of soils, and agricultural land, protection of river banks, streams and lakes and prevention of erosion and flood),
c) Special forest (a forest whose protection was recognized as necessary from the scientific, edu-

cational, historical and recreational stand-point.)

The forest law further specifies restrictions in the management of forests in the "General Forest System" and in the "Regulations of the utilization of forests". Particularly the following restrictive clauses are noteworthy in relation to the agricultural development:

a) Prohibition of the use of forests and forest lands in such a manner so as to lead to their destruction (23rd clause),

b) Prohibition of fires in the forest except in already permitted areas such as agricultural and grazing land and within permitted period of time by Forest Agency (30th clause),

c) Prohibition of felling or giving damage to or destroying tall and low trees in the neighborhood of water resources and streams (31th clause),

d) Those who own land of more than 20 ha within an area designated as forest must maintain 25% of their forest area as an area to be kept untouched. Those who cannot secure this percentage of forest area must afforest the area which is 5% of the total forest area owned (42nd clause).

These clauses have been enacted from the stand-point of the orderly use of forests, conservation of national land and nourishment of water resources, although they have not necessarily been enforced as enacted. For example, the three types of forest mentioned above have not been defined clearly nor agricultural and grazing areas have not been designated yet. It seems that there are many problems in the literal execution of the forest law. Although the law does not seem to have many restrictions for

the project, it would be necessary to prepare for the agricultural development project after fully understanding the technical statements in the forest law.

(2) Ten-year afforestation plan

This ten-year afforestation plan (1976~1986) was prepared by the Forest Agency in 1976 based on the agricultural and industrial development plan of Paraguay. The final goal of the project is placed on the utilization of human and resource values Paraguay possesses. This goal consists of four objectives:

a) Afforestation of quick-growing species for the production of pulp, lumber and fuels for industrial use.

b) Afforestation of trees which are fitted to the agricultural land and ranch development

As it seems that the climatic and soil conditions of Paraguay allow the increase in agricultural productivity if the agricultural development is combined with afforestation, the introduction of farm forests should be uncluded in the afforestation project.

c) Afforestation for the protection and conservation

Afforestation will be performed around the reservoir area for the maintenance of the impounding ability of the dam and for the control of water. At the same time it is necessary to grow forests as windbreaks and sun shades for the improvement of the agricultural and stock production system. Therefore, it is necessary to prepare forests for the purpose of providing prevention of

erosion, protection of the reservoir, protection of the agricultural land against winds and the sun, and providing shade for domestic animals.

d) Afforestation in recreational areas

According to the original ten-year afforestation plan, an area of 90,000 ha was planned to be planted over the whole country from 1976 to 1986. However, the plan was modified, and according to the new plan. Afforestation of an area of 77,000 ha will be performed in the period between 1978 and 1989. This plan includes the afforestation around farm lands, although the number of trees to be planted by farmers will be small because of economic reasons. Some farmers in the survey area already grow Eucalypts and pines (Elliottii Pine) for shade and pulp; other farmers who do not have any trees on their vast ranches still consider that afforestation is necessary. Generally speaking, it seems that there is a strong wish and good understanding for the afforestation of agricultural land.

5.9 Surveying

5.9.1 Topographic Map

Topographic maps of Paraguay are not freely available as they are controled by the Ministry of National Defence. Those which can be obtained through the Ministry Department of National Defence are maps of Paraguay at scales of 1/2,000,000, 1/1,000,000, 1/250,000, 1/50,000 as well as partial maps of three departments around Asuncion at a scale of 1/10,000.

There are plan to draw a mas of Paraguay to a scale of 1/10,000, but when it iwll be completed is unknown.

Topographic maps of Asuncion and Encarnacion are presently being drawn to a scale of 1/25,000.

Aerial photographs of the survey area and which were taken at a scale of 1/25,000 in 1965 (25 south, N-S axis) can also be obtained through the Ministry of National Defence.

There are aerial photographs, taken in 1980, of Enacarnacion, Stroessner and their neighborhoods along the Parana River and which are at a scale of 1/50,000, but these are not related to the survey area.

Moreover, there are aerial potographs taken at a scale of 1/20,000 in 1972 and possessed by Yacyreta Public Corporation, and which cover most of the survey area. The negatives of these aerial photographs are kept in the Bucnos Aires office of the Yacyreta Public Corporation.

The topographic maps at a scale of 1/30,000 used were made into map with 10m contour intervals in 1976 on the basis of aerial photographs taken in 1965 by the Department of Survey. Paraguaian Army (Instituto Geogratico Militar) and the Inter-American Surveying Service (inter-Americano Giodesico Servicio).

Topographic maps at a scale of 1/10.000 were drawn in 1976 at 2m contour intervals aerial photographs for

projects related to the Yacyreta Dam, on the basis of taken by the Yacyreta Public Corporation in 1972.

The difference of height in the survey area is about 20m, and the areas between EL 70m - 80m and EL 80m - 90m comes to about 70,000 ha, having an extremely gentle slope. Therefore, it may be impossible to make a precise plan of the drainage system using a topographic map at a scale of 1/50,000. It is necessary to raise the precision additional surveying.

5.9.2 Datum Point

There are two types of datum point in this area. One was established by the Department of Survey Paraguaian Army and another by the Yacyreta Public Corporation. The datum points established by Yacyreta Public Corporation are being used for planning the facilities for Yacyreta Dam and related agricultural development projects and for map making on a scale of 1/10,000. It will also be used for this project. Datum points are located along the center line of the Yacyreta Dam, the center line of Ita Ibate Dam, the access road and in the eastern area of the line connecting Santiago to Ayolas. However, there is no points west of a line connecting Santiago to Ayolas datum. Therefore, datum points shall be established in the future for investigations regarding agricultural development.

5.9.3 Data Collection and Site Reconnaissance of Datum Points

The location and elevation of the dam control point and datum points (39 points) along the right bank of the Parana River were collected by the Yacyreta Public Corporation in order to confirm the location and hight of the intake and other facilities. The location and elevation of the datum points are shown in Appendix Table 5-45.

In the field reconnaissance around the proposed point of the intake facility, confirmation of the location of the intake facility and the exsistence of survey piles was carried out. The proposed intake point was to be decided by verifying the point on the 1/10,000 map obtained from Yacyreta Corporation with the point surveyed from 2 datum points. However, the survey piles could not be found. The neighborhood is a flat with an elevation of about EL 82m.

5.9.4 Site Reconnaissance on The Triangulation Point in Survey Area

Site reconnaissance on triangulation points established by the Department of survey, Paraguaian Army in the survey area was carried out using topographic maps at scales of 1/250,000 and 1/50,000. The 6 triangulation points of Dionisio, Francisco, Santiago, Yabebyry Rita and Ayolas were confirmed. Triangulation points are fixed in concrete with their tops level with the ground and not well maintained. The point at Francisco is located nearby the access road and is inclined and it is supposed that the triangulation point was moved during road construction. There is preparatory point about 30m from the triangulation point, and shows the direction triangulation point by an arrow. Dimensions of the confirmed triangulation points are described in the following table and a sketch of the location is shown in Appendix Fig. 5-5.

Table 5-34

Triangulation point	Elevation on topographic map	Preparatory point	Established year
Dionsio	148 m	MR 2, $MRAZ^{2}$	1965
Francisco	177	$MRAZ^{1}$	"
Santiago	136	MR 1, $MR\ 2^{2}$	"
Rita	104	MR 1, MR 2, $MRAZ^{3}$	"
Yabebyry (SMC 2)	71	MR 1, $MRAZ^{2}$	1969
Ayolas (SMC 1)	81.2	$MR\ 2^{1}$	"

5.9.5 Establishment of Bench Marks at the Water Gauges and Graduated Water Gauges

Bench Mark Network will be established in order to join together between exsisting water level observatories and ones newly set up by the same elevation standard. This year, two B.M.S were established at recording water gauges along the Yabebyry River and the Atinguy River, and five B.M.S were established at graduated water gauges except for the Yabebyry River. Moreover, levelling was carried out. The datum points of Yacyreta Dam and the access road established by Yacyreta Public Corporation were used to establish B.M.S.

A third grade level was used for the survey method, and survey points were set up at 50m intervals and levelling was carried out in one cycle.

CHAPTER 6 ROUGH DETERMINATION OF PROJECT AREA

6.1 Rough Determination of Project Area

The area adjacent to the Yacyreta Dam, which is covered by this survey is, as stated in Chapter 5 Present Circumstances in survey area, the south-easten portion of a large triangular swampy zone approx. 1,500,000 ha connecting the confluence of Paraguay and Parana rivers, Asuncion (capital), and San Cosme y Damián. It is part of the Neembucú Swamp and consists of generally poorly drained zones.

With the construction of the Yacyreta Dam, the drainage condition of this area will not be improved, but, on the contrary, with the construction of the Ita Itate Dam (equalizing reservoin), the current water level of the Parana River will rise. In particular, this will largely affect the drainage of Yabebyry River.

The area adjacent to the Yacyreta Dam will cover a vast area if the area adjcent to the Ita Ibate Dam is included. However, judging from the results of the last aerial survey and field reconnaissance, the project area shall be limited to the east by the neighborhood of San Cosme y Damián reached by the Yacyreta Dam embankment on the right bank of Parana River, by the 90m contour line of the eastern and northern hills to the east and north, and by the road connecting San Ignacio and Yabebyry to the west. The southern boundary shall be the Yacyreta Dam's lot boundary (1 km from the center of the dam embankment) and the road connecting Ayalas and San Cosme, and southern boundary shall be the road connecting Ayalas and Yabebyry. Its size is 154,000 ha (See Fig. 4-1).

6.2 Philosophy for Rough Determination of the Project Area

6.2.1 Relationship to Location of Yacyreta Dam Embankment

The Yacyreta Dam has rather a strange shape if compared wit ordinary dams. The innundation of the adjacent area is avoided by extending the dam embankment along the right bank of Parana River. Consequently, the covered area is mostly at El. 60 - 80 m which is lower than the El. 84.5m planned flood level of the dam. Therefore the southern boundary of the area has been decided to be the lot boundary of the dam (1 km from the dam's centerline outward), while the east end to be the point where the dam embankment reaches the hill.

6.2.2 Boundary with East and North Hilly Zones

If viewed topographically, the elevation 90 - 80 m falls upon the transitional portion with a sudden change from hilly to flat zones. The hilly zone whose elevation is 90m or more is covered by terrarossa, already considerably developed, converted into farmland, and settled by cultivation, sowing and stockraising. Rivers flow into this area and the marshes (into which water comes in despite the existence of a river) are filled with water or poorly drained up to the elevation 90m.

If viewed from the drainage point of view, since the water level of the Intake facility near San Cosme y Damián is El. 82m, and considering the area to be, the irrigated shall be located less than El. 80m the canal gradient. However, the elevation 90m or so is included in the project area when the drainage improvement is studied. In this rough determination of the area, the elevation 90m

was made the boundary with the hilly zone because the contours on the available 1/50,000 topographical project maps were at 10m intervals. We included in the project area only 2 km or wider river valleys, etc. discarding smaller ravines.

6.2.3 West Boundary

The west side of the area extends in to the Great Neembucu Swamp from which similar swamps stretch to Paraguay River undistinguishable from water-covered zones. Therefore, the extent of the west boundary is a big problem in determinating this area. As also stated under in the chapter of Present Circumstances, the covering waters influence each other through several breakes in wooden bridges on the road connecting San Ignacio and Yabebyry. Nevertheless, in studying the agricultural development plan or this area, drainage improvement should be planned in any case. In such a study, the isolation of the west side from outside by constructing a dike should be an idea for drainiage improvement. The flow of Pikyry River flowing into the central inundated zone is larger than that of Yabebyry River, adjusted for the inundated area. If a road or so is newly constructed ructed outside of the catchment area of the Pikyry and Yabebyry rivers, the area west to the road connecting San Ignacio and Yabebyry would conceivably suffer from deteriorated drainage due to the decreased adjusting effect by water coverage. In order not to adversely affect the area west to the San Ignacio-Yabebyry Road by the drainage plan, the west boundary in this survey should be studied to make the existing said road into the boundary. Therefore, this road was made the west boundary.

6.2.4 South Side of Area

The south side is currently a natural dike of the Parana River, along which some forests remain. Since the submerging line of the Ita Ibabe Dam will reach into the neiboughhood of the existing Ayalas-Yabebyry Road and the Ayalas-San Cosme y Danian Road, these two roads have been made the southern limit of the survey area. However, both sides of the Ayalas-Yabebyry Road are laleady developed with many scattered farmhouses. Since some of the farmhouses will be obliged to move partly in connection with the submersion by the Ita Ibate Dam, the area has been roughly demarcated temporarily by making the road the boundary.

6.2.5 Matters Studied and Problematic Points

Matters studied and problematic points in roughly determinating the area re listed up as follows:

1) Topographical map

The topographical maps locally obtained are 1/50,000 maps covering the whole area published by the Department of Survey, Paraguaian Army (I.G.M.). As stated in Chapter 5, however, their contour lines are at 10m intervals. Since most of the area is flat, the contours at 10m interval do not tell the topographical features. However, we have obtained from the Yacyreta Public Corporation 1/10,000 topographical maps (contours at 2m intervals) for the east side up to Atinguy River. Therefore, the future survey plan can be worked out for this area.

Nevertheless, for the side west up to the Atinguy River, it will be difficult to make the future irrigation/drainage plans solely using I.G.M.'s 1/50,000

topographical maps, because the topography on the flat portion is still unknown. Before pushing the survey to the western portion, it is necessary to prepare topographical maps with contours at 2m intervals by surveying the ground levels by the depth survey of water-covered zones. This will invalue an enormous amount of work.

2) Irrigation

The intake facility of the Yacyreta Public Corporation is planned to be located near San Cosme y Damián taking water at an elevation of 82m. If the irrigation canal is constructed along the hilly portion, its length would be about 50 km to reach as far as the access road (1-B) which runs through the central portion. Even assuming a canal gradient of 1/4,000, the head loss will be more than 12.5m, the water level at this point will be lower than 70m, and the irrigation by gravity will be difficult for the side east of the access road (1-B). The area east of the access road is 68,000 ha up to the elevation 90m, and 61,000 ha up to the elevation 80m.

However, if the water of smaller rivers flowing into the area are stored for utilization, some irrigation would be possible for the west side, too.

3) Drainage

As stated under 6.2.3, it is a big problem to determine the extent of the western boundary. The area covered by the 1/10.000 topographical maps obtained is the side east of the access road (1-B), and in the catchment areas of Atinguy River and artificial drainage canals, whose basins are 785 km^2 and 248 km^2 respectively totaling 1,033 km . The size of the east area at the access road 1-B is 68,000 ha, of which the area covered by water is 13,000 ha or about 19.2%.

Considering altogether the area for which the irrigation by gravity is feasible as stated under 2), the drainage condition mentioned above, and the status of topographical maps, it would be a tentative plan to determinate the area near the access road (1-B). This matter should be studied in the future.

The plan to determinate in the side east or the access road (1-B) is as already stated in 6.2.3. The sizes of basins of Yabebyry River and Yaguary River in the side west to the access road (1-B) are 1,520 km^2 and 38 km respectively totaliing 1,558 km^2. The size of the area is larger 86,000 ha, 52.3% or more than half of which is covered by water.

6.3 Matters to be Surveyed in Future

6.3.1 Military Reservation

There are zones near Ayolas and Yabebyry in the survey area, which are currently controlled by the Army as military reservations. In this survey, however, due to inavailability of materials connected to land ownershiop, neither their locations nor sizes were known, but they are included in the roughly determinated areas. Therefore, it is necessary to adjust for them in future surveys.

6.3.2 Wild Life Sanctuary

For protecting the wild life on Yacyreta Island, a 100 ha provisional snactuary is currently established near the mouth on the right bank of Atinguy River. It is planned to establish another sanctuary in the future covering approx. 10,000 ha extending from the source of the Yabebyry River toward the north-west, though its exact size, location, etc. are yet to be determined. There may

be a case where some portion of the area could be excluded if it becomes a sanctuary.

6.3.3 Access Road

At present there is a road (non-paved) between Ayolas and Yabebyry. An access road for the Ita Ibate Dam is planned by the Yacyreta Public Corporation. Though the survey of its center line has been finished, its alignment plan is still under study. The soutern boundary from Ayolas to Yabebyry will be subject to restudy according to the result.

Further, farmhouses scattered along this road will be affected by the submerging by the Ita Ibate Dam. It is necessary to reorganize and redevelop them in accordance with a plan for relocating farmhouses and lands submerged. Whether or not they are to be included in this project should be determined.

6.3.4 Zone Covered by Water

Of the survey are (154,000 ha), 38% or 58,000 ha zone is always covered by water. Some of its portions are possibly as deep as 4 - 5 m according to the sounding survey. Though a detailed survey could not be made have, it is necessary to determinate the scope of the future survey by the consulting the results of a depth survey.