

are there the sites of borrow pit, materials yards, and residences for the working class now under plan by the Yacyreta Public Corporation. That section of district which encompasses these planned sites is excluded from the plan.

4) The right bank of the Yacyreta Dam

The project area is demarcated to border on the right bank of the Yacyreta Dam to the southeast. The Yacyreta Public Corporation is planning to use as a borrow pit the area within one kilometer of the axis of the dam on the right bank side. This planned borrow pit site, from which earth and sand will be dug out for use in embankment construction, is designed in a plan as the site of catch canal. Accordingly, some coordination with this catch canal plan is necessary to proceed with our general agricultural plan.

6.1.3 Land classification

Land classification represents classification of land by the degree of fitness to the production of farm products between ranks or grades determined by certain criteria. This requires grasp of the various conditions of the land to be classified. Consequently, land classification is a very indispensable task in the design of an agricultural plan.

The project area was subjected to assessment in terms of fitness to the requirements of a paddy field and upland field on the basis of factors of topology and the soil, with the current condition of vegetation and land utilization taken into account as a reference, and classified by the following; 1) soil productivity, 2) the safety of land, 3) the easiness of the land with which the execution of a development plan is achieved, and 4) the land utilization potentially as considered from the viewpoint of natural condition. Table 6-1-1 illustrates a flowchart of the method of land classification. For detail, refer to the Appendix.

(1) The requisitions of land classification

1) Level of agricultural technology

The farming program in question entails employment of high levels of farming technology in the application of fertilizers and the attainment of mechanization.

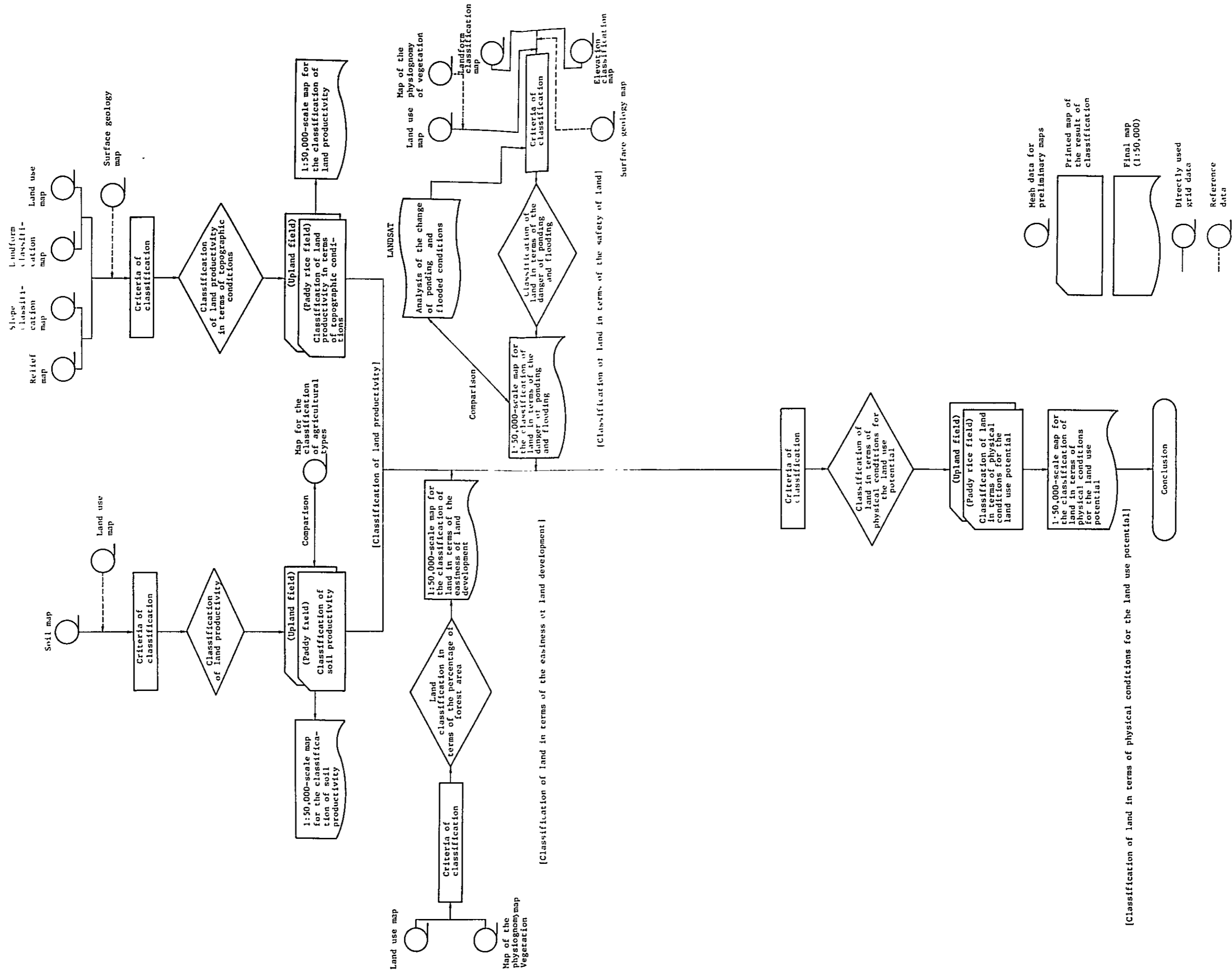


Fig. 6-1-1 Process of Land Classification

Table 6-1-1 Standard Properties by Soil Classification

Soil course	Soil color	Mottling	Cray	Moisture	Cohesion degree	Compactness	Nums (H ₂ O)	pH (H ₂ O)	pH (KCl)	Electrical conductance	Ex. Ca	Ex. Mg	Ex. K	Ex. Na	Al	CEC	Degree of base saturation	Effective phosphor	Particle size component			Name of soil textures		Remarks	
																			C	Si	S	Japan	USDA		
Surface course	10YR 7/3	-	-	Semi wet	Non	Sparse	Non															SL	3 sections		
Lower course	"	Exist	-	Wet (within 1 m)		"	"															SL			
Surface course	7.5YR 4/2	-	-	Semi wet	Weak	21	0.67	4.7	3.6	0.0	2.6	0.82	0.06	0.0	1.4	7.4	47	2		17.9	23.6	38.5	CL	12 sections	
Lower course	"	Exist	G	Very wet (within 50 cm)	Weak	18	0.38	4.8	3.6	0.0	2.7	0.86	0.06	0.0	2.3	9.9	37	1		22.2	20.7	37.0	CL	SCL	
Surface course	7.5YR 4/2	-	-	Wet	Medium	19	0.98	4.7	3.5	0.0	2.8	0.80	0.09	0.0	1.5	15.0	25	3		25.9	26.9	47.2	Lic	12 sections	
Lower course	10YR 5/2	Contained	G	Very wet (within 50 cm)	Strong	18	0.50	4.7	3.3	0.0	2.9	0.90	0.06	0.0	3.4	14.8	26	1		36.5	23.2	40.3	Lic	CL	
Surface course	10YR 4/3	-	-	Dry	Weak or non	15	0.52	5.1	4.2	0.07	2.7	0.77	0.07	0.2	0.6	7.0	53	2		16.7	16.2	67.1	SCL	SL	12 sections
Lower course	"	-	-	Semi wet (under 1 m)	Weak	14	0.29	5.1	4.0	0.07	2.6	0.81	0.06	0.1	0.8	5.6	64	3		18.0	16.4	65.6	SCL	SL	
Surface course	7.5YR 4/3	-	-	Semi wet	Medium	24	0.61	4.9	3.8	0.0	2.5	0.75	0.06	0.0	0.8	22.7	15	1		24.5	29.9	65.6	CL	1	3 sections
Lower course	"	Exist	-	Wet (within 1 m)	Medium	21	0.42	5.6	4.1	0.04	2.8	0.96	0.06	1.2	1.7	16.3	31	1		34.3	21.0	44.7	Lic	CL	
Surface course	7.5YR 3/1	-	-	Wet	Weak	22	1.08	5.0	3.7	0.0	2.8	0.83	0.07	0.0	0.8	13.3	28	2		21.1	23.5	55.4	CL	SCL	2 sections
Lower course	10YR 4/3	Exist	G	Very wet (within 50 cm)	Weak	12	0.21	5.7	4.2	0.3	2.8	0.84	0.04	0.5	0.2	10.1	41	2		31.1	11.9	57.0	SC	SCL	
Surface course	7.5YR 4/2	-	-	Semi wet	Medium	24	0.73	4.7	3.6	0.05	2.7	0.84	0.08	0.05	1.6	12.2	30	2		23.1	28.0	48.9	CL	L	15 sections
Lower course	"	Contained	G	Wet (within 1 m)	Medium	22	0.33	4.8	3.5	0.01	2.8	0.88	0.05	0.07	3.4	11.9	32	1		31.9	20.2	47.9	Lic	SCL	
Surface course	5YR 4/6	-	-	Semi wet	Medium	22	0.86	5.2	4.1	0.01	2.7	0.84	0.13	0.02	0.4	10.4	35	1		29.2	27.3	41.5	Lic	CL	4 sections
Lower course	2.5YR 5/8	-	-	Semi wet (under 1 m)	Strong	20	0.49	5.3	4.1	0.0	2.9	0.93	0.12	0.1	0.7	10.6	38	1		36.7	22.9	40.4	Lic	CL	

Table 6-1-2 Criteria for the Classification of the Productivity Potential

Class	Criteria																									
Class 1	Land which is considered to be a good cultivable land without much or any pedologically limiting or inhibiting factors for the reasonable harvesting and soil control or any danger of deterioration of soils																									
Class 2	Land which is considered to have some pedologically limiting or inhibiting factors for the reasonable harvesting and soil control or some danger of deterioration of soils																									
Class 3	Land which is considered to have substantial amount of pedologically limiting or inhibiting factors for the reasonable harvesting and soil control or considerable danger of deterioration of soils																									
Class 4	Land which is considered to present extreme difficulties to be used as a cultivated land because of very large pedologically limiting or inhibiting factors for the reasonable harvesting and soil control or because of the very large danger of deterioration of soils																									
Items	Symbols	Class																								
		I						II						III						IV						
		Paddy field		Upland field				Paddy field		Upland field				Paddy field		Upland field				Paddy field		Upland field				
	Paddy rice	Upland field crops	Ordinary crops	Mulberry	Tea plant	Fruit trees	Paddy rice	Upland field crops	Ordinary crops	Mulberry	Tea plant	Fruit trees	Paddy rice	Upland field crops	Ordinary crops	Mulberry	Tea plant	Fruit trees	Paddy rice	Upland field crops	Ordinary crops	Mulberry	Tea plant	Fruit trees		
Thickness of surface soil *1	I	25cm-15cm	Thicker than 25 cm				Less than 15cm	25-15cm				Less than 15cm				Less than 15cm										
Depth of effective soil horizon	d	100cm-50cm	Thicker than 100cm				50-25cm	100-50cm				25-15cm	50-15cm	50-25cm				Less than 15cm		Less than 25cm						
Gravel content of surface soil *2	R	Less than 20%	Less than 5%	Less than 10%	Less than 20%	Less than 20%	10-50%	5-20%		10-20%		10-50%	20-50%	10-50%		More than 20%				Greater than 50%	Greater than 20%		More than 50%			
Easiness of cultivation *3	P	Easy to cultivate and cruch						Slightly difficult to cultivate and cruch						Difficult to cultivate and harvest												
Wetness of land *4	w	Little or not danger of too much or too little soil moisture						Moderate danger of too much soil moisture						Much danger of too much soil moisture						Great danger of too much soil moisture						
	(w)							Moderate danger of too little soil moisture						Much danger of too little soil moisture						Great danger of too little soil moisture						
Water permeability after submergence *5	I	Low to medium						High						Ex-treme-ly high												
Oxidation and reduction *6	r	(a1)						(a2)						(a3)												
Natural fertility *7	f	High						Moderate						Low												
Nutrient content *8	n	High						Moderate						Low												

(a1): Small damage to paddy rice due to weak reduction.

(a2): Considerable amount of damage to paddy rice due to progressive reduction.

(a3): Great damage is caused or expected to paddy rice due to the extremely high reduction.

Remarks:

*1:

- *2: 1) The content shows a percentage of an area of gravel in the soil profile.
2) For paddy field with the gravel content of 10 to 50%, ordinary crops of 5 to 50%.

Mulberry and tea plant of greater than 50% and fruit trees or greater than 10%, their classes will be determined after the consideration of the gravel size, degree of weathering, and the amount of gravel content.

*3: Determined from the soil texture, Stickiness and the hardness of air-dry soils.

*4: Determined from the permeability, water holding capacity, and wetness (soil moisture condition prevailing throughout the year).

*5: Determined from the soil texture and Compactness of soils 50 cm from the surface.

*6: Determined from the degradable organic material content, free oxidized iron content and the degree of gleyzation.

*7: Determined from the cohesiveness and the base status of soils.

*8: Determined from among the variables considered to be specially important in a given area, including the exchangeable lime, magnesia, potassium content, effective phosphorus, nitrogen, silicic acid content, minor element content and acidity.

Table 6-1-3 Classification standards Based on Classification Standard of Productivity

Soil classification	Land utilization type	Synthetic grade	Thickness of surface soil	Depth of effective soil layer	Gravel content of surface soil	Ease of tilling	Humidity of soil	Permeability of inundation	Oxidation and reduction	Fertility	Nourishment
Coarse regosol	Paddy field	III	II	I	I	I	-	II	I	II	III
	Upland field	III	III	I	I	I	III	-	-	-	III
Fine regosol	Paddy field	III	I	I	I	II	-	I	II	III	III
	Upland field	III	II	I	I	II	II	-	-	-	III
Coarse gleysol	Paddy field	III	I	I	I	I	-	II	II	III	III
	Upland field	III	II	I	I	I	II	-	-	-	III
Fine gleysol	Paddy field	III	I	I	I	II	-	I	II	III	III
	Upland field	III	II	I	I	II	II	-	-	-	III
Plysol	Paddy field	III	I	I	I	II	-	I	II	III	III
	Upland field	III	II	I	I	II	II	-	-	-	III
Humic plysol	Paddy field	III	I	I	I	I	-	I	II	II	III
	Upland field	III	II	I	I	I	III	-	-	-	II
Acrisol	Paddy field	III	I	I	I	II	-	I	I	II	III
	Upland field	III	II	I	I	II	I	-	-	-	III
Fulgysol	Paddy field	III	II	I	I	I	-	II	I	I	III
	Upland field	III	III	I	I	I	II	-	-	-	III

Note: As Fulgysol is not analyzed, the analysis value is supposed to be same as coarse regosol.

2) Transportation requirements

As a consequence of execution of the land consolidation works, the road networks will be improved and local traffic differentials dissolved. Therefore, in the classifications made in the project no traffic requirements were considered.

(2) Land classification

1) Classification of soil productivity

The soil of the project area was assessed through examination of the average properties of the soil determined as a result of the analytical study of sampled soil from the area, as summarized in Table 6-1-1, and classified as shown in Table 6-1-3 in accordance with the standards for the classification of potentiality of productivity (by the Farm Products Division of the Ministry of Agriculture and Forestry, 1961) of Table 6-1-2, which is employed in Japan. Furthermore, the classifications by this Japanese standards were corrected with the characteristics of the soil proper to the conditions of the project area such as soil texture, cation exchange capacity, soil color, soil mottled pattern, and underground water level. The corrected classifications are as shown in Table 6-1-4.

Table 6-1-4 Classification of Soil Aptitude

Aptitude class	Grading		Aptitude	Soil
	Grade	Points		
1	A	12	High	Coarse regosol Plysol Acrisol
2	B	11, 10	Rather high	Fine Gleysol Plysol
3	B	9	Medium	Coarse gleysol
4	C	8	Low	Coarse regosol Fulgysol

Aptitude class	Grading		Aptitude	Soil
	Grade	Points		
1	A	12	High	Acrisol
2	B	10	Rather high	Fine regosol Plysol
3	C	9	Medium	Coarse regosol Fine gleysol
4	C	8, 7	Low	Coarse gleysol Plysol Fulgysol

The standards for the classification of soil productivity have been established, as shown in Table 6-1-6, from a standpoint of topological conditions with respect to relief energy, determined in accordance with the standards for the classification of gradient as shown in Table 6-1-5, classifications of farming pattern, and topological classifications while taking into account the easiness of the land with which the project for mechanical work is executed rated on the basis of the state of topological factors (slope, reliefs).

Table 6-1-5 Classification Standards of Reclaimed Paddy Field and Upland Field in Japan (Slope)

Grade Item	I	II	III	IV
Reclaimed paddy field	0 ~ 35'	35' ~ 3°	3° ~ 8°	8° or more
Reclaimed upland field	0 ~ 3°	3° ~ 15°	15 ~ 30°	30° or more

The results of classification of soil productivity conducted with respect to the area, with the condition of topological features of the area studied and assessed from an overall standpoint, area graphically represented, plotted according to the standards of Table 6-1-7. In Figs. 6-1-2 and 6-1-3 respectively designed for a paddy field and upland field.

Table 6-1-6 Classification of Land Productivity by Topographical Conditions

Sub- ject	Fun- damen- tal data	Rank		
		I	II	III
Paddy field	Slope	Less than 1°	1 ~ 3°	Over 3°
	Relief	Less than 5 m	5 ~ 15 m	Over 15 m
	Topogra- phical classi- fication	Hinterland marsh	Alluvial area Gentle alluvial fan	Hills Shallow vallery of hills Natural embankment Slight high land (high, low) Old river channel River side lowlands Sandbar River, pond
Upland field	Slope	Less than 3°	3 ~ 8°	Over 8°
	Relief	Less than 1.5 m	15 ~ 20 m	Over 20 m
	Topogra- phical classi- fication	Hills Natural embank- ment Slight high land (high)	Shallow of vallery of hills Alluvial area Gentle alluvian fan Slight high land (low) Sandbar	Hinterland marsh Old river channel Riverside lowlands River, ponds

Table 6-1-7 Classification Standards of Land Productivity

Rank	Details of ranking	Paddy field		Upland field	
		ductivity	Land productivity by topographical conditions	Land productivity	Land productivity by topographical conditions
1	High land use potential as paddy fields and upland fields	I	I	I	I
2	Comparatively high land use potential as paddy fields and upland fields	I II	II I,II	I II	II I,II
3	A little low land use potential as paddy fields and upland fields	I II III	III III I,II,III	I II III	III III I,II,III
4	Low land use potential as paddy fields and upland fields	I II III IV	IV IV IV I,II,III,IV	I II III IV	IV IV IV I,II,III,IV

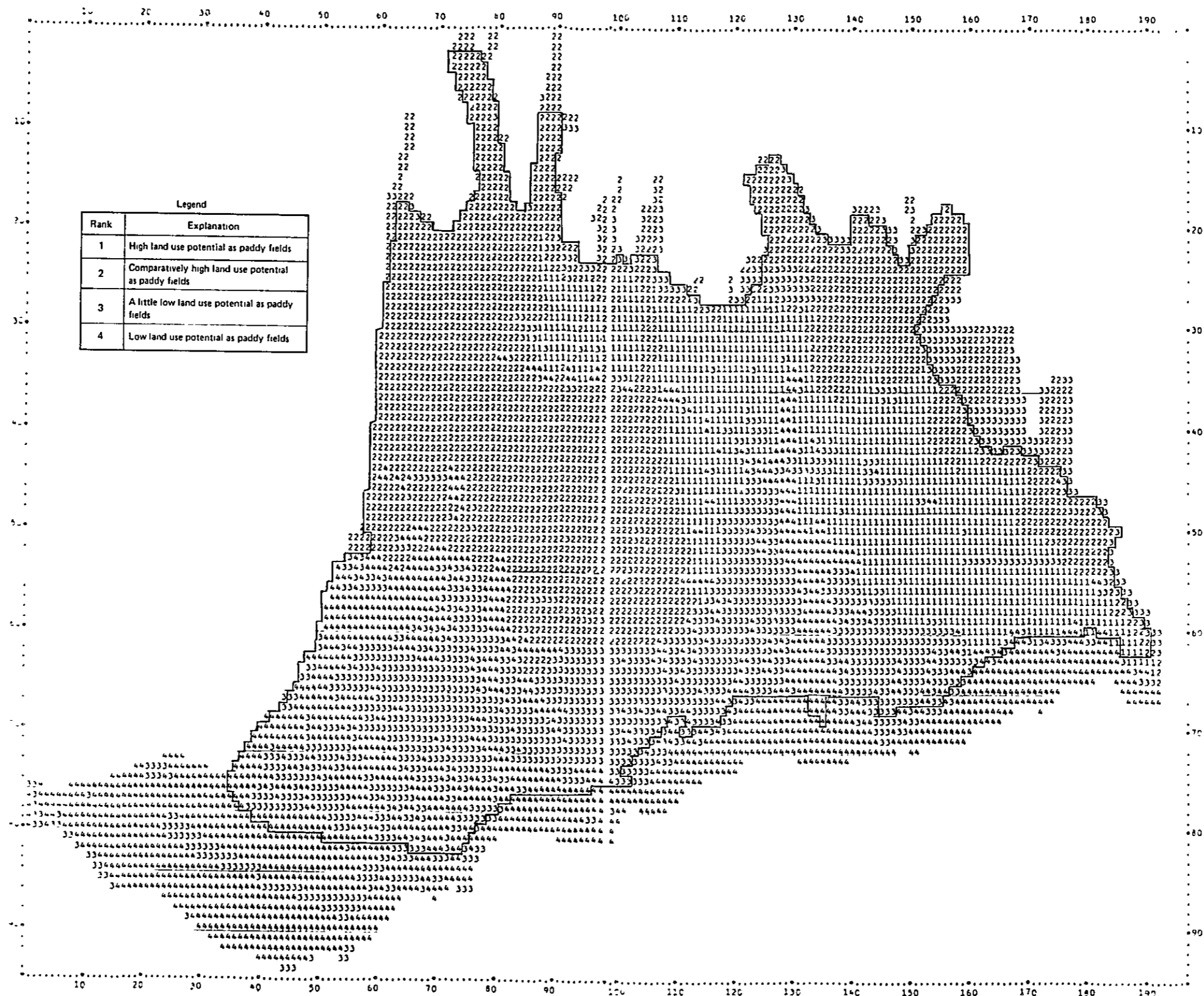


Fig. 6-1-2 Map for the Classification of Land Productivity (paddy fields)

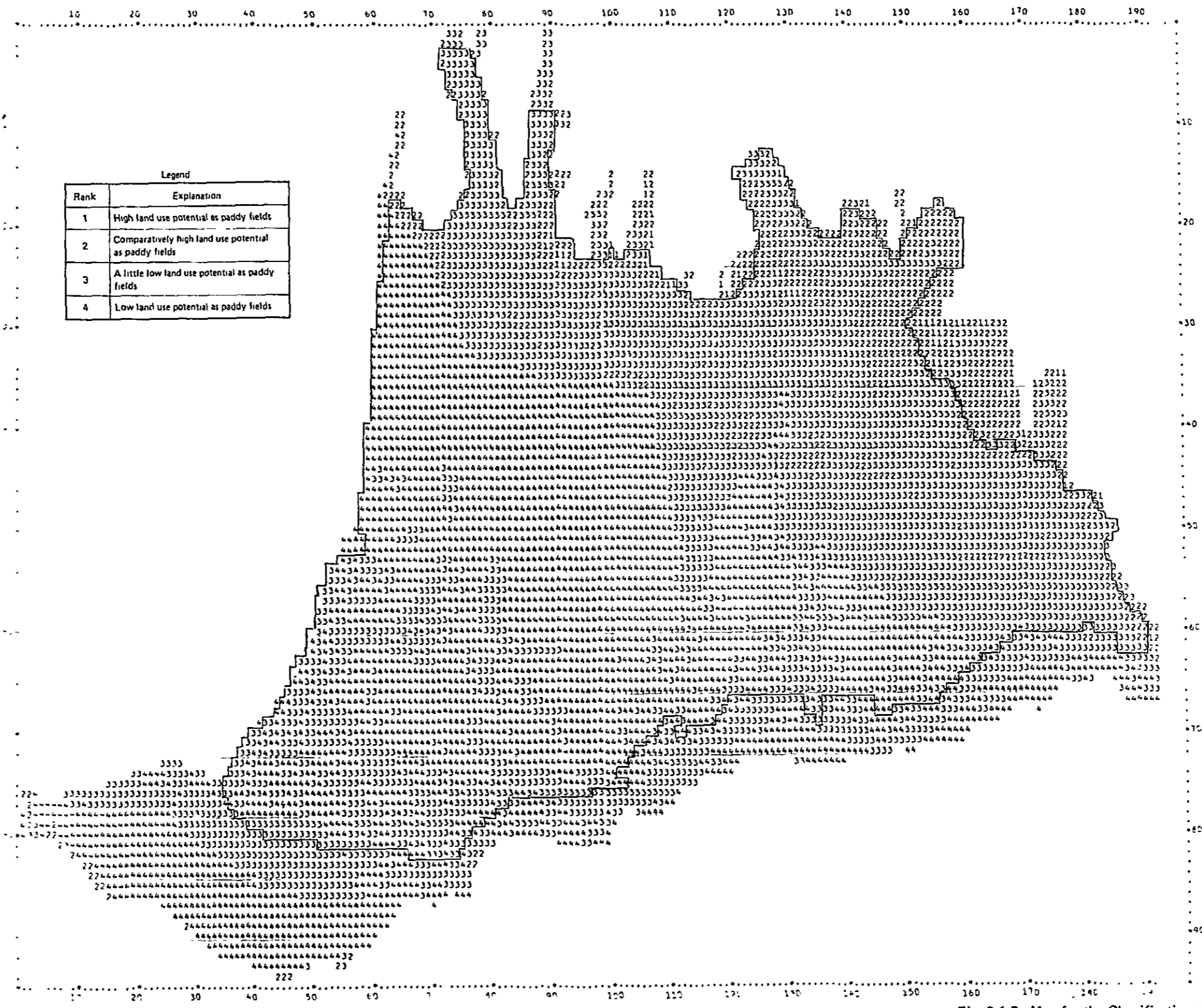


Fig. 6-1-3 Map for the Classification of Land Productivity (crop fields)

2) Classification of the safety of land

Land is subject to risks of inundation and flooding due to topological conditions, and these problems were considered with respect to the area on the basis of topological classifications, classifications of elevation, existing condition of land use, and the studies of cases of inundation of the seven times reported by LANDSAT. The results of classification conducted in accordance with the standards of Table 6-1-8, are graphically represented in Fig. 6-1-4.

Table 6-1-8 Ranking standards of Dangerousness of Flooding

Rank Fundamental data	Safe ←————→ Danger		
	1	2	3
Topographical classification	Hills Shallow varley of hills Natural embankment Slight high land (high and low)	Alluvial area Gentle alluvial fan	Hinterland marsh Old river channel River side lowlands Sandbar River, pond
Elevation	Over 90 mm	80 ~ 90 m	Less than 80 m
Land utilization	Natural trees Artificial trees Dry grassland Artificial grassland Upland field Others()	Paddy field	Wet grassland March River, pond

3) Classification of the easiness of development of land

Table 6-1-9 shows the standards for the classification of the easiness of the land with which the land is developed or cleared with the surface obstructs (roots, stumps), which classification is conducted with the local specifics taken into account. Fig. 6-1-5 shows graphically the results of this classification made with respect to the area.

Table 6-1-9 Ranking by Ease of Land Development

Rank	Details of ranking	Ranking standards by forest area rate (500 m × 500 m/)
4	Very difficult	Forest area rate over 50%
3	Comparatively difficult	Forest area rate 10 ~ 50%
2*	A little difficult	Forest distributing area by potential vegetation
1	Comparatively easy	Forestless area

*Rank 2 is forestless area at present, where forest tends to distribute potentially from a viewpoint of plant ecology. Namely, it correspond to areas for embankment etc.

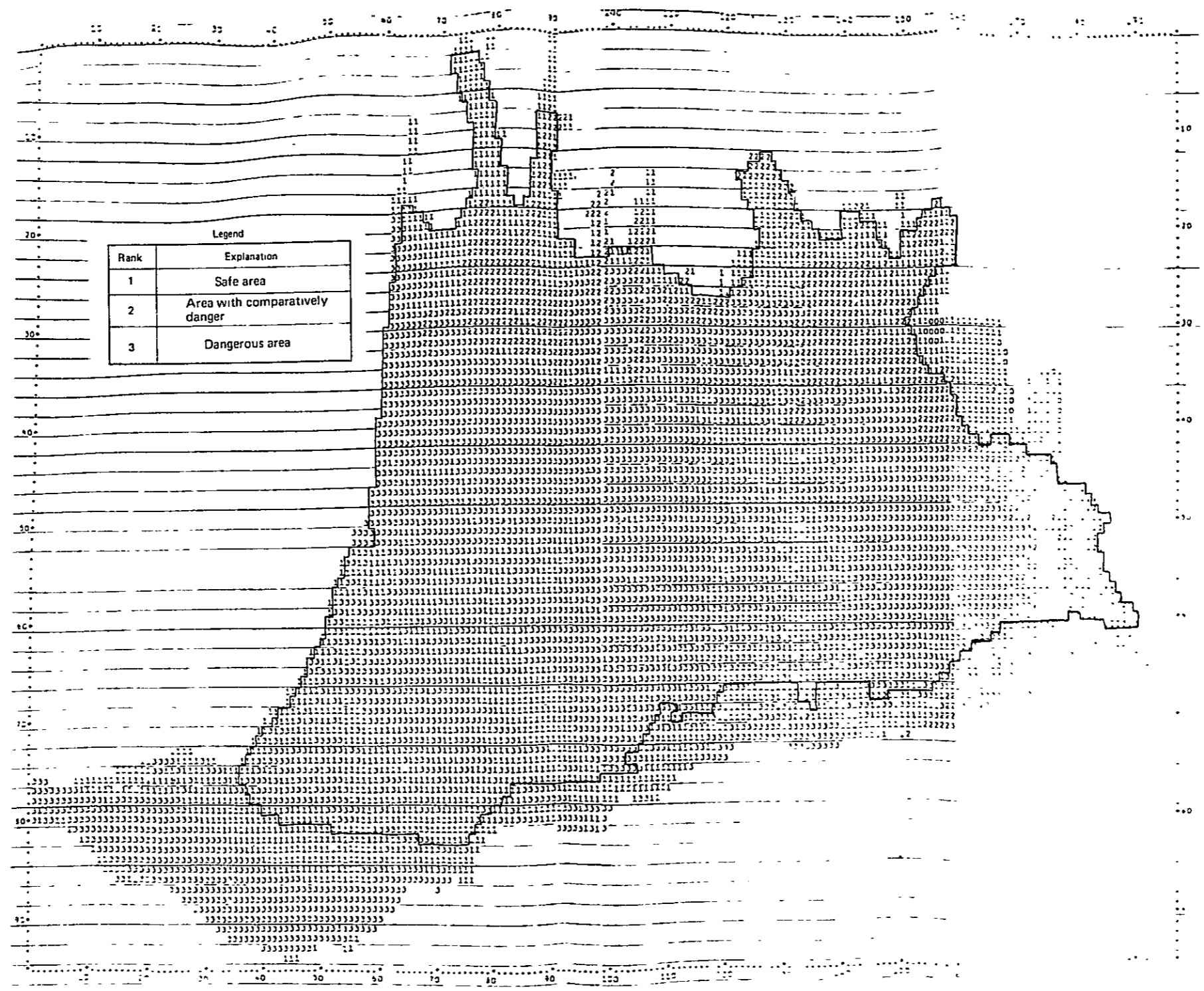


Fig. 6-1-4 Map for the Dangerous Classification of Ponding and Flooding

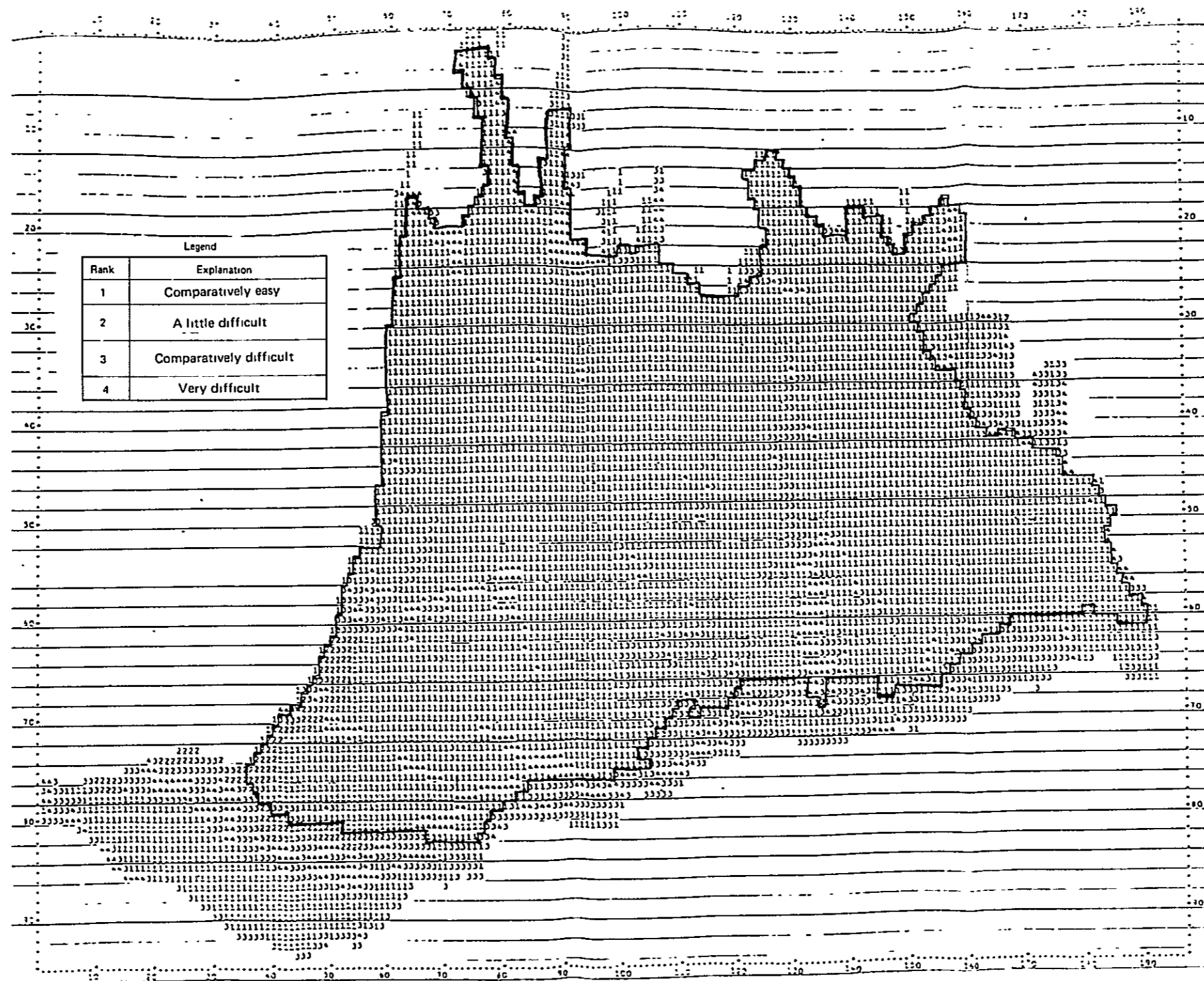


Fig. 6-1-5 Map for the Classification of Land Agricultural Development Difficulty (forest clearance)

4) Land utilization capability from viewpoint of natural potentiality

The land utilization capability ranked by item is conformed, and aptitude ranking for paddy field and upland field use is performed as ranking standard by land category (Table 6-1-10). The results are shown in Fig. 6-1-6 and 6-1-7.

Table 6-1-10 Classification Standard of Land Category

Rank	Details of ranking	Paddy field			Upland field		
		Ranking results of land productivity	Ranking of safe of land	Ranking by ease of land development	Ranking results of land productivity	Ranking of safe of land	Ranking of ease of land development
1	High land use potential as paddy fields and upland fields	I	I,II	I,II,III	II I	I I,II	I,II,III I,II,III
2	Comparatively high land use potential as paddy fields and upland fields	I I II	III I,II	I,II,III IV I,II,III	I I	III II	I,II,III IV
3	A little low land use potential as paddy fields and upland fields	II II III	II I,II	I,II,III IV I,II,III			
4	Low land use potential as paddy fields and upland fields	III III IV	III I,II I,II	I,II,III IV I,II,III			

a. Capability ranking of paddy field use

- ① The area classified in "Rank 1" is distributed merely over the southern Bolf farm and Cemirrite farm located in the east survey area, as well as the southern Lomita farm. As these areas are presently used for paddy field, it is reasonable ranking.
- ② The area classified in "Rank 2" is distributed from the east to the north-west survey area, which is presently paddy field, swamp etc.
- ③ The area classified in "Rank 3" is rather concentratedly at the central to northern part on the west of the survey area. This area is flooded normally with wet grassland distributed extensively so that it is scarcely used for farm land.
- ④ The area classified in "Rank 4" is distributed along natural embankments of Parana, Yabebyry and Atinguy River as well as bottom land and sandbar of Parana River, which is presently forest and partly used for upland field.

b. Capability ranking of upland filed use

- ① The area classified in "Rank 1" is distributed merely over hills of the east survey area, which is presently artificial grassland and dry grassland and partly used for upland field.
- ② The area classified in "Rank 2" is distributed over natural embankment and micro relief along Parana River, as well as Piedmont along hills, particularly distributed over natural embankment along Parana River in bulk. Presently these areas are used for dry grassland and upland field.
- ③ The area classified in "Rank 3" is distributed over valley bottom plain, alluvial fan, micro relief etc. of the surrounding of hills, which is presently dry grassland, wet grassland, forest etc.
- ④ The area classified in "Rank 4" is distributed widely from the central east side though the central west side, as well as bottom land of Parana River, which is mainly wet grassland and swamp.

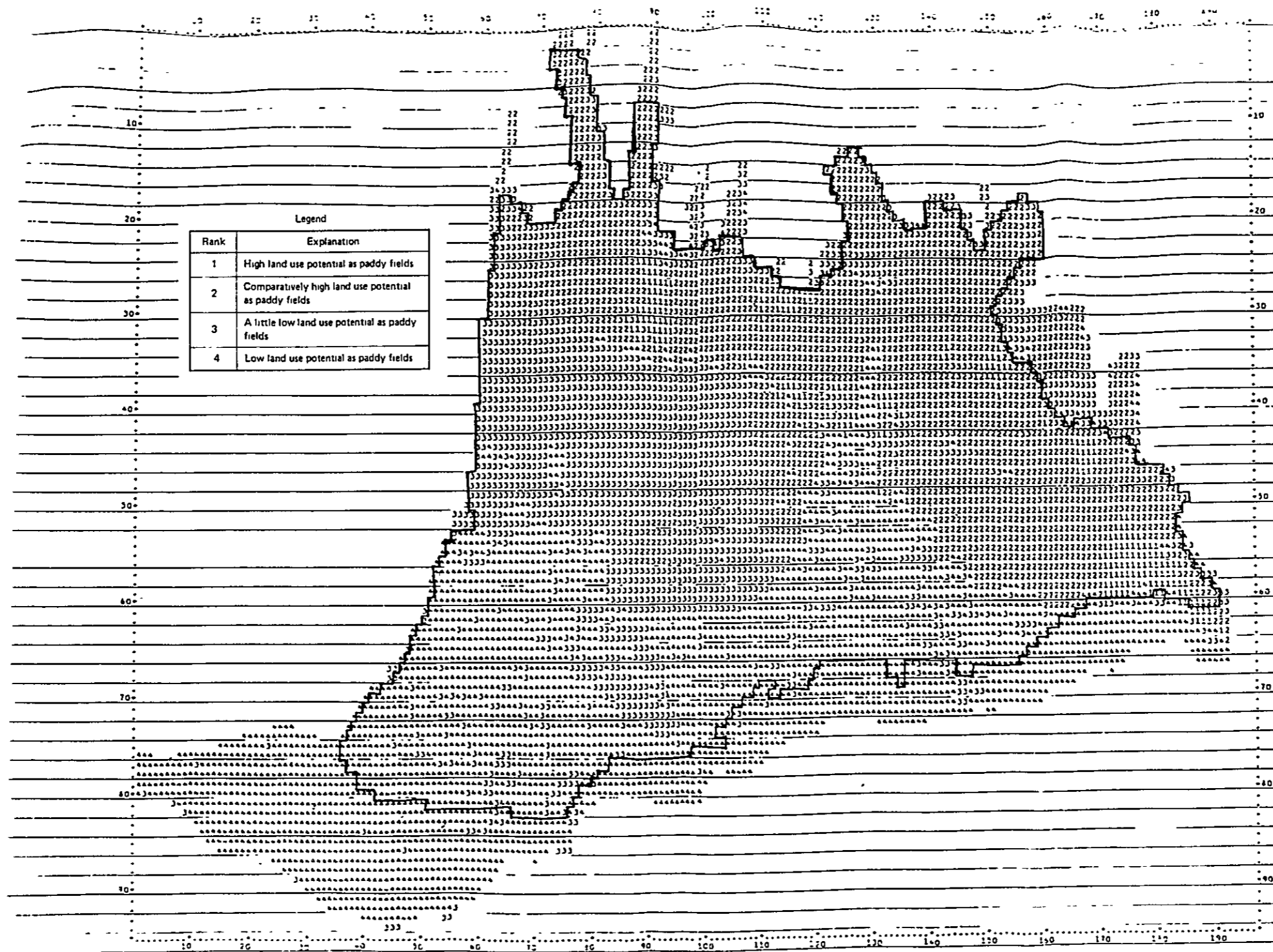


Fig. 6-1-6 Map for the Classification of Land Use Potential of Physical Conditions (Classification for Land Use Potentiality as Paddy Fields)

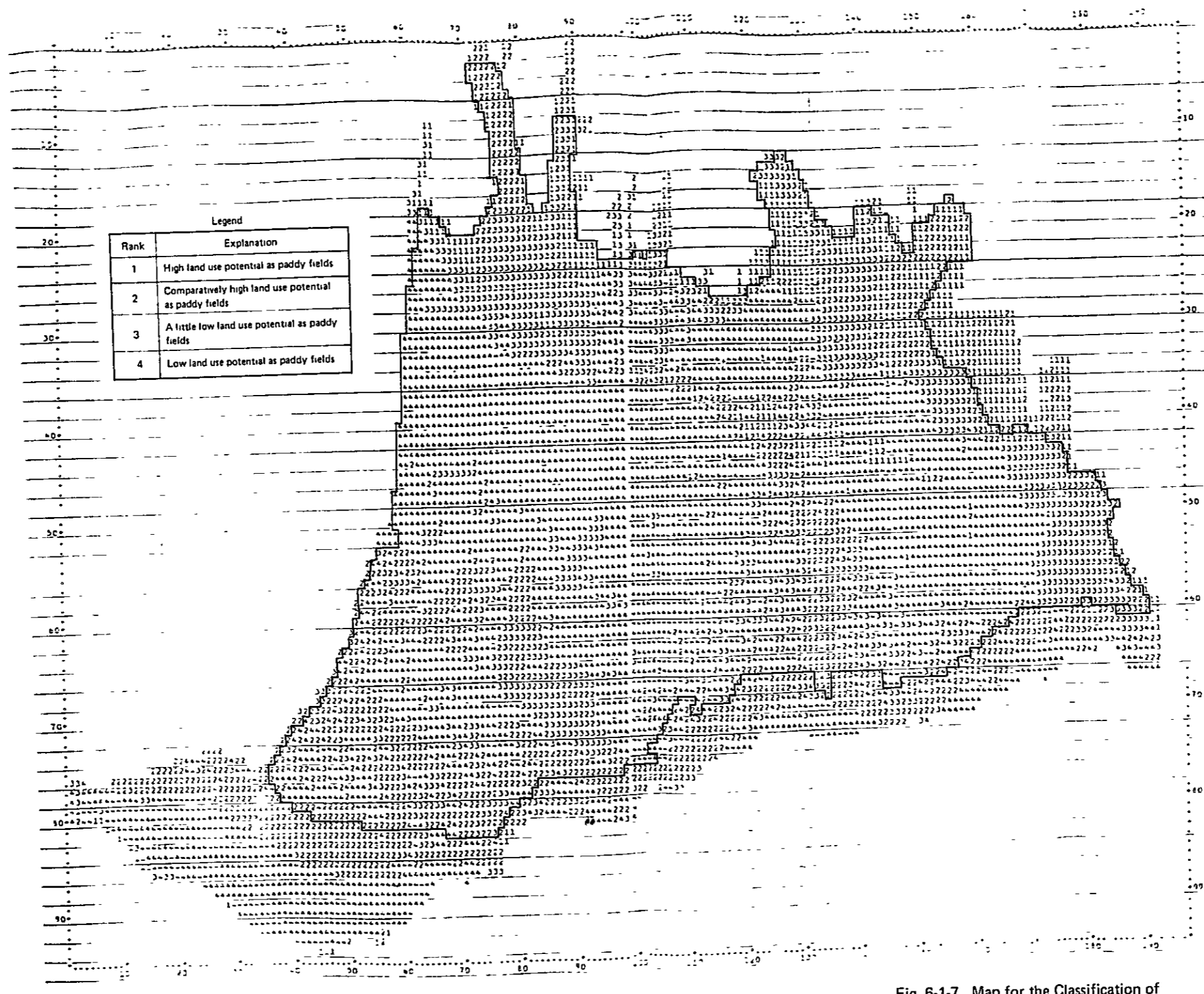


Fig. 6-1-7 Map for the Classification of Land Use Potentiality of Physical Conditions (classification for land use potentiality as crop fields)

5) General classification

Table 6-1-11 shows the standards for the classification of the land use potential synthesized with respect to paddy rice fields and upland fields. Fig. 6-1-8 shows graphically project area classified according to the standards of Table 6-1-11.

Table 6-1-11 Synthetic Land Utilization Possibility

Index number	Details	Relation between ranking of paddy field utilization possibility and ranking of upland field utilization possibility
1	High land use potential as paddy fields and crop fields	I ----- I,II II ----- I,II
2	Comparatively high land use potential as paddy fields and crop fields	I ----- III,IV II ----- III,IV
3	A little low land use potential as paddy fields and crop fields	III ----- I,II IV ----- I,II
4	Low land use potential as paddy fields and crop fields	III ----- III,IV IV ----- III,IV

Notes.

1. The area marked by code "1" in the table represents the area distributed in the hillylands and the colluvial slopes that flank the hillylands in the northern and eastern section of the area. Some of this area have been turned into dry grassland while others into upland fields.
2. The area coded "2" is the area that deminate a very wide part encompassed by the eastern to northwestern section of the area. The majority of this area form wet grasslands with some patches used as paddy fields.
3. The area coded by "3" is the area including the natural levees situated on the river, the slightly elevated areas, and the part of the hillylands. This area represents for the most part forests and dry grassland with some patches turned into upland fields.
4. The area "4" represents the area including the belts of marshes lying behind the natural levee and the parts equated with the mid western to north section of the area. This area is characterized by extreme inundation and has a wide distribution of wet grassland. The Parana Rive, the Yabebyry River, and the Atinguy River have their river side lowlands placed within the scope of the area "4".

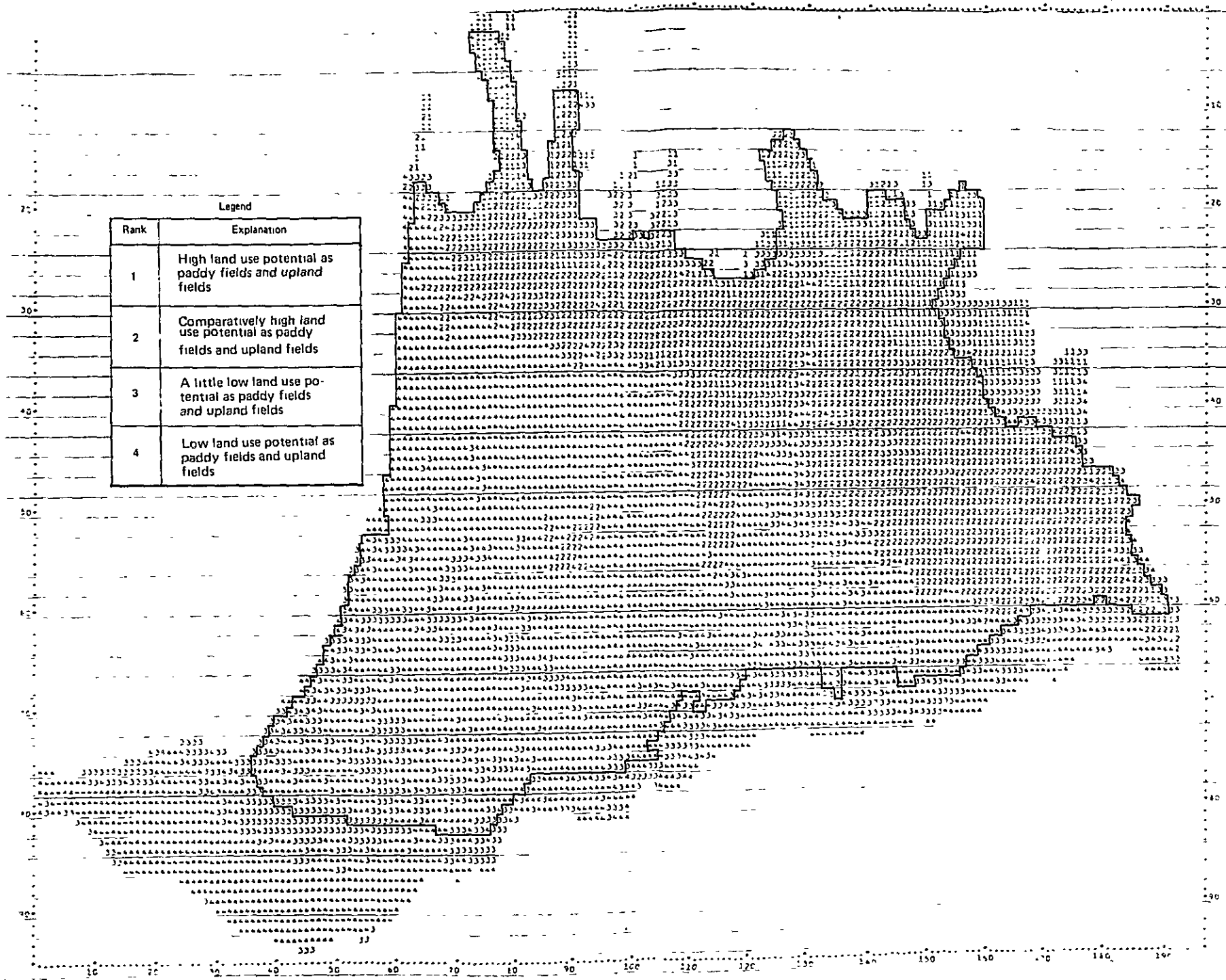


Fig. 6-1-8 Map for the Overall Classification of Land Use Potentiality

(3) Land aptitude rate by land utilization types

1) Aptitude of irrigation paddy field

a. Soil conditions

The thickness of surface soil, gravel content and water penetration are favorable. As fertilizer holding capacity of every soils is weak, it is expected to apply green manure, perform rotation with grassland and supply organic fertilizer. (Refer to Table 6-1-1)

b. Topographical conditions

As a large part of the area is under 1 degree in scoping, topographical limitation is little. To perform suitable irrigation management, construction of land consolidation such as irrigation and drainage canal, topographical improvement etc. are required.

Drainage improvement is required due to large dangerousness of flooding by reclamations to paddy field as it is. The area of land safety 3 is ranked into aptitude II, assuming that drainage improvement project is carried out. (See Figure 6-1-4)

2) Aptitude of upland field

a. Soil conditions

Soil conditions of the area classified into fine textured regosols adjacent to the northern hill is ranked aptitude 1 as its fertility is favorable. The area of fine textured gleysols, humic planosols, planosols, coarse textured gleysols etc. distributed over swamp can be improved one rank, assuming drainage improvement is carried out. As each soils are high acidity, it is required to consider acidity improvement for selection of crops introduced.

b. Topographical conditions

As same with paddy field, the area of land safety Rank 3 can be improved one rank, assuming drainage improvement is carried out. On the other hand, the area under well drainage condition such as hills, alluvial fan, micro relief etc. has large topographical relief rate, it is suitable for upland field more than paddy field use.

6.1.4 Land utilization plan

(1) Classification of land utilization

On the basis of a general study of the basic policies, the related plans, the agricultural development plan, the land consolidation plan, and the results of classification of the project area, the area is divided into the following use parts; 1) the land for agriculture (the land for paddy field with irrigation, upland fields, grazing land) 2) the land for irrigation and drainage canals and road, 3) the land for residence, and 4) the land for conservation purposes such as forest. This report deals with the stage of classification of land use and the subject of planning land use on the basis of synthesizing plan for farming, settlement improvement and cattle breeding will be summarized for the year which follows.

Table 6-1-12 shows the broad classification of land into three parts, (a) upland fields, (B) paddy fields with irrigation, and (C) woodlands made as an overall study of the irrigation and drainage plan, the forest conservation plan, and land classifications.

Table 6-1-12 Land Use Plan Area

	Farming land			Forest area	Total area
	Irrigation paddy field	Upland field	Total		
Area (ha)	99,850	33,525		18,925	152,300
Percentage (%)	66	22		12	100

(2) Land condition and land utilization

Table 6-1-13 is the characteristics of paddy fields and upland fields as use patterns revealed as a result of classification of the development area. The outline of a land use plan will be designed with reference to this results of classification.

The results of classification of the area indicate that the development of land into paddy fields will, from a general standpoint, produce greater advantages than into others. Consequently, a land use plan will be centered on the development of paddy fields.

1) A plan for paddy fields with irrigation

① Limiting factors of irrigation confine the scope of land for paddy fields below an approximate elevation of 82 meters. An irrigation system should, as a rule, be of the gravity type for economic reason. Low lift irrigation may be employed, if economical, by means of pumping.

② Land slightly elevated with high relative relief or with great gradient should be avoided since construction of an irrigation and drainage system and land improvement would result high expenses.

③ Land where the soil has high permeability should be avoided since irrigation would demand large amounts of water. However, there are much possibility for paddy field because of very gentle inclination and a big size for unit farm block.

④ Paddy shows high measures of adaptation to relatively high acid soil.

2) A plan for upland fields

① Crops raised in the upland field are generally susceptible to damage due to effects of humidity. Consequently, land with proper drainage, slope and soil should be selected.

② Land found unsuitable for a paddy field for the purpose of the paddy field project should then be first considered as to fitness to an upland field.

3) Woodlands

The forest conservation plan is intended to leave as much part of the woodlands as they are as possible. Moreover, natural levees will be left intact for the purposes of land conservation in the area on the lower Yabebyry and Atinguy River where the difference in relative height is great between the levee and river.

(3) The land utilization plan and land classification

Table 6-1-14 shows the results, collated to land classifications, of determination of the two land use patterns, i.e., a paddy field (A) and upland field (B), based on the condition of land and use conditions, as discussed in above (2), with respect to the separate blocks of the area generally defined in a plan for irrigation and drainage. Refer to Fig. 6-1-9 diagramed outline of the land utilization plan.

Table 6-1-13 Properties of Land Utilization and Land Ranking of Paddy Field and Upland Field

Division	Paddy field utilization	Upland field utilization
1. Topographical conditions		
1) Elevation	Irrigation water from Yacyreta dam (elevation 82 m) shall be used in natural runoff as much as possible.	No special
2) Relief rate	The present topography shall not be improved as much as possible. Relief rate about 5 m is good condition.	Relief rate in this area may be the present condition for upland field.
3) Slope grade	Grade around 35 m is good condition	Same as above
2. Soil conditions		
1) Cohesion degree	No special	No special
2) Penetration	Coarse regosol and coarse gleysol are large one	No special
3) Thickness of surface soil	Thin for coarse regosol	Almost all soils are Grade II.
4) Effective soil layer	No special hindrance	No special hindrance
5) Gravel content	Same as above	Same as above
6) Bearing capacity	Same as above	Same as above
7) Moisture of soil	No special hindrance	Coarse regosol and humic plysol are Grade III.
8) Oxidation and reduction	Bad for fine gleysol and humic plysol	No special hindrance
9) Groundwater table	Same as above	Severe for certain crops
10) Soil acidity	No special hindrance because of effects of paddy rice acidity and irrigation water	Improvement of acid soil is required for certain crops introduced.
11) Natural fertility	Insufficient for fine regosol, coarse regosol, fine gleysol, and plysol.	No special hindrance
12) Existance of nourishment	Grade III for every soils	Grade III for every soils
3. Dangerousness of inundation	Some leeway exists comparing with upland farming.	Severe for certain crops.

Table 6-1-14 Land Use Plan Area and Present Land Classification Table

Area No.	Block No.	Area				Upland field			Paddy field		
		Upland field ha	Paddy field ha	Lignosa area ha	Total ha	Soil	Drainage	Topo-graphy	Soil	Drainage	Topo-graphy
I	1	2,290	-	-	2,290	②~3	2~③	1~②	1	2~③	②~3
	2	3,360	-	220	3,360	2~③	②~3	②~3	1~②	②~3	2
	3	5,170	-	-	5,170	②~3	1②3	②~3	①~2	1②3	1~②
	4	4,480	-	190	4,670	2~③	2	②~3	1~②	2	1②3
	5	-	4,730	-	4,730	②~3	①~3	2~③	①~2	①~3	①~3
	6	-	4,100	-	4,100	2	①~3	2~③	1	①~3	①~3
	7	-	4,470	-	4,470	2	①~3	2~③	1	①~3	①~3
	8	-	8,440	670	9,110	②~4	①~3	2~③	①~4	①~3	①~3
	9	-	2,860	280	3,510	②~4	1~③	2~③	①~3	1~③	①~3
	Atinguy Total	15,300	24,600	3,950	43,850						
II	1	1,770		1,340	3,110	②~3	1~③	1~③	①~2	1~①	1②3
	2	2,305		420	2,725	1~②	①~3	3	1	①~3	①~3
	3		2,440		2,440	②~3	1~②	2~③	①~2	1~②	①~2
	4		3,600		3,600	2~④	①~3	2~③	①~2	①~3	①~3
	5		3,360		3,360	②~4	①~3	2~③	①~2	①~3	①~3
	6		3,390	330	3,720	②~4	①~3	2~③	①~3	①~3	①~3
	7		2,300		2,300	2	①~3	2~③	1	①~3	①~3
	8		3,950	120	4,070	2~④	①~3	2~③	①~3	①~3	①~3
	9		4,105	370	4,475	2~④	①~3	3	2	①~3	①~3
	10		3,580		3,580	4	①~3	3	2	①~3	1
	11		2,940	100	3,040	2~④	①~3	2~③	1~②	①~3	①~3
	12		2,710		2,710	3~④	①~3	2~③	②~3	①~3	①~3
	13		3,520	1,280	4,800	3~④	①~3	2~③	2~③	①~3	①~3
	14		1,770	570	2,340	3~④	①~3	2~③	③~4	①~3	①~3
	15		3,620	140	3,760	3~④	①~3	2~③	③~4	①~3	①~3
Atinguy Total	4,075	41,275	5,725	51,075							
III	1	4,650		610	5,260	2~④	①~3	2~③	①~2	①~3	①~2
	2	2,535		380	2,920	3	2~③	2~③	1~②	2~③	2
	3		1,470		1,470	3	②~3	2	2	②~3	②~3
	4		7,035	30	7,065	3~④	①~3	3	②~4	①~3	①~3
	5		7,640	240	7,880	3~④	①~3	2~③	2~④	①~3	①~3
	6	873			870	3~④	1~③	②~3	3~④	1~③	1~③
	7		1,150		1,150	3~④	1~③	1②3	③~4	1~③	1~③
	8	800			800	③~4	1~③	①~3	③~4	1~③	1~③
	9		1,738		1,738	3~④	①~3	1~③	②~4	①~3	1~③
	10	5,302		1,650	4,350	3~④	1~③	1~②	③~4	1~③	1~③
	11		3,020	50	3,070	3~④	①~3	2~③	③~4	①~3	①~3
	12		7,947	630	8,577	③~4	1~③	1~③	③~4	1~③	1~③
	13		3,975	200	4,175	③~4	1~③	1②3	3~④	1~③	①~3
Yabebyry Total	14,160	33,975	9,240	57,375							
Total	33,535	99,850	18,915	152,300							

Note: 1. The numbers for each field and paddy field division represent the land classification for each block.
 2. Circled figures are for block classifications with large No. of points.

Fig. 6-1-9

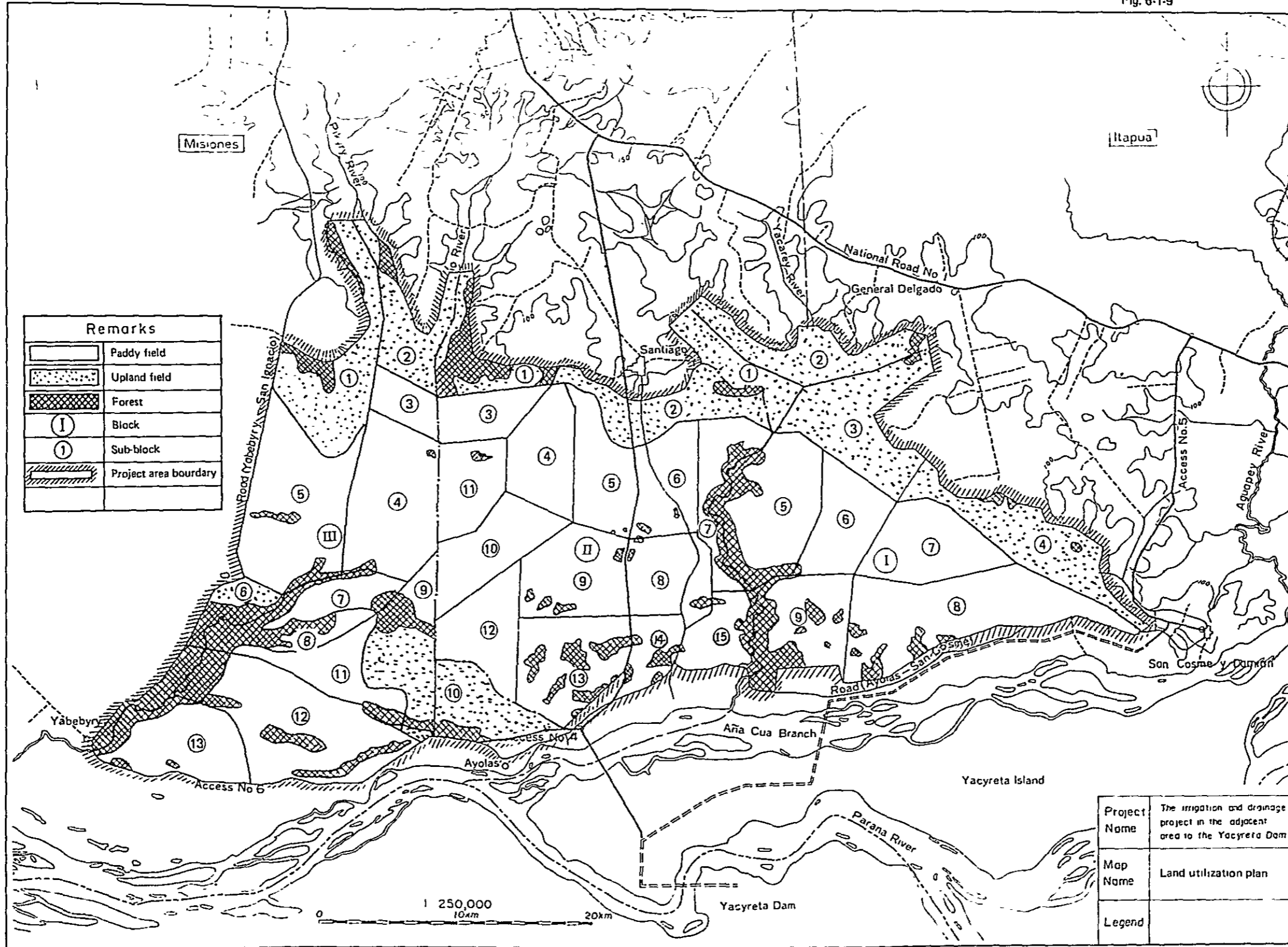


Fig. 6-1-9 Land Utilization Plan

6.2 Social Infrastructure

The social infrastructure in the agricultural development plan is not only made on the basis of summarizing the local needs and extracting individual elements necessary to carry out, but also has to contribute the improvement of the social services for residents by strengthening the social capital relating to the productive and living activities over the entire region.

The major construction work of the Yacyreta Dam, appurtenant work and preparatory work will give many direct impacts on Itapua Department and Misiones Department as well as Paraguay.

The Yacyreta Dam Project and the agricultural development in its adjacent area will contribute to the neighborhood regions in long term both directly and indirectly.

In particular, the contribution to Misiones Department and Itapua Department, which are surrounded by the national road No. 1 running from Asuncion City to the capital of Itapua Department, Encarnacion City, and River Parana, will be great.

The investment to the social infrastructure at the national level has already resulted in some effects in the traffic and communication networks to the metropolitan area and the capital in the neighboring towns (Santiago and Ayolas) with the construction of the connecting road 1-B with the national road No. 1 and the construction of the microwave network connecting between Asuncion City and the dam construction base (hereinafter referred to as the base) in Ayolas which were completed in the preparatory stage of the Yacyreta Dam Project.

This survey is made for the purposes of the maximum utilization of the social infrastructure provided by the Yacyreta Dam Project and the establishment of plans to improve the social basic facilities in the rural communities in this region by adding the social capital provided by the agricultural development side, and in this year's survey was conducted mainly to collect data.

The basic facilities in the rural communities and the social services are composed of 7 sectors:

- (1) educational facilities,
- (2) traffic/telecommunication facilities,
- (3) health/medical care facilities,
- (4) electrification facilities,
- (5) drinking water facilities,
- (6) communication facilities, and
- (7) other related facilities.

A population growth will influence greatly the abovementioned projects. The government of Paraguay prepared a report on the regional development plan (Plan De Desarrollo Regional De Itapua Y Misiones: the planning agency of the President's Office) in 1979, in which it's impacts on Misiones Departments and Itapua Departments are taken into consideration. It reported that about 20,000 persons population growth is expected within Ayolas - San Cosme region. This increase is equal to a 20% of the total population of Misiones Department.

Therefore, social services are planned considering for this 20,000 persons population growth.

6.2.1 The present situation of the social infrastructure and the outline of the plan

(1) Educational facilities

The basis of educational planning lies in elementary education. The percentage of school attendance in Misiones and Itapua Department is 82.1%, 1.6% lower than the national average, 84.7%. This is attributable to more school children in the rural regions and the worse road condition compared with that in urban areas. (Table 6-2-1)

On the assumption of a 20,000 persons population increase a scale of educational facilities is estimated from the rates described in Table 6-2-2.

Next, a number of primary school is estimated. Planning is made on the assumption that the increase in school children distributes equally in the base and the adjacent cities, towns, and villages. (including families)

- 1) An elementary school is planned in each one Yabebyry, Santiago, and San Cosme. In addition, the existing schools are enlarged and improved.

Table 6-2-1 Standard of Educational Population Over 7 Year Old of Itapua and Misiones Department

Item	1972								Remarks
	Itapua Department		Misiones Department		Total		%	%	
	Number of persons	%	Number of persons	%	Number of persons	%			
Number of schooling persons (over 7 year old)	154,028	100.0	52,726	100.0	206,754	100.0			
1. Number of non-school child	26,562	17.2	10,360	19.6	36,922	17.9			
2. Number of school child	127,466	82.8	47,366	80.4	169,832	82.1			
a) Elementary schools	115,961	75.3	37,790	71.7	153,751	74.4			
b) Junior high schools and senior high schools	10,305	6.7	4,127	7.8	14,432	7.0			
1) Junior high school	(6,748)		(2,533)		(9,281)				
2) Senior high school (Ordinary)	(1,404)		(638)		(2,042)				
3) Senior high schools (Teacher's training)	(1,340)		(685)		(2,025)				
4) Commercial high schools	(813)		(271)		(1,084)				
c) Universities	742	0.5	156	0.3	898	0.4			
d) Non reporters	458	0.3	293	0.6	751	0.5			

Table 6-2-2 Record of Educational Circumstances of Areas Concerned and Whole Country (Elementary School)

Item	Itapua Department		Misiones Department		Both Department		Whole country	
	1972	1976	1972	1976	1972	1976	1972	1976
1. Total population (I)	201,411	227,589	72,277	77,367	273,688	204,956	2,431,222	2,724,391
2. Number of children to be school child (II)	48,069	56,120	17,032	18,337	65,701	74,457	540,980	610,622
3. Number of school child (III)	39,138	41,806	14,763	14,970	53,901	56,776	451,856	467,552
4. Number of schools (IV)	326	377	100	110	426	487	2,641	2,960
5. Number of teachers (V)	1,304	1,557	492	534	1,796	2,091	14,576	17,770
Percentage								
a) II/I	24.2%	24.7%	23.6%	23.7%	24.0%	24.4%	22.3%	22.4%
b) III/II	80.4%	74.5%	86.7%	81.6%	82.0%	76.3%	83.5%	76.6%
c) III/IV	120	111	148	136	127	117	171	158
d) III/V	30.0	26.9	30.0	28.0	30.0	27.2	31.0	26.3

Table 6-2-3 Number of Increase of Schoolchild

	Calculation	Number of schoolchild
Number of objective schoolchild	$20,000 \times 24.4\%$	4,880
Number of schoolchild	$4,880 \times 76.3\%$	3,723
Elementary school	$3,723 \times 90.5\%$	3,370
Junior high school and senior high school	$3,723 \times 8.5\%$	315
University	$3,723 \times 0.4\%$	18
Others	$3,723 \times 0.6\%$	20

Table 6-2-4 Number of Elementary Schools

Name of cities, towns and villages	Increase in population	Elementary school	Number of elementary schools
Yabebyry	3,000 (15%)	506	1
Ayolas (including bases)	10,000 (50%)	1,685	4
Santiago	3,000 (15%) †	505	1
Sancosme	4,000 (20%)	674	1
	20,000 (100%)	3,370	7

One school in Ayolas, one in the base, and two in this agricultural development plan area in accordance with the rural community plan are built.

2) Junior high/high school

The existing facilities in the adjacent cities, towns and villages and the school in the base in which currently a combined class system is carried out are sharply improved.

3) University

For the purposes of leveling up of youths of farmers living within the area and the neighborhood and educating successors a three years agricultural college is built.

4) Adult education

a) One adult education school in the base and each rural community is established in accordance with the rural community plan to re-educate illiterate adults (about 17%).

b) In the multiple purpose hall set in the base an audio-visual education facility and a library are provided, and a travelling library goes periodically round the adjacent cities, towns and villages and new rural communities.

(2) Traffic/telecommunication facilities

1) Traffic

The completion of the key roads and trunk roads including the connecting roads (1-B, 1-C, and Access Nos. 4 and 5) which were already constructed in association with the Yacyreta Dam construction work, the access road No. 6 which is not yet improved, the trunk road No. 8 (Yabebyry - San Ignacio) and the trunk road No. 3 (Ayolas - San Cosme) which are expected to be improved as a part of the agricultural development plan will improve remarkably the transportation level within and outside the region. Consequently, the traffic map will be drastically changed due to travelling time reduction.

2) Telecommunication

The improvement of the national telecommunication network by means of microwave lines has been conducted as one of the national projects by

the Agency of National Communication Management (ANTELCO) centering around Asuncion City. Currently, direct distance dialing to major cities in the country is possible. Telephonic communication with foreign countries is also possible within a short period of time through the communication satellite line. A telephone office was already set in the base and the telephone line was set in the office of the Yacyreta Public Corporation and it's staff members' houses to communicate inside and outside the country.

The extension of the communication line to this project area is planned based on the settlement plan and the rural community plan established in the agricultural development plan including the increasing number of lines in the telephone office.

(3) Health/medical facilities

The mortality in Paraguay in 1980 is 0.4% in nationwide average, while the mortality in Misiones and Itapua Department is 0.82%, about double the national average. As shown in Table 6-2-5, the infant mortality before 28 days after birth and that before 1 year age are very high. The main causes of this high mortality of infants are influenza, diarrhoea, respiratory diseases, malnutrition and others, all of which are resulted from insufficient chances to get modern health care such as the shortage of medical facilities, poor public sanitation and the poor living environment. The general causes of death are shown in Table 6-2-6.

The numbers of hospitals and beds as indicators of medical facilities are summarized in Table 6-2-7. According to the 1980 statistics the total number of beds over the country amounts to 3,207, of which 2,439 beds concentrate on the Asuncion region accounting for 76%. This is equal to 4 beds per 1,000 persons, which far exceeds the national average, 1 bed per 1,000 persons.

The number in Misiones Department is only 0.4 bed per 1,000 persons, 1/10 of Asuncion City, or 1/2 of the national average, showing remarkable shortage of medical facilities.

Table 6-2-5 Deaths and Mortality (1975)

	Itapua Department			Misiones Department		
	Population	Deaths		Population	Deaths	
		Persons	%		Persons	%
Whole death	105,831	868	0.82	49,664	407	0.82
Stillbirth	2,372	12	0.51	1,220	7	0.58
Within 28 day after birth	2,372	85	3.58	1,220	29	2.38
Within 1 year after birth	2,372	221	9.32	1,220	84	6.89
1 ~ 2 year after birth	13,869	63	0.45	6,039	41	0.68
Within 5 year after birth	16,456	284	1.73	7,722	125	1.62

Table 6-2-6 Death Causes (1975)

Item	Itapua Department	Misiones Department
	%	%
Heart disease	12.5	8.1
Epidemic	10.8	12.8
Diarrhea	10.8	15.5
Endimic	7.9	2.9
Tumor	6.9	8.1
Brain injury	6.4	7.6
Accident	6.1	2.0
Respiratory organ	5.4	8.8
Tuberculosis	3.5	5.2
Crime	2.9	2.0
Undernourishment	2.3	4.7
Arterialize	2.3	-
Circulatory organ	1.9	0.5
Accident of pregnant woman	1.9	1.7
Kidney trouble	1.5	0.7

Table 6-2-7 (1975) Number of Hospitals and Number of Beds

(Misiones Department)

Place	Number of hospital	Number of beds	Remarks
Public hospital			
<u>Central hospital</u>			
1. San Juan Bautista	1	15	
2. San Ignacio	1	13	
3. Ayolas	1	3	
4. Santa Rosa	1	2	
5. Yabebyry	1	3	
6. Santiago	1	2	
<u>Clinic</u>			
7. Villa Florida	1	2	
8. San Miguel	1	4	
9. Santa Maria	-	-	
10. Santa Rosa	-	-	
11. San Patiricio	-	-	
12. Panchito Lopez	-	-	
13. Arazape	-	-	
Total	8	44	

Taking consideration of those figures the following plan is made for health/medical facilities.

1) The medical facility of the Yacyreta Public Corporation set in the base is used as a central hospital along with the full utilization of medical personnel there and branch hospitals are planned in Ayolas, Yabebyry and Santiago, to provide additional 200 beds (for 20,000 persons, one bed per 1,000 persons is provided -- national average). Thus, the improvement of the medical facilities and medical personnel and the integration of each branches are achieved.

2) A health clinic is set in each rural community in accordance with the settlement plan and the rural community plan.

3) Travelling vehicles are introduced for regular health checking.

(4) Electrification facility

Electrification is essential for the welfare of rural residents, and safe lightning can bring about a civilized life after the sunset. The spread of T.V. using the existing micro wave lines will provide information on culture, societies, and economics both inside and outside the country.

Only in two towns in Misiones Department, San Juan Bautiata and San Ignacio, the supply of electricity is conducted by the Agency of National Electricity Management (ANDE), while in other regions independent electric power plants are working to supply only during night.

This agricultural development plan includes the construction of a power transmission network to be used for the operation of pumps for irrigation, pumping up of small water-supply systems, electrification for rational agricultural management and electrification of farmers' houses.

(5) Water supply for living

Water supply in Paraguay is carried out by the Sanitary Work Corporation (CORPOSANA) for groups with a more than 4,000 population, while for groups with a less than 4,000 population each local government is supplying water using a simple water-supply system. However, rural areas are still dependent upon wells and rainfall, and the strong need for improving water supply systems are expressed to solve water quality and

sanitary problems and poor health management.

As the plan of water-supply for living,

- 1) in addition to the maximum utilization of the capacity of the facility set in the base (pumps and high-speed filtration equipments), simple water-supply systems are provided to cover the shortage.
- 2) the water supply facility plan included in the settlement and rural community plans is based on simple water-supply systems equipped with deep wells and filtration installations.

(6) Communication center

For the purpose of the active utilization of a variety of facilities in the base (Figure 6-2-1 and Table 6-2-9) 1) the central shopping street, 2) the restaurant, 3) the church, 5) the meeting room, 6) the culture center, 8) the multiple-purpose hall, 10) the open air theatre, 12) the soccer field, and 13) the gymnasium are fully used to make the area a center of the regional communication.

In the settlement and rural community plans 3), 5) and 12) are planned to establish good communication among residents.

(7) Other related facilities

Social services mean basic social facilities to provide residents with well-being in a safer and more comfortable environment. Table 6-2-8 shows the result of a survey on social services in major cities in Misiones Department.

This agricultural development plan includes (1) through (6) as the plan to improve the basic facilities in rural communities, and improving the facilities listed in Table 6-2-8 is the basic policy. Therefore, the following facilities are planned.

1) Administration agencies

- a) Branch offices of the central and the departmental governments
- b) Municipal offices
- c) police
- d) court
- e) tax office
- f) banks
- g) markets

2) Agriculture-related facilities

The technical support for productive activities in agriculture has to be conducted under the strong back-up by the central government.

Along with the construction plan of the above-mentioned agricultural college, an organization is required to cope with a variety of troubles in practicing agricultural operation and to accelerate research and development of new technologies.

Thus, the following facilities are planned.

- a) An agricultural engineering laboratory (centering around paddy rice) is built.
- b) An agricultural improvement and extension center is built.
- c) A seed center is built.
- d) An experimental farm is built.
- e) An agricultural implement repair center (as an organization of the agricultural cooperative) is built.
- f) A center for storage, preparation and transportation (as an organization of the agricultural cooperative) is built.

These facilities are planned in the place for the storage of construction equipments and materials in the Yacyreta Dam construction work shown in Figure 6-2-2.

Table 6-2-8 The Present Circumstances of Social Service of
Main Cities in Misiones Department

	San Juan Bautista	San Patricio	Santa Maria	Santiago	Villa Florida	San Ignacio
Overall service						
1. Light	ANDE 700 (houses) (102 AP)	X	Private generator 2 units	Private 76 (houses)	ANDE	ANDE 172 (houses) (79 AP)
2. Water supply	CARPOSANA 732 (houses)	X	X	X	Private 40 (houses)	X
3. Refuse disposal	○	○	○	○	○	○
4. Sanitation	Sewerage	No equipped	No equipped	No equipped	No equipped	No equipped
Inhabitants service						
1. Government branch office	○	X	X	X	X	X
2. City office	○	○	○	○	○	○
3. Police office	○	○	○	○	○	○
4. Court (mediation)	○	○	○	○	○	○
5. Tax office	○	○	○	○	○	○
6. Bank	National 1	X	X	X	X	National 1 Private 2
7. Post office	○	○	○	○	○	○
8. Telephone office	○	○	○	○	○	○
9. Telegram office	○	○	○	○	○	○
10. Telex	○	X	X	X	X	X
11. Elementary school	○	○	○	○	○	○
12. Junior high school	○	○	○	○	○	○
13. Agricultural high school	○	X	X	X	X	X
14. Health center	○	X	X	X	X	X
15. Doctor	○	○	X	X	X	X
16. Electricity service	○	X	X	X	X	X
17. Movie theater	○	○	X	X	○	○
18. Community centre	○	○	○	X	○	○
19. Watering place, hot spring resort	X	X	○	X	○	X
20. Other recreation facilities	○	○	○	○	○	○
21. Market	○	X	X	○	○	○
22. Meat processing place	○	○	○	○	○	○
23. Livestockhygiene service center	○	X	X	X	○	○

Table 6-2-9 Facilities in the Base of Yacyreta Public Corporation

Number	Facilities	Number	Facilities
①	Central shopping district	⑮	Lodging house
②	Restaurant	⑯	Naval facilities
③	Church	⑰	City water facility
④	Administrative district	⑱	River wharf
⑤	Meeting place	⑲	Fish farm
⑥	Cultural center	⑳	Health center
⑦	Elementary school	㉑	Hospital
⑧	Multipurpose conference hall	㉒	Repair and service factory
⑨	Junior high school	㉓	Police office
⑩	Outdoor theater	㉔	Telephone office
⑪	Hotel	㉕	Bus terminal
⑫	Stadium	㉖	Plot for persons concerned with construction
⑬	Gymnasium	㉗	Apartment house
⑭	Club		

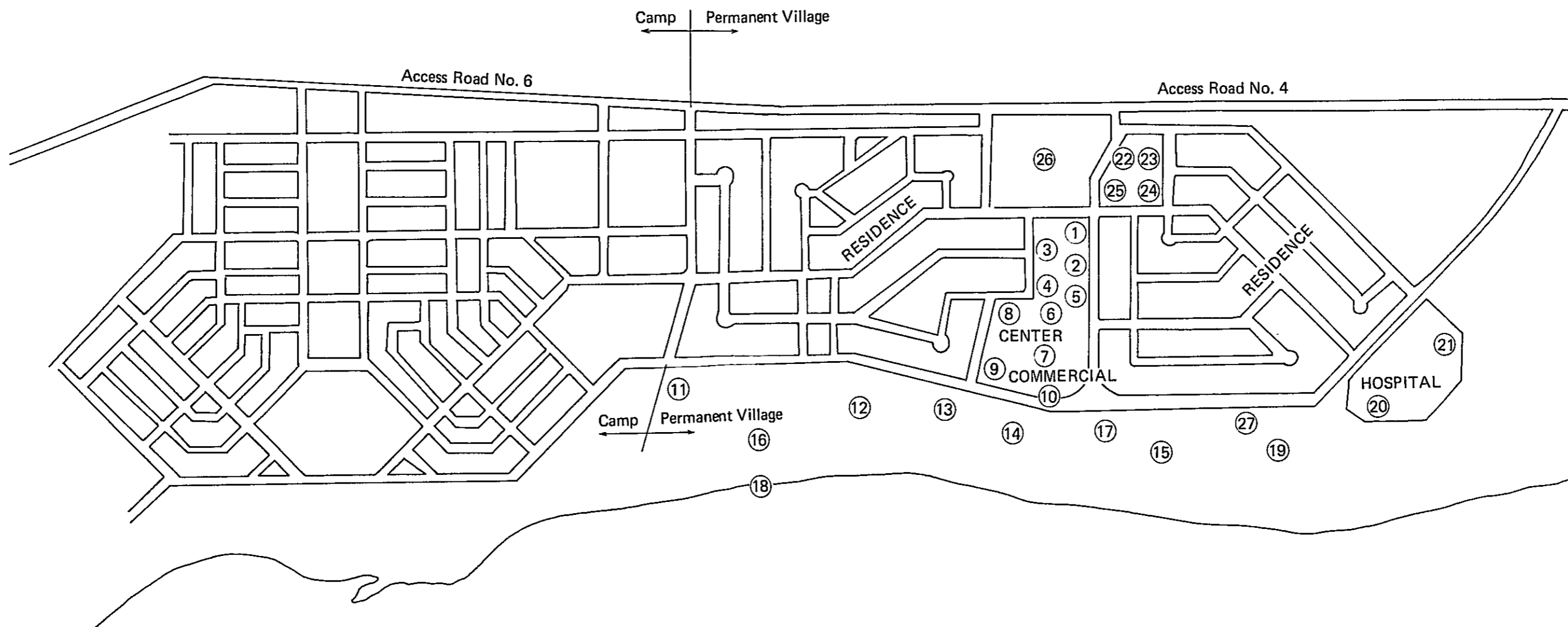


Fig. 6-2-1 Permanent Village and Camp in Ayolas

Fig. 6-2-2

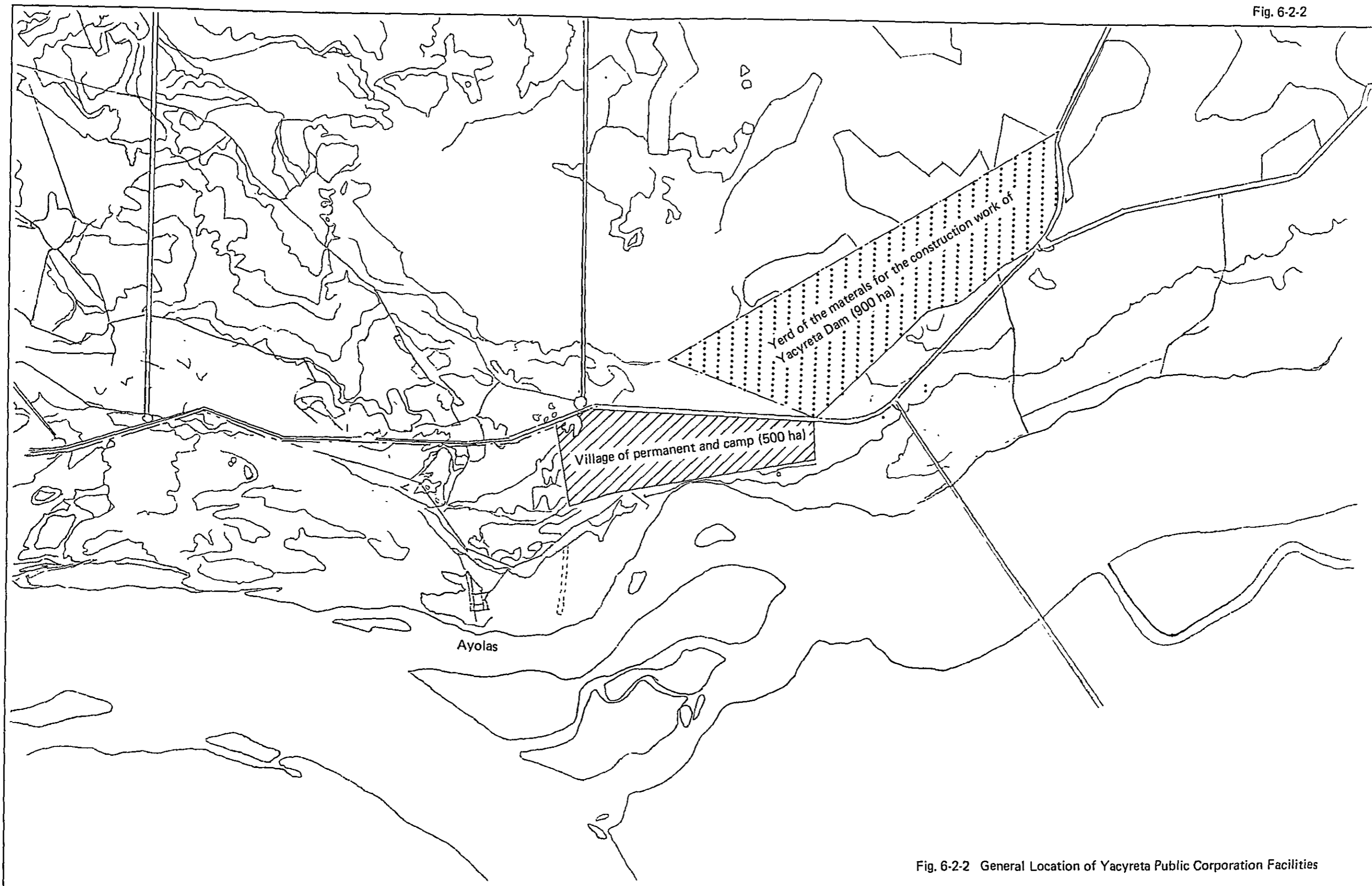


Fig. 6-2-2 General Location of Yacyreta Public Corporation Facilities

6.3 Environmental conservation

6.3.1 Legal treatment of the forests in the survey area

The Forest Law of Paraguay (Ley No. 422, enacted in 1973) defines forest and timber land as the land which has soil conditions suitable to the production of timber and others (Article 3), and forest and timber land area further divided into 3 categories (Articles 4-7) ; 1) production forest (forest in which regular benefit can be expected through certain forest management), 2) protection forest (forest for the adjustment of water resources, the conservation of soil and rivers, the protection of erosion and flood, prevention of abnormal drying caused by wind, and the protection of agriculture), and 3) special forest (forest to be protected for scientific, educational, historical, and recreational purposes).

In addition, in forest development for agricultural use, the followings are provided;

- 1) prohibition of any usage which might lead to the devastation of forest and timber land (Article 23),
- 2) prohibition of cutting in any area adjacent to the source of a stream and water flow (Article 31), and
- 3) Any owner of more than 20 ha land within the areas provided as forest area has to maintain 25% of the forest area as a non-utilizable area. If this can not be met, planting has to be carried out for the area equivalent to 5% of the total forest area. (Article 42)

At the present stage faithful application of the law causes a variety of difficulties, and forest can not necessarily be said to be controlled sufficiently.

However, the Ministry of Agriculture and Livestock has expressed a view on the legal treatment of the forests within the survey area, that is, "The forests in the project area fall in the category of forest to be protected for soil erosion control in the light of the Forest Law. Positive planting is not required, but when the existing forests are cut, then trees equivalent to this should be planted".

Although no special limiting condition is imposed on agricultural development of the project area by the Forest Law, the technical facts described in the Forest Law and the above mentioned view by the Ministry of Agriculture and Livestock have to be thoroughly considered in making a plan.

6.3.2 Environmental consideration of the forests

(1) Appropriate location of the forests

The survey area with a 60 ~ 90 m altitude forms a flat low land on the whole except the northern hilly land. Presently, the entire land except water surface such as ponds and rivers is covered with grass and forest vegetation, resulting in a stable soil system along with its flat topography.

Nevertheless, the soil of the area is sandy with easy soil erosivity. There are cases that the road construction has caused heavy erosion near the both sides of the road, which is very remarkable particularly in sites with a slope more or less.

In any agricultural development project earthmoving works accompanied with the construction of roads, irrigation and drainage canals and reclamation of agricultural land is unavoidable, but it should be as little as possible.

In particular, special consideration is required in developing a sloping land in the northern hilly area.

In addition, the development has to facilitate in its early stage and to maintain as long as possible water charging ability of the agricultural ecosystem consisting of agricultural land, rivers including artificial water canals and forests, water control function such as flood control, and soil preservation function such as soil erosion/run-off control and soil drift control.

In order to attain these purposes locating minimum forest within the area to be developed is essential.

As the Forest Law of Paraguay provides that a certain part of forest should be left untouched or should be planted for soil conservation, flood control, and cattle protection when a forest zone is developed for agriculture, it is obvious that sound relation between agriculture and forest carries great weight in Paraguay.

Although there are a very few forests existing in this area, all the functions of the ecosystem have to be fully displayed by locating the forests adequately in view of the forests as a part of the agricultural ecosystem. For this purpose, basically the existing forests

should be preserved as much as possible, and when cutting is inevitable in constructing roads, irrigation and drainage facilities, planting has to be performed in an area equivalent to this. In addition, since the existing forests are unevenly distributed, the creation of forest by planting has to be considered, if necessary, such as a trees belt along the road or the rivers (including the artificial water canals) and a shade forest for pasturing livestock (the possibility of natural regeneration should be considered). With regard to forestation, it's economical efficiency has to be questioned, but this will be examined in the third year.

(2) Treatment of the existing forests

The agricultural development plan should be based on the basic concept on land use of this study, that is,

- a) higher place with good drainage is used as upland farming area, (Area A), and
- b) other places are used as paddy rice fields through improvement of drainage and irrigation (crop rotation system of paddy rice and grazing) (Area B).

As has been described in the previous chapters, the existing forest area is to be preserved as much as possible. However, many small areas of forest dot in the survey area and these area considered to constitute an obstacle to the efficiency of agricultural management and the large-scale agricultural land reclamation in these parts of the area. These small areas of forest also pose problems for the improvement of drainage and the effectiveness of irrigation.

Accordingly, as to the treatment of the existing forest areas in the project area, a certain planned forest area including the existing forest has been set to use them effectively as environment and agricultural land conservation area depending on the viewpoint shown below.

- 1) The zone of forest in the northern region is situated on the border of hilly and low swampy land. These are considered to be valuable in the prevention of sediment flowing down from the plateau land which includes regions outside of the survey area and which have been already developed.

Therefore, the existing forest regions will be generally preserved as such.

2) The small area cluster forests are of value in shading and protecting the pasturing stock and so the existing forest with the area of over 20 ha largely remain. Moreover, in cases in the southern part of the survey area where there are many small-area forests distributed in grouping, the entire area including forest and wildgrass area is to be designated as a forest area in consideration of the efficiency of irrigation and agricultural utilization. Here, the designated forest has the area of over 50 ha with the forested area within them being planned to be over 50%.

3) Forests alongside the Atinguy and Yabebyry Rivers will be retained for their effect in conserving the river banks and water conservation, with a 1 km wide strip along the both bank (500 m each).

From the above, the planning forest area and other values are as shown in Table 6-3-1. (Refer to Fig. 6-1-9.)

Table 6-3-1 Forest Area of Land Use Plan

Plot	Total area ha	Farming area ha	Forest area ha	Forest area rate %	Remarks
A (Upland field area)	39,155	33,525	(3,400) 5,630	14.3	
B (Paddy field area)	104,865	99,850	(2,600) 5,015	4.8	
Area along Atinguy and Yabebyry River	8,280	-	(1,500) 8,280	100	
Total	152,300	133,375	(7,500) 18,925	12.4	

Note: The bracketed values in the 'Forest' column indicate the area of the existing forests, being included in total value. The difference of 500 ha between the two values is not planned as the forested region because of the presence of many small area forests scattered.

As has been described above, the existing forest areas are largely planned to become the forest area but there is a considerable number of grassland regions planned within them. These grassland area will be able to contribute to the natural renewal of the forest to a certain extent if the drainage for the land can be improved to facilitate good drainage for the soil in the future.

As the aforementioned basic concept, these existing forests along the Atinguy and Yabebyry River should be desirably be preserved as much as possible for the conservation of the natural riverbanks and the water conservation. In addition, the clustered small forests within the project area are valuable as the shade forests for pasturing stock and the supplier of logs for farm stockades.

In addition, in the residential areas of farmers forests to protect houses from wind and heat and trees as a place of recreation and relaxation (large trees are desirable) are essential. In particular, the forests within this area are located in a little higher places than their surroundings, and provide residents with the cores for living, so that the utilization of the forests from these viewpoints is desirable.

Although in the first year report, we mentioned about the necessity of the preservation of forests which supply fuel wood, the consideration of forests serving as suppliers of fuel wood for self-consumption is not necessary, since domestic fuels are largely supplied by propane gas, according to the inquiry survey of farmers.

(3) On planting

1) Necessity of planting

In the previous sections, we have discussed the basic concept of the forest location and the treatment of the existing forests based on this basic concept. In fact, however, these forests do not distribute uniformly within the region, but distribute unevenly, as already described. In addition, the construction of roads and irrigation/drainage facilities and the creation of agricultural lands might require cutting of the existing forests.

Therefore, if the existing forests are cut, planting at least equivalent of the cutting is necessary, and if there is no trees belt

along the both sides of roads, water canals for irrigation and drainage, no shade forest to protect cattle, and no forest in the residential areas, the creation of forest should be considered.

Because location, scale and economic efficiency of planting are closely related to plans in other fields, we will examine them in the third year.

As drying of the low marshland is expected by improving drainage in this region and resultant natural formation of forests (natural regeneration) is possible, although it will take a long time, examination based on this aspect should be taken.

2) Technical examination of planting in the survey area

In Paraguay planting got off the ground in the 1960's, and she is green in it's experience. In order to cope with the recent decrease in forest resources the Forestry Agency of Paraguay set the 10 Years' Reforestation Plan to encourage planting (this plan was already mentioned in the first year report). The actual record from 1960 to the present is summarized in the following table.

Table 6-3-2 Afforestation area in Paraguay

Kinds of tree	1960 1977	1978	1979	1980	1981	1982	Total
Pine tree (Pinos)	1,350	335	431	1,263	401	300	4,080
Eucalyptus (Eucaliptos)	1,200	85	73	586	499	378	2,821
Paulownia (Kiri)	—	17	4	5	22	—	48
Total	2,550	437	508	1,854	922	678	6,949

Source: Areas de Reforestacion, Forestry Agency, Jun. 1983.

Pine trees (*Pinus Elliotti* and *Pinus taeda*, native to the U.S.A.) and Eucalyptes (*Eucalyptus* sp.) are mainly planted.

The major areas where active planting has been carried out include Alto Paraná (approximately 46% of the total planted area), San Pedro (21%), Guairá (10%), Ñeembucu (7%), Amambay (5%), Caaguazú (5%), and Itapua (5%) Department.

The main planted tree in Itapua Department is pines. In Misiones Department reforestation has hardly been done (although planting has been conducted in a very small scale for providing shade forests, this does not appear in the above described data by the Forestry Agency).

The survey area located in the low marshland extending from Misiones Department to Itapua Department does not have a good locating condition as a land to be planted, but we have examined possible trees on the assumption that the improvement of drainage can lead to drying of the land.

Firstly, the growth of a part of pines and Eucalyptes which were planted as shade forests for cattle or residential forests in the neighborhood of farmer's houses in the area was surveyed.

① Pinus Elliottii

Location	shade forest in the Santa Ana farm (hilly topography)
Area	0.9 ha
Stand age	9 years
Number of planted trees	2,700 trees/ha
Growth	diameter $\frac{14 \text{ cm}}{9 \sim 21 \text{ cm}}$ tree height : 7 m in average mortality rate (standing trees/planted trees)15 % good growth

② Eucalyptus sp.

Location	near the Bolf Farm's house
Area	(single tree planting)
Stand age	45 to 50 years
Growth	diameter 110 ~ 130 cm tree height 20 ~ 25 cm Because of single tree planting branches extend horizontally and tree height growth is inferior.

Since there are a very few planted places within the survey area and they are located in the hilly land with a little effect from the low marshland and furthermore the possible extent of drying to be attained by the drainage improvement is not known, it is very difficult at the present stage to make any decision on suitable trees.

However, as Eucalyptes which include many kinds have a very wide range of adaptation including meteorological conditions (mainly climate) and locating conditions (such as futile soils, sandy land and dry land), they can be expected as trees to be planted in this region. The range of planting by pines which have an inclination for relatively dry land is limited. Although broad leaved trees accompany a difficulty in nursery stock cultivation, the possibility of reforestation by willows with adaptability to marshland should be considered.

With regard to technical issues on planting in this region the Yacyreta Public Corporation is planning the recovery of the forest which will be buried under water after the dam construction and the reforestation to protect the dam body and the land where sand and soil will be collected, and it is expected to perform examination and survey in the near future. The results and the passage of the examination have to be fully taken into consideration.

6.3.3 Coordination of the animal protection plan with the agricultural development plan

(1) On the wildlife sanctuary to be set by the Yacyreta Public Corporation

The Yacyreta Public Corporation has a plan to catch and move to other areas a part of wildlives living in the area to be submerged by the dam construction (more than half of Yacyreta Island, whole Talavera Island and other islands will be buried under water, in total some 82,000 ha) for wildlife protection.

The major animals to be protected living in the planned submerged area include;

Table 6-3-3 Tentative List of Animals to Be Protected

Popular name (local name)	Japanese name	Family name	Remarks
(Mammalia)			
Guazú pucú	Deer	Cervidae	Ciervo de los pantanos (living in a swamp, and it is said that it lives in only this place and Mato Grosso in Brazil)
Aguará popé	Fox	Canidae	
Carayá	Monkey	Cebidae	
Kaguareé	Giant anteater	Myrmecophagidae	
Tatú Poyú	Armadillo	Dasypodiidae	
Ky-yá	Otter	Mustelidae	
Actí pay	Guinea pig	Caviidae	
Apereá	Rat rabbit	(Unknown)	
Capihva	River rat	Soricidae	Carpincho
Mbracayá eirá	Black wildcat	Felidae	
Lobo-pé	Wolf	Canidae	
Curé-í	Wild pig	(Unknown)	
(Birds)			
Nandú	Ostrich	Tinamidae	
Mytú	Duck	Anatidae	
Halcones	Hawk	Falconidae	
Yambu-i	Quail	Phasianidae	
Tortolita	Turtledove	Columbidae	
Ciguëña	White stork	Ardeidae	
Quiri-quiri	Kite	Accipitridae	
(Reptiles)			
Yacare	Crocodile	Crocodylidae	

These animals are mainly living in places where ponds and lakes, marshlands, grasslands and forests distribute properly, and in particular, the deer (Guazú pucú) living in marshlands, which is considered the most important animal to be protected, eats plants growing near the ponds and lakes and rests in the forests and the high grass.

The Yacyreta Public Corporation is examining a candidate place for the wildlife sanctuary in consultation with environmental experts of Harza Company and the World Bank. The results of surveys carried out up to now has clarified that the places with a similar environment with the planned submerged area are;

- 1) although the non-submerged area of the Yacyreta Island was considered, the area was omitted from the candidates for the wildlife sanctuary, because the present natural environment of this area can not be maintained after the dam construction.
- 2) Since then, the upper and middle stream area of River Yabebyry with a total area of about 8,000 to 10,000 ha has been examined (This is because several deers mentioned before were confirmed to live in this area, and so it was concluded that this area has a proper living conditions for the deer).

Nevertheless, this candidate area is located within the planned area for the agricultural development plan. As a matter of course, any agricultural development and wildlife protection have to be achieved in harmony, but we have sent a message to the Yacyreta Public Corporation that the followings should be taken into account and if a better candidate is found out, then a survey on the living conditions should be carried out to provide the basis for proper judgement.

- 1) The natural environment of this region, of which breakdown is approximately 70% of low marshland, 20% of wild grassland and 10% of forest, is largely utilized for grazing cattle, and so it is not necessarily in a natural condition. Therefore, can wildlife co-exist with cattle and is this area the best place as a wildlife sanctuary?
- 2) In the agricultural development plan the best use of the low

marshland near this region is considered to be the agricultural management based on a crop rotation system of paddy rice and grazing after the drainage improvement. In this case, drainage might accelerate drying of the marshland within this region, resulting in a gradual change in vegetation.

3) When the surrounding of this area is used for agricultural production, noise problem which will be caused by prospective operation of large agricultural machines and chemical control with aeroplanes might result in adverse effects on wildlife.

4) In order to conduct agricultural management in a large scale and to ensure a certain yield, the application of fertilizers and chemical control are inevitable in the course of planting. In this case, it is a matter of course that chemicals harmless not only to human bodies but also to animals, birds and fishes should be applied, but doesn't this cause any adverse effect on the animals living in the isolated condition.

In response to this view, the Yacyreta Public Corporation has expressed the opinion that the south-east part of the Ñeembucu marshland (the west of River Yabebyry) can be considered as one of the wildlife sanctuary and investigation of the living condition of this area will be executed. Thus, we have to wait for the result of this investigation, but at the present stage the upper and middle reaches of River Yabebyry proposed as a wildlife sanctuary is examined as an area to be included in the agricultural development plan.

The result to be obtained from the above-mentioned investigation might lead to setting a wildlife sanctuary within the region for the agricultural development. This will be coordinated in the third year.

(2) Planned fish farm

The Yacyreta Public Corporation is planning the cultivation of fish such as Surubi, Dorado and Pacú using the dam to be constructed. Based on this plan the establishment of a fish breeding center is considered in the lower reaches of River Atinguy abutting on the planned area for the agricultural development (at present, an experimental wildlife

sanctuary). Although any concrete plan has not yet made, the water quality of the agricultural waste water has to be fully taken into consideration, because the utilization of the water of Atinguy River is expected.

CHAPTER 7 SUB-PROJECT

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7.1 Sub-Project

The survey area is a wide-spread tract with 152,300 ha. As it was not profitable to develop the whole area simultaneously viewing from the standpoint of effectiveness, there arose the need to implement step by step development. The development project was divided into several parts, sub-projects determined, and development priorities given.

Based upon the survey conducted in the first and second years, the formulation of an outline of the development plan will be made this year and several proposals erected on the results. This priority order will be confirmed in the final year.

The project is an integrated agricultural development consisting mainly of irrigation, drainage and land reclamation. Since this area is a low and swampy land including constantly inundated portion, there arises the need to make the drainage improvements as the precondition of development. The construction of the Yacyreta Dam will make it possible to take in irrigation water of $108 \text{ m}^3/\text{s}$ from the dam at the eastern end of the area.

Under such conditions, sub-projects of the agricultural development will be studied for division in the ways of division by construction type and division by zone. It is considered that a drainage construction by type has progressed before the improvement by pasture land or farmland reclamation is implemented. This project is not aimed at improving the drainage in a complete way in order to make it effective by keeping the cost/ha as low as possible. Instead, it is considered that some inundated water will be permitted against a ten year rainfall probability. A complete effect cannot, therefore, be expected as improved pasture land or farmland. Accordingly, there is the need to make it effective by the introduction of irrigation. It is considered suitable to proceed project using zones, rather than type of construction as a development strategy.

The following matters are taken into account in zone division:

- (1) The facilities must be utilized effectively after completion and become a profitable investment.
- (2) The operation and maintenance must be conducted in a suitable way.
- (3) The way of works implementation must be reasonable.

- (4) Adequate adjustment with the related must be made.
- (5) It must be suited for the government financial condition.

It is best to divide the whole area into 3 zones, granted that the term of works for a zone is "Detail Design" 2 years and the period of construction 5 years.

Such a division should be made as the first zone Eastern side of the Atinguy River covering 43,850 ha, the second zone of 51,075 ha between the Atinguy River and the tenth trunk drainage canal and the third zone of 57,375 ha on the Western side of the 10th trunk drainage canal.

The priority order of work commencement should be determined upon the study of economy. Since the position of taking in water is provided for the work plan of the Yacyreta Dam, it is recommended that the construction begin with the upper stream section of the trunk irrigation channel.

In cases where an area is divided, what is important is the investment effectiveness of irrigation and drainage channel stretching over the area.

At first, by way of dividing the area, it is necessary to study about the drainage channel stretching over two zones.

The Atinguy River runs across both the first and second zone. The runoff of some portion of the catchment area in the second zone now flows into the Atinguy River. While the drainage channel will be improved in the second zone, improvement of the Atinguy River is to be made based upon a planned cross-section as a difference in runoff of water can hardly give an impact on the cross-section. The 10th trunk drainage channel dividing the second and third zone has the catchment area equivalent to that of the Atinguy River. The 10th channel receive drains only from the left-hand side meaning second zone in the plan. Consequently, there is no problem without flowing in from the third zone.

The trunk channel will be considered preceding investment until the second and third zone are implemented if the first zone is to be implemented with the whole cross-section. When it is implemented with the cross-section for irrigation water necessary for the first zone, enlargement works will become necessary at the time when the second and third zone are implemented. When a big zone is irrigated with a whole irrigation system, however, such a problem will arise even if the area is not divided.

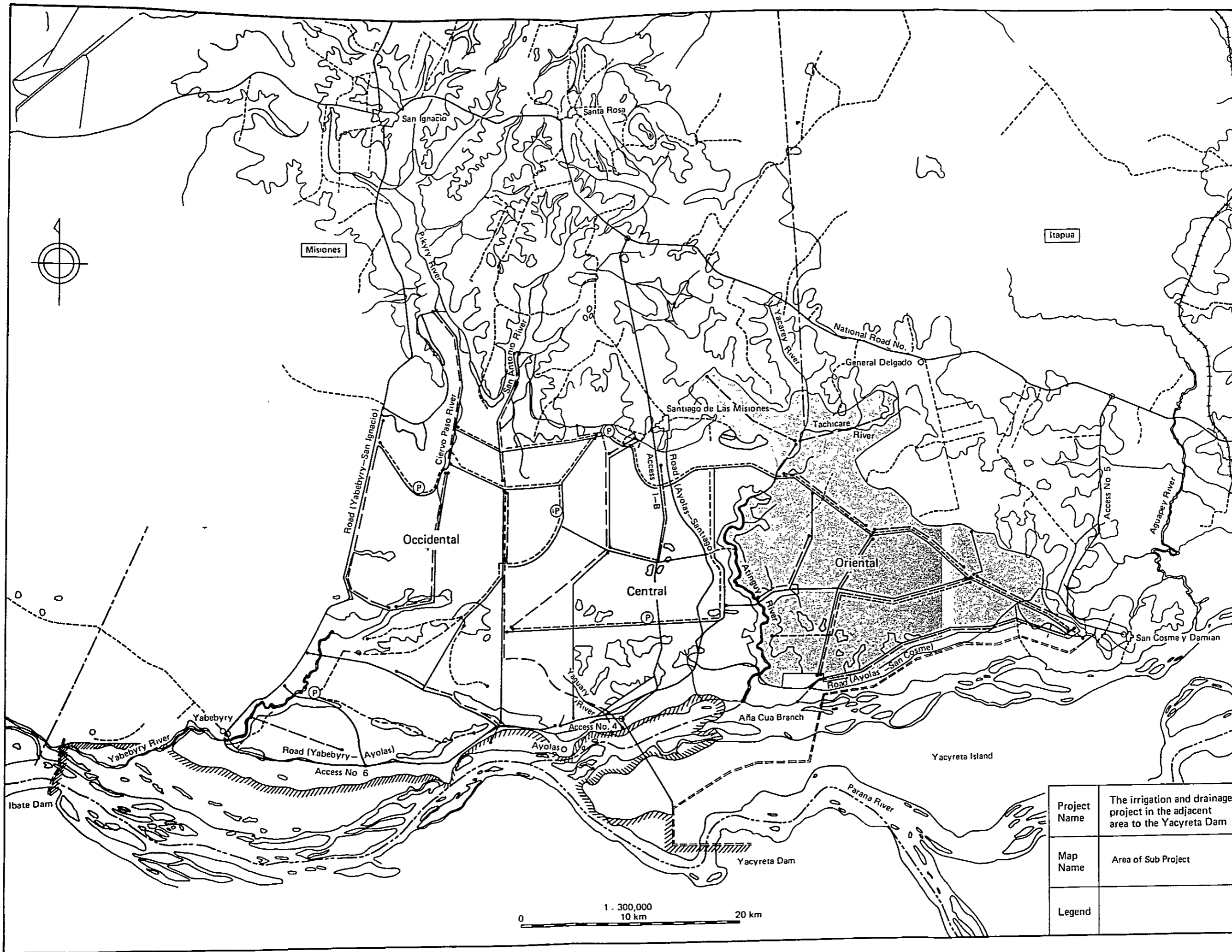
Whether or not it is preceded with the whole cross-section, enlargement

works are implemented with the second and third zone works at the same time and which is more reasonable, should be determined in comparing the interest of preceding investment, growth rate of administration costs and construction costs of enlargement works. At the same time it owes much to the year when the second and third zone are implemented. Therefore, it must be determined in consideration of these points. Although the content of the sub-project will be studied in detail in the next year, this will not hinder the establishment of sub-projects for these 3 zones.

Table 7-1 Area of Subproject by Zones

(Unit: ha)

	Zone A (Upland crops)	Zone B (Paddy rice, pasture)	Subtotal	Forest	Total	Remarks
I (Eastern part)	15,300	24,600	39,900	3,950	43,850	
II (Central part)	4,075	41,275	45,350	5,725	51,075	
III (Western part)	14,150	33,975	48,125	9,250	57,375	
Total	33,525	99,850	132,375	18,925	152,300	



Project Name	The irrigation and drainage project in the adjacent area to the Yacyreta Dam
Map Name	Area of Sub Project
Legend	

JICA