2.10 Agricultural Form

In the studied area, large-scale farms possessing land of over 4,000 ha occupy about 99% of the land. A particularly large farm is the Bolf Farm.

The most popular cultivated crop in the studied area is maize, but cotton, paddy rice, soybeans, wheat and manioc are also cultivated in the decreasing order of popularity. Maize, cotton and manioc are cultivated on sandy soils in hill lands, and on natural levees along the Parana River. Paddy rice is cultivated in the lowland around the hill lands and in the lowland along the Parana River, since most of the studied area is the alluvial lowland of the Parana River and favorable for the cultivation of rice. Artificial grassland is observed on hill lands and natural grassland in the back swamp.

In consideration of the distribution of agricultural types in the studied area, the following classification items were selected for the classification of agricultural types. The 1:50,000-scale map of agricultural forms is shown in the separate collection of maps and the conceptional map is given in Figure 27. The percentage of an area occupied by each classification item is listed in Table 7.

Table 7 Percentage of are by classification

	Natural forest (01)	Artificial forest (02)	Dry grass-land (03)	Wet grass-land (04)	Artificial grassland (05)	Paddy field (06)	Crop field (07)	Swamp (08)	River and pond (09)	Others (10)	Total
(01) Hill land	1,600 (0.8%)	0 (0.0%)	1,350 (0.7%)	400 (0.2%)	800 (0.4%)	0 (0.0%)	1,125 (0.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5,275 (2.6%)
(02)	25 (0.0%)	00 (0.0%)	50 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	75 (0.0%)
(03) Colluvial slopes	2,600 (1.3%)	0 (0.0%)	6,025 (3.0%)	5,525 (2.8%)	525 (0.3%)	125 (0.1%)	100 (0.0%)	50 (0.0%)	0 (0.0%)	0 (0.0%)	14,950 (7.5%)
(04) Alluvial fans	25 (0.0%)	0 (0.0%)	75 (0.0%)	50 (0.0%)	75 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	225 (0.1%)
(05) Valley bottom plains	200 (0.1%)	0 (0.0%)	2,550 (1.3%)	3,425 (1.7%)	200 (0.1%)	175 (0.1%)	0 (0.0%)	125 (0.1%)	0 (0.0%)	0 (0.0%)	6,675 (3.3%)
(06) Gentle fan plains	25 (0.0%)	0 (0.0%)	750 (0.4%)	10,350 (5.2%)	0 (0.0%)	375 (0.2%)	0 (0.0%)	25 (0.0%)	0 (0.0%)	0 (0.0%)	11,525 (5.8%)
(07) Natural levee	5,525 (2.8%)	0 (0.0%)	6,850 (3.4%)	1,000 (0.5%)	0 (0.0%)	875 (0.4%)	1,925 (1.0%)	950 (0.5%)	0 (0.0%)	100 (0.0%)	17,225 (8.6%)
(08) Back swamps	400 (0.2%)	0 (0.0%)	4,775 (2.4%)	62,175 (31.0%)	0 (0.0%)	4,125 (2.1%)	75 (0.0%)	24,350 (12.2%)	0 (0.0%)	0 (0.0%)	95,900 (47.9%)
(09) Micro reliefs (high)	1,300 (0.6%)	0 (0.0%)	950 (0.5%)	175 (0.1%)	25 (0.0%)	0 (0.0%)	75 (0.0%)	250 (0.1%)	0 (0.0%)	0 (0.0%)	2,775 ((1.4%)
(10) Micro reliefs (low)	2,550 (1.3%)	0 (0.0%)	10,900 (5.4%)	4,750 (2.4%)	0 (0.0%)	375 (0.2%)	100 (0.0%)	3,925 (2.0%)	0 (0.0%)	0 (0.0%)	22,600 (11.3%)
(11) Abandaned river channels	0 (0.0%)	0 (0.0%)	125 (0.1%)	50 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	100 (0.0%)	0 (0.0%)	0 (0.0%)	275 (0.1%)
(12) Low land along the river	650 (0.3%)	0 (0.0%)	700 (0.3%)	6,875 (3.4%)	0 (0.0%)	700 (0.3%)	0 (0.0%)	9,200 (4.6%)	0 (0.0%)	0 (0.0%)	18,125 (9.0%)
(13) Sand barsand dunes	1,350 (0.7%)	0 (0.0%)	400 (0.2%)	2,125 (1.1%)	0 (0.0%)	0 (0.0%)	50 (0.0%)	500 (0.2%)	0 (0.0%)	25 (0.0%)	4,450 (2.2%)
(14) Rivers and ponds	100 (0.0%)	0 (0.0%)	25 (0.0%)	0 (0.0%)	0 (0.0%)	25 (0.0%)	0 (0.0%)	75 (0.0%)	75 (0.0%)	0 (0.0%)	300 (0.1%)
Total	16,350 (8.2%)	0 (0.0%)	35,525 (17.7%)	96,900 (48.4%)	1.625 (0.8%)	6,775 (3.4%)	3,450 (1.7%)	39,550 (19.7%)	75 (0.0%)	125 (0.1%)	200,375 (100.0%)

Fig. 27 Aguricultural Form Map

(1) Artificial grassland (improved pasture land)

A grassland which appears fine in texture and constant in tonal range and has a distinct border line on aerial photographs was designated as the artificial grassland. It is distributed in the northern and eastern hill lands in the studied area and occupies only a small area.

(2) Natural grassland

This is distributed in the back swamp which occupies the most of the studied area and is used as the natural pasture land. All the unused areas except for forests the map of agricultural forms were designated as the natural grassland.

(3) Paddy field

Paddy fields are distributed in the lowland around the hill lands and in the lowland to the east of the Parana River. Particularly, in the Bolf Farm a crop rotation between the paddy field and the grassland is being employed by the use of their own irrigation and drainage canals.

Also distributed largely in the lowland adjacent to the hills are old paddy fields cultivated in the past by the rotation with the grassland.

(4) Crop field

Cultivation in the crop field on commercial basis is rare, and only the cultivation of maize and manioc is performed for the self-sufficiency on the hills, natural levees along the Parana River and micro reliefs.

(5) Rivers and ponds

(6) Others

Residential areas, airfields, cemeteries and forests were grouped in this category.

2.11 Soils

The final soil map was prepared by examining, in the field survey of this year, and correcting, by the interpretation of aerial photographs, the soil map (in other words, the soil map made by the estimation using the information of the landform classification map, subsurface geological map, vegetation map, etc.) made in the first-year study. The general description of the studied area and the results of the study are given as follows:

(1) General description of the field survey

The field survey was performed at locations selected by the use of the soil map, map of the soil characteristics, geomorophology map, etc. In the field survey, both the trial pit (a trench of about 1 m in depth was excavated for athe observation of soil profiles) and the trial boring (the subsoil of approximately 50 cm in depth was studied by the use of a boring stick) methods were employed. The number of study sites of soils including the ones for the first-year study is listed in Table 8.

Table 8 Number of survey points and soil samples for analysis

	Test pit	Boring	Soil samples	Remarks
1982	22	8	Test pit : 22 locations Soil samples: 69 samples	(Additional analysis) Volumetric weight analysis: 7 samples, Lime requirement for neutralization: 31 samples, Phosphate absorption coefficient: 15 samples
1983	38	124	Test pit : 38 locations Soil samples: 79 samples	
Total	60	132	Test pit : 60 locations Soil samples: 148 samples	

Soil samples collected from each horizon of each trial pit were analyzed at the Soil Science Department of the Faculty of Agriculture of the Asuncion University.

The items studied by the trial pit study in the field are:

1) Horizon

Soil horizons were classified by the difference in siol color and texture, and the depth of each horizon was indicated.

2) Soil texture

The soil texture was estimated by the feeling of fingers and the estimation was corrected by the particle size analysis.

3) Soil color

The standard soil color chart was used and the soil color was expressed according to the Munsell notation system.

4) Mottles

The pattern was observed and the percentage of mottles was indicated.

5) Gley

It was determined by the soil color (chroma) and the location was indicated.

6) Humus

The result of the examination of soil color, etc. was corrected by the result of the chemical analysis.

7) Moisture (seepage surface)

Moisture was judged by the feeling of a mesh of soil cluster by hand. The depth of the seepage surface was also recorded.

8) Viscosity

It was classified into none, low, intermediate, high, very high based on the feeling of fingers.

9) Hardness

It was measured by the use of the Yamanaka-type soil hardness equipment and expressed in mm.

10) Distribution of roots

The depth to which plant roots have reached was recorded.

11) Others

Other remarks, if any, were recorded.

(2) Soil classification

Soil was classified according to the classification system by the FAO/UNESCO. The soils in the studied area were classified into five great groups first, the same taxon used for the preparation of the estimated soil map last year.

These soils were further divided into eight groups based on the organic content of the surface soil and the texture as listed in Table 9.

Table 9 Classification of soils

Soil types	Subdivision of soil types
Fluvisols	Fluvisols
Gleysols	Coarse-textured greysols, Fine-textured gleysols
Regosols	Coarse-textured regosols, Fine-textured regosols
Planosols	Planosols, Humic planosols
Acrisols	Acrisols

(3) Distribution and characteristics of soil types

The distribution and characteristics of soils in the studied area will be explained below. The soil map is presented in Figure 28.

1) Fluvisols

They are distributed in the frequently flooded lowlands along the Parana River, the Yabebyry River and the Atinguy River. Therefore, the development of vegetation is very poor. Because of the repeated deposition and displacement of new materials, little soil development, including surface soils, is recognized. They are sandy soils of greyish to reddish brown color.

2) Coarse-textured gleysols

They are distributed in the back swamp, but particularly in swamps encircling the micro reliefs, swampy lowlands within natural levees, and abandoned river channels near the Parana River. Hydric grassland is the dominant vegetation type. They exist adjacent to the coarse-textured regosols which will be mentioned later. The ground water level is near the surface (within 50 cm) and flooded condition often prevails. The soils were probably sandy first but it seems that the coveragn of the ground with the imperfectly-decomposed organic materials due to the high ground water level in the basin-like landform and also the secondary deposition of clay carried from the surrounding, slightly elevated, lands, etc. contributed to the formation of an impermeable layer.

The profile shows the surface layer of sandy clay in greyish brown to dark brown color, the subsoil of sandy clay loam in dark brown color, and mottles of iron oxide from around 50 cm in depth. The subsoil is very moist and low in hardness and viscosity.

3) Fine-textured gleysols

They are distributed in the valley bottom plain between hill lands and gentle fan plains of sandy deposits which are the extensions of the valley bottom plains. They are used for the hydric grassland and partly for paddy fields.

Due to the sandy deposits carried by water from hill lands, they are more finely grained than the above-mentioned coarse-textured gleysols. The ground water level is high at the depth of about 50 cm but the flooded condition is rare.

The soil profile shows the subsoil of gleyzation indicating the process of reduction and the surface soil of sandy clay loam of greyish brown. The subsoil is also greyish brown in color and consists of clay with high viscosity and moisture. Both surface soil and subsoil show intermediate hardness.

4) Coarse-textured regosols

They are distributed on natural levees along the Parana River, the Atinguy River and the Yabebyry River and on micro reliefs in the back swamp, where the land use type is forest, crop fields and grassland.

The soils are formed by the parent material of sandy deposits supplied by the flood of rivers. The organic content is small due to the good drainage condition and the comparatively dry condition. Thus, the soil development is immature.

The soil profile does not show clear development of horizons except for the thin surface soil. The medium-grained sandy loam of yellowish brown color persists throughout the horizon. Viscosity is almost none and the hardness is also low.

5) Fine-textured regosols

They are distributed on gentle slopes located at the margin of hill lands. The land use type is either grassland or forest. The parent material is the mixture of the flood deposits of rivers and colluvial materials from the hill lands behind and is fine in texture compared with the above coarse-textured regosols derived from the flood deposits of rivers. Therefore, they have high water holding capacity, although the soil development is immature like the coarse-textured regosols.

Fig. 28 Soil Map

The profile shows a surface soil comparatively thicker than the coarse-textured regosols and brown to greyish brown throughout the horizon. The subsoil is moist and the ground water is sometimes encountered within 1 m from the surface. The soils are clay loam with high viscosity and have higher hardness than the coarse-textured regosols.

6) Humic planosols

They are distributed at the central portion to the west of the studied area, i.e., the swamp behind the micro reliefs (high). Much of the area is ponded and forms a swampy plain with little human activity. The area of this soil type has little elevated land.

The humus layer of partly decomposed organic materials is accumulated on the surface because of the high ground water level located near the surface. This soil type is sandy compared with the planosols which will be mentioned below. Although the presence of hard pan is not clear, it seems that an impermeable layer is formed. Hydric characteristics, such as gleyzation, are distinctive.

The profile shows a dark brown surface layer and yellowish brown subsoil with gleyzation. Both layers are sandy clay laom and have low viscosity. The surface layer is comparatively hard but the subsoil is soft. Out of all the soil types classified this time, this soil type has the greatest humus content.

7) Planosols

They are widely distributed in the back swamp in the northeast of the studied area. The land use type is mostly grassland, except for the eastern part of the studied area where paddy fields and pasture lands are seen. The ground water level is somewhat low, compared with the above humic planosols, and therefore the humus layer on the surface is thin. The soil texture is generally clayey.

The profile shows a dense B horizon in leached white color, forming a hard pan of an impermeable layer. An A2 horizon sometimes exists. The subsoil has mottles of iron oxide and is high in moisture. The surface soil is loamy in greyish brown and the subsoil is made of clay loam. The ground water level is usually at the depth of around 1 m.

8) Acrisols

They are distributed in the hills in the north and east of the studied area. The land use type was originally forest but is now crop fields at many places.

These are the residual soils of bright reddish yellow color, developing on highly weathered sand and basalt layers.

The profile shows eluviation of clay from the surface layer to the B horizon in the process of podzolisation. The soils have high water holding capacity and high viscosity. The surface layer is reddish brown and the subsoil is bright reddish brown. The hardness of the soils is high. The distribution of acrisols in the studied area is very limited in area.

The relationship between the micro-reliefs and soil types in the studied area is shown in Figure 29 and the standard profile by the soil type is shown in Table 9.

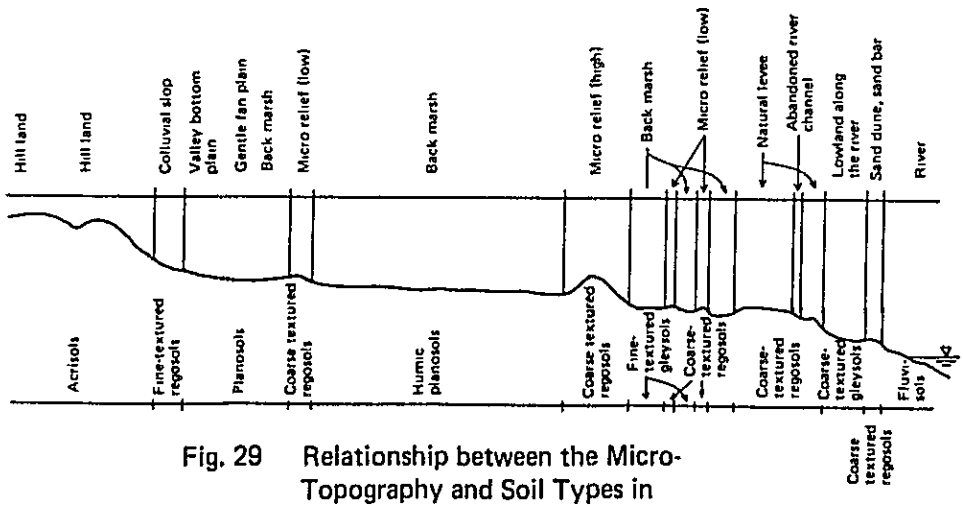


Fig. 29 Relationship between the Micro-Topography and Soil Types in the Study Area

Table 9 Physical characteristics in standard soil profiles

Location No.	Horizon	Depth	Texture	Color	Mottles	Gleyzation	Humus	Moisture	Stickiness	Compactness	pH(KCl)	Remarks
Fluvisols (Stick boring No. 1)	1	0 ∿	SL	10YR 7/3	None	None	None	Moist	None	Very loose		
Coarse-textured gleysols (Test pit No. 19)	1	0 ∿ 19	SL	7.5YR 4/2	None	None	Few	Moist	Weak	Moderate (22)		
	2	19 ∿ 65	L	7.5YR 5/3	None	Weak	Few	Wet	Weak	Moderate (19)		
	3	65 ∿	SCL	7.5YR 6/2	Few (5YR 5/8)	gleied	None	Very wet (Seepage 85cm)	Weak	Moderate (23)		
Fine-textured gleysols (Test pit No. 18)	1	0 ∿ 30	CL	5YR 4/2	None	None	Few	Moist	Moderate	Moderate (19)		
	2	30 ∿ 60	CL	5YR 5/2	Few (7.5YR 5/6)	Weak	Few	Wet	Moderate	Moderate (19)		
	3	60 ∿	C	7.5YR 5/3	Common (7.5YR 5/6)	gleied	Few	Very wet (Seepage 70cm)	High	Moderate (20)		
Coarse-textured regosols (Test pit No. 15)	1	0 ∿ 17	SL	10YR 2/1	None	None	Few	Dry	None	Vrey loose (7)		
	2	17 ∿ 45	SL	10YR 3/1	None	None	Few	Moist	None	Very loose (7)		
	3	45 ∿	SL	10YR 7/3	None	None	None	Moist	None	Vrey loose (7)		
Fine-textured regosols (Trial pit No. 12)	1	0 ∿ 30	SCL	7.5YR 3/2	None	None	Few	Moist	Weak	Moderate (22)		
	2	30 ∿ 70	SCL	7.5YR 4/4	None	None	Few	Wet	Weak	Loose (18)		
	3	70 ∿	C	10YR 5/4	None	None	Few	Very wet	Moderate	-		
Humic planosols (Test pit No. 9)	1	0 ∿ 23	L	7.5YR 2/1	None	None	Common	Wet	Weak	Intermediate (23)		
	2	23 ∿ 35	SL	10YR 4/1	Few	None	Few	Wet	Moderate	Loose (15)		
	3	35 ∿ 60	C	10YR 3/2	Common	gleied	Few	Very wet (Seepage 45cm)	High	Loose (15)		
Planosols (Test pit No. 33)	1	0 ∿ 13	SCL	10YR 2/3	None	None	Few	Moist	Weak	Moderate (21)		
	2	13 ∿ 18	CL	10YR 7/1	None	None	None	Moist	Moderate	Very compact (31)		
	3	18 ∿	C	10YR 3/3	Common (10YR 6/6)	Weak	None	Wet	High	Loose (18)		
Acrisols (Test pit No. 47)	1	0 ∿ 34	CL	7.5YR 5/6	None	None	Few	Moist	Moderate	Moderate (20)		
	2	34 ∿ 52	C	5YR 4/8	None	None	Few	Moist	High	Moderate (22)		
	3	52 ∿	C	2.5YR 5/8	None	None	None	Wet	High	Moderate (21)		

2.12 Subsurface Geology

The geological condition of the surface layer is closely related to the present landforms and soil distribution, and is by itself the basic information for the classification of land.

In the present study, the 1:50,000-scale map of the subsurface geology prepared in the first-year study was checked by the field survey and corrected by reference to the landform classification map and the available data* (Figure 30).

(1) Bedrock

The bedrock is classified into the following three types:

1) Muddy sandstone

It is distributed as the layer overlying the basalt in the hill lands in the east of the studied area. No outcrops were observed in the studied area and the weathered layer seems to be thick.

2) Sandstone

It is estimated that the sandstone is distributed in hill lands in the northeast of the studied area, but it was not confirmed by the field survey. The outcrops of sandstone were observed on slightly high elevations in the southwest of the studied area.

3) Basalt

It is mainly distributed in the northeast of the studied area but it is outside the studied area. Within the studied area, it is distributed in the natural levee areas along the Atinguy River and the Parana River. No outcrops are observed due to the thick cover of the surface layer.

*: MAPA GEOLOGICO AREA DEL PROYECTO
Entidad Binacional YACYRETA 1983

(2) Colluvial deposits (Silt and clay)

They are deposited on gentle slopes at the margin of the hill lands. These deposits are supplied from the hill lands behind and are distributed encircling the hill lands.

(3) Alluvial deposits

1) Sand and sandy silt

These materials are distributed on topographically rather high areas, such as natural levees and micro reliefs in the back swamp. They are relatively widely distributed particularly along the Parana River and along the lower stream portions of the Yabebyry River.

2) Sand and muddy silt

These materials are distributed in the swampy lowland in the northwest of the studied area and around micro reliefs to the south, and in the swampy lowlands along the Parana River. They are a little more fine-textured than the above sand and sandy silt.

3) Sand, silt and clay

These materials are distributed in the swampy lowland in the northeast of the studied area. They have higher clay content than 2) above.

4) Silt and clay

These materials are distributed in the valley bottom plain and gentle fan plains and have stronger effect from the hill lands located behind than 3) above.

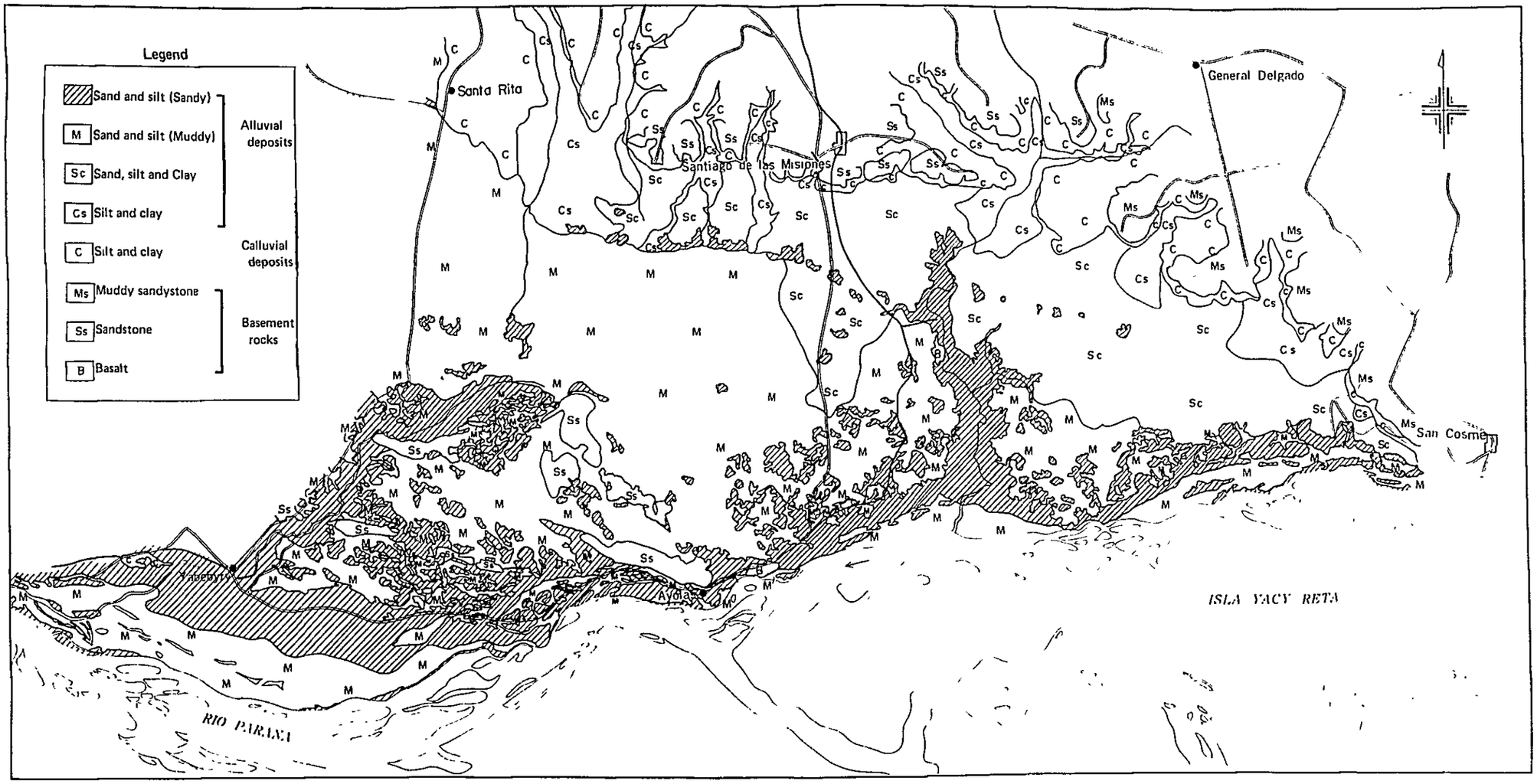


Fig. 30 Subsurface Geological Map

CHAPTER 3 LAND CLASSIFICATION

3.1 Method of Land Classification

Land classification entails classification of the land according to fixed standards after the various types of land conditions have been determined and is therefore an essential part of the agricultural development plan (project).

Land classification was performed with respect to the 4 aspects of:

(1) land productivity (as determined from soil productivity and topographic conditions)

(2) land safety (danger of ponding, flooding) g)

(3) land improvement classification

(4) possibility for natural land use

Figure 31 shows the methods adopted for each classification.

(1) Classification of land productivity

The classification of land productivity was made for the two criteria to soil productivity and the topographic conditions. Factors such as the soil elements of (strata, roughness, structure, texture, gravel conent, humic content, etc.) effective soil, wetness soil, ponding and water permeability were surveyed for the soil productivity classification to determine the suitability of the soil for crop or paddy use. When seen from the aspect of landform conditions, the classification of land use is determined according to cultivation and ease of cultivation for cases when soil improvement for field or paddy use is taken as a promise.

(2) Classification of land safety

The land safety is the degree of danger of ponding or flooding and soil disasters (such as mud-flows and hill collapse), and the degree

of potential danger of soil erosion and the soil base. The land classification in this case was determined on the basis of the flooding danger and the gravel content as there was no sand dangers recognized for the slopes.

The presence or absence of the danger of ponding due to flooding or rainfall, and the danger of land flooding ex extremely important information for the agricultural development plan. The presence or absence of ponding is determined by LANDSAT satellite data and periodically evaluated and analyzed to obtain a macro-determination. Accordingly, this survey used LANDSAT information for the geomorphology map, the elevation classification map and the land use map. Information for the danger of flooding was also used to classify the land in the regions of the Parana River, Atinguy River and the Yabebyry River regions.

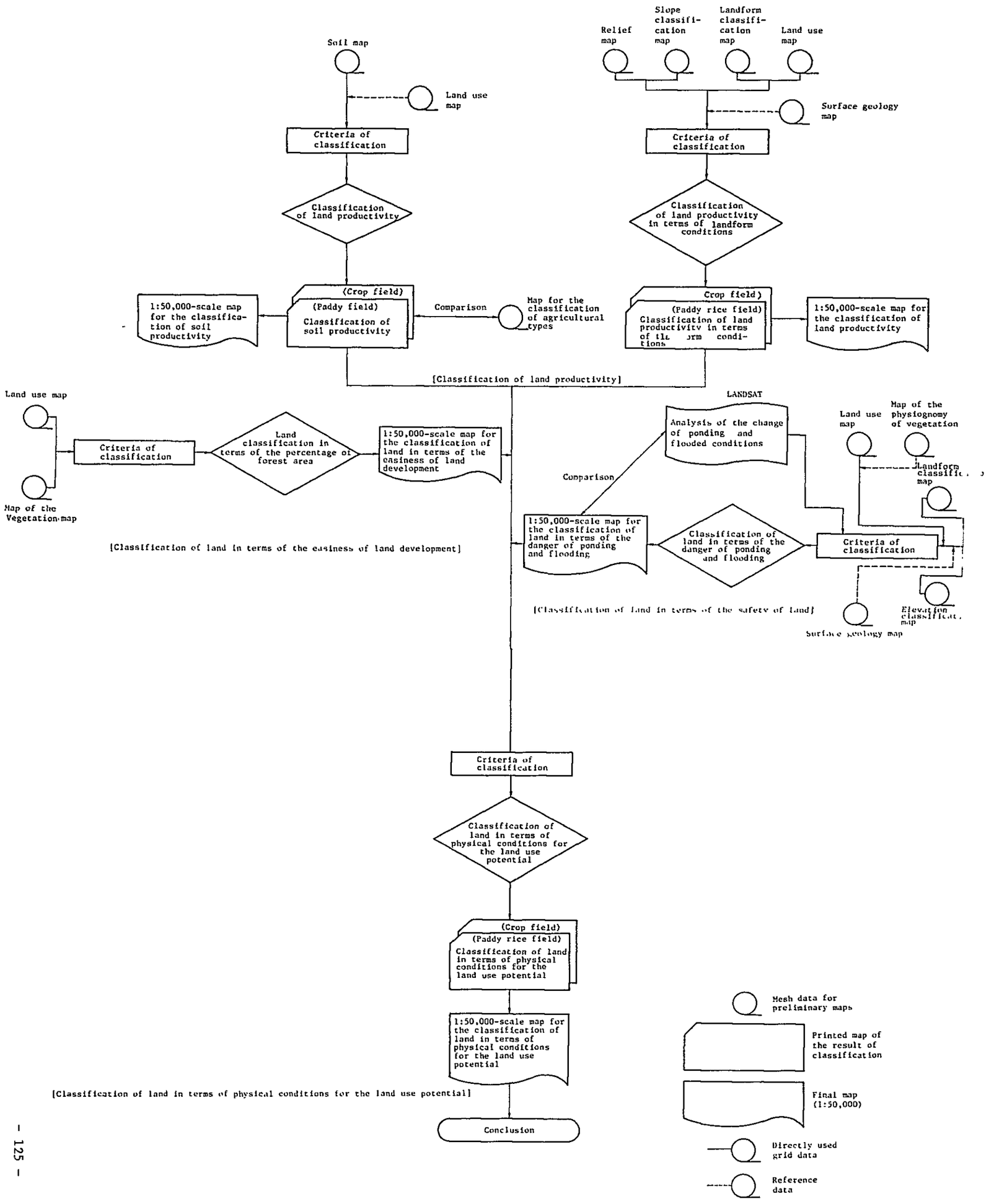


Fig. 31 Process of land classification

(3) Classification of land development (easiness of forest clearance)

Investigation of the vegetation conditions along with the cultivation, ease of cultivation and forest clearing is necessary along with that for the execution of the project with respect to the landform conditions and slope, when performing the classification of land use. The latter has already been explained in (1). With this, the land improvement was classified according to the existing vegetation (ratio of vegetated area within one mesh unit) was conducted for areas where forest clearing would be necessary.

(4) Classification of the land use potential from natural conditions

The classification of the land use potential was derived from the danger of flooding and ponding, the protection of the natural environment and the land productivity using the siol productivity and the topographic conditions as base data.

These above land classifications were converted into mesh information for the preliminary maps objectively analysed uning the computer system described in Figure 32.

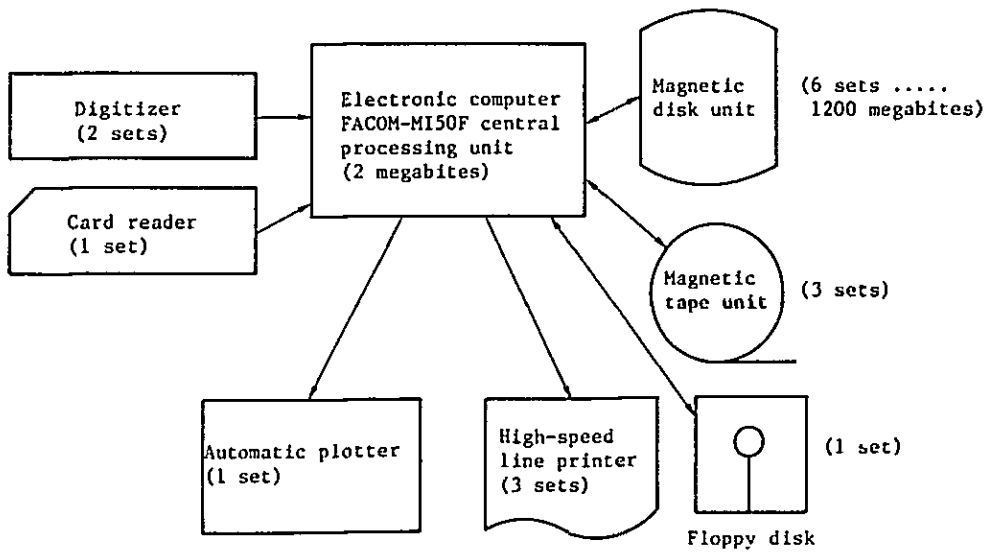


Fig. 32 Computer system for the study

3.2 Classification of Land Productivity

3.2.1 Classification of soil productivity

A classification of their productivity of the eight groups of soil in the survey area was made by the following.

(1) Understanding of soil characteristics of each group

To compare and classify the eight soil groups, the characteristics of each soil were reviewed and organized. The results of our cross-section study and those of subsequent analyses were tabulated according to each item and soil group. Surface soil and lower-layer soil were defined as those 0-30 cm and 30-100 cm below the ground, respectively, and the average geological features were organized into Table 10.

Presuming that the results in this table represent the characteristics of each soil group, we used those data in classifying soil productivity by comparing them with various classification standards. No sample analysis was made for fluvisols, because these were spread in the ponding areas from the beginning, so in its classification, the values of coarse-textured regosols, a soil pattern close to fluvisols, were employed as substitutes for chemical characteristics of fluvisols.

(2) Classification based on uninversal standards

Universal and uniform standards of classification are supposed to be employed in the classification of soil characteristics. In this respect, we depended on the classification standards for productivity possibility (the ministry or agriculture, forestry and fisheries' Crop Production Division, 1961) as a measure used widely in Japan, and of them, chose those concerning soils. Tables 11 and 12 indicate the classification standards used and subsequent results of classification, respectively.

Table 10 Mean properties of soils by the soil type

		Soil color	Mottles	Gley	Moisture	Stickiness	Hardness	Humus	pH (H_2O)	pH (KCℓ)	Electric conductivity	ex. Ca	ex. Mg	ex. K	ex. Na	Aℓ	CEC	Base saturation percentage	Available phosphate	Particle size composition			Soil texture name		Remarks
																				C	Si	S	Japan	VSDA	
Fluvisols	Surface soil	10YR 7/3	-	-	Moist	None	Loose	None																SL	3 borings
	Subsoil	10YR 7/3	Few	-	Wet (Within 1 m)		Loose	None																SL	
Coarse-textured gleysols	Surface soil	7.5YR 4/2	-	-	Moist	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	58.5	CL	SC	12 profiles
	Subsoil	7.5YR 5/3	Few	G	Very moist (Less than 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	57.0	CL	SCL	
Fine-textured gleysols	Surface soil	7.5YR 4/12	-	-	Moist	Moderate	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	SCL	12 profiles
	Subsoil	10YR 5/2	Common Few	G	Very Wet (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	
Coarse-textured regosols	Surface soil	10YR 4/3	-	-	Dry	None-Weak	15	0.52	5.1	4.2	0.0^{7}	2.7	0.77	0.07	0.2	0.6	7.0	53	2	16.7	16.2	67.1	SCL	SL	12 profiles
	Subsoil	10YR 6/4	-	-	Moist (Less than 1 m)	Weak	14	0.29	5.1	4.0	0.0^{7}	2.6	0.81	0.06	0.1	0.8	5.6	64	3	18.0	16.4	65.6	SCL	SL	
Fine-textured regosols	Surface soil	7.5YR 4/3	-	-	Moist	Moderate	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	45.6	CL	L	3 profiles
	Subsoil	7.5YR 4/3	Few	-	Moist (Less than 1 m)	Moderate	21	0.42	5.6	4.1	0.0^{4}	2.8	0.96	0.04	1.2	1.7	16.3	31	1	34.3	21.0	44.7	LIC	CL	
Humic planosols	Surface soil	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 profiles
	Subsoil	10YR 4/3	Few	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	
Planosols	Surface soil	7.5YR 4/2	-	-	Moist	Moderate	24	0.73	4.7	3.6	0.0^{5}	2.7	0.84	0.08	0.0^{5}	1.6	12.2	30	2	23.1	28.0	48.9	CL	L	15 profiles
	Subsoil	7.5YR 5/2	Common Few	G	Wet (Within 1 m)	Moderate	22	0.33	4.8	3.5	0.0^{1}	2.8	0.88	0.05	0.0^{7}	3.4	11.9	32	1	31.9	20.2	47.9	LIC	SCL	
Acrisols	Surface soil	5YR 4/6	-	-	Moist	Moderate	22	0.86	5.2	4.1	0.0^{1}	2.7	0.84	0.13	0.0^{2}	0.4	10.4	35	1	29.2	27.3	43.5	LIC	CL	4 profiles
	Subsoil	2.5YR 5/8	-	-	Moist (Within 1 m)	Strong	20	0.49	5.3	4.1	0.0	2.9	0.95	0.12	0.1	0.7	10.6	38	1	36.7	22.9	40.4	LIC	CL	

Table 11 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		Crop field				Paddy field		Crop field				Paddy field		Crop field				Paddy field		Crop 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%	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 miosture						Great danger of too little soil moisture					
Water permeability after submergence *5	I	Low to medium						High						Extremely 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 exepcted 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 12 Classification criteria of soils based on the criteria for the classification of productivity

Soil classification	Land use type	Overall classification	Thickness of surface soil	Depth of effective soil horizon	Gravel content of surface soil	Easiness of cultivation	Wetness of land	Water permeability after submergence	Oxidation and reduction	Natural fertility	Nutrient content
Coarse-textured regosols	Paddy field	III	II	I	I	I	-	II	I	II	III
	Crop field	III	III	I	I	I	III	-	-	-	III
Fine-textured regosols	Paddy field	III	I	I	I	II	-	I	II	III	III
	Crop field d	III	II	I	I	II	II	-	-	-	III
Coarse-textured gleysols	Paddy field	III	I	I	I	I	-	II	II	III	III
	Crop field	III	II	I	I	I	II	-	-	-	III
Fine-textured gleysols	Paddy field	III	I	I	I	II	-	I	II	III	III
	Crop field	III	II	I	I	II	II	-	-	-	III
Planosols	Paddy field	III	I	I	I	II	-	I	II	III	III
	Crop field	III	II	I	I	II	II	-	-	-	III
Humic planosols	Paddy field	III	I	I	I	I	-	I	III	II	III
	Crop field	III	II	I	I	I	III	-	-	-	III
Acrisols	Paddy field	III	I	I	I	II	-	I	I	II	III
	Crop field	III	II	I	I	II	I	-	-	-	III
Fluvisols	Paddy field	III	II	I	I	I	-	II	II	II	III
	Crop field	III	III	I	I	I	II	-	-	-	III

Note: Since no analysis was made on fluvisols, it was assumed that the data for coarse-textured regosols were applicable to them.

After studying the results of classification, it was found that the soils of the survey areas cleared the standards in terms of effective soil and gravel content, but that they fell in the 3rd grade with in terms of both the volume of nutrition and natural fertility and the general characteristics. To put it simply, it was discovered that the soils in the concerned areas have many limiting and disturbing factors.

(3) Classification covering regional characteristics

In the classification based on the above-mentioned universal standards, the soils of the survey areas were all ranked in the 3rd grade, so the divisions of soils in terms or proper applications of arable lands could not be clarified. Therefore, soil characteristics of the concerned districts were taken into account to make a classification with the aim of giving comparative standings to forms of arable land application.

Of the items of soil characteristics of the survey areas, base exchange capacity (CEC), soil texture, spot, gley and ground water level are the measurement tools which help distinguish between soil patterns relatively easier. These items are representative indicators for the natural fertility of soils, flood water permeability, aquatic environments, etc. that full attention was paid to them in classification works.

The classification standards were based on preceding classification models, were those modified into criteria, in which local soil characteristics were taken into full account. Tables 13 and 14 indicate the classification standards and a subsequently compiled classification, respectively.

In this classification, each soil pattern was given comprehensive grades (a, b or c) and scores. Based on these grades and scores, along with data on the relationship between each soil pattern and its present land use (particularly as arable land, see Table 16), the classification of soil characteristics was finally determined. The final division is given in Table 15.

Table 13 Criteria for the classification of the soil productivity potential in study area

Factors	Land use type	Suitability classification			Remarks
		a	b	c	
Cation exchange capacity	Paddy field	More than 10	Less than 12		
	crop field				
Soil texture	Paddy field crop field	Fine	Intermediate	Coarse	Fine : Clay content of more than 30% Intermediate: Clay content of 20-30% Coarse : Clay content of less than 20%
Soil color and mottles	Paddy field	No gley horizon within 50 cm	Gley horizon within 50 cm		
	crop field	No gley horizon within 100 cm, No mottles within 50 cm	No gley horizon within 50 cm	Gley horizon within 50 cm	
Ground water level	Paddy field	Less than 50 cm	Within 50 cm		
	Crop field	Less than 100 cm	50-100 cm	Within 50 cm	

Table 14 Soil classification based on the four factors

Soil classification	Land use type	Overall classifi-cation	Score	Cation exchange capacity	Soil texture	Soil color and mottles	Ground water level
Fluvisols	Paddy field	C	9	b	c	a	a
	Crop field	C	7	b	c	b	b
Coarse-textured gleysols	Paddy field	B	9	b	b	a	b
	Crop field	C	7	b	b	b	c
Fine-textured gleysols	Paddy field	B	11	a	a	b	a
	Crop field	C	9	a	a	c	b
Coarse-textured regosols	Paddy field	C	9	b	c	a	a
	Crop field	C	9	b	c	a	a
Fine-textured regosols	Paddy field	A	12	a	a	a	a
	Crop Field	B	10	a	a	b	b
Humic planosols	Paddy field	B	10	a	a	b	b
	Crop Field	C	8	a	a	c	c
Planosols	Paddy field	A	12	a	a	a	a
	Crop Field	B	10	a	a	b	b
Acrisols	Paddy field	A	12	a	a	a	a
	Crop field	A	12	a	a	a	a

Note 1) The score was calculated by adding the points of four factors (a = 3 points, b = 2 points, c = 1 point).

Note 2) For the CEC and soil texture of fluvisols, the respective values of coarse-textured regosols were applied.

Table 15 Suitability classification of soils

(Paddy field)

Suitability classification	Classification		Suitability	Soils
	Class	Score		
1	A	12	High	Coarse-textured regosols, Planosols, Acrisols
2	B	11,10	Moderately high	Fine-textured gleysols, Humic planosols
3	B	9	Moderate	Coarse-textured gleysols
4	C	9	Low	Coarse-textured regosols, Fluvisols

(Crop field)

Suitability classification	Classification		Suitability	Soils
	Class	Score		
1	A	12	High	Acrisols
2	B	10	Moderately high	Fine-textured regosols, Planosols
3	C	9	Moderate	Coarse-textured regosols, Fine-textured gleysols
4	C	8,7	Low	Coarse-textured gleysols, Humic planosols, Fluvisols

Table 16 Relationship between soils and the present land use

Soil classification		Classification of land use										
		Natural forest (01)	Artificial forest (02)	Dry grassland (03)	Wet grassland (04)	Artificial grassland (05)	Paddy field (06)	Crop field (07)	Swamps (08)	Rivers (09)	Others (10)	Total
	Fluvisols (01)	34 0.4%	0 0.0%	30 0.4%	283 3.5%	0 0.0%	27 0.3%	0 0.0%	374 4.7%	1 0.0%	0 0.0%	749 9.4%
	Coarse-textured gleysols (02)	22 0.3%	0 0.0%	173 2.2%	619 7.7%	0 0.0%	12 0.2%	5 0.1%	625 7.8%	0 0.0%	0 0.0%	1456 18.2%
	Fin-textured gleysols (03)	10 0.1%	0 0.0%	137 1.7%	539 6.7%	11 0.1%	19 0.2%	0 0.0%	6 0.1%	0 0.0%	0 0.0%	722 9.0%
	Coarse-textured regosols (04)	384 4.8%	0 0.0%	626 7.8%	107 1.3%	0 0.0%	42 0.5%	80 1.0%	193 2.4%	2 0.0%	5 0.1%	1439 18.0%
	Fine-textured regosols (05)	121 1.5%	0 0.0%	186 2.3%	163 2.0%	20 0.3%	2 0.0%	7 0.1%	14 0.2%	0 0.0%	0 0.0%	513 6.4%
	Humic planosols (06)	6 0.1%	0 0.0%	71 0.9%	953 11.9%	0 0.0%	0 0.0%	0 0.0%	309 3.9%	0 0.0%	0 0.0%	1339 16.7%
	Planosols (07)	7 0.1%	0 0.0%	136 1.7%	1191 14.9%	0 0.0%	169 2.1%	1 0.0%	61 0.8%	0 0.0%	0 0.0%	1565 19.6%
	Acrisols (08)	68 0.9%	0 0.0%	54 0.7%	13 0.2%	34 0.4%	0 0.0%	45 0.6%	0 0.0%	0 0.0%	0 0.0%	214 2.7%
	Total	652 8.2%	0 0.0%	1413 17.7%	3868 48.4%	65 0.8%	271 3.4%	138 1.7%	1582 19.8%	3 0.0%	5 0.1%	7997 100.0%

3.2.2 Classification of land productivity from the viewpoint of geographical conditions

In classifying land productivity, the geographical conditions of land surfaces, such as the interrelationship between slope or relief and the execution of land reform or cultivation easiness, have to be sufficiently discussed. The slope and relief of the land were considered in making the classification of land productivity.

(1) Land slope

In the case of paddy fields, the slope of land is influenced by the size of those fields to be prepared and their elevation as well, which results from the fact that the faces of paddy fields, unlike those of dry lands, are prepared on a separate basis. Refer to Table 16 for slopes out of the Japanese classification standards for opening of paddy fields and dry lands. In accordance with these standards, classification standards for the survey areas were compiled as shown in Table 17.

Table 17 Criteria for the classification of land for the opening of paddy fields and crop fields in terms of the slope gradient in Japan

Class / Items	I	II	III	IV
Paddy field	0 ∿ 35'	35' ∿ 3°	3 ∿ 8°	More than 8°
Crop field	0 ∿ 3°	3 ∿ 15°	15 ∿ 30°	More than 30°

Table 18 Relationship between relief energy and agricultural form

[Upper row (ha) / Lower row (%)]

Relief / agricultural form	Less than 5m	5 ∿ 10m	10 ∿ 15m	15 ∿ 20m	20 ∿ 25m	Greater than 25m	Total
Artificial grassland	625 (0.3%)	500 (0.2%)	425 (0.2%)	75 (0.0%)	0 (0.0%)	0 (0.0%)	1,625 (0.8%)
Natural grassland	165,725 (82.7%)	4,000 (2.0%)	1,875 (0.9%)	375 (0.2%)	25 (0.0%)	0 (0.0%)	172,000 (85.8%)
Paddy field	6,750 (3.4%)	75 (0.0%)	50 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	6,875 (3.4%)
Crop field	1,700 (0.8%)	800 (0.4%)	550 (0.3%)	225 (0.1%)	0 (0.0%)	0 (0.0%)	3,275 (1.6%)
Rivers and ponds	100 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	100 (0.0%)
Others	11,675 (5.8%)	2,850 (1.4%)	1,450 (0.7%)	325 (0.2%)	200 (0.1%)	0 (0.0%)	16,500 (8.2%)
Total	186,575 (93.1%)	8,225 (4.1%)	4,350 (2.2%)	1,000 (0.5%)	225 (0.1%)	0 (0.0%)	200,375 (100.0%)

Table 19 Relationship between landforms and types of agriculture

Landforms / agricultural form	Hill land	Shallow valley on a hill	Colluvial surface	Alluvial cone	Valley bottom plain	Gently sloped alluvial fan	Natural levee	Back swamp	Micro relief (high)	Micro relief (low)	Abandoned river channel	Lowland along a river	Sand bar and sand dune	Rivers and ponds	Total
Artificial grassland	800 (0.4%)	0 (0.0%)	525 (0.3%)	75 (0.0%)	200 (0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	25 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1,625 (0.8%)
Natural grassland	1,775 (0.9%)	50 (0.0%)	11,600 (5.8%)	125 (0.1%)	6,100 (3.0%)	11,125 (5.6%)	8,925 (4.5%)	91,275 (45.6%)	1,325 (0.7%)	19,525 (9.7%)	275 (0.1%)	16,275 (8.1%)	3,550 (1.8%)	75 (0.0%)	172,000 (85.8%)
Paddy field	25 (0.0%)	0 (0.0%)	125 (0.1%)	0 (0.0%)	175 (0.1%)	375 (0.2%)	950 (0.5%)	4,150 (2.1%)	0 (0.0%)	375 (0.2%)	0 (0.0%)	675 (0.3%)	0 (0.0%)	25 (0.0%)	6,875 (3.4%)
Crop field	1,075 (0.5%)	0 (0.0%)	100 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1,700 (0.8%)	75 (0.0%)	125 (0.1%)	150 (0.1%)	0 (0.0%)	0 (0.0%)	50 (0.0%)	0 (0.0%)	3,275 (1.6%)
Rivers and ponds	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	100 (0.0%)	100 (0.0%)
Others	1,600 (0.8%)	25 (0.0%)	2,600 (1.3%)	25 (0.0%)	200 (0.1%)	25 (0.0%)	5,650 (2.8%)	400 (0.2%)	1,300 (0.6%)	2,550 (1.3%)	0 (0.0%)	675 (0.3%)	1,350 (0.7%)	100 (0.0%)	16,500 (8.2%)
Total	5,275 (2.6%)	75 (0.0%)	14,950 (7.5%)	225 (0.1%)	6,675 (3.3%)	11,525 (5.8%)	17,225 (8.6%)	95,900 (47.9%)	2,775 (1.4%)	22,600 (11.3%)	275 (0.1%)	17,625 (8.8%)	4,950 (2.5%)	300 (0.1%)	200,375 (100.0%)

(2) Land relief

The standards for land relief and land productivity are virtually non-existent. It was therefore, attempted to establish land productivity standards for the studied areas by comparing relief energy, level of land elevation, and geographical classifications with present agricultural patterns. (See Tables 18 and 19)

As far as these two tables are concerned, paddy fields are located in most cases in areas with a relief volume of 5 m, and are geographically inclined to concentrate in back swamp. They are also non-existent in areas with a relief volume of 15 m or more. Crop fields, meanwhile, are likely to concentrate in areas with a relief volume of 5-15 m, including hill lands and natural levees. In this way, were established standards to classify land productivity based on the relief energy and geographical conditions, as are organized in Table 20.

Table 20 Classification of land productivity in terms of land form conditions

Land use type	Class / Basic data	I	II	III
Paddy field	Slope	Less than 1 degree	1 ∿ 3°	More than 3 degree
	Relief	Less than 5 m	5 ∿ 15 m	More than 15 m
	Geomorphology	Back swamp	Colluvial slope, Alluvial cone, Valley bottom plain, Gentle fan plain	Hill land Shallow valley on a hill land, Natural levee, Micro relief (high, low), Abandoned river channel, Lowland along a river, Sand bar, Sand dune, River, Pond
Crop field	Slope	Less than 3 degree	3 ∿ 8°	More than 8 degrees
	Relief	Less than 15 m	15 ∿ 20 m	More than 20 m
	Geomorphology	Hill, Natural levee, Micro relief (high)	Sahllow valley on a hill land, Colluvial surface, Alluvial cone, Gentle fan plaine, Micro relief (low), Sand bar, Sand dune	Valley bottom plain, Back swamp Abandoned river channel, Lowland along a river, River, Pond

3.2.3 Results of land productivity classification

From land productivity based on soil productivity and geographical conditions, the land productivity of the survey areas was comprehensively classified. The standards of this classification are given in Table 21 and its results are summarized in Tables 33 and 34.

Table 21 Criteria for the classification of land productivity

Rank	Explanation	Paddy fields		Crop fields	
		Soil productivity	Land productivity according to topographic conditions	Soil productivity	Land productivity according to topographic conditions
1	High land use potential as paddy fields and crop fields	I	I	I	I
2	Comparatively high land use potential as paddy fields and crop fields	I ---------- II II ---------- I,II		I ---------- II II ---------- I,II	
3	A little low land use potential as paddy fields and crop fields	I ---------- III II ---------- III III ---------- I,II,III		I ---------- III II ---------- III III ---------- I,II,III	
4	Low land use potential as paddy fields and crop fields	IV	I,II,III	IV	I,II,III

(1) Paddy field

The paddy fields in Rank 1 in the table above are distributed 1) in a vast region from Bolf Farm in the east of the survey areas up to the Atinguy River, 2) in a region spreading vertically along the right-hand bank of the Atinguy River and 3) in a district along the hill lands and spreading from the access road to the south of Guavira Ranch.

1) Those paddy fields from Bolf Farm up to the Atinguy River are made of planosols in terms of soil, and located in back swamps geographically. Most of this region is paddy fields and wet grasslands.

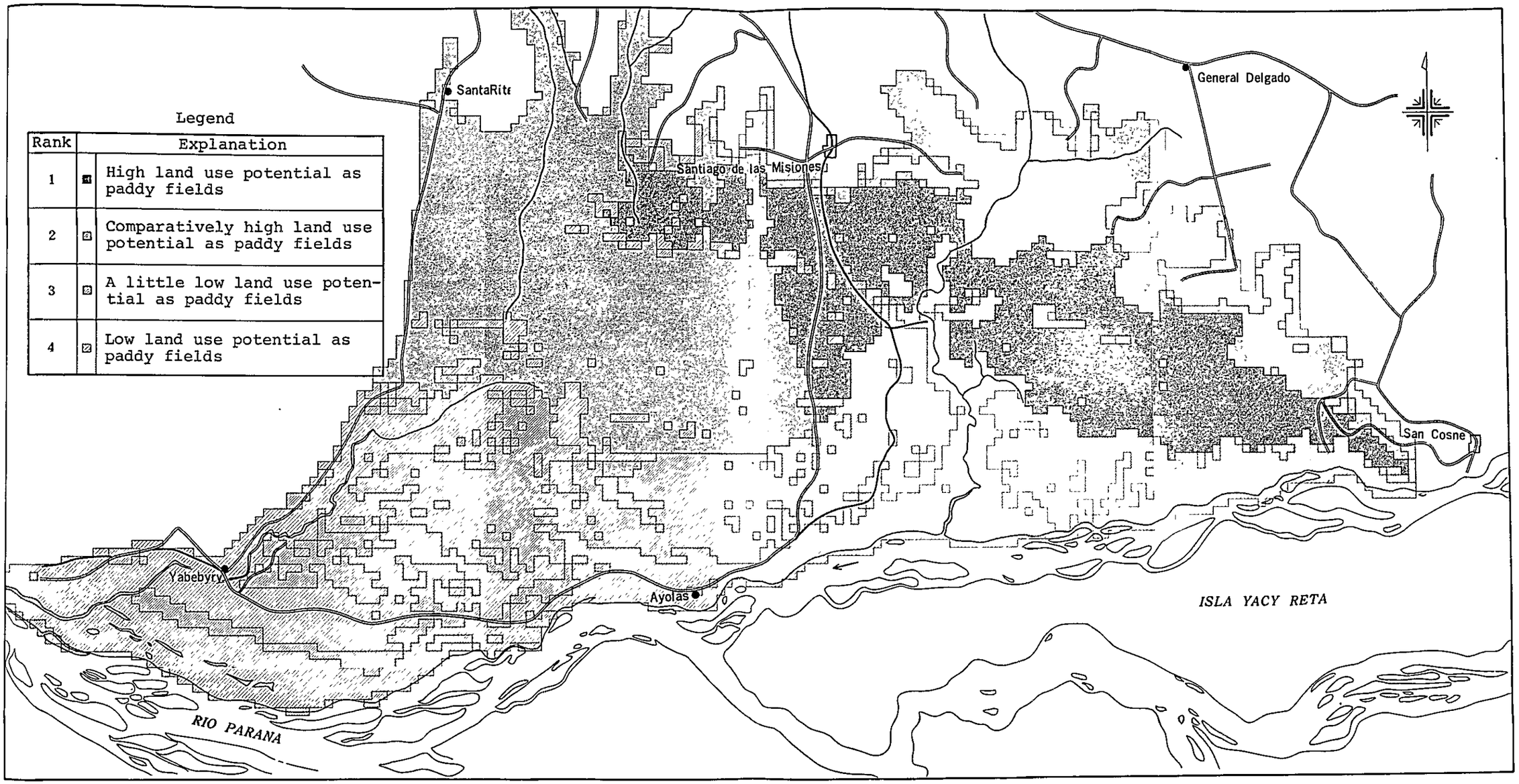
2) Like the district in 1), the areas on the right-hand bank of the Atinguy River are made of planosols and are back swamps. Also they constitute wet grasslands.

3) The region spreading along the hill lands has planosols and fine-textured regosols. Geographically, they constitute back swamps and a colluvial slope, making paddy fields and wet grasslands.

The paddy fields in Rank 2, meanwhile, are distributed from the rims of the hill lands and the access road to the central parts of the west and then run in the direction of north-west. Those along the hill lands are made of fine-textured regosols and gleysols, and constitute a valley bottom plain and a colluvial slope. They are being applied as artificial grasslands and paddy fields.

Legend

Rank	Explanation
1	High land use potential as paddy fields
2	Comparatively high land use potential as paddy fields
3	A little low land use potential as paddy fields
4	Low land use potential as paddy fields



0 5 10 15Km

1 : 250,000

Fig. 33 Map for the classification of land productivity (paddy fields)

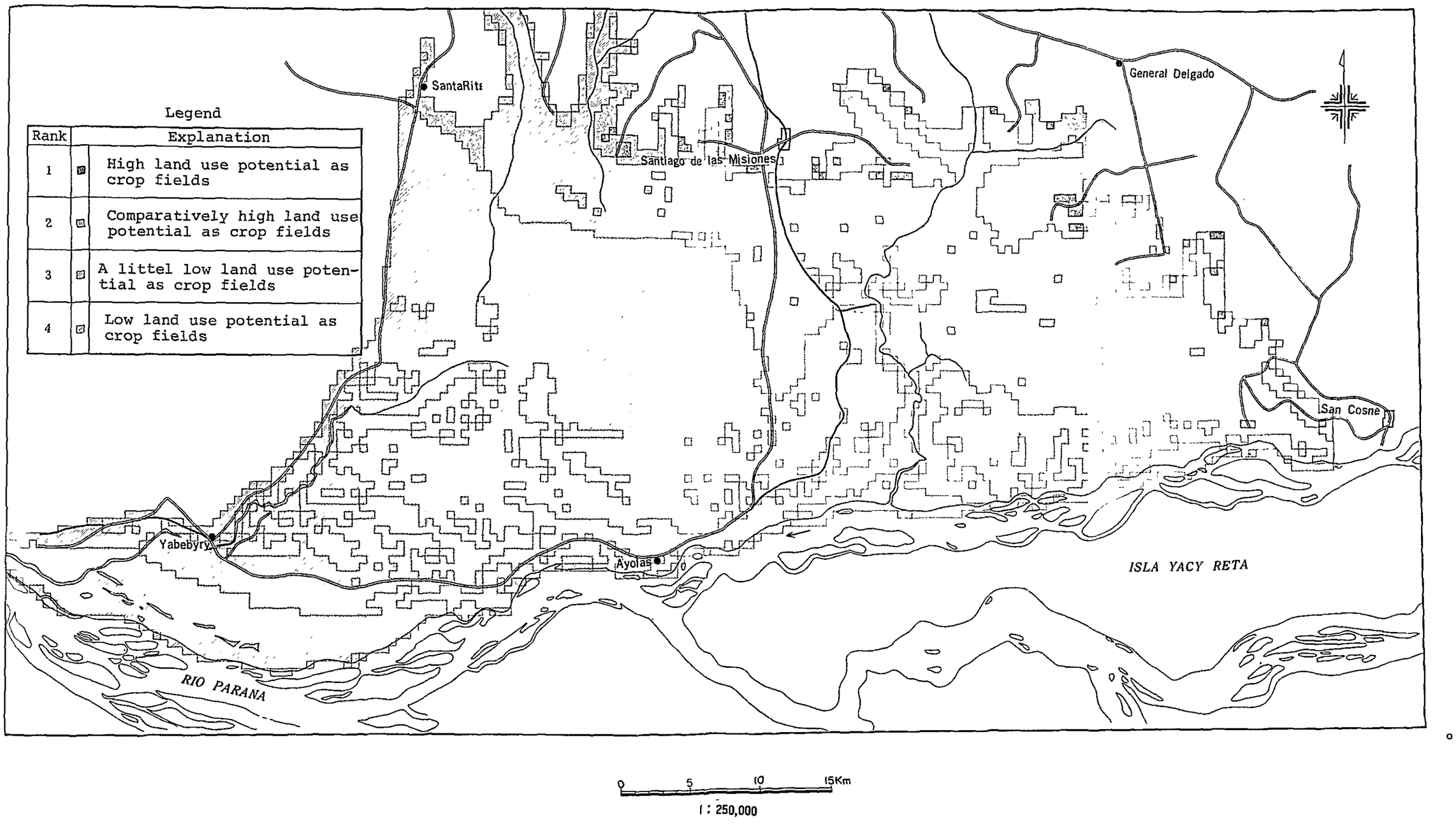


Fig. 34 Map for the classification of land productivity (crop fields)

Those in Rank 3 are distributed in the back swamps north of the survey areas and on the natural levees and in micro reliefs along the Parana River. In terms of soil, they are planosols or coarsely-textured regosols. They constitute forests, crop fields, ranches, and so on.

The fields grouped in Rank 4 are scattered in the back swamps (ponding areas) in the central parts to the west of the studied areas, in highly humid areas along the natural levees and lowered parts near rivers. They are made up of coarse-textured gleysols, humic planosols, fluvisols, etc.

(2) Crop field

There are very few regions which are classifide as Rank 1. The few which are present are all distributed in the hill land at the eastern extremity of the studied region.

Regions classified as Rank 2 include hill land and colluvial slopes and artificial grassland regions.

Regions classified as Rank 3 include the area from the central part of the studied region natural levees and micro relief in the back swamps and the Parana River, and follow the areas having planosols and coarse-textured regosols. These regions are mainly used for forests, crop fields and pasture.

Regions classified as Rank 4 are the back swamps (areas with danger of ponding) in the central western part of the studied area, back swamps along natural levees and river lowlands having coarse-textured gleysols, humic planosols and fluvisols, etc.

3.3 Classification of the Safety to Flooding and Ponding of Land

3.3.1 Classification standards

The danger of ponding in humid areas and the danger of fields along the Parana River were taken into consideration in the classification of land safety. Since no classification standards were available for ponding or flooding danger, there was no choise but to determine them voluntarily for individual areas. The dangers or this kind, however, can be assumed to some extent from geographical conditions, such aselevation and landform types, and land application patterns.

In this particular case, classification standards were set by reviewing the ponding areas discovered through time-sequential studies and analyses of Landsat-assisted data (those for seven periods) as well as geomorphological classification, elevation and the present application of lands.

To establish classification standards for ponding, data on the scale of ponding at the time of the Parana River's flood in 1983 and the reviewed landform divisions and elevation were used.

(1) Danger of ponding

Tables 22 through 24 indicate the analyzed results of the 7-period Landsat data (see Table 16 and the 1/250,000-scale ponding area frequency map), in addition to geomorphological classification, elevation and the present application of lands.

1) In comparison of geomorphological classification with the frequency of ponding,

- The areas whose ponding frequency tops 4 constitute back swamps or micro reliefs (low).
- Those with an ponding frequency of 6 to 7, refer to back swamps.

2) In comparison of elevation with the frequency of ponding,

- In areas with an elevation of 80 m or less, the ponding frequency always remains high.
- Those areas, with a ponding frequency of 3 or less, correspond to the areas with an elevation of 60-70 m and 70-80 m. The areas with a ponding frequency of 4 and more correspond to those with an elevation of 70-80 m.
- Even those areas with an elevation of 80-90 m, one or two ponding are confirmed.

3) When the present applications of lands are compared with ponding frequency,

- Those areas with high ponding frequencies match well with wet grasslands and swamp areas..
- The areas low in ponding frequency correspond to dry grasslands, as well as wet grasslands and humid areas.

Table 22 Relationship between landforms and the frequency of ponding and the flooded area

[Upper row (ha) / Lower row (%)]

ponding flooding \ Landform type		Hill land	Shallow valley on a hill	Colluvial slope	Alluvial cone	Valley bottom plain	Gentle fan plain	Natural levee	Back swamp	Micro relief (high)	Micro relief (low)	Abandoned river channel	Lowland along a river	Sand bar, sand dune	Rivers and ponds	Total
Frequency of ponding	Period 1	325 (0.3%)	0 (0.0%)	1,025 (0.9%)	50 (0.0%)	500 (0.4%)	3,400 (3.0%)	625 (0.5%)	13,900 (12.2%)	375 (0.3%)	5,250 (4.6%)	25 (0.0%)	675 (0.6%)	0 (0.0%)	25 (0.0%)	26,175 (22.9%)
	Period 2	50 (0.0%)	0 (0.0%)	625 (0.5%)	0 (0.0%)	0 (0.0%)	1,700 (1.5%)	75 (0.1%)	18,500 (16.2%)	50 (0.0%)	2,875 (2.5%)	0 (0.0%)	700 (0.6%)	0 (0.0%)	0 (0.0%)	24,575 (21.5%)
	Period 3	0 (0.0%)	0 (0.0%)	100 (0.1%)	0 (0.0%)	0 (0.0%)	100 (0.1%)	100 (0.1%)	12,925 (11.3%)	25 (0.0%)	1,825 (1.6%)	0 (0.0%)	250 (0.2%)	0 (0.0%)	0 (0.0%)	15,325 (13.4%)
	Period 4	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	8,925 (7.8%)	0 (0.0%)	600 (0.5%)	25 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	9,550 (8.4%)
	Period 5	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	7,300 (6.4%)	0 (0.0%)	400 (0.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	7,700 (6.7%)
	Period 6	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	8,250 (7.2%)	0 (0.0%)	200 (0.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	8,450 (7.4%)
	Period 7	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2,175 (1.9%)	0 (0.0%)	100 (0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2,275 (2.0%)
Flooded area		0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2,425 (2.1%)	100 (0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	12,750 (11.2%)	4,600 (4.0%)	225 (0.2%)	20,100 (17.6%)
Total		375 (0.3%)	0 (0.0%)	1,750 (1.5%)	50 (0.0%)	500 (0.4%)	5,200 (4.6%)	3,225 (2.8%)	72,075 (63.1%)	450 (0.4%)	11,250 (9.9%)	50 (0.0%)	14,375 (12.6%)	4,600 (4.0%)	250 (0.2%)	114,150 (100.0%)

Table 23 Relationship between elevation and frequency of ponding and the flooded area

Elevation / ponding Flooding		50∿60 m	60∿70 m	70∿80 m	80∿90 m	90∿100 m	100∿110 m	110∿120 m	120∿130 m	Total
Frequency of ponding	Period 1	325 (0.3%)	775 (0.7%)	23,100 (20.2%)	1,800 (1.6%)	100 (0.1%)	50 (0.0%)	25 (0.0%)	0 (0.0%)	26,175 (22.9%)
	Period 2	0 (0.0%)	1,550 (1.4%)	21,225 (18.6%)	1,775 (1.6%)	25 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	24,575 (21.5%)
	Period 3	0 (0.0%)	1,400 (1.2%)	13,825 (12.1%)	100 (0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	15,325 (13.4%)
	Period 4	0 (0.0%)	275 (0.2%)	9,275 (8.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	9,550 (8.4%)
	Period 5	0 (0.0%)	50 (0.0%)	7,650 (6.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	7,700 (6.7%)
	Period 6	0 (0.0%)	300 (0.3%)	8,150 (7.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	8,450 (7.4%)
	Period 7	0 (0.0%)	0 (0.0%)	2,275 (2.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2,275 (2.0%)
Flooded area		5,325 (4.7%)	12,350 (10.8%)	2,425 (2.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	20,100 (17.6%)
Total		5,650 (4.9%)	16,700 (14.6%)	87,925 (77.0%)	3,675 (3.2%)	125 (0.1%)	50 (0.0%)	25 (0.0%)	0 (0.0%)	114,150 (100.0%)

Table 24

Relationship between the present land use type and the frequency of ponding and the flooded area

Land use type / ponding Flooding		Natural forest	Artificial forest	Dry grassland	Wet grassland	Artificial grassland	Paddy field	Crop field	Swamps	Rivers and ponds	Others	Total
Frequency of ponding	Period 1	1,250 (1.1%)	0 (0.0%)	4,200 (3.7%)	14,750 (12.9%)	25 (0.0%)	575 (0.5%)	150 (0.1%)	5,200 (4.6%)	25 (0.0%)	0 (0.0%)	26,175 (22.9%)
	Period 2	925 (0.8%)	0 (0.0%)	3,025 (2.7%)	14,700 (12.9%)	25 (0.0%)	50 (0.0%)	0 (0.0%)	5,850 (5.1%)	0 (0.0%)	0 (0.0%)	24,575 (21.5%)
	Period 3	325 (0.3%)	0 (0.0%)	1,400 (1.2%)	8,475 (7.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5,125 (4.5%)	0 (0.0%)	0 (0.0%)	15,325 (13.4%)
	Period 4	75 (0.1%)	0 (0.0%)	525 (0.5%)	4,875 (4.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4,075 (3.6%)	0 (0.0%)	0 (0.0%)	9,550 (8.4%)
	Period 5	50 (0.0%)	0 (0.0%)	125 (0.1%)	6,225 (5.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1,300 (1.1%)	0 (0.0%)	0 (0.0%)	7,700 (6.7%)
	Period 6	0 (0.0%)	0 (0.0%)	200 (0.2%)	7,250 (6.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1,000 (0.9%)	0 (0.0%)	0 (0.0%)	8,450 (7.4%)
	Period 7	0 (0.0%)	0 (0.0%)	100 (0.1%)	1,400 (1.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	775 (0.7%)	0 (0.0%)	0 (0.0%)	2,275 (2.0%)
Flooded area		2,850 (2.5%)	0 (0.0%)	1,225 (1.1%)	8,450 (7.4%)	0 (0.0%)	900 (0.8%)	125 (0.1%)	6,525 (5.7%)	0 (0.0%)	25 (0.0%)	20,100 (17.6%)
Total		5,475 (4.8%)	0 (0.0%)	10,800 (9.5%)	66,125 (57.9%)	50 (0.0%)	1,525 (1.3%)	275 (0.2%)	29,850 (26.1%)	25 (0.0%)	25 (0.0%)	114,150 (100.0%)

(2) Danger of flooding

In the studied areas, the Parana River swelled abnormally in a flood of 1983. The following were discovered when the scope of this flood (Interpretation of the LANDSAT image on April 26 of the same year) with related geomorphological classification and elevation.

1) The areas with an elevation of up to 80 m were flooded. Those areas elevated by more than that escaped flooding.

2) When viewed from landforms, the riverside lowlands along the Parana were mostly flooded, and sand bars, sand banks and the natural banks with slight relative heights also were subject to the flood.

Based on the data and results mentioned above, the standards for classification of ponding and flooding dangers were determined in the studied areas. See Table 25.

Table 25 Criteria of classification of the danger of ponding and flooding

Class / Basic data	Safe ⟷ Dangerous		
	1	2	3
Landform type	Hill land Shallow valley on a hill land Natural levee, Micro relief (high, low)	Colluvial slope Alluvial cone, Valley bottom plain, Gentle fand plain	Back swamp Abandoned river channel, Lowland along a river, Sand bar, Sand dune, River, Pond
Elevation	More than 90 m	80 ∿ 90 m	Less than 80 m
Land use	Natural forest, Artificial forest, Dry grassland, Artificial grassland, Crop field Others	Paddy field	Wet grassland, Swamp, River, Pond

3.3.2 Results of classification

Figure 35 shows the results of classification made in accordance with the standards for ponding and flooding dangers in Table 25.

The areas grouped into Rank 1 (safety areas) correspond to hill lands in the north of the studied areas, natural levees and the micro reliefs in marshes. The hill lands, which have an elevation of about 80 m, are applied as forests, crop fields and artificial grassland.. The natural levees or slightly elevated swamp lands cannot be defined in elevation, but in either case, there is difference of elevation of about 1 m with those swamp lands in Ranks 2 and 3. They are currently used as forests and crop fields. Analyses of Landsat data (7 periods) indicate that any of these areas was ponded and flooded.

Those areas in Rank 2 (areas of relatively less danger) correspond to colluvial slopes along the hill lands, valley bottom plains and gentle fan plains, and either of them has an elevation of about 80 m. They now are used as paddy fields, wet grasslands and dry grassland.

Rank 3 areas (areas of much danger) refer to back swamps, abandoned river channels and raiverside lowlands, and in most cases, there is wise distribution of wet grasslands. As a result of the analyses of Landsat data and flood remains, the water level was elevated by about 63 m to reach Ayolas in a huge flood of the Parana River of 1983, but the flood did not affect natural levees.

Legend

Rank	Explanation
1	Safe area
2	Area with comparatively low danger
3	Dangerous area

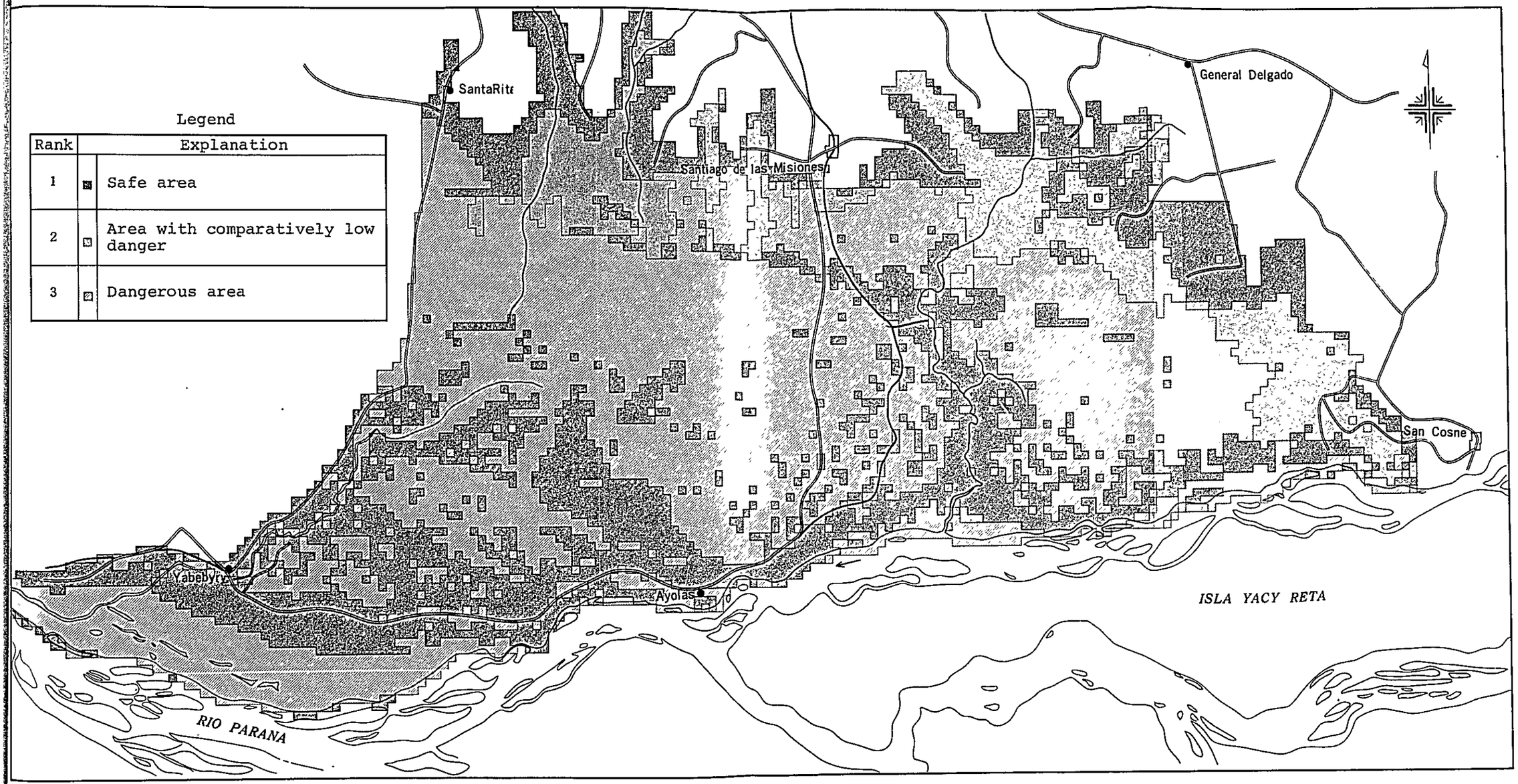


Fig. 35 Map for the dangerous classification of ponding and flooding

3.4 Classification of Land Agricultural Development Difficulty

When classification is made with respect to the development of lands, studies should be conducted on the difficulty of executing the landform conditions (slope, relief, etc.) cultivation and forest clearance in relation to the present distribution of forests. The results of discussion of the former issue were mentioned in 3.2. Classification was therefore made for the difficulty of forest clearance in reforming lands relative to the present distribution of forests. This classification had its basis on forest space ratios.

In determining classification standards, we considered regional characteristics and resorted to the standards mentioned below (See Table 26). This is because no uniformed or universal standards of classification were available. The results of our classification were shown in Figure 36.

Table 26 Classification of land in terms of the easiness of land agricultural development (forest clearance)

Rank	Explanation	Classification criteria according to the forest area (500m x 500 m grids)
1	Comparatively easy	Unforested area
2*	A little difficult	Potentially forested area
3	Comparatively difficult	The percentage of forest area of 10 to 50%
4	Very difficult	The percentage of forest area of greater than 50%

* This area, although unforested at present, is likely to be forested potentially from the ecological viewpoint, as indicated in the forest distribution on natural levees. Forest in the study area is more concentrated on natural levees as shown in Table 5 in 2.2 Land use in Chapter 2.

(1) Rank 1 areas correspond to those other than the areas mentioned above, such as back swamps.

(2) Rank 2 areas are distributed in the periphery of the Yabebyry River and on the natural levees along the Parana River in the neighborhood of Yabebyry.

(3) Rank 3 areas correspondent to the aforementioned hill lands, natural levees, micro reliefs, sand bars and sand dunes.

(4) Rank 4 areas refer to the hill lands in the north and east, as well as the natural levees and micro reliefs along the Parana, Atinguy and Yabebyry Rivers.

Legend

Rank		Explanation
1		Comparatively easy
2		A little difficult
3		Comparatively difficult
4		Very difficult

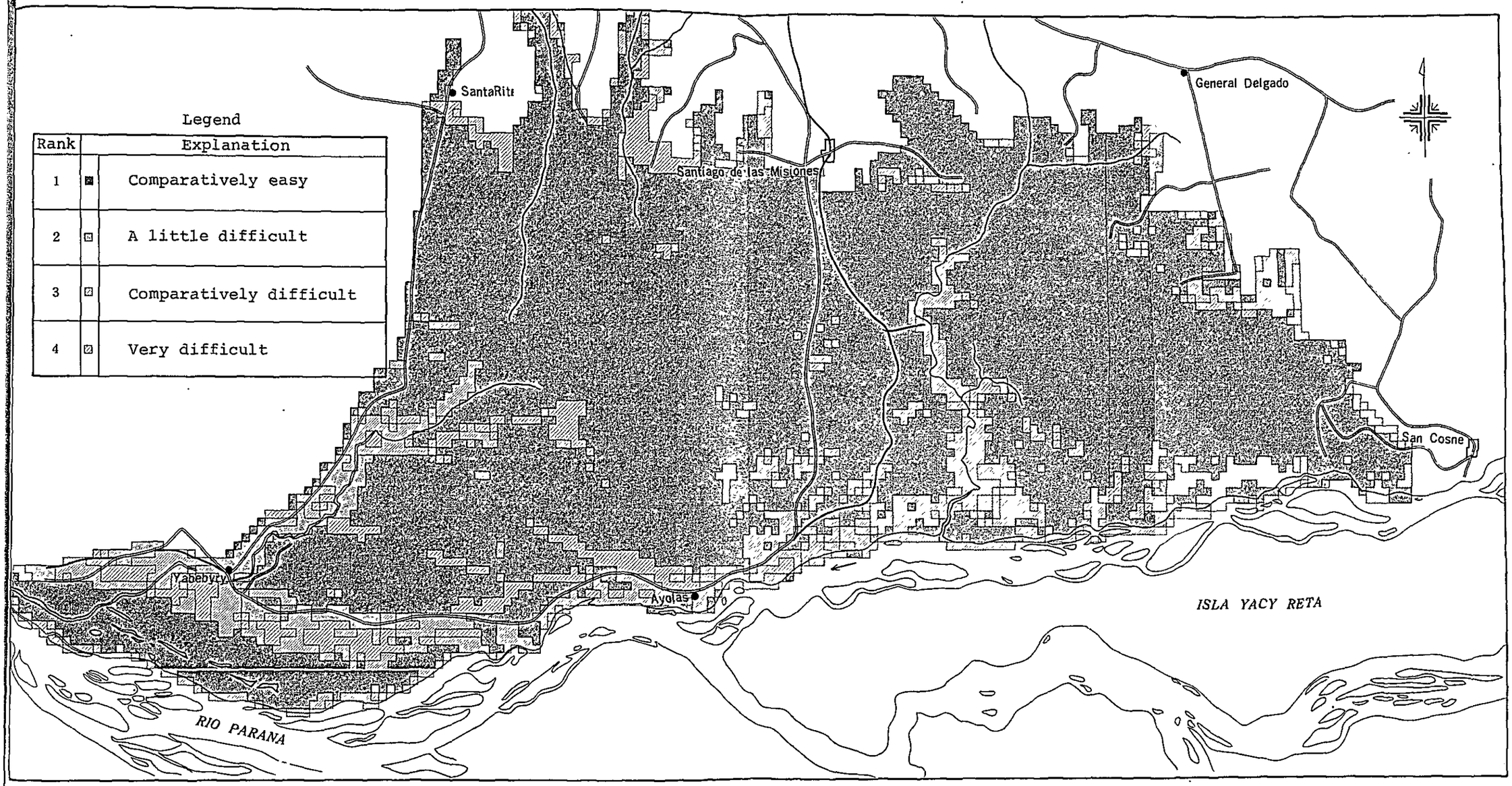


Fig. 36 Map for the classification of land agricultural development difficulty (forest clearance)

3.5 Classification of Land Use Potentiality of Physical Conditions

The classification of land use possibility for the studies areas was comprehensively made from the viewpoint of physical conditions, in which land productivity relative to soil productivity and geographical conditions, dangers of ponding and flooding and development (Forest clearance) difficulty. Figure 37 shows the classification's procedures.

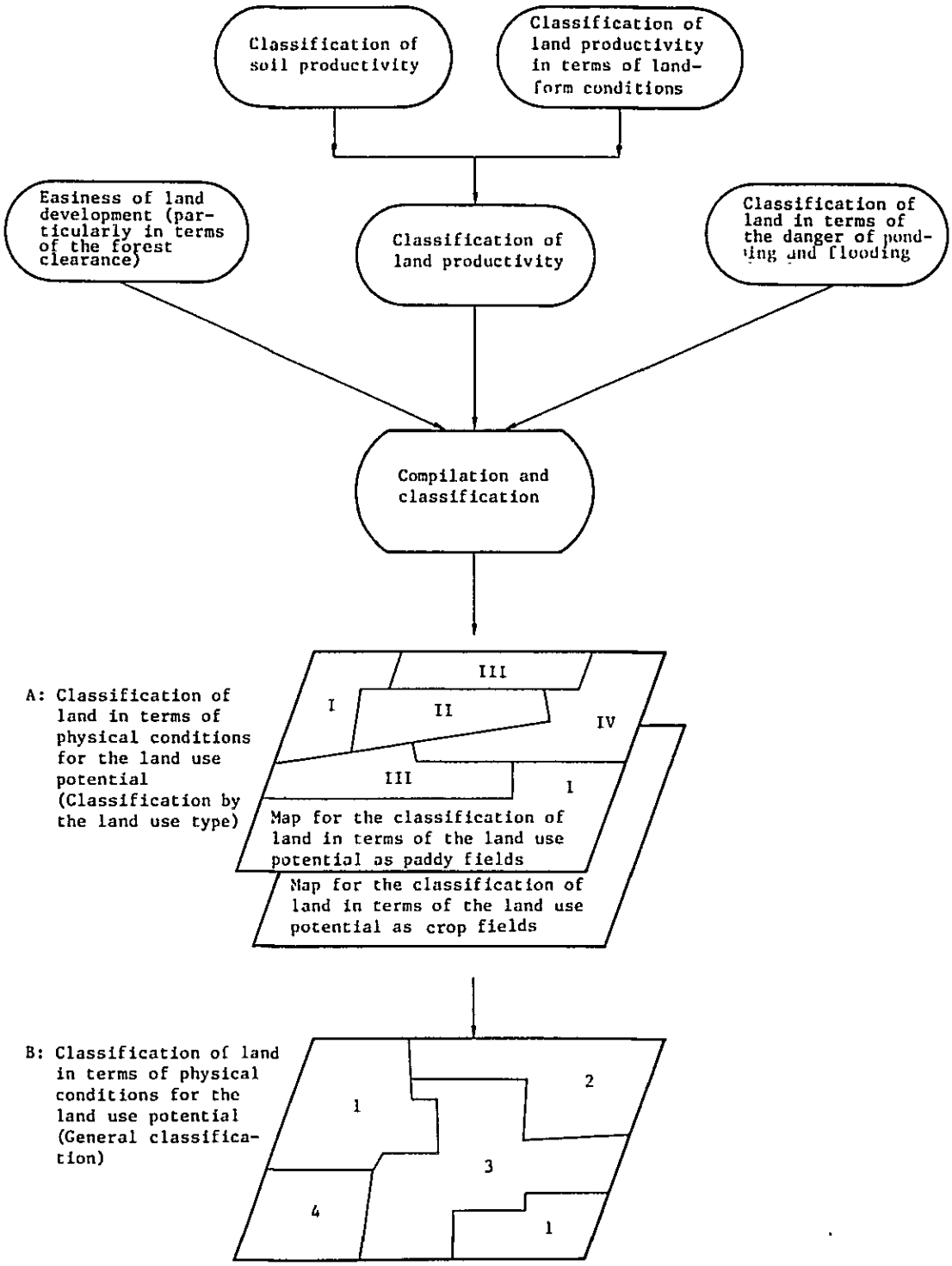


Fig. 37 Coassification of land in terms of physical conditions for the land use potential

3.5.1 Classification according to field types

Table 27 shows the standards for the classification of land use possibility according to field types.

Table 27 Criteria for the classification of land by the land use type

Rank	Explanation	Paddy fields			Crop fields		
		Classification of land productivity	Classification of land in terms of the safety of land	Classification of land in terms of the easiness of land development (forest clearance)	Classification of land productivity	Classification of land in terms of the safety of land	Classification of land in terms of the easiness of land development (forest clearance)
1	High land use potential as paddy fields and crop fields	I	I,II	I,II,III	I II	I,II I	I,II,III I,II,III
2	Comparatively high land use potential as paddy fields and corp fields	I I II	III I,II I,II	I,II,III IV I,II,III	I I II III	III II II I	I,II,III IV I,II,III I,II,III
3	A little low land use potential as paddy fields and crop fields	II II III	III I,II I,II	I,II,III IV I,II,III	II II III IV	III II II I	I,II,III IV I,II,III I,II,III
4	Low land use potential as paddy fields and crop fields	III III IV	III I,II I,II	I,II,III IV I,II,III	III III IV	III II II	I,II,III IV I,II,III

(1) Results of the classification of the land potentials as paddy field

The results of the classification of the land potentials as paddy fields in the studied areas are given in Figure 38.

1) The areas grouped in Rank 1 are distributed to the south of Bolf Farm in the north of the studied areas, near Cemirrite Farm and to the south of Lomita Farm in the northren part of the studied areas. These areas are used as paddy fields and their classification results are proper.

2) Rank 2 areas, located along hill lands running from east to northwest in the studied areas, provide paddy fields and wet grasslands.

3) Rank 3 areas are concentrated in the center of the western part of the studied areas and to the north of it. Most of those are ponded with lots of wet grasslands, and almost none of them are applied as arable lands.

4) Rank 4 areas, meanwhile, are scattered on natural levees along the Parana, Yabebyry and Atinguy Rivers, riverside lowlands along the Parana River and sand bars and dunes. They constitute forests and on a partial basis crop fields.

(2) Results of the classification of land potentials as crop fields

The results of the classification of the land potentials as crop fields in the studied areas are shown in Figure 39.

1) Rank 1 areas can be sighted partially only in the hill lands in the eastern part of the studied areas. They presently are used as artificial grasslands or dry grasslands, but some of them already are applied as crop fields.

2) Rank 2 areas are distributed on the natural levees along the Parana River and on the colluvials slopes along slightly elevated or hill lands. They are concentrated on the natural levees along

the Parana River. They constitute dry grasslands and crop fields presently.

3) Rank 3 areas are scattered in the valley-bottom plains, gentle fan plains and micro reliefs in the periphery of hilly districts. They are presently used as dry grasslands, wet grasslands or forests.

4) Rank 4 areas are extensively distributed from the center in the east to the center of the studied areas. They are primarily used as wet grasslands or swamps. Some of them are found in the river-side lowlands along the Parana River.

Legend

Rank	Explanation
1	High land use potential as paddy fields
2	Comparatively high land use potential as paddy fields
3	A little low land use potential as paddy fields
4	Low land use potential as paddy fields

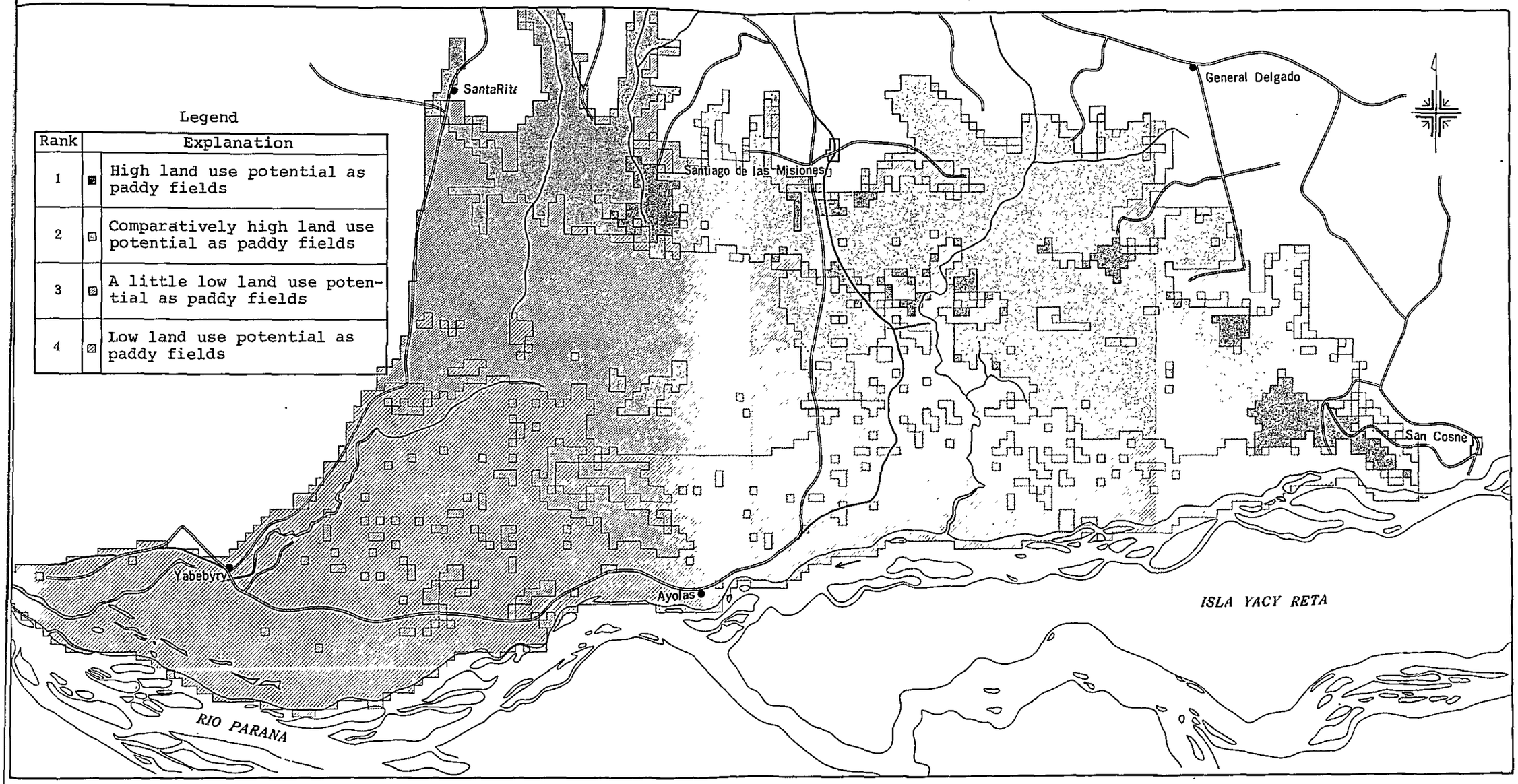
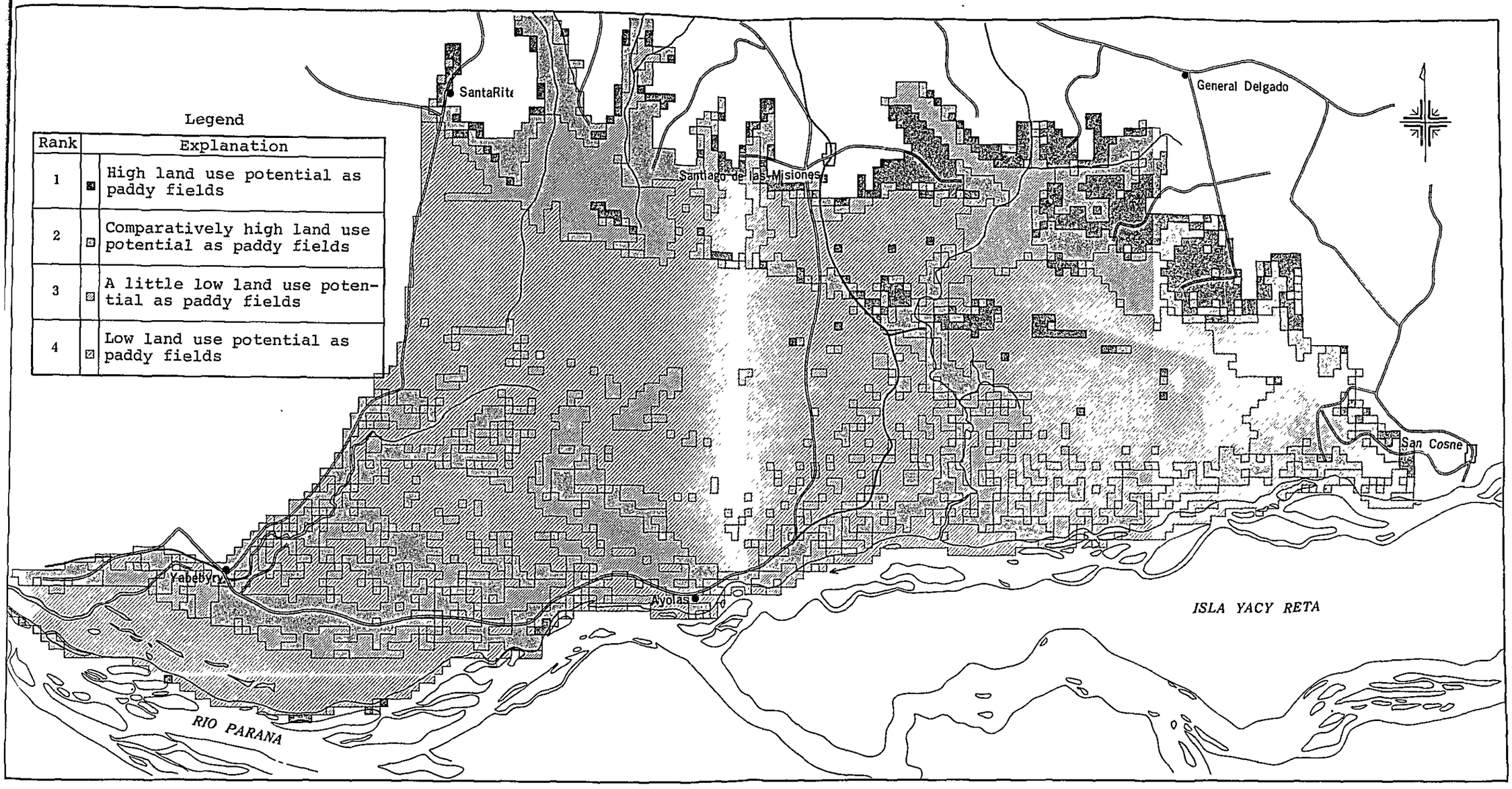


Fig. 38 Map for the classification of land use potentiality of physical conditions
(Classification for land use potentiality as paddy fields)

Legend

Rank	Explanation
1	High land use potential as paddy fields
2	Comparatively high land use potential as paddy fields
3	A little low land use potential as paddy fields
4	Low land use potential as paddy fields



0 5 10 15Km

1 : 250,000

Fig. 39 Map for the classification of land use potentiality of physical conditions
(Classification for land use potentiality as crop fields)

3.5.3 General classification

The results of the classification of the land potentials as both paddy and crop fields are comprehensively organized into Table 28.

Table 28 Overall land use potential

Symbols	Explanation	Classification of the land use potential as paddy fields	Classification of the land use potential as crop fields
1	High land use potential as both paddy fields and crop fileds	I II	I,II 1,II
2	High land use potential as paddy fields but a little low potential as crop fields	I II	III,IV III,IV
3	A little low land use potential as paddy fields but high potential as crop fields	III IV	I,II I,II
4	A little low land use potential as both paddy fields and crop fields	III IV	III,IV III,IV

(1) The areas referred to as 1 in the table above can be sighted in the hill lands from the north to the east of the studied areas, as well as the colluvials slopes of the hill lands. Thev presently constitute crop fields or dry grasslands.

(2) The areas referred to as 2 in the same table are scattered from the east to the northwest of the studied areas, and are mostly wet grasslands. Parts of them are applied as paddy fields.

(3) The areas mentioned as 3 cover the natural levees along rivers, micro reliefs and parts of the hilly districts. They mostly are forests and dry grasslands, and are used as paddy fields to a partial degree.

(4) The areas mentioned as 4 in the table spread in the belt-shaped swamps along the back of the natural levees and run from the center of western studied areas to the north, mostly of them being heavily ponded. Those areas are presently covered with wet grasslands. The river-side lowlands along the Parana, Yabebyry and Atinguy Rivers also correspond to this group of areas.

Legend

Rank	Explanation
1	High land use potential as both paddy fields and crop fields
2	High land use potential as paddy fields but a little low potential as crop fields
3	A little low land use potential as paddy fields but high potential as crop fields
4	A little low land use potential as both paddy fields and crop fields

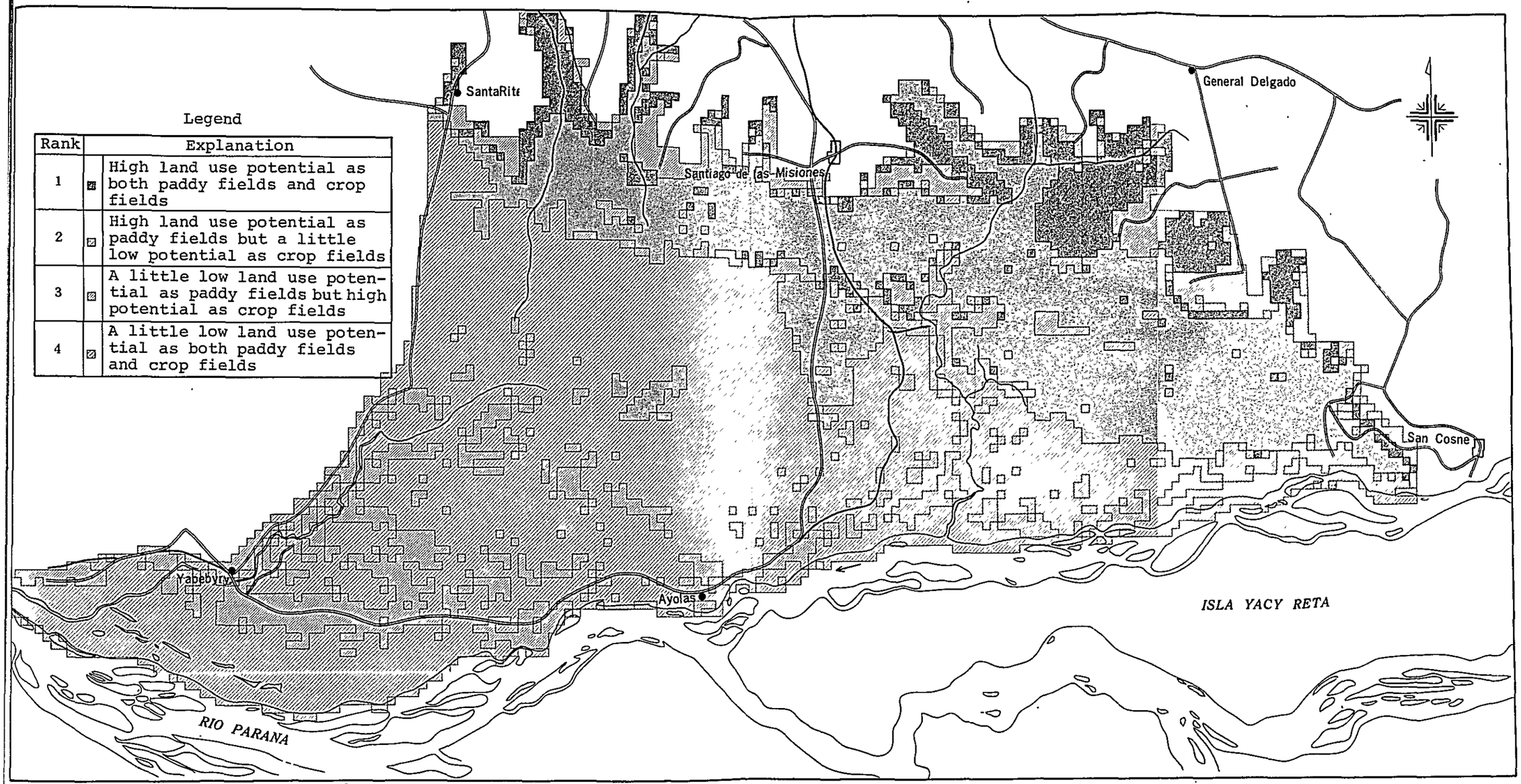


Fig. 40 Map for the overall classification of land use potentiality

The classification based on various sets of standards has been discussed so far, and the availability of each of those standards has been verified. To this end, we conducted a cross tabulation of the results of land potential classification (for both paddy fields and crop fields), those of comprehensive land potential classification and patterns of agriculture. Refer to Tables 29, 30 and 31.

(1) Relationship between the results of land potential classification (for paddy fields) and actual land application as paddy fields

As can be found in Table 29, the lands currently used as paddy fields total 6,875 ha, which can be classified as follows.

Rank 1 → 3,800 ha (1.9%)
Rank 2 → 800 ha (0.4%)
Rank 3 → 525 ha (0.3%)
Rank 4 → 1,750 ha (0.9%)

This is thought to display the appropriate tendencies. However, 1,750 ha of paddy fields are distributed in Rand 4 in the area of fluvisols in the lowland along the Parana River in the studied area. It is generally not good to use fluvisols for paddy fields as those in the region have a relatively thick regolith layer, resluting in relatively poor conditions for the utilization of water. However, they will be used for paddy fields despite this.

This classification shows that the lands concerned are used reasonably. About 1,750 ha of lands grouped in Rank 4 apparently correspond to the river-side lowlands of the Parana River (paddy fields) with much danger of flooding.

(2) Relationship between the results of land potential classification (crop fields) and actual land use as crop fields

As can be found in Table 30, the lands currently used as crop fields total 3,275 ha, which can be classified as follows.

Rank 1 → 1,075 ha (0.5%)
Rank 2 → 1,850 ha (0.9%)
Rank 3 → 300 ha (0.1%)
Rank 4 → 50 ha (0.0%)

This classification also appears to indicate the proper application of lands.

(3) Cross tabulation of the results of classification of comprehensive land potentials and actual patterns of agriculture

Table 32 indicates the details of each rank of land applications and the comparison of paddy fields and crop fields.

Table 32 Comparison between the land use potential and the present land use

Symbols	Explanation	Paddy fields	Crop fields
1	High land use potential as both paddy fields and crop fields	125 ha (0.1%)	100 ha (0.0%)
2	High land use potential as paddy fields but a little low potential as crop fields	4,475 ha (2.2%)	0 ha (0.0%)
3	A little low land use potential as paddy fields but high potential as crop fields	1,050 ha (0.5%)	2,825 ha (1.4%)
4	A little low land use potential as both paddy fields and crop fields	1,225 ha (0.6%)	350 ha (0.2%)

According to this table, both paddy and crop fields are high in land potential, though minimal in space. Also, balances are maintained between paddy fields and crop fields; paddy fields in Rank 2 show higher land potential, while crop fields indicate lower potential, and vice versa in Rank 3. This indicates the standards of classification are properly set.

Table 29 Relationship between the land use potential as paddy fields and the type of present land use

Land use type / Classification rank	Artificial grassland (01)	Natural grassland (02)	Paddy field (03)	Crop field (04)	Rivers and ponds (05)	Others (06)	Total
(01)	0 (0.0%)	2,400 (1.2%)	3,800 (1.9%)	25 (0.0%)	0 (0.0%)	0 (0.0%)	6,225 (3.1%)
(02)	600 (0.3%)	56,325 (28.1%)	800 (0.4%)	75 (0.0%)	0 (0.0%)	425 (0.2%)	58,225 (29.1%)
(03)	1,000 (0.5%)	45,500 (22.7%)	525 (0.3%)	1,200 (0.6%)	0 (0.0%)	3,400 (1.7%)	51,625 (25.8%)
(04)	25 (0.0%)	67,775 (33.8%)	1,750 (0.9%)	1,975 (1.0%)	100 (0.0%)	12,675 (6.3%)	84,300 (42.1%)
Total	1,625 (0.8%)	172,000 (85.8%)	6,875 (3.4%)	3,275 (1.6%)	100 (0.0%)	16,500 (8.2%)	200,375 (100.0%)

Table 30 Relationship between the land use potential as crop fields and the present land use type

Land use type / Classification rank	Artificial grassland	Natural grassland	Paddy field	Crop field	Rivers and ponds	Others	Total
	(01)	(02)	(03)	(04)	(05)	(06)	
(01)	1,250 (0.6%)	10,650 (5.3%)	175 (0.1%)	1,075 (0.5%)	0 (0.0%)	1,025 (0.5%)	14,175 (7.1%)
(02)	375 (0.2%)	29,550 (14.7%)	1,000 (0.5%)	1,850 (0.9%)	0 (0.0%)	5,350 (2.7%)	38,125 (19.0%)
(03)	0 (0.0%)	27,400 (13.7%)	4,900 (2.4%)	300 (0.1%)	0 (0.0%)	9,175 (4.6%)	41,775 (20.8%)
(04)	0 (0.0%)	104,400 (52.1%)	800 (0.4%)	50 (0.0%)	100 (0.0%)	950 (0.5%)	106,300 (53.1%)
Total	1,625 (0.8%)	172,000 (85.8%)	6,875 (3.4%)	3,275 (1.6%)	100 (0.0%)	16,500 (8.2%)	200,375 (100.0%)

Table 31 Relationship between the overall land use potential and the present land use type

Land use type / Classification rank	Artificial grassland	Natural grassland	Paddy field	Crop field	Rivers and ponds	Others	Total
	(01)	(02)	(03)	(04)	(05)	(06)	
(01)	600 (0.3%)	15,775 (7.9%)	125 (0.1%)	100 (0.0%)	0 (0.0%)	325 (0.2%)	16,925 (8.4%)
(02)	0 (0.0%)	42,950 (21.4%)	4,475 (2.2%)	0 (0.0%)	0 (0.0%)	100 (0.0%)	47,525 (23.7%)
(03)	1,025 (0.5%)	24,425 (12.2%)	1,050 (0.5%)	2,825 (1.4%)	0 (0.0%)	6,050 (3.0%)	35,375 (17.7%)
(04)	0 (0.0%)	88,850 (44.3%)	1,225 (0.6%)	350 (0.2%)	100 (0.0%)	10,025 (5.0%)	100,550 (50.2%)
Total	1,625 (0.8%)	172,000 (85.5)	6,875 (3.4%)	3,275 (1.6%)	100 (0.0%)	16,500 (8.2%)	200,375 (100.0%)

CHAPTER 4 CONCLUSION

This study, as parts of the efforts to formulate a master plan for the general agricultural development project in an area adjacent to the Yacyreta Dam, was aimed to establish various preparatory maps and was made in tandem with land classification studies in fiscal 1982 and 1983.

The data of this study were compiled in accordance with the analyzed results of Landsat color images, landform maps, measurement statistics and other existing materials and documents, which were organized in various preparatory maps in the first year. In the second year, using those preparatory maps as the bases, more accurate preparatory maps were prepared through on-the-spot surveys and by analyzing aerial photographs (owned by the Yacyreta Corp), thereby conducting land classification researches. Through this series of surveys and studies, we reached tentative agreement on the following points:

(1) The alluvial plains of the Parana River give the survey area flat landforms, and so ponds are likely to be formed in newly constructed roads. This may pose one of the most serious barrier to drainage plans of the agricultural land development project.

(2) In developing aquatic rice fields in naturally formed lands, it will be imperative to solve the issues concerning the lowlands neighboring the Parana River's natural levees, where a heavy distribution of micro reliefs and accompanying forests are sighted.

(3) The development of the paddy fields in the micro relief 2), requires the overcoming of relatively large obstacles in the distribution of irrigation water and in maintenance management. In addition, it is hypothesized that the depth of low water will also increase to be more suited to crop fields than paddy fields.

(4) Clay soils are found along the hill lands running from the east to the north-west of the study area and these soils are highly suitable for paddy fields. In addition, they are also suitable for crop fields if drainage is provided.