

REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

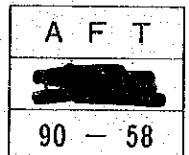
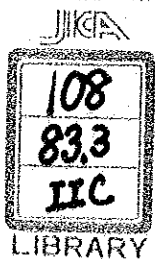
FEASIBILITY STUDY
ON
AIR SELAGAN IRRIGATION PROJECT
IN BENGKULU PROVINCE

SUMMARY

NOVEMBER 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO, JAPAN



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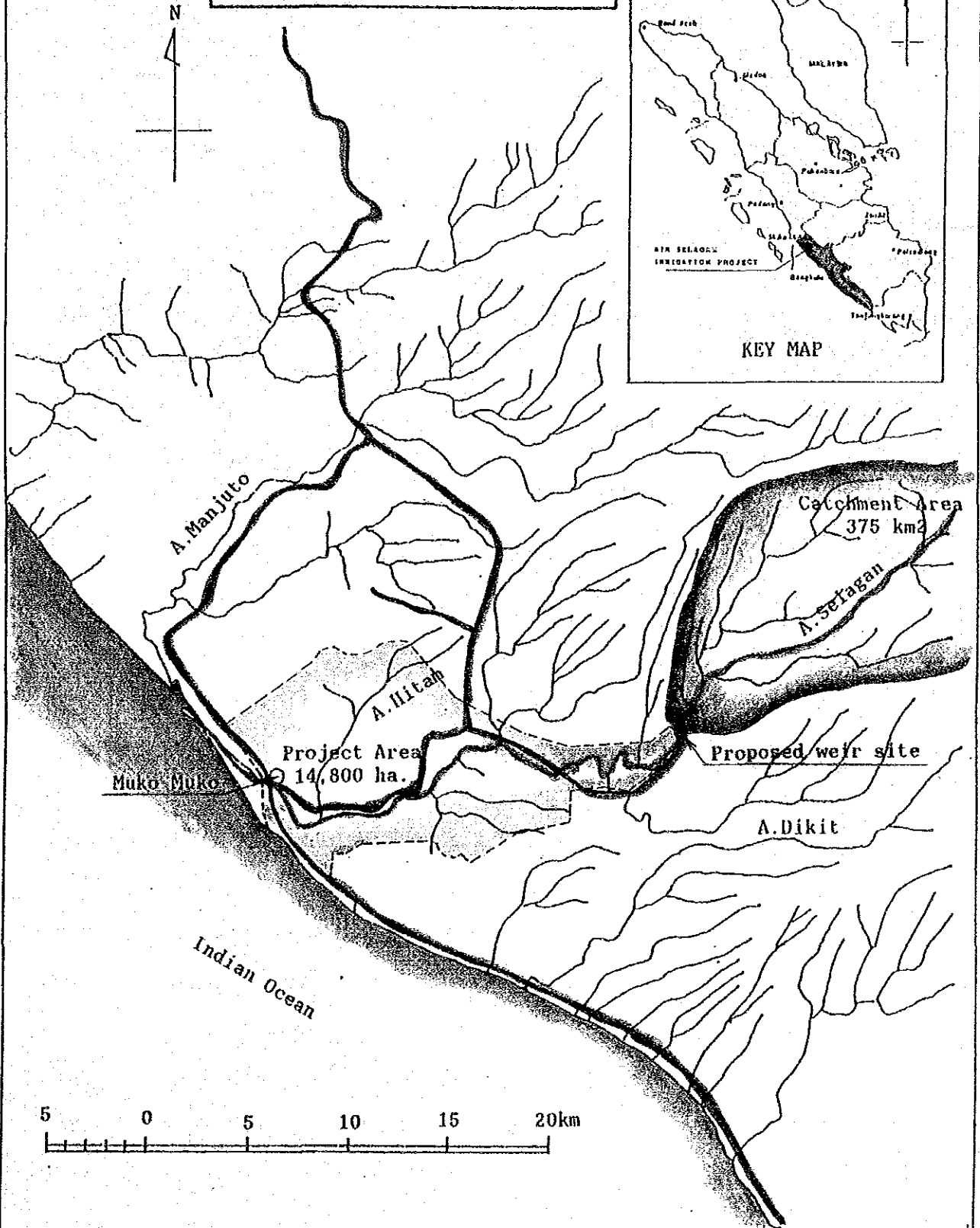
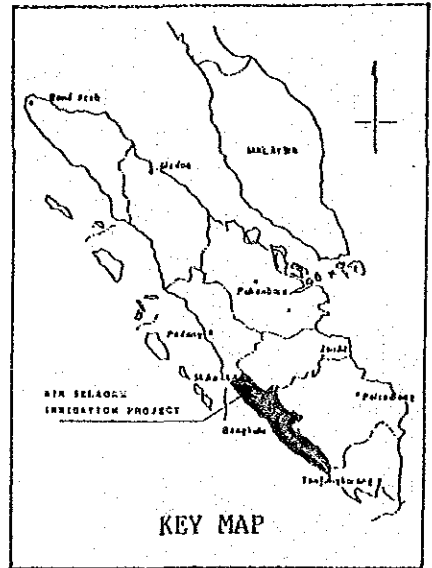
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LOCATION MAP
FOR
AIR SELAGAN IRRIGATION PROJECT



FEASIBILITY STUDY
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AIR SELAGAN IRRIGATION PROJECT
IN
RIAU PROVINCE
SUMMARY REPORT

LOCATION MAP

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INTRODUCTION

1. The feasibility study on the Air Selagan Irrigation Project in the Bengkulu Province of the Republic of Indonesia has been carried out since September 1989 in accordance with the Scope of Work agreed upon in February 1989 between the Government of Indonesia and the Government of Japan. This reports presents the development formulated on the basis of the field survey and the analysis in Japan for the feasibility study on the Project.

2. The Government of Indonesia has embarked on the fifth five-year development plan (REPELITA V : 1989/90 - 1993/94), of which the development plan for the agricultural sector puts primary emphasis on the following major objectives:

- a) To strengthen self-sufficiency in food,
- b) To increase production and to improve quality,
- c) To promote the income and living standard of the farmers,
- d) To expand employment opportunity and business chance,
- e) To support the transmigration program and regional development, and
- f) To support industrial development and boosting export.

The agricultural sector has been expected to grow at 3.6% per annum including 3.2% per annum of rice production increase and new paddy field formation of 375,000 ha in total during Repelita V.

3. The Bengkulu Province is situated on the south western coast of the island of Sumatra and most of the Province lies in a narrow strip 400 Km long located between the Indonesian Ocean to the west and the volcanic Barisan Mountain range in the east. The Province is bounded to the north by the province of West Sumatra, to the east by Jambi and South Sumatra and to the south by Lampung.

The agriculture in the Bengkulu Province accounts for more than 50% of the Province's gross domestic regional product and over 81% of working population are classified as being employed in agriculture. The population growth shows an annual rate of 4.12% from 1985 to 1990 and the Province still imports rice every year.

To overcome the above situation, the provincial government has aimed to develop plantations in southern part with relatively steep topography, and paddy cultivation by transmigrants in northern part, centering around Bengkulu, the capital of the Province. During the Fifth Five Year Development Plan's period, the provincial government expects to form new paddy fields about 18,000 ha (4.5% annum) and to settle new transmigrants of about 12,500 households.

4. The Project area covers an area of 14,800 ha along the Selagan river in the Kec, Muko-Muko Utara, Kab. Bengkulu Utara situated at the northwestern end of the Province. To the north of the Project area, the Muko-Muko Kiri Irrigation Project area, of which the construction works almost finished in 1988/89 using the loans from IBRD and OECF, adjoins the Project area and to the south, a plantation project for oil palm, rubber, cocoa, etc. by a private firm borders the Project area and planting commenced in a part of the plantation area.

5. There are the governmental transmigration areas called Air Manjuto SP-II, III, IV and VI, SKP-G, WPP-I and one spontaneous transmigration area in the Project area and at present, the transmigrants of about 1,090 families settle in the area. As for SP-II and IV, 3 to 4 years have passed after the settlement, but SP-III and VI are for the emergent transmigrants from Kedung Ombo in the central Java settling in 1989.

6. The Project area mainly consists of the natural forest of about 8,600 ha and the rubber forest of about 2,300 ha, and the remaining area is for homeyard, upland field, rainfed paddy field, newly reclaimed area, grass land, etc. One of the important areas is the undeveloped swampy area of about 4,400 ha with peat soil existing in the natural forest.

7. Under these topography, soil and land use conditions, the net irrigable area is estimated at about 4,200 ha. The allocated paddy field is planned to be 1.5 ha per family and the number of transmigration families is planned to be 1,090 for the existing transmigration and 1,010 for the new one and 700 for the local people.

8. The double cropping of paddy for a year can be proposed because the discharge of the Selagan river is affluent in comparison with the irrigable area. The intake facility is a weir with 3.8 m in height and 74.0 m of width and the length of link canal from the intake to the benefited area is 4.58 Km.

9. In the Project area, there is the swampy area enabled to be developed for the plantation of oil palm or others by equipping drainage canal as seen in the adjacent plantation area. The possible net plantation area is estimated at 2,200 ha in the Project area. The allocated plantation area is planned to be 2.0 ha per family and the number of transmigration families for the plantation is planned to be 1,100.

10. The above drainage canal network are also used for the flood protection to Muko-Muko, the capital of the Kec. Muko-Muko Utara. Further, it is possible to equip a small scale hydroelectric power station of about 290 KW at the proposed weir site because the discharge of the Selagan river is affluent in comparison with the diversion discharge for irrigation. In addition, the discharge for domestic water supply is included in the irrigation canals. Moreover, the construction of a national road connecting the provinces of Bengkulu and West Sumatra has been planned near

the Project area.

11. Therefore, to promote comprehensively irrigation, drainage and other developments in the Project area situated in the agricultural region remaining in the Province is not only to promote agricultural production and to contribute to the economic stabilization of the transmigrants in the Project area, but also to encourage the transmigration scheme and the regional development.

GENERAL ECONOMIC AND AGRICULTURAL BACKGROUND

12. The Indonesian economy grew by nearly 6% in 1988 after a growth rate of 3.6% in 1987. The average annual growth rate in GDP for the period 1980-87 was also 3.6%, and the economy should be able to easily sustain this figure for much of the 1990s.

The agricultural sector still plays a very important role in the country's economy, with approximately 55% of the national labour force employed in agriculture. Agriculture accounts for approximately 25% of GDP and a similar proportion of exports. During Repelita V, agricultural production is projected to increase by 3.6% per year, and by 1993 agriculture is still expected to account for 21% of gross domestic product.

13. The principal food crops produced in Indonesia are rice, maize, cassava, sweet potatoes, groundnuts and soybeans. However, rice is by far the dominant food crop, with total paddy production currently exceeding 40 million tons per annum. Over the period 1981 - 87, the average annual increase in paddy production was 3.7%.

Cash crops such as rubber, palm oil, coffee, etc. are major export crops. The exports of rubber and coffee are particularly important.

14. Indonesia has attained self-sufficiency of its staple food, rice. However, it can be said that the increase in rice production through a continuous expansion of irrigation area and a powerful extension of crop intensification program would be prerequisite to meet domestic demand increasing along with population growth.

15. The Bengkulu Province is situated on the south western coast of the island of Sumatra and covers an area of 19,784 Km². The population of the Bengkulu Province was about 1,070,000 in 1988 and is projected to increase to 1,160,000 by the end of 1990 and 1,390,000 by 1995. Between 1985 and 1990 the population was estimated to grow at an annual rate of 4.12% compared with the projected national average growth rate of 2.1%. The projected population growth for the Bengkulu Province is expected to decline to 3.73% over the period 1990 - 95, but this is still much higher than the projected national average of 1.8%. This is due in part to a higher fertility rate and partly to a higher immigration rate in the Province. Over 81% of working population were classified as being employed in agriculture.

16. In terms of area cultivated, the most important crop in 1988 was rice, with 68,000 ha planted to paddy sawah and 26,000 ha planted to upland rice. The Province, however, still imports rice and imported over 30,000 tons from other regions of Indonesia in 1988.

The major cash crops produced and exported from the Province are coffee and rubber, but significant areas of oil palm have been planted in recent years. These are not yet in production, but will produce substantial quantities of palm oil for export once they reach maturity.

The Bengkulu Province has generally the land with steep and complexed topography, and most of comparatively flat land along the coast is swampy with peat soil. Therefore, the irrigable area for paddy cultivation is limited in the Province.

17. Total families of transmigrants in the country has amounted 616,000 since 1950. In the Bengkulu Province, about 20,000 families of transmigrants had settled as farmers during the past ten years from 1974 to 1984, and about 3,600 families settled from 1985 to 1988, and about 10,000 families including 2,500 families to Muko-Muko Utara are planned to settle for 5 years between 1989 and 1993.

THE PROJECT AREA

18. The area for the Air Selagan Irrigation Project is situated in the Kecamatan Muko-Muko Utara of the Kabupaten Bengkulu Utara in the northwest about 270 Km far from Bengkulu municipality, the capital of the Bengkulu Province through the national road and provincial road, and the center of the area is located at 2° 35' South Latitude and 101° 10' East Longitude. The Project area belongs to the northern part of the Province and is near the boundaries to the West Sumatra Province to the north, the Jambi Province to the east and faces the Indonesian Ocean to the west.

Proposed weir site is located on the Selagan river about 50 Km in the upstream from its mouth to the sea. The Project area is about 14,800 ha in total dividing into about 5,350 ha on the left side of the Selagan river and about 9,450 ha on the right side.

19. The topography of the area is divided into two (2) parts, that is, the hilly part with gentle slope of about 1/1,000 bordering on the catchment area with abrupt slope and flat swampy area with the slope of 1/10,000. The swampy area with 7 to 8 Km in width adjoining to the coast stretches north-west and the elevation of the area becomes a little higher to the Manjuto river.

The hilly area with undulated topography is between the swampy area and the mountainous area. The highest part of the irrigable area in the Project area is estimated at about 23.6 m and the lowest at about -0.50 m.

20. The soils of the project area can be divided into four distinct edaphic and morphological groups. Firstly along the coast a series of marine sands have developed into a band of regosols. Secondly there are the uplands of the interior, comprising deep brown forest soils. Thirdly lying between the two, is an area of peat swamp which varies between two and six kilometers wide. Finally dissecting all three groups are the alluvial soils, which have been deposited by the rivers flowing across the project area.

In the peat swamp area, oil palm plantation is planned instead of paddy cultivation.

21. The geological conditions at the proposed weir site are favorable in foundation of the weir to be constructed because the formation of tuff is overlaid by about 1.5 m thick of the sand and gravel.

22. Mean annual rainfall in the Project area is approximately 3,000 mm. Generally, the year may be divided into the wet season from September to April and the dry season from May to August. Mean annual air temperature is 31°C with small fluctuation. Mean

annual relative humidity, sunshine duration, solar radiation and wind velocity are respectively 93%, 41%, 332 Cal/cm²/day and 29.3 Km/day. Annual pan evaporation is about 1,830 mm and the mean monthly one ranges from 4 to 6 mm/day.

23. The catchment area of the proposed weir site is estimated at 375 Km². Mean annual run-off at the proposed weir site is 39.6 m³/sec. The maximum monthly run-off is 51.94 m³/sec in November and the minimum is 22.06 m³/sec in June. The annual sediment transport is roughly estimated at 33,000 m³/year. The water in the Selagan river can be used for irrigation, but it is not suitable for drinking judging from evaporated residue and the amount of KMnO₄ demand.

24. In the Project area, there are the governmental transmigration areas called Air Manjuto SP-II, III, IV and VI, SKP-G, WPP-I and one spontaneous transmigration area, and at present the transmigrants of about 1,090 families settle in the area divided into 490 families on the left side of the Selagan river and 600 on the right side. SP-II and IV have been settled for 3 to 4 years, but in SP-III and VI the emergent transmigrants from Kedung Ombo in the central Java have been resident for less than a year.

Farmers in the Project area accounts for 2,640 families including the local people in the Project area. The farm population is estimated at 11,860 and the average size of a farmer's family is 4.5 persons.

25. No irrigation paddy field is found in the Project area demarcated to be 14,800 ha in total and rainfed paddy field accounts for only 140 ha, and dry land paddy field 950 ha. In the upland field estimated at 1,200 ha, corn, bean and fruit are cultivated with dry land paddy. Rubber is planted in 2,300 ha. About 58% or 8,560 ha in the Project area are covered with forest. However, almost all the major trees in the Project area were cut already except the land of protection forest of 300 m in width along the coast.

26. According to the standard of the Transmigration Office, the area of land to be allocated to the transmigrants is 2.00 ha per one family, which consists of 0.25 ha of home yard, 1.00 ha for first arable farm land and 0.75 ha for second arable farm land. The land clearing for the first arable farm land is done by the Ministry of Transmigration and, that for the second arable farm land is carried out by the transmigrants themselves. Moreover, the land of 0.25 ha per one family is generally kept for public land and the land itself is not allocated to the transmigrants.

27. All the farm fields in the Project area are put under rainfed condition. The cropping pattern is generally affected by the seasonal distribution of labour force, rainfall, marketing condition, resulting the fluctuation of the cropping pattern and

harvested area year by year.

Normally, cropping season of rainfed paddy is in the wet season (July/August to November/December), while, for the dry land paddy also in the wet season (August/September to December/January). Mixed cultivation is normal for upland crops in the Project area.

28. In the farming practices for rainfed paddy and dry land paddy, plowing is made by man power, and fertilizers and agro-chemical are not applied.

29. Present crop yields in the Project area are very low. The average crop yield in the Project area is 1.5 ton/ha rainfed paddy, 1.0 ton/ha for dry land paddy, 1.5 ton/ha for corn, 0.8 ton/ha for peanut, 0.5 ton/ha for soybean and 7.0 ton/ha for cassava.

30. In the Project area, most of paddy and upland crops are consumed by farmers themselves, and a small quantity is sold at local markets in and around the Project area either by the farmers themselves or through brokers in order to get some cash income. In the Project area, the net supply of rice is estimated at 1,160 ton. On the contrary, the demand of rice is 2,440 ton and the rice shortage of about 1,280 ton is found in the area.

31. The present farm gate prices of major farm products prevailing in the Project area are per Kg. Rp.250 for rice, Rp.150 for maize, Rp.500 for peanut, Rp.100 for cassava, Rp.25 for oil palm and Rp.450 for rubber. DOLOG controls the price of rice in the market.

32. These are four (4) KUD (Koperasi Unit Desa) in the Project area, as the villagers' cooperative. Agricultural extension services in the Project area is carried out by two (2) agricultural extension centres (BPP : Balai Penyuluhan Pertanian). Junior extension workers in the Project area have the responsibility to provide the extension services to the farmers' group (Kelompok Tani), as for the improvement of agricultural technique and the protection of crops and livestock from some damages, etc.

33. The major source of credit traditionally available to farmers within the Project area is the extended family group or possibly their neighbours in the village.

34. In the neighborhood of the northern part of the Air Selagan Irrigation Project, the Muko-Muko irrigation project which has a commanded area of about 16,000 ha has been constructed using IBRD loan since 1983/84 and OECF loan since 1988/89. As to the development of the left side for 6,768 ha, main irrigation system was almost constructed up to 1988/89, but that of right side for 9,919 ha of the Manjuto river is not yet started except for the right side intake facilities at the weir structure.

35. P.T. Tolan Tiga has two concession areas of approximately 10,100 ha and 7,520 ha in the Kecamatan Muko-Muko, the larger of which borders the Project area. The two areas are in the process of being developed and are currently being planted with oil palm, rubber and cocoa. In the larger concession area, 6,000 ha area being planted with oil palm, 3,000 ha with rubber and up to 1,000 ha with cocoa. In the second area it is planned to plant 4,000 ha of oil palm, 1,000 ha of rubber and 1,000 ha of cocoa.

36. The regions of natural conservation forest and protection forest are situated in the upstream area of the proposed weir site and most of the Project area belongs to the concession land for forest except the land of protection forest of 300 m in width along the coast.

THE PROJECT

37. The objective of the Project is to implement an irrigation project mainly for paddy cultivation aiming at contributing to increase the yield for food products to realize an economic stability of the farmers in the region, and encourage the transmigration scheme and the regional development.

For this purpose, it is necessary to realize prompt implementation of the following matters for the Project area to be transmigration area and the land for local people and with no irrigation and drainages facilities, using water resources effectively.

- a. Construction of systematic irrigation facilities
- b. Improvement of drainage conditions by the construction of drainage facilities
- c. Development of paddy field and farmland in the transmigration area and uncultivated land
- d. Coordination to the new transmigration/re-settlement plan in newly developed farm land
- e. Construction of operation and maintenance facilities
- f. Arrangement of agricultural support services and organization.

38. The development plan of the Project area has been formulated taking the following points into considerations.

- a. The Project area is demarcated in the areas where transmigrants settled already on the both sides of the Selagan river fixing the boundaries to the adjacent Muko-Muko Kiri Irrigation Project and the plantation area by P.T. TOLAN TIGA.
- b. The water source is planned to be the Selagan river, the type of facility to take water is the weir, and the intake water level is decided so as not to give the influence of the backwater due to the weir to villages in the upstream.
- c. The irrigable area is delineated from the viewpoints of the intake facility, intake water level, soil, land slope, etc.
- d. The double cropping of paddy per year can be introduced for the whole irrigable area because the Selagan river has comparatively affluent discharge.
- e. Taking into consideration the Provincial Government's policy for the agricultural development in this region, 1.5 ha of farm land is allocated for paddy cultivation per one transmigration family and 25% of the benefited land is assured for the local people. From this point of view, the total number of agricultural household,

the number of household of transmigrants and the land use plan are decided.

- f. With regard to the swampy area which the paddy cultivation could not be introduced because of the poor soil condition, the introduction of oil palm cultivation after the excavation of drainage canal, is proposed on the basis of the allocated land of 2.0ha per one transmigration family. Ratio of oil palm farmer is 50% of the transmigration and 50% of forestry worker or shifting farmer in the province.
- g. Supply of irrigation water to the existing extension canal (S.S. Baru) in the Muko-Muko Kiri Irrigation Project is included in the Selagan Irrigation Project considering the future development plan of the Muko-Muko Irrigation project.
A part of existing canal facilities is improved and then irrigation to higher land is enabled.
- h. Drainage canals are planned to reduce the floods to Muko-Muko and also the small scale hydroelectric power generation is planned using the proposed weir. Moreover, the water for domestic use in the Project area is kept in the irrigation canals.

39. The Project area is demarcated to be 14,800 ha in gross on the both sides of the Selagan river taking into account the planning intake water level at the proposed weir site on the Selagan river, cropping pattern, water requirement, irrigable area, present condition of transmigration, land use, land suitability, possible number of families of new transmigrants, allocated land, the Government's policy for development, etc. The proposed land use for the Project is as follows:

Unit : ha			
Land	Left Side	Right Side	Total
Gross Irrigable Area	2,700	2,000	4,700
Gross Oil Palm Land	-	2,500	2,500
Upland	300	506	806
Homeyard (new)	200	337	537
Homeyard (existing)	134	219	353
Public Land	300	528	828
Steep Land/High Land	1,210	2,220	3,430
Flood/Peat Land	356	960	1,316
River, Lake, etc.	150	180	330
Total	5,350	9,450	14,800

40. The number of transmigration families is planned as follows:

Division	Left Side	Right Side	Total
Irrigation Area			
Settled Already	290	460	750
Planned Already	200	140	340
Additional Program	710	300	1,010
Local People	400	300	700
Sub-total	1,600	1,200	2,800
Plantation Area			
New Settlement	-	1,100	1,100
Total	1,600	2,300	3,900

41. Paddy is cultivated in the irrigation area of 4,200 ha in the both wet and dry seasons and the unit yield is estimated to increase gradually from the present level to the anticipated yield in the 5th year after completion of the construction of tertiary networks. Oil palm is planted in the area of 2,200 ha after the construction of drainage canal and the target yield is estimated to be obtained in 7 years after planting. In the upland of 550 ha in the plantation area, the introduction of double cropping of corn a year is planned and the target yield is estimated to be obtained within two years. The annual crop production after the target yield in the future with project condition is expected as follows:

Crop	Unit Yield	Area	Production
	ton/ha	ha	ton
Wet season paddy	5.0	4,200	21,000
Dry season paddy	5.0	4,200	21,000
Oil palm	21.0	2,200	46,200
Corn	2.0	1,100	2,200

42. After implementation of the irrigation facilities, year round irrigation would be provided to all farmers in the Project area. Crop production cost under the future with project condition would increase substantially due to application of increased amounts of labour force and farm inputs such as fertilizers and agro-chemicals, but a significant increase in yield and production of crop would be expected. As a result, a significant increase in farm income would be also expected in the future with project condition.

43. Two alternative sites on the Selagan river for the weir were thoroughly surveyed and studied from the technical and economical viewpoints. As a result, the site at about 2.3 Km in the upstream from the Kp. Lubuk Sahung bridge is recommendable for constructing diversion weir at an elevation of 25.90 m in its intake water level.

44. The irrigation water requirement for the Project is estimated on the basis of the proposed cropping pattern with irrigation efficiency of 55%. As a result, the maximum ten day requirement is estimated at 1.36 l/sec/ha for the wet season paddy and 1.53 l/sec/ha for the dry season paddy. The maximum diversion requirement at the proposed weir site is estimated at 5.73 m³/sec in the wet season and 6.45 m³/sec in the dry season including 0.02 m³/sec of domestic water supply for about 3,000 households in the Project area.

45. The irrigation water is diverted by gravity method from the weir and conveyed through the link canal of 4.58 Km on the right side of the Selagan river, and then diverted to two main canals for the both sides of the Selagan river. The left main canal crosses the Selagan river by a siphon structure.

46. The following table shows the salient features of the weir, irrigation and drainage canals, and road network.

1)	Weir	
	Intake water level	: EL.25.90 m
	Weir height	: 3.80 m
	Weir width	: 74.0 m
	Flood way	: 68.0 m
	Scouring sluice	: undersluice (2.0m x 2 spans)
	Intake	: sluicgate (2.9m x 3 spans)
	Fish way	: ludder type, 2.0m x 21.24m
2)	Link canal	
	Length	: 4.58 Km
	Canal slope	: 1/5,500
	Type of canal	: trapezoidal, unlined
	Width of canal base	: 4.60 m
	Related structures	: 15 nos.
3)	Main irrigation canals	
	Length, left	: 13.95 Km
	Length, right	: 10.51 Km
	Type of canal	: trapezoidal, unlined
	Related structures, left	: 48 nos.
	Related structures, right	: 38 nos.
4)	Secondary irrigation canals	
	Length, left	: 21.72 Km
	Length, right	: 18.08 Km
	Type of canal	: trapezoidal, unlined
	Related structures, left	: 91 nos.

- Related structures, right : 81 nos.
- 5) Drainage canals
- Irrigation area
 - Length, left : 32.70 Km (18 lines)
 - Length, right : 38.50 Km (14 lines)
 - Related structures, left : 3 nos.
 - Related structures, right: 14 nos.
 - Plantation area
 - Length : 28.60 Km (9 lines)
 - Related structures : 10 nos.
- 6) Inspection roads
- Main road : 29.2 Km
 - Secondary road : 139.7 Km
- 7) Tertiary system and farm road
- Irrigation canal : 284 Km
 - Drainage canal : 110 Km
 - Farm road : 84 Km
- 8) Land clearing : 470 ha
- 9) Operation and Maintenance
- Equipment : L.S.
 - Facilities : L.S.

47. A small scale hydroelectric power station with the capacity of 290 Kw is planned as a facility attached to the proposed weir using effective water head of 3.50 m and maximum discharge of 10.72 m³/sec.

48. To reduce the drainage by floods to Muko-Muko, a drainage canal with the discharge of 24 m³/sec and the length of 4.3 Km is specially planned in addition to the whole drainage system on the left side of the Selagan river which also bears the drainage effect as a whole.

49. The Ministry of Public Works (DPU) is responsible for implementation of irrigation and drainage projects. For the construction works of these projects, the responsibility of DPU is generally limited up to the end of secondary canal or its tertiary box. On-farm development within the tertiary irrigation block such as tertiary canal, quaternary canal, farm ditch, farm road and land reclamation of field are left to the farmers' hands. Because of the lack of fund and insufficient technique, however, this on-farm development is apt to be delayed in its commencements. Although there are various technical and credit services by the Ministry of Agriculture, the construction cost for the works described in the article 46 should be included in the Project cost taking into consideration the lack of fund of the farmers and the gap between the allocated first arable farm land and the irrigation area in the Project area. However, the farmers group has a responsibility to maintain the tertiary system by themselves. On the other hand, the Project cost for new transmigration of about 2,450 families including the costs

for home yard, house, well, road, clearing of first arable farm land, etc. would be left to the Ministry of Transmigration. As for the construction of the small scale hydroelectric power station, the domestic water supply, the drainage canal for flood protection, etc., it is necessary to coordinate the works with the authorities concerned.

50. First of all, the detailed design is needed for the implementation of the Project. It is recommendable to divide the whole project works into five (5) works and to construct the weir and link canal at the first and then other facilities to the downstream in order following the above work divisions.

51. The Directorate General of Water Resources Development (DGWRD), the Ministry of Public Works, the Government of the Republic of Indonesia would be the executing agency for the implementation of the Air Selagan Irrigation Project. DGWRD would be responsible for both the engineering works and the construction works of the Project. It would coordinate all activities of the relevant Government agencies and regional administrative organizations in connection with the project implementation. The Directorate of Irrigation-II under the said DGWRD would direct responsibility for the project implementation. Bengkulu Regional Public Works would coordinate the construction of the Project at the provincial level on behalf of Ministry of Public Works. In order to implement the Project successfully, it is proposed to establish the Air Selagan Irri. Project Office under the superintendence of the Directorate of Irrigation II.

52. After completion of the construction works, the Project Office will be reorganized into the O&M office which will responsible for the operation and maintenance of all facilities down to inlets to tertiary blocks. The operation and maintenance of the tertiary blocks down to terminal facilities will be entrusted to the water user's association (P3A) and farmers themselves.

53. The total project cost is estimated at about US\$37.3 million which comprises US\$27.5 million of foreign portion and US\$ 9.8 million equivalent of local portion, which includes the physical contingency of 5% of direct cost and price contingency of 3.5 - 4.9% per annum for the foreign currency portion and 9.9% per annum for the local currency portion. The annual operation and maintenance cost is estimated at about Rp.130 million per annum. (US\$1.0 = Rp.1,845 = ¥153).

54. The agricultural net incremental benefit through the irrigation, drainage and small scale hydroelectric power generation project is estimated at about Rp.10,551 million at maximum per annum. The economic feasibility of the project is evaluated in terms of economic internal rate of return of the basis of a 50 year useful life including the costs for new transmigration. The calculated economic internal rate of return is around 12.7% including the benefits from the small scale hydro-electric power generation, excluding the flood protection to Muko-Muko and the domestic water supply, which indicates the

economic soundness of the Project.

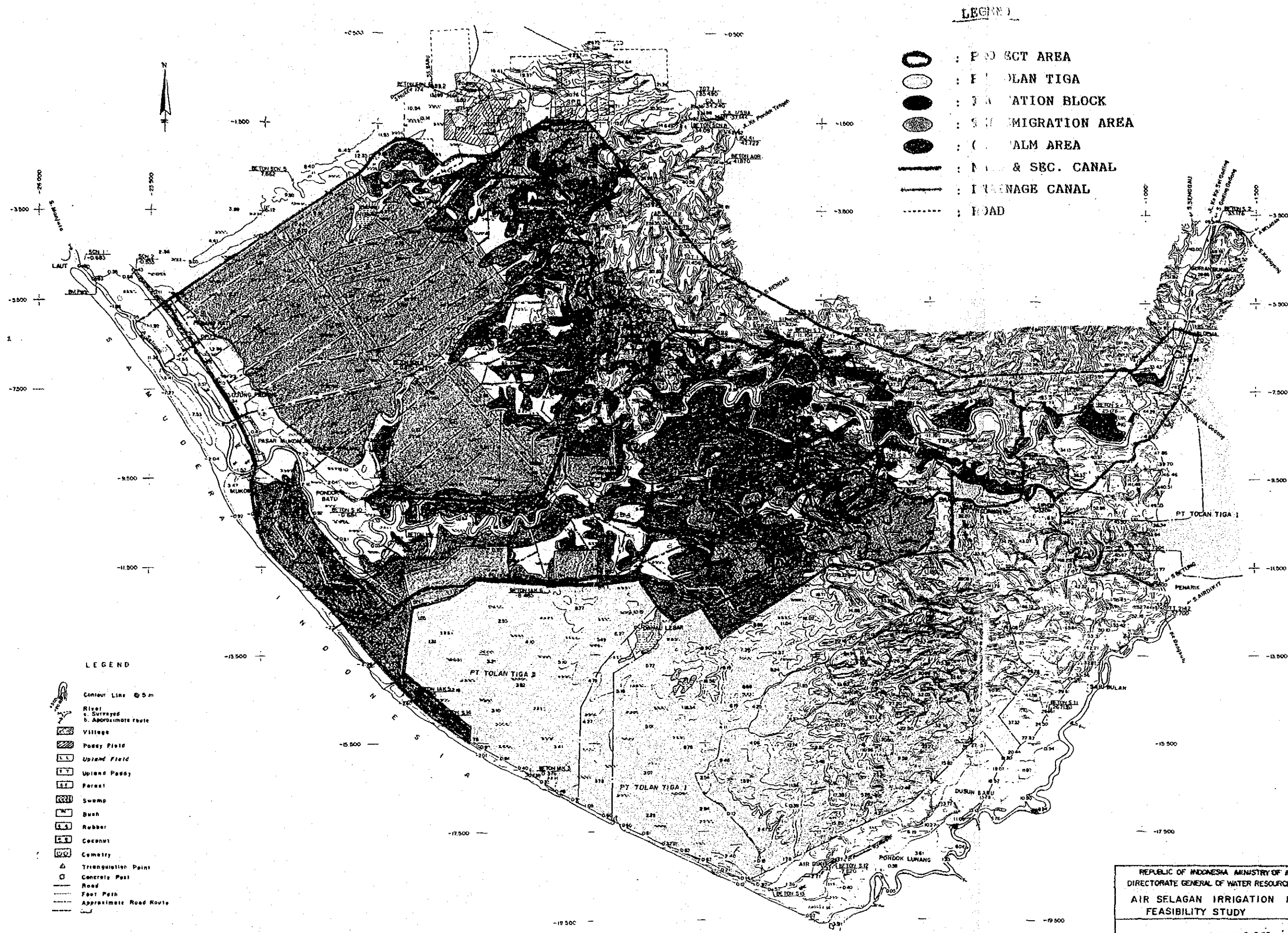
RECOMMENDATIONS

1. The Project is an irrigation and drainage project for paddy cultivation and oil palm plantation in the existing and newly planned transmigration areas. Therefore, it is expected that the new transmigration program is reconfirmed for the implementation. In addition, it is desirable to implement and coordinate the Project comprehensively because the Project is integrated including the small scale hydroelectric power generation, the flood protection work, the domestic water supply, etc.
2. It is also necessary to coordinate the Project works especially with the Muko-Muko Kiri Irrigation Project constructed using the assistance from IBRD and OECF, and the plantation project by P.T.TOLAN TIGA.
3. It is desirable to prepare the following works before the implementation of the Project.
 - a. Preparation of topographic map on a scale of 1 to 2,000 using the aero-photo mapping about the project area and its adjacent area of 15,000 ha in total.
 - b. Detailed soil survey especially on the swampy land in the Project area.
4. It is strongly expected that the Project is urgently implemented for realizing economic stability of the emergent transmigrants from Kedung Ombo in the central Java especially.

Table 1 SUMMARY OF CONSTRUCTION COST

(Unit: Million Rp.)

Item	Project Cost		
	Foreign Portion	Local Portion	Total
1. Preparatory Works	1,451	622	2,073
2. Irrigation and Drainage Construction(4,200ha)	25,879	7,909	33,788
2.1 Work Division-I	4,324	1,662	5,986
Head Works	2,754	1,219	3,973
Main & Sec. System	1,530	431	1,961
Tertiary System	40	12	52
2.2 Work Division-II	7,102	2,172	9,274
Main & Sec. System	6,242	1,924	8,166
Tertiary System	860	248	1,108
2.3 Work Division-III	6,533	1,847	8,380
Main & Sec. System	5,928	1,673	7,601
Tertiary System	605	174	779
2.4 Work Division-IV	2,323	602	2,925
Secondary System	2,181	561	2,742
Tertiary System	142	41	183
2.5 Work Division-V	5,597	1,626	7,223
Main & Sec. System	4,798	1,397	6,195
Tertiary System	799	229	1,028
3. Small-scale Hydro-power Generation(290KW)	6,323	887	7,210
3.1 Electric Equipment	5,742	638	6,380
3.2 Civil Works	581	249	830
4. O & M Facilities Cost	735	245	980
5. Land Acquisition Cost	-	237	237
6. Administration Cost	-	880	880
7. Engineering Services	4,342	482	4,824
7.1 Detailed Design	1,737	193	1,930
7.2 Construction S/V	2,605	289	2,894
Sub-total(1 to 7)	38,730	11,262	49,992
8. Physical Contingency	1,937	563	2,500
Sub-total(1 to 8)	40,667	11,825	52,492
9. Price Contingency	10,038	6,334	16,372
Total	50,705	18,159	68,864



LEGEND

- : PROJECT AREA
- : P. TOLAN TIGA
- : PLANTATION BLOCK
- : MIGRATION AREA
- : CALM AREA
- : MAIN & SEC. CANAL
- : DRAINAGE CANAL
- : ROAD

LEGEND

- Contour Line @ 5 m
- River
- Surveyed
- Approximate route
- Village
- Paddy Field
- Upland Field
- Upland Paddy
- Forest
- Swamp
- Bush
- Rubber
- Coconut
- Cemetery
- Triangulation Point
- Concrete Post
- Road
- Foot Path
- Approximate Road Route

REPUBLIC OF INDONESIA MINISTRY OF PUBLIC WORKS
 DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
 AIR SELAGAN IRRIGATION PROJECT
 FEASIBILITY STUDY

GENERAL PLAN

JAPAN INTERNATIONAL COOPERATION AGENCY TOKYO (JICA) DWG. NO. 1

Fig. 1 GENERAL MAP



Legend for Soil Map

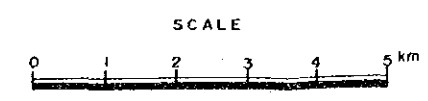
Soil Type	Description	Area (ha)
Rd	Regosols, dystic Sand to sandy clay loam Dark reddish brown (2.5/2) to yellowish brown (10YR 5/4) Weakly structured Low fertility Drainage frequently impeded	1,240
Od	Histosols, dystic Very humate, fibric to hemic or sapric where drained Dark red (2.5/2) Low fertility Medium very liquid Low bearing capacity	4,400
Fo	Ferralsol, orthic Deep forest soil Dark brown (2.5YR 3/3) to reddish yellow (2.5YR 6/6) Silty to silty clay loams, weakly structured Well drained, weakly acid Deeply incised Severe erosion hazard	3,200
Fp	Ferralsol, plinthic Forest soil, dark reddish brown (2.5YR 3/3) to strong brown (2.5YR 4/4) Silty to silty clay loams, weakly structured Well drained, weakly acid Moderate erosion hazard	660
Fr	Ferralsol, rhodic Deep forest soil, reddish brown (2.5YR 4/3) to yellowish brown (10YR 5/4) Silty to silty clay loams, weakly structured Well drained, weakly acid Moderate erosion hazard	1,200
Fx	Ferralsol, xanthic Deep forest soil, dark brown (2.5YR 3/3) to brownish yellow (10YR 6/6) Silty clay to clay loams, moderately structured Poorly to well drained Erosion hazard	1,700
Jd	Fluvisol, dystic Dark grayish brown (10YR 3/3) to yellow (10YR 7/8) Stratified Clay to silty clay loam Swampy in places Moderate to strongly structured Drainage poor, flooding common	2,100

-Others-

—	Roads.	—	Survey boundary
—	Existing canal.	—	Project boundary
P	Soil pit.		
A	Auger hole.		

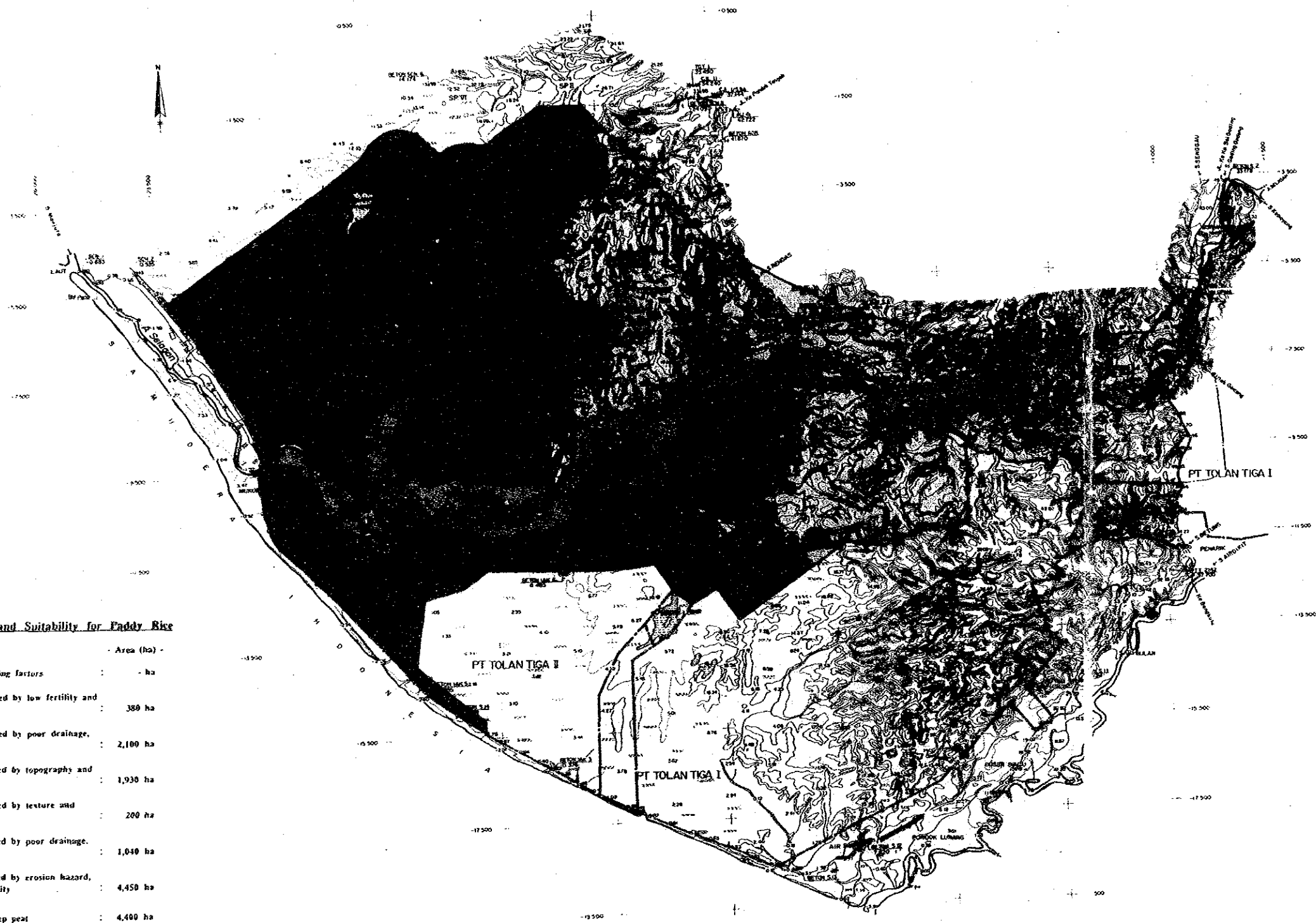


Fig. 2 SOIL MAP



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REPUBLIC OF INDONESIA - MINISTRY OF PUBLIC WORKS DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT AIR SELAGAN IRRIGATION PROJECT FEASIBILITY STUDY	
SOIL MAP	
JAPAN INTERNATIONAL COOPERATION AGENCY TOKYO (JICA)	DWG. NO. 3



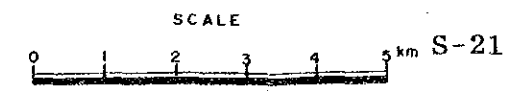
Legend for Land Suitability for Paddy Rice

Class	Description	Area (ha)
S1	Highly suitable, no limiting factors	- ha
S2y	Moderately suitable, limited by low fertility and occasional flooding	389 ha
S2fy	Moderately suitable, limited by poor drainage, flooding and low fertility	2,100 ha
S2ty	Moderately suitable, limited by topography and low fertility	1,930 ha
S2ly	Moderately suitable, limited by texture and low fertility	200 ha
S3vyd	Marginally suitable, limited by poor drainage, texture and low fertility	1,040 ha
S3tye	Marginally suitable, limited by erosion hazard, topography and low fertility	4,450 ha
N1p	Currently not suitable, deep peat	4,400 ha
N2	Permanently unsuitable	- ha

- Subscripts -
- d : drainage
 - e : erosion hazard
 - f : flooding/drainage
 - l : texture, sandy loams
 - p : peat
 - t : topography
 - y : S2 slopes : < 20%, vertical interval < 15m
 - v : S3 slopes : > 20%, vertical interval > 15m
 - l : texture, coarse sand
 - y : low fertility

- Others -
- : Survey boundary
 - : Project boundary

Fig. 3 PRESENT LAND USE MAP



REPUBLIC OF INDONESIA MINISTRY OF PUBLIC WORKS
 DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
 AIR SELAGAN IRRIGATION PROJECT
 FEASIBILITY STUDY

**LAND SUITABILITY MAP
 FOR PADDY RICE**

JAPAN INTERNATIONAL COOPERATION AGENCY TOKYO (JICA) DWG. NO. 4



Legend for Present Land Use
(November 1989)








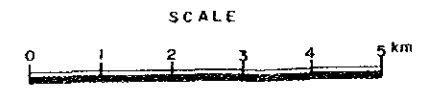
		- Area (ha) -
	H : Hevea brasiliensis (Rubber)	2,300 ha
	F : Natural forest	8,620 ha
	G : Uplandfield, mixed cropping	1,200 ha
	Ru : Upland rice, padi gogo	950 ha
	Rp : Lowland rice, padi sawah	140 ha
	C : Cleared and half burnt forest	250 ha
	S : Scrubland and secondary growth	1,040 ha

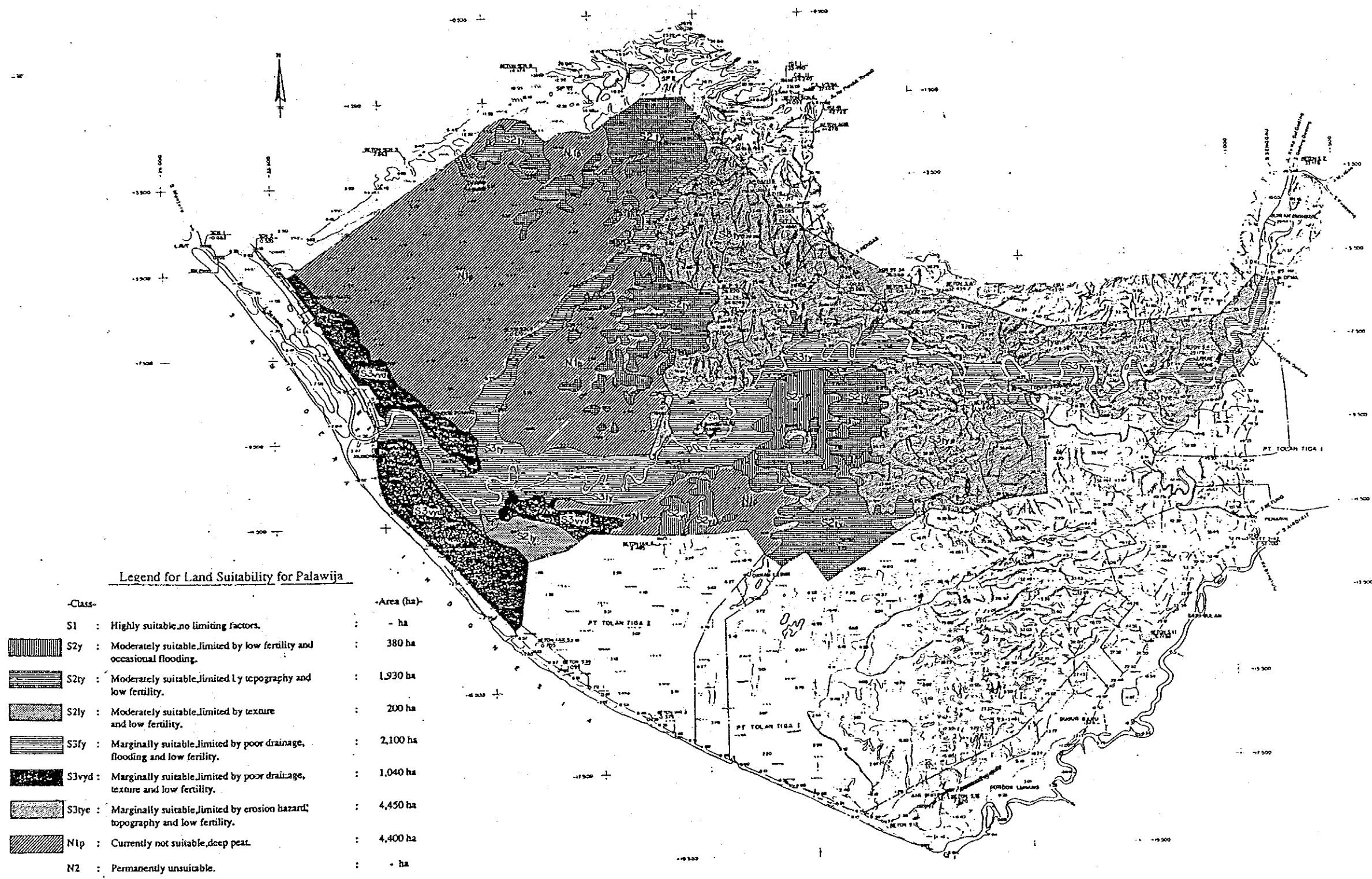
Fig. 4 LAND SUITABILITY FOR PADDY



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REPUBLIC OF INDONESIA MINISTRY OF PUBLIC WORKS DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT AIR SELAGAN IRRIGATION PROJECT FEASIBILITY STUDY	
PRESENT LAND USE MAP	
JAPAN INTERNATIONAL COOPERATION AGENCY TOKYO (JICA)	DWG. NO. 7

Fig. 5 LAND SUITABILITY FOR PALAWIJA

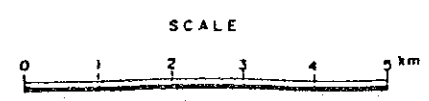


Legend for Land Suitability for Palawija

-Class-		-Area (ha)-
S1	: Highly suitable, no limiting factors.	: - ha
S2y	: Moderately suitable, limited by low fertility and occasional flooding.	: 380 ha
S2ty	: Moderately suitable, limited by topography and low fertility.	: 1,930 ha
S2ly	: Moderately suitable, limited by texture and low fertility.	: 200 ha
S3fy	: Marginally suitable, limited by poor drainage, flooding and low fertility.	: 2,100 ha
S3vyd	: Marginally suitable, limited by poor drainage, texture and low fertility.	: 1,040 ha
S3tye	: Marginally suitable, limited by erosion hazard, topography and low fertility.	: 4,450 ha
N1p	: Currently not suitable, deep peat.	: 4,400 ha
N2	: Permanently unsuitable.	: - ha

-Subscripts-

- d : drainage.
- e : erosion hazard.
- f : flooding/drainage.
- f : texture, sandy loams.
- p : peat.
- t : topography.
- t2 slopes : < 20%, vertical interval < 15m.
- t3 slopes : > 20%, vertical interval > 15m.
- v : texture, coarse sand.
- y : low fertility.



REPUBLIC OF INDONESIA MINISTRY OF PUBLIC WORKS
 DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
 AIR SELAGAN IRRIGATION PROJECT
 FEASIBILITY STUDY

**LAND SUITABILITY MAP
 FOR PALAWIJA**

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) Dwg. No. TOKYO (JICA)

Fig. 6 LAND SUITABILITY FOR TREE CROPS

Legend for Land Suitability for Non-irrigated tree crops
Oil Palm(O), Rubber(R), Coffee(C)

Land Group	Crop	Suitability	Limitations	Area (ha)
1	O	S2	dfy	2,100 ha
	R	S3	dfy	
	C	N2	dfy	
2	O	S2	y	380 ha
	R	S2	y	
	C	S2	dy	
3	O	S3	l2y	1,930 ha
	R	S2	l2y	
	C	S2	l2y	
4	O	N2	l3ey	4,450 ha
	R	S2	l3ey	
	C	S2	l3ey	
5	O	S2	y	200 ha
	R	S2	y	
	C	S2	dy	
6	O	N2	vyd	1,040 ha
	R	S3	vyd	
	C	S3	vyd	
7	O	S3	dfy	4,400 ha
	R	N2	peat	
	C	N2	peat	

Limitations

- d : drainage.
- s : erosion hazard.
- f : flooding.
- l : coarse sandy loam.
- p : peat.
- l2 : topography, slopes < 20%, vertical interval < 15m.
- l3 : topography, slopes > 20%, vertical interval > 15m.
- y : coarse sand to sandy loams.
- y : soil fertility.



SCALE

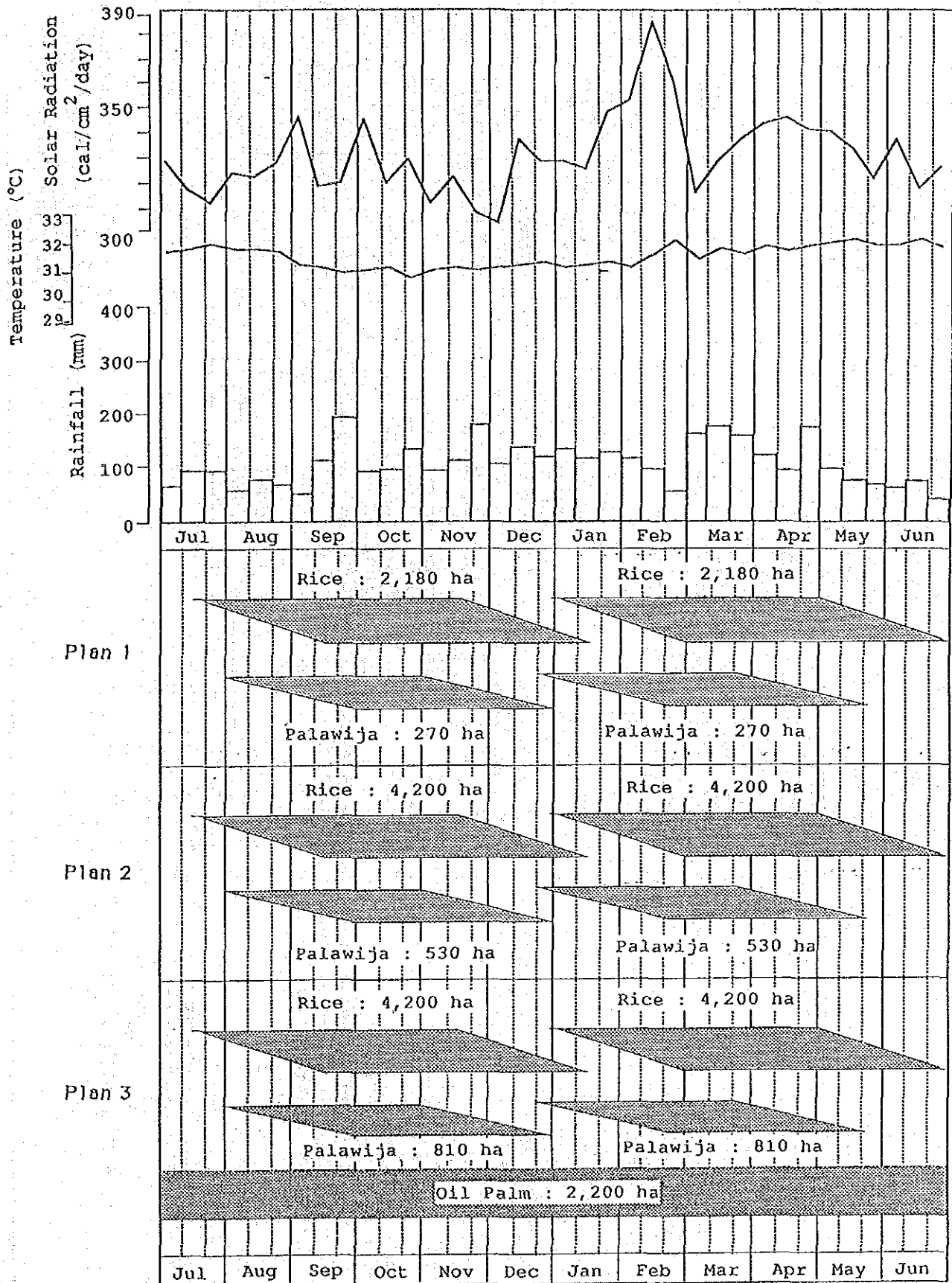


REPUBLIC OF INDONESIA MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
AIR SELAGAN IRRIGATION PROJECT
FEASIBILITY STUDY

LAND SUITABILITY MAP FOR
NON-IRRIGATED TREE CROPS

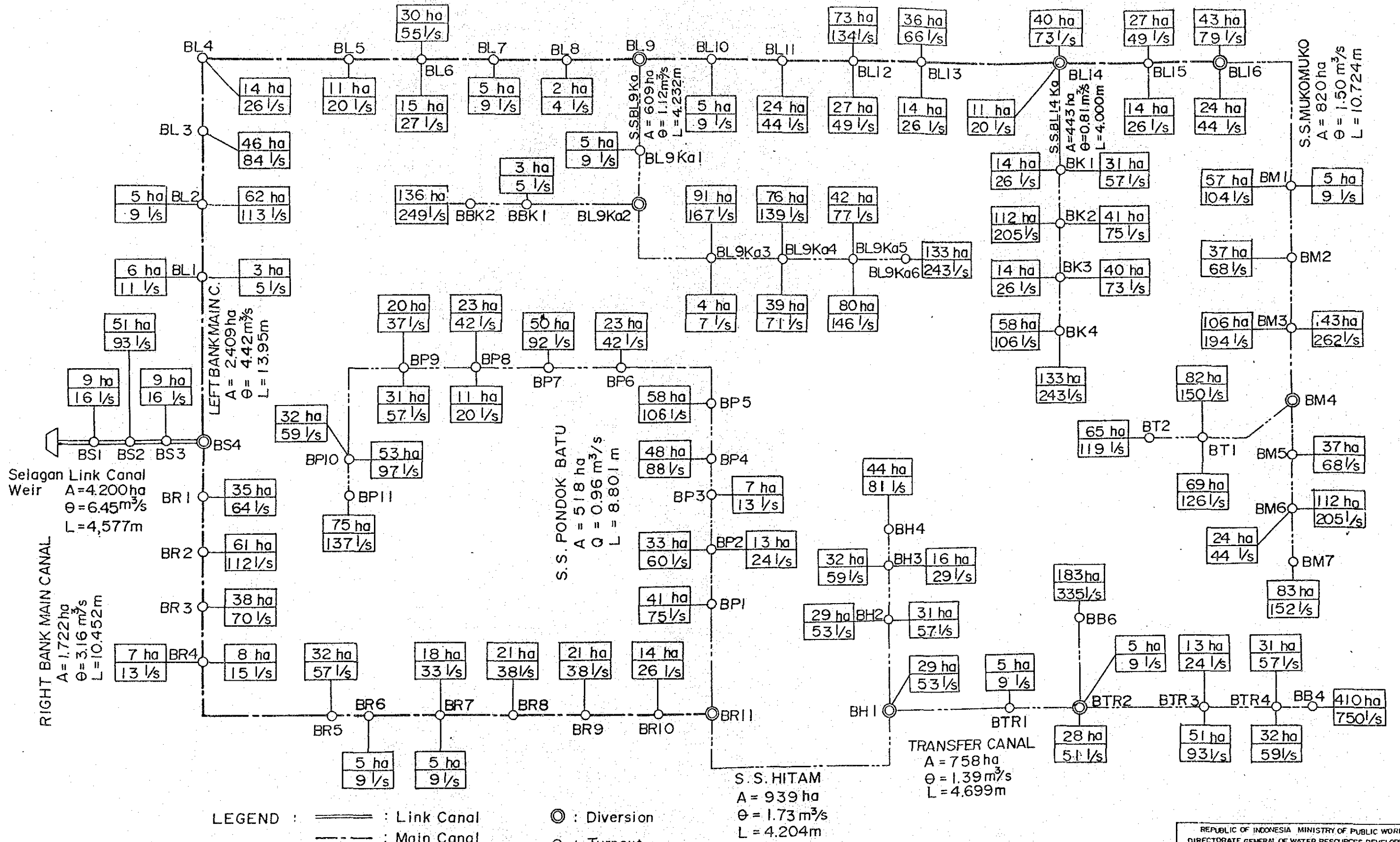
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Fig. 7 PROPOSED CROPPING PATTERN



Remark) All the figure means net cultivated area.

Fig. 8 WATER DISTRIBUTION OF MAIN SYSTEM



LEGEND :
 ——— : Link Canal
 - - - : Main Canal
 - · - · : Secondary Canal
 - · - · : Tertiary Canal
 ○ : Diversion
 □ : Turnout

REPUBLIC OF INDONESIA MINISTRY OF PUBLIC WORKS
 DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
 AIR SELAGAN IRRIGATION PROJECT
 FEASIBILITY STUDY

DISTRIBUTION DIAGRAM FOR
 MAIN AND SECONDARY SYSTEM

JAPAN INTERNATIONAL COOPERATION AGENCY
 TOKYO (JICA)

DWG. NO. 2

JICA