4.3 Irrigation Development

Ten(10) irrigation schemes are being carried out covering a total irrigable area of 5,525 ha in the Objective Area. Out of the total areas of 5,525 ha, 4,370 ha is potential area now for which the main system has already been developed, and 1,155 ha is potential area for which the main system has not been developed yet. Now, the existing paddy field is 1,628 ha in which the tertiary system has already been developed for 1,303 ha. Now, irrigation is being carried out for the area of 1,303 ha in wet season, and for that of 394 ha in dry season.

To review the optimum development scale for the existing irrigation schemes, water balance computation is made. The focal points to be taken into account are available quantity of river discharge at the water source sites and irrigation water requirements for the prevailing cropping patterns are compared with the dependable flows and the potential areas.

By referring to the result of hydrological analysis, water availability at intake sites is reviewed for the existing 10 irrigation schemes on the basis of non-exceedance probable discharge in five years. As a result, re-estimated irrigable area is 4,587 ha in wet season, and 3,159 ha in dry season. Out of the existing 10 irrigation schemes in the Objective Area, only 3(three) schemes have reasonable planning, while the remaining 7(seven) schemes have inadequate planning.

As diversion weirs have been constructed on these tributaries at the foot of hills, their catchment areas are small. Consequently, the quantity of water available in these tributaries is limited.

For the improvement of the existing irrigation schemes, the following measures should be adopted:

(1) Based on the detailed water balance for the whole schemes, the optimum development scale of the irrigation area should be decided, and technical irrigation system should be introduced.

(2) To maximize the effect of the existing schemes, supplemental water supply to the schemes, or water source conversion of the schemes should be introduced by the utilization of water source for the new schemes.

In the formulation of the new irrigation development schemes, incorporation of the existing schemes located close to the new schemes is studied.

Except for the above existing schemes, there exist partly tidal swamp development schemes that are located on alluvium along the Rokan river mouth. However, such infrastructures as access roads, domestic waters, etc. are still less developed. In addition to these conditions, irrigation water can not be derived from the Rokan river due to salt intrusion during dry season. Therefore, most people have escaped from the area, and the benefitted area is being reduced. For the development of lower area, arrangement of infrastructure is a prerequisite subject.

New irrigation development has good potentiality because of abundant water resources and land resources of the Objective Area. On the other hand, as the Objective Area is blessed with natural resources such as natural forest and tropical rain forest, it is necessary to plan a well-harmonized development. Therefore, the new irrigation development should be made to avoid the protected forest area and swamp area paying careful attention to soil and topographical condition.

In studying new irrigation development areas, gravity irrigation system without a reservoir is regarded as the given condition. Based on this concept, locations of water sources for new projects should be selected paying attention to the following items: 1) Sufficient water available to irrigable area, 2) Flow condition at weir sites to be proposed, 3) Easiness of water conveyance, 4) Easiness of weir construction, 5) Extent of inundation after completion of weirs. and 6) Inland navigation at weir sites to be proposed.

From the view point of topography and soil, the area with 60m-25m expanding over from hilly area to peneplain is mostly suitable for irrigation area. Other potential area is situated on alluvium distributed at the confluence of the Rokan Kiri river and the Rokan Kanan river. However, for the development of this area, polder development should be applied because the area belongs to perennial flooding area. The basic data such as detailed topographical map and long term water level data are required for this purpose, and study should be made from the long term view of point.

4.4 Social Infrastructure

(1) Domestic Water

The basic approach to the development of domestic water supply in the Objective area is to increase the cover rate for water service facilities. Construction of new facilities and expansion of the existing facilities are required for that purpose.

Under the fifth 5-year development plan, new construction and expansion of existing water service facilities are planned for the larger kecamatan capitals (see the table below). Nevertheless, in order to achieve a long term solution for demand, it is necessary to study water source and development method for swamp and low coastal areas where poor water quality makes the construction of water supply facilities particularly urgent.

(2) Public Roads and Inland Water Transportation

Priority will be given to the basic approach under the fifth 5-year plan of the provincial government to upgrade the utility rate of existing roads.

In particular, the improvement of connector roads from the trunk routes to the kecamatan capitals is being expedited. The total length of such roads in the Objective area is 138 km. The remaining road length of 289 km also plays an important role in access between settlements, and should be steadily upgraded.

The major industries in the Objective area are primary products in the agricultural (including plantations) and forestry sectors. As such, connector roads with processing and consumption centers in Dumai and Pekanbaru are essential.

At present, national and provincial highways connect Bengalis District in the north with Dumai, and Kampar District in the south with Pekanbaru. However, there is no road north-south through the area, which at present can be traversed only by inland waterway transport. Accordingly, the following 2 roads are proposed (however, this is premised on a long term construction program in view of the serious engineering and economic constraints affecting road routes which are proposed over swampy terrain):

a) A 97 km road (including 70 km of existing provincial highway) along the Kumu river to connect Dalu Dalu (Kecamatan Tambusai) and Sedinginan (Kecamatan Tanah Putih).

b) A 94 km road (including 58 km of existing provincial highway) along the Rokan Kiri river to connect Kotalama (Kecamatan K. Darusalam) and Duri(Kecamatan Mandau).

The basic approach for inland waterway development is to integrate the same in the most rational manner with the expanding road network in the area. With the increased development of the latter, the utilization ratio for inland waterway transport will steadily decrease. Accordingly, development will focus on the effective operation and maintenance (O/M) of existing facilities as opposed to new construction, and the upgrading of navigational safety.

On the basis of the foregoing approach, it is necessary to establish facilities relevant to navigational safety where necessary, and upgrade the existing inland waterway facilities like piers.

(3) Power Supply

The basic orientation for power supply development is to respond to the increment in demand and upgrade customer service. In view of the national strategy to reduce petroleum consumption, it is also necessary over the long term to decrease dependence on diesel consumption. Within this context, diesel generation would be resorted to only where necessary in the short term to meet urgent energy requirements, with hydropower generating capacity to be expanded over the long term.

Current power development planning for the Objective area is as follows:

a) Kota Panjang hydropower station
A 114 MW hydropower station is to be constructed on the upper Kampar river with funding assistance from the Japanese government. Construction is to commence in 1991 and be completed in 1997. After completion, 150 kV transmission line will connect to Bangkinang, Pekanbaru, Duri, Dumai and Bagan Siapi Api in Riau province. The system is also planned to be connected

to the existing transmission grid in West Sumatra.

b) Rural electrification
All villages ("desa") are planned for electrification under the fifth 5-year plan.

c) Strengthening and maintenance of existing diesel facilities

d) Survey of potential hydropower sites
Within the Objective area, this would include Rokan Kiri No.1(67 kW) and No.2(65 kW), and Rokan Kanan No.1(46 kW) and No.2(10 kW).

4.5 Basin Conservation

Around 6,800 ha of wasteland and slash and burn area, and 2,000 ha of farm field exist within forest reserve and protected forest in the Objective area. Not only do these areas need to be returned to their original state through reforestation, but legal measures need to be enacted as well to control cutting of these forests.

Also in the case of limited production forests (for which controls exist on conversion to farmland and plantation), a large area has been deforested: 46,900 ha (2.9% of the Objective area) of wasteland and slash and burn area, and 15,900 ha (1.0% of the Objective area) developed as cultivated field. Although pressure is expected to increase in the future for development of this limited production forest which accounts for 26% of the Objective area, it is important to maintain forest cover from the long term standpoints of water and soil conservation within the basin.

Accordingly, already deforested areas should be returned to their original state by reforestation, and legal measures strengthened to control cutting of forest. At the same time, the program for permanent settlement of the population engaged in shifting cultivation should be vigorously pursued to contain the practice of slash and burn agriculture.

5. BASIC STRATEGY FOR OVERALL IRRIGATION DEVELOPMENT

5.1 Development Constraints

The Objective Area is relatively sparsely populated, with the average population density of 26 persons per sq km in 1990. Therefore, the provincial government has promoted the transmigration program in this region to stimulate development through increase in agricultural production of food crops as well as estate crops. In spite of these efforts, however, the Objective Area is still not self-sufficient in some of major food crops such as rice, maize, vegetables, etc. The reasons for the above are, among other things, considered to be as follows.

1) Due to large fluctuations of rainfall in the rainy seasons, the agricultural production can not be stabilized.
2) Availability of arable land suitable for food crops production is relatively small, occupying only about 20% of the total land area.
3) Traditional shifting cultivation is still extensively carried out with lower productivity.
4) Stable production is not possible due to lack of agricultural infrastructures including irrigation systems.
5) Road system is not adequately provided.
6) Agricultural extension services are not sufficiently provided and are not functioning properly.
7) Agricultural processing facilities are not properly provided.

5.2 Development Needs

5.2.1 Socioeconomic Projections

(1) Population Projections

Population of Riau province increased at an annual average of 4.25% between 1980 and 1990. Within the province, Kabupaten

Kampar increased at an anuual average of 6.2% and Kabupaten Bengkalis at 4.8%. Population of the Objective Area increased at an annual average of 7.0% during 1980 and 1990 .

Taking into account the population growth rates in the past, population projections in Riau province as well as the Objective Area up to the year 2020 have been prepared. In the population projections, it is assumed that population growth rate will gradually be reduced due to the reasons that overall fertility rate would be reduced by implementation of family planning and the number of transmigrants would be dwindled owing to difficulty in securing suitable agricultural land in the future.

The assumed population growth rates and projected population for Riau province and the Objective Area are summarized below.

Projected Population Growth Rate

		Riau Province	Objective Area
1991 - 2000	Natural Increase	2.0 %	2.0 %
	Social Increase	2.0 %	4.5 %
	Total	4.0 %	6.5 %
2001 - 2010	Natural Increase	1.9 %	1.9 %
	Social Increase	1.6 %	3.6 %
	Total	3.5 %	5.5 %
2011 - 2020	Natural Increase	1.8 %	1.8 %
	Social Increase	1.2 %	2.7 %
	Total	3.0 %	4.5 %

Projected Population, 1990-2020

	1990 *	2000	2010	2020
Riau Province				
Total Population	3,281,046	4,856,750	6,850,926	9,207,072
Objective Area				
Total Population	426,899	801,348	1,368,818	2,125,732
Farm Population	308,990	520,876	821,291	1,169,153

Note: * Population in 1990 is based on the 1990 Population Census data.

(2) Supply and Demand Forecast for Major Food Crops

Based on the population projections and projected production of major food crops, supply and demand forecast for major food crops in Riau as well as the Objective Area has been prepared. (See details in Annex A). Production projections are based on the assumptions that paddy, maize, soybeans and groundnut will be increased at an annual rate of 3.7%, 5.7%, 3.7%, and 6%, respectively between 1991 and 2020. As a result, self-sufficiency ratio of each crop in 2020 will be 85.1%, 72.5%, 31.5% and 73.4% in Riau province. Likewise the percentage will be 49.9%, 96.2%, 77.6% and 175.0%, respectively in the Objective Area.

5.2.2 Development Needs

(1) Food Crops

As a result of supply and demand forecast of major food crops, it is apparent that the Riau province including the Objective Area needs to increase the production of major food crops at the rates of 4 to 6% per annum. It will be necessary, therefore, to make a considerable amount of investment for the development of irrigated agriculture, improvement of farming practices for rice as well as palawija crops, and improvement of marketing and road system. It is worth stressing that such investment for improvement of agricultural infrastructures and efforts to improve the farming practices is particularly required in the Objective Area where population is projected to grow at a higher growth rate.

In terms of achieving self-sufficiency in rice production, magnitude of development needs for agricultural infrastructures has been estimated on the basis of demand and supply analysis of rice. The result is summarized below.

1) Rice Demand and Supply Balance in 1989

	Objective Area	Riau Province
Rice Supply	50,152 tons	443,767 tons
Rice Demand	56,255 tons	243,540 tons
Balance	- 6,103 tons	-200,227 tons

2) Rice Demand and Supply Forecast in the Objective Area

2.1 Without Project (Annual production increase of 3.5% is assumed without any new irrigation projects.)

Year	Demand	Supply	Balance
2000	112,990	79,319	- 33,671 tons
2010	193,003	111,887	- 81,115 tons
2020	299,728	157,827	-141,900 tons

2.2 With Project (with implementation of Batang Kumu Project starting in 1992 and another project(s) covering about 40,000 ha thereafter)

Year	Demand	Supply	Balance	Deficit in Riau
2000	112,990	116,025	3,035 tons	131,652 tons
2010	193,003	267,475	74,472 tons	184,262 tons
2020	299,728	418,700	118,972 tons	193,741 tons

The above estimate is based on the assumptions that the Batang Kumu Project will be implemented after 1992 producing about 34,000 tons of milled rice; the second irrigation project (about 20,000ha) will be implemented around 2000 producing additional 122,850 tons; and the third iriigation project (about 20,000ha) will be implemented around 2005 producing additional 122,850 tons of milled rice.

It is apparent from the above analysis that rice self-sufficiency in the Objective Area can be attained through the implementation of the Batang Kumu and another two or three irrigation projects in the Rokan River Basin. Implementation of the Batang Kumu (with irrigable area of 7,000ha) and another projects in the Rokan River Basin (with irrigable area of 40,000ha in total) will lead to attainment of self-sufficiency in the Objective Area and coverage of major part (61%) of rice deficit in Riau province. It is required therefore to carry out the above mentioned irrigation projects in the Objective Area.

(2) Fish

Fishery production in Riau totaled 172,198 tons in 1988, of which marine fishery accounted for 92.6%, and per capita supply of fish amounted to 57kg. A part of production of marine fishery were exported either to foreign countries or other provinces.

Therefore, actual supply of fish was less than 57kg per person.

In the Objective Area, marine fishery is dominant in Kubu and Bangko of Kabupaten Bengkalis, with per capita supply of 550kg and 220kg, respectively. In Mandau and Tanah Putih of Kabupaten Bengkalis, inland fishery is dominant, with per capita supply of 19.5kg which is a level of self-sufficiency in fish production. In the 6 sub-districts of Kabupaten Kampar, fishery production is limited to inland fishery due to its location. A larger part of fish demand is dependent on fishes from inland fishery. The level of production is only 7kg per person in 1989 which is not self-suffcient. Marine fishes are imported from neighbor provinces taking advantage of lower transport cost. In such a situation, it is particularly required to increase fish production in the 6 sub-districts of Kabupaten Kampar through increasing fish catch in open waters and increasing production of freshwater aquaculture.

(3) Basin Conservation

Wasteland and area denuded as a result of slash and burn cultivation is widely distributd within designated forest within the Objective area. These denuded areas alter conditions of rainfall runoff, resulting in increased sediment in the Rokan river and threat over the long term of depletion of both water and soil resources in the basin.

The following are accordingly considered necessary from the standpoint of basin conservation:

a) Reforestation of denuded wasteland and slash and burn areas.
b) Sustained conservation of forest resources in designated forest area.
c) Promotion of permanent settlement of slash and burn farmers.

5.3 Development Potential

5.3.1 Land Resources

Total size of the Objective area is 1,605,900 ha. Of this, a portion of the area is unsuitable for farming due to soil characteristics or topography. In addition, a portion is affected by administrative restrictions to curb unmanaged development of the basin. Finally, a portion of swamp and area affected by flooding will require a long term approach in order to be developed effectively.

Land Resources in the Objective Area

Soils	Land unsuitable for farming	Land development restrictions	Land suitable for farming		Total
			Developed	New	
Alluvial plain	41,000	63,900	91,300	75,400	271,600
Peat	520,600	62,100	-	39,900	622,600
Old marine terrace	-	91,200	27,800	50,100	169,100
Undulating plain	-	104,100	122,700	136,800	363,600
Hilloky plain	-	34,800	8,900	26,000	69,700
Barisan	109,300	-	-	-	109,300
Total	670,900	356,100	250,700	328,200	1,605,000

Lands unsuitable for agriculture are defined as follws;

a) Slopes in excess of 25%
b) Highly Saline Soil
c) Swamp with Thick Peat Layer

On the basis of an interagency agreement on the forest utilization plan among the concerned administrative entities (TGHK) at the provincial level, forest areas have been classified into several categories to control unmanaged development. Among these, the designations of protection forest, conservation forest and production forest are intended to contain development to a

level where the forest can be maintained without compromising its ecological integrity. Such foregoing areas within which development is restricted total 356,100 ha (excluding areas unsuitable for farming).

Land suitable for agriculture within the Objective area totals 578,900 ha. Of this 250,700 ha have already been developed; remaining area is 328,200 ha.

Of the as yet undeveloped area, 101,200 ha is either subject to flooding or is swampy, constraints that would require a long term program for effective development into farmland. Land suitable for agriculture but requiring such long term considerations for development are discussed in more detail below:

a) Swamp with peat layer less than 1 m thick
b) Area subject to flooding
c) Alluvial plain in coastal area

The development potential for the Objective area is summarized as follows on the basis of the above described status of soil resources in the Objective area.

-- From the standpoint of basin conservation, area designated as protection forest, conservation forest and permanent or limited production forest should be maintained under its current classification, and not developed for agriculture. Total area for the foregoing is 798,600 ha. Of this 6,400 ha is presently wasteland and otherwise open land, and should be reforested as soon as possible.

-- The 50,100 ha of old marine terrace is broad, gently sloping terrain suitable for large scale development of irrigated agriculture.

-- The 162,800 ha of undulating and hillocky terrain is excessively rugged (with the exception of one portion of flatland) for paddy field development.

-- River alluvial plain is divided into upper, middle and downstream classifications. The upstream portion of 14,100 ha exhibits the same topography as old marine terrace, and is likewise appropriate for development of irrigated agriculture. The 14,300 ha along middle reaches is subject to flooding, and

accordingly requires a long term development approach. Downstream reaches (including coastal area) of 47,000 ha has potential for development using differential in tidal levels. However, as conditions in other districts similarly developed have not been satisfactory, it is concluded that this area, like the middle reaches, will require long term considerations for development in order to be effectively converted into farmland.

-- Swampy area where peat layer is under 1 m thickness totals 39,900 ha. The nature of this area will require a long term approach to development.

On the basis of the above, development potential for the Objective Area is summarized below.

Development Potential in ha

Classification	Total Area	Development Potential	
		Developed	New
Forest	798,600 (49.7%)	-	-
Suitable for paddy	65,600 (4.1%)	1,400	64,200
Suitable for upland field/plantation	372,300 (23.2%)	209,500	162,800
Suitable for agriculture from long term view	141,000 (8.8%)	39,800	101,200
Other (unsuitable for agriculture)	228,400 (14.2%)	-	-
Total	1,605,900(100.0%)	250,700	328,200

5.3.2 Water Resources

Water resources potential in the Study Area is expressed as long term flow. The long term flows of four(4) sub-basins are estimated by long term rainfall data employing mathematical simulation model(Tank Model). The river discharge of non-exceeding of five(5) years is used to use for the establishment of irrigation plan. Therefore, rainfall in 1984 is applied for the estimation of each river discharge as the base year after the calculation of probable annual rainfall. According to the simulation results, monthly river discharges in 1984 (non-

exceeding of 5 years) for the Rokan river, Lubuk river and Kumu river sub-basins are as follows.

Monthly River Discharge of Rokan River Basin in 1984, Unit:m^3/s

Sub-basin No. Name of river Catchment area	Block 1 S.Rokan Kiri 4,312 Km^2	Block 2 Bt.Lubuk 4,610 Km^2	Block 3 Bt.Kumu 3,913 Km^2
Jan.	141.4	295.4	176.1
Feb.	208.6	196.5	147.4
Mar.	176.6	181.6	234.7
Apr.	180.1	242.2	172.1
May	174.8	145.7	186.4
Jun.	131.2	87.9	174.0
Jul.	86.1	103.1	83.7
Aug.	66.4	74.2	119.7
Sep.	90.6	116.8	60.2
Oct.	93.0	119.6	94.0
Nov.	248.8	113.4	107.1
Dec.	119.3	106.2	155.8
Average	143.1	148.6	142.6
Total runoff (m^3/year)	4,506 mil.	4,692 mil.	4,513 mil.

On the other hand, the total discharge of Rokan river is not able to estimate because of effect by tide and time lag of inflows from each sub-basin. Although it is estimate the tide may intrude until Sedinginan, about 60 Km far from the estuary, no data for salinity in river is available. Therefore, long term observation on tidal variation and salinity for the utilization of river water in the downstream of the Rokan river.

Probable flood flows at proposed weir sites on the main tributaries of the Rokan river are estimated employing the Rational Formula which shows rather bigger amount of flood discharge compared with the other formulas. The results are presented below.

Flood Flow at Proposed Weir Sites, Unit:m^3/s

Project Name	River Name	Catchment Area(Km^2)	Return Period(Year)			
			500	200	100	50
1.Lower Rokan Kiri	S.Rokan Kiri	3,312	3,576	2,956	2,551	2,196
2.Bt.Lubuk	Bt.Lubuk	816	1,151	1,053	980	905
3.Upper Sosa	Bt.Lubuk	816	1,151	1,053	980	905
4.Lower Sosa	Bt.Sosa	1,348	1,160	1,057	977	899
5.Mahato	S.Mahato	348	497	453	419	385

5.4 Basic Development Concept

(1) National Development Policy

Economic development in Indonesia is being pursued in the context of successive five year development plans. The focus of the current development plan, Repelita V (1989/90-1993/94), is to create a financially sound and consolidated economy, that is, an economy where the external debt problem has been brought into manageable proportions and where, within a conservative financial policy framework, a dynamic industrial sector is supported by a strong agriculture sector.

The importance of agriculture sector is reflected on the development budget allocations in Repelita V, where share of budget allocation of agriculture development including irrigation development increased from 12.9% in Repelita IV to 16.1% in Repelita V. In addition, regional development is also empahsized with budget allocation of 10% in Repelita V compared to 6.9% in Repelita IV.

National development objectives in agriculture sector include the following;

1) increase in food crops production (rice and non-rice) to sustain food self-sufficiency;

2) agricultural production increase to meet the demand of export, feed, and raw materials for domestic manufacturing industries;

3) increase of agricultural productivity and value added of agricultural goods;

4) increase of farmers' income; and

5) rural area development and natural resources conservation.

(2) Provincial Development Policy

Basic long term goals of the provincial development plan are based on the "Development Trilogy" of; (i) equal distribution of development fruits; (2) high economic growth; and (3) national

stability. In order to achieve the above goals, the provincial Repelita V set out the following objectives.

1) to upgrade standards of living, education and welfare of the population of Riau Province;

2) to support, expand and complete the implementation of national Repelita V); and

3) to establish a strong base for the coming Sixth Five-Year Development Plan.

Based on the "Development Trilogy", priority for development in Riau Province has been put on agriculture sector in its broad sense, industry sector and communication sector. Development of these priority sectors is aimed at increasing income level of the people, expanding employment opportunities and achieving balanced economic structure of the province.

In agriculture sector, the first priority is put on achievement of self-sufficiency in foodstuff, especially rice. Continued efforts to increase the production and to improve the quality of foodcrops for better nutrition are also required. At the same time, increase in the production of plantation crops are needed to increase exports as well as to meet the demand of domestic industries.

(3) Basic Development Concept in the Objective Area

In line with the objectives of national as well as provincial development plans, the basic development concept has been set as follows.

1) The first priority is given to the increase in rice production in order to contribute to attainment of self-sufficiency of rice in the province;

2) Priority is also given to the increase in palawija crops to contribute to attainment of self-sufficiency in food crops in the province;

3) Development plans are oriented to upgrade the farmers' income level; and

4) Participation of local population is to be promoted at every stage of the development activities.

6. IRRIGATION DEVELOPMENT PLAN

6.1 Irrigation Development Plan

The provincial government has proposed the following 5(five) projects in the Objective Area as the agricultural development projects:

1) The Bt.Lubuk project
2) The Upper Sosa project
3) The Lower Sosa project
4) The Mahato project
5) The Rokan Kiri project

On the other hand, the survey team made survey on the above schemes based on the irrigation development plan mentioned in 4.3, and proposed the Lower Rokan Kiri project as the alternative of the above projects. Therefore, 6(six) projects are studied. As mentioned above, irrigation water for either the Batang Lubuk scheme and the Upper Sosa scheme are derived from the Batang Lubuk river, and both schemes can be irrigated by unifying water source on the Batang Lubuk river from the view point of the topographical conditions. Along with this, the existing schemes close to the Batang Lubuk and Upper Sosa schemes can be incorporated to stabilize their water supply. In addition to the above 6(six) new schemes, the Bt.Lubuk-Upper Sosa scheme can be studied as an additional scheme.

a) <u>The Bt.Lubuk project</u>

The Bt.Lubuk scheme is an additional area to the existing Kaiti-Samo scheme to expand it more than 1,695 ha. In planning the Bt.Lubuk project, some existing projects will be incorporated because they are located along the right bank of the Bt.Lubuk river and near the Bt.Lubuk project.

Since the area is raised in undulations, the irrigable area for the Bt.Lubuk project will be dotted over the area.

b) <u>The Upper Sosa project</u>

The Upper Sosa project is located on the hilly terrain hemmed in between the Bt.Lubuk and the Bt.Sosa rivers. The

project area is raised in undulations, and the elevation of the area ranges from about 90m to 50m. The provincial road that runs through the highest part of the project area divides the area into two. The left side of the road, facing Dalu Dalu, is occupied by the transmigration settlement area, SKP-C and the right side of the road by SKP-D. The SKP-C area is located a little to the Bt.Lubuk, while the SKP-D a little to the Bt.Sosa. From standpoint of developing paddy fields, land and slope may be problem. The area is raised in undulations as mentioned above. Therefore, the irrigable area will be dotted over the area.

Considering the conveyance of water from the water source, the Batang Lubuk river is suitable for the water source from the view point of topography. The existing Aek Tangun scheme that is located close to the project and on the left bank of the Batang Lubuk river is included in the new project formulation.

c) The Lower Sosa project

The Lower Sosa project is located in the left bank of the Bt.Sosa river upstream from the confluence of the Bt.Lubuk and the Bt.Sosa, and Bt.Lubuk. The project is extending over the comparatively flat area, centering the regional capital, Kota Tengah. The elevation of the area ranges from around 40m to 20m. The water source will be the Bt.Sosa. The primary canal will be aligned along the 50m contour line, and then will pass through the field with 35m to 25m high in the direction of north-east.

d) The Mahato project

The project is situated, hemmed in by the Mahato Kiri and the Meranti rivers. The area is flat, and is expanding over around 50m above sea level. The irrigation area will be developed in the direction from the West to the confluence of the Bt.Kumu and the S.Napangga. The water source will be the Mahato Kiri. On the other side of the Mahato river, the Bt.Lubuk project that was studied by JICA for F/S is located.

e) The Rokan Kiri project

Most of the Rokan Kiri project area has already been developed for the oil plantations and the rubber planta-

tions. More development for irrigation will not be expected from the view point of topography and location of water source.

f) The Lower Rokan Kiri project

The proposed area is situated at either bank of the Rokan Kiri river. The left bank area is a comparatively flat area hemmed in by the Bt.Lubuk and the Rokan Kiri, extending from the skirts of the hills stretched from Tandun to Dalu Dalu, to the lower reaches of the both rivers. The elevation of the area ranges from around 40m to 20m. The right bank area is located the downstream end of the hilly area that is stretching along the right bank of the Rokan Kiri river from Kota Lama. In the area, the transmigration settlement schemes have already been executed.

The existing Kota Intan project is located on the left bank of the river and close to the project is included in the new project formulation. The water source will be the Rokan Kiri river.

g) The Bt.Lubuk-Upper Sosa project

The project is formulated by unifying both a) and b), and the irrigable area is located on the left and right banks of the Bt.Lubuk river. In this scheme, the existing (1) Kaiti-Samo, (2) Sei Perak, (3) Sei Menaming, and (4) Aek Tangun schemes are incorporated.

Considering the conditions mentioned above, the topographical conditions of the proposed projects are examined except the Rokan Kiri project. As a result, 5(five) areas are delineated as topographically irrigable area of 46,960 ha as shown below. In addition to this irrigable area, the Bt.Lubuk-Upper Sosa scheme is studied as an additional scheme. Namely, irrigable area of 4,060 ha that is obtained by combining the area of the Bt.Lubuk scheme and that of the Upper Sosa scheme is considered for the additional scheme.

	Scheme	Topographically Irrigable area(ha)
1)	Bt.Lubuk project	460
2)	Upper Sosa project	3,600
3)	Lower Sosa project	11,800
4)	Mahato project	11,800
5)	Lower Rokan Kiri project	19,300
6)	Bt.Lubuk-Upper Sosa	(4,060)
	Total	46,960

Remarks Lower Rokan Kiri project

Left bank area :	12,400 ha
Right band area:	6,900 ha
Total	19,300 ha

To have a proper irrigation plan for each irrigable area selected, quantities of available discharges at each new water-supplying facility site are examined on the basis of non-exceedance probable discharge in 5 years.

After examining quantities of available discharges at each intake site, potential area is decided as follows. Out of the irrigable area of 46,960 ha topographically selected, 44,160 ha is concluded to be the proper scale of new irrigation schemes considering the limitations of water resources.

Scheme	Water Availability		Irrigable Area	
	Wet S.	Dry S.	Wet S.	Dry S.
1) Bt. Lubuk	13,975	8,731	460	460
2) Upper Sosa	13,975	8,731	3,600	3,600
3) Lower Sosa	24,066	15,035	11,800	11,800
4) Mahato	9,046	8,704	9,000	8,700
5) L.Rokan Kiri	61,944	53,681	19,300	19,300
6) (Bt.Lubuk-Upper Sosa)	(13,975)	(8,731)	(4,060)	(4,060)
Total	123,006	94,882	44,160	43,860

Remarks Wet S.: Wet Season
Dry S.: Dry Season

6.2 Water Balance

Water balance calculation is carried out for each sub-basin taking irrigation water for all the existing and proposed projects and all the proposed domestic and industrial water into consideration. The river flows used for the calculation are the long term flows of the base year,1984, obtained by Tank Model Method. The rainfall data applied for the Tank Model Method are the representative rainfall stations for each sub-basin. The respective project for the calculation is shown in Fig.6.1.

The detail calculation results are presented in ANNEX B of Volume II. The results show no water deficit is found throughout the year in each sub-basin. The summary of the results of every sub-basin are as follows;

(1) Rokan Kiri River sub-basin

1) The minimum river flow at Kota Lama where is the place just after taking irrigation water to the Lower Rokan Kiri Project is estimated at 12.97 m^3/s. This discharge offers no problem to maintain the Rokan Kiri River.

2) The minimum river flow at the end of the river is 31.3 m^3/s against the water requirement of 2.16 m^3/s for domestic and industrial water to Duri and Dumai.

3) The total annual run-off at the end of the river after use of all the water demands is estimated at 3,726 million m^3.

4) The total annual run-off for the two(2) hydroelectric power generation plans in the upstream of the river are expected to be 2,766 million m^3 and 2,232 million m^3 respectively.

(2) Lubuk River sub-basin

1) The minimum river discharge at the place just after taking irrigation water to the Lower Sosa Project is estimated at 1.93 m^3/s which is less than an aim of maintenance flow. Therefore, the detail study on irrigable area and necessary river maintenance flow shall be given when a feasibility study is carried out.

2) The total annual run-off for two(2) hydroelectric power generation plans in the upstream of the river are expected to be 828 million m^3 and 288 million m^3 repectively.

3) River discharge can cover the Siarang arang existing irrigation project located in the downstream of the river.

4) The total annual run-off at the end of the river after use of all the water demands is estimated at 3,480 million m^3.

(3) Kumu River sub-basin

1) The river discharge of the Kumu river at the place just after taking irrigation water to the Bt. Kumu Project will be less than the above mentioned aim of maintenance flow. However, the Project is located at the most upstream of the Kumu river so, it gives no problem.

2) Notwithstanding that no water deficit is found in 1984 on the Mahato river, successive water deficit for June to July happens in 1985 and 1989. Therefore, the detail study on irrigable area and necessity of dams shall be carried out.

3) The total annual run-off at the end of the Kumu river after use of all the water demands is estimated at 4,844 million m^3.

6.3 Selection of Irrigation Development Plans

The irrigation development plans (18 cases in 6 development areas) formulated in the preceeding section has been evaluated and compared in terms of economic internal rate of return (EIRR) for the purpose of identifying development plans to be implemented in the Objective Area for the achievement of the Master Plan target.

As a result of economic comparison of the irrigation development plans, the following plans with EIRR of more than 10% have been selected as the ones to be proposed for implementation during the Master Plan period.

1)	Lower Rokan Kiri Irrigation Development Plan	19,300 ha
2)	Mahato Irrigation Development Plan	9,000 ha
3)	Lower Sosa Irrigation Development Plan	11,800 ha

The Batang Kumu Project is not included in the list of the projects comparison as the feasibility study of the same is already undertaken by JICA.

6.4 Justification of the Overall Irrigation Development

The total irrigated area in the Rokan River Basin will be approximately 47,000 ha with the implementation of three(3) Irrigation Development Projects and the Bt.Kumu Project (7,000 ha) of which feasibility study has been finished by JICA. The planted area for rice cultivation will total 84,600 ha with the cropping intensity of 180 %. As a result, rice production will be increased to about 420,000 tons (milled rice) in the target year of 2020.

Taking into account the irrigated as well as un-irrigated area for rice cultivation in the future, the rice demand and supply forecast will be estimated as follows.

Rice Demand and Supply Forecast in the Objective Area and Rice Deficit in Riau Province

Year	Rice Demand and Supply Forecast in the Objective Area: Demand	Supply	Balance	Rice Deficit in the Province
2000	112,990	116,025	+ 3,035 tons	131,652 tons
2010	193,003	267,475	+74,472 tons	184,262 tons
2020	299,728	418,700	+118,972 tons	193,741 tons

Note:

1/ Rice production in 2000 is based on the assumptions; 15,000ha of rainfed rice, 20,000 ha of upland rice and 7,000ha of irrigated rice.

2/ Rice production in 2010 is based on the assumptions; 20,000ha of rainfed rice, 25,000 ha of upland rice and 26,300ha (the Bantang Kumu and the Lower Rokan Kiri) of irrigated rice.

3/ Rice production in 2020 is based on the assumptions; 25,000ha of rainfed rice, 30,000 ha of upland rice and 47,000 ha (the Bantang Kumu, Lower Rokan Kiri, Lower Sosa and Mahato) of irrigated rice.

4/ Per capita consumption of rice of 141 kg and the conversion rate of 65% from paddy to rice are assumed.

5/ Rice deficit forecast in Riau province is also presented in ANNEX-E of Volume II.

As mentioned above, rice supply in 2020 will be approximately 420,000 tons which can not only meet the requirement of rice demand in the Objective Area, but also supplement about 60% of rice deficit in the Province.

In addition to the increased production of rice, increased production of palawija crops are also expected. Palawija crops will be cultivated in about 6,000 ha of irrigated land. Combined with the production of palawija crops in upland areas, the total production of palawija crops in the Objective Area will well exceed the level of self-suffciency in the area. There is great possibility that farm families in the Objective Area will have surplus of palawija crops to be sold to other provinces.

Apart from the direct benefits as mentioned above, favorable but intangible socio-economic impacts are expected from the implementation of the overall irrigation development plans. Such impacts include raising of farmers' income level, promotion of transmigration program due to improved agricultural infrastructures, increased employment opportunities for local population as a whole, raising of income level of fish farmers, improved standard of living due to improvement of social infrastructures (road, water supply, etc.), promotion of regional development, activation of local economy, and others.

6.5 Selection of the Priority Area

The second step selection intends to select the priority development plan from the three (3) development plans in Lower Rokan Kiri, Mahato and Lower Sosa areas for the purpose of carrying out its feasibility study. For the priority ranking of the 3 development plans, more elaborate evaluation has been carried out using several criteria for the ranking in due consideration of selection criteria established by the DGWRD (Directorate General of Water Resources Development). Such criteria include water source, soil and topographical conditions, land use pattern, percentage of transmigrants, accessibility, construction cost per ha, and EIRR. Each criterion has its priority point and weighting point depending on its importance for the development.

Priority ranking of the 3 development plans is presented in Table below;

Priority Ranking of New Irrigation Projects

Criteria/ Points	Lower Sosa Project	Mahato Project	Lower Rokan Kiri project
Irrigable Area	11,800 ha	9,000 ha	19,500 ha
Points	50	40	50
Soil/Topographical conditions	Fair	Fair	Fair
Points	40	40	40
Present land use	Forest	Forest	Forest/Farmland
Points	6	6	30
Percentage of farmers	0 %	0 %	25 %
Points	8	8	24
Accessbility	Bad	Bad	Fair
Points	6	6	18
Construction cost per ha (US$/ha)	4,165	4,532	4,631
Points	50	50	50
EIRR(%)	12.6 %	10.7 %	11.8 %
Points	50	50	50
Total Points	210	200	262
Ranking	2	3	1

Three (3) development plans mentioned above did not show much difference in terms of construction cost per ha and EIRR. However, the most influential point rested on such factors as the present land use, accessibility and percentage of transmigrants.

As a result of priority ranking of the 3 irrigation development plans, the Lower Rokan Kiri has been ranked the first at the total points of 262, followed by the Lower Sosa at the points of 210, and the Mahato at 200. The result indicates that the detailed study for the Lower Rokan Kiri should be carried out for its early implementation.

7. FEASIBILITY STUDY ON THE PRIORITY AREA (LOWER ROKAN KIRI IRRIGATION PROJECT)

7.1 Project Area

The Project Area of Lower Rokan Kiri Irrigation Project is 942 km² surrounded by the administrative boundary of the Kepunuhan and Kunto Darussalam sub-districts. In the Project Area, the area of 426² km including the sites for the headworks and the headreach to be constructed and the extent of photo mapping is defined as the Survey Area (See Fig.7.1.1).

The gross area of about 120 km² is situated downstream from Kotalama and is extending over either bank of the Rokan Kiri river. The area is comparatively flat, and ranges from around 40m-20m above sea level. The existing Kota Intan project which is located between the weir site and the project site is included in the new project formulation. The water source is the Rokan Kiri river.

The climate in the Project Area belongs to tropical monsoon, and mean monthly temperature is about 24.5°C-26.1°C. The mean annual rainfall varies largely from about 3,600 mm to 2,400 mm in the catchment area, while the rainfall in the gross area is about 2,300 mm. However, the annual variation in rainfall is large in the area. Judging from monthly rainfall, the area has a lot of humidity throughout the year. From view point of temperature and average wind velocity, the climate in the area is suitable for irrigation.

The Rokan Kiri river, which will be water source for the area, has the catchment area of about 3,267 Km² at the headworks location, and the area is well blessed with abundant river discharges all the year round. The mean annual discharge is 146.7 m³/sec, and the minimum mean monthly discharge is 72.6 m³/sec which occurs in July. The total outflow is estimated at about 4,600 million m³ throughout the year. Water quality offers no problem for irrigation.

Soil in the Project Area is classified into four(4) soil groups according to US soil classification: Tropodults, Dystropepts, Tropaquepts, and Tropofluvents. On the basis of land classification criteria which had been made based on the criteria prepared by FAO system and Soil Research Institute in Bogor, soil

suitability for paddy and upland crop cultivation has been studied. Accordingly, land resources have been assessed. As a result, terraces and alluvial zone excepting hilly area has been concluded to be suitable for irrigation, which occupy about 90% of the irrigable area.

The present land use in the Project Area is grouped into orders: primary forest(42.3%), secondary regrowth forest(24.9%), bush/grass land/alang alang(19.3%), plantation(7.5%), cultivable land(3.6%), and others. With respect to the land use condition of cultivable land in the irrigable area, there exist only 2 ha of paddy fields. Rainfed fields are being mostly cultivated in the Project Area. In the irrigable area, irrigation facilities have not been installed yet. The partly paved provincial road is connecting from Ujung Batu to Kotalama near the Project Area. Within the irrigable area, unpaved transmigration roads lead to the transmigration settlements which are located either bank of the Rokan Kiri river from Kotalama. Despite the fact that the head required for drainage can be expected if the water surface rise of the Rokan Kiri river occurs during high water, people suffers from perennial inundation due to poor drainage, which is caused by flat topography and insufficient cross section of drainage canals.

In the Project Area, the total households are 5,111 of which 3,968 households corresponding to 77.6% of total households are engaging in farming. Population engaging in agriculture is estimated at about 17,000. Each family was allocated 2.0 ha of land of which 1.75 ha(1.0 ha for 1st cultivable land, and 0.75 ha for 2nd cultivable land) was intended as farmland, and 0.25 ha was as a houseplot/garden. At present, the 2nd cultivable land is still covered with forest,and has not been used for cultivation yet. The number of farmhouses in the irrigable area is 1,216 households of former occupant farmers, and 1,120 households of transmigrants.

The principal farm products in the Project Area consist of paddy, upland paddy, maize, cassava, sweet potatoes, peanuts, etc. Generally, yield in the Project Area is low compared to that in the Rokan river basin. As this example, the yield in the basin is 3.6 t/ha, while that in the Project Area is 2.3 t/ha in the case of paddy. The low yield is caused by poor farming practice such as insufficient fertilizer,and by damages done by wild animals.

According to the farm economy survey in the irrigable area, 58%

of farmer's income is derived from agriculture, and the remaining is gained from labors for the large plantations. Within the agricultural income, 52% is obtained from crop, and the remaining 48% is from rubber, small holding of coconut plantation, livestock, and fishery. In addition, 88% of farmers intimate their strong will to join the irrigation scheme, while the remaining farmers do not consider that irrigation bring profit because understanding of irrigation has not infiltrated into their minds yet.

In the Project Area, 9 villages out of 12 villages have agricultural cooperative(KUD), and about 62% of farmers groups belong to KUD. Most of the newly settled villages and transmigration farmhouses participate in KUD. Their participation ratio is 83%, and 69% respectively, which is high compared to 22% of the former occupant farmers. Generally, KUD holds an important position as an economic basis for local farmers. However, lively activities of KUD has not been performed yet, which is considered to be a cause to obstruct agricultural development in the Project Area. In addition to this condition in the area, agricultural extension services, researches, and finance which are performed insufficiently under the government cause major constraints for agricultural development.

From the aspect of environment, forest in the Project Area belongs to convertible forest to which the government has assigned as exploitable forest. This is distinguished from reserved forest and protection forest. However, it is feared that disordered shifting cultivation in the region which has no systematic irrigation system will have a bad influence on the surrounding area. Accordingly, implementation of irrigation scheme can expedite settlement of local people who live in and around Project Area. Thus, prevention against destruction of surrounding nature is being expected.

7.2 Development Plan

7.2.1 Basic Principles of Development Plan

The objectives of Lower Rokan Kiri irrigation project which was formulated on basis of overall irrigation development plan are as follows:

1) To stabilize livelihood of the transmigrants who have already settled and former occupant local people in the area by introducing irrigation and drainage system.

2) To contribute increase of rice productivity which is directing attainment to self-sufficiency of rice in Riau Province.

3) To support the government policy on resettlement of people living in the region for protection of natural environment as well as on new transmigration settlement.

The irrigable area is dotted with 1,216 households of the existing three(3) villages(Muara Dilam, Teluk Sono and Kotalama) and 1,120 farmhouses of four(4) transmigration settlements(SKP-A, SKP-B, SKP-F and SKP-G).

In accordance with positioning the Project Area as rice production base which has been planned by the provincial government, development plan should be formulated to bring the maximum profits by utilizing affluent water resources and land resources in the region as well as by forwarding development which keeps with environment. For increasing rice production, the following factors should be increased:

1) The unit yields of paddy
2) The annual cropping intensity of paddy
3) The area of paddy fields as much as possible

For this purposes, the following items should be implemented as soon as possible:

a) Construction of systematic irrigation facilities
b) Improvement of drainage conditions by introducing drainage system
c) Development of paddy field and farmland an the area

d) Coordination to the new transmigration plan in the area to be newly developed
e) Introduction of operation and maintenance facilities to the area
f) Arrangement of agricultural support services and organization
g) Construction of related social infra-structure

7.2.2 Decision of Development Scale

In deciding the development scale, the following factors area taken into account:

1) Location and intake water level of weir
2) Possible intake discharge and water requirements
3) Land suitability classification
4) Number of household of farmers, allocated area and land use plan

Water resources availability of the Rokan Kiri river is estimated to be about 40,000 ha at the proposed weir site. Thus, it is said that the Project Area has high potential for irrigation development. On the other hand, there are 2,336 households of the existing farmhouses including the transmigration ones at present. In deciding the appropriate scale of development, the following alternatives are studied taking the above factors into account:

Alternative-1 (Plan-1)	:	Scheme scale on irrigation and drainage plan for the existing farmhouses only.
Alternative-2 (Plan-2)	:	In addition to the above Alternative-1, new settlement will be made for the area which is located upstream from the Alternative-1 area. Namely, scheme scale is the Alternative-1 area plus upper reach area of the irrigation canal which has been aligned for the Alternative-1.
Alternative-3 (Plan-3)	:	Scheme scale is expanded to such an extent that water resources as well as land resources can be utilized maximally for irrigation and drainage plan.

The development area, irrigable area and other basic statistics are shown in the following Table.

COMPARISON OF ALTERNATIVE STUDY ON IRRIGATION PLAN

Item	Plan-1	Plan-2	Plan-3
Gross area	5,580 ha	12,200 ha	25,200 ha
Net irrigable area	4,360 ha	8,300 ha	17,140 ha
Upland	(1,246 ha)	(2,371 ha)	(4,897 ha)
Existing transmigrants	1,120 KK	1,120 KK	1,216 KK
Local people	1,216 KK	1,216 KK	1,120 KK
New settlers	-	2,254 KK	7,305 KK
Distributed land			
Homeyard	0.25 ha	0.25 ha	0.25 ha
Paddy field	1.75 ha	1.75 ha	1.75 ha
Upland field	(0.50 ha)	(0.50 ha)	(0.50 ha)
Water source	Rokan Kiri river	Rokan Kiri river	Rokan Kiri river
Intake facility	Gated weir	Gated weir	Gated weir
Catchment area	3,267 Km2	3,267 Km2	3,267 Km2
Location of weir	Approximate 5 Km upstream from Kp. Kotaintan		
Elevation of river bed	EL.41.7 m	EL.41.7 m	EL.41.7 m
Height of weir(gate)	3.5 m	4.3 m	4.3 m
Elevation of crest	EL.45.2 m	EL.46.0 m	EL.46.0 m
Length of flood gate	24mx4nos=96 m	24mx4nos=96 m	24mx4nos=96 m
Length of sand flush gate	5mx2nos=10 m	5mx2nos=10 m	5mx2nos=10 m
Max. water requirement			
For first paddy	1.16 l/s/ha	1.16 l/s/ha	1.16 l/s/ha
For seconf paddy	1.58 l/s/ha	1.58 l/s/ha	1.58 l/s/ha
PLanning intake discharge	4.92 m3/s	9.35 m3/s	19.34 m3/s
Intake water level	EL.45.1 m	EL.45.9 m	EL.45.9 m
Flood discharge (1/100)	2,200 m3/s	2,200 m3/s	2,200 m3/s
Head reach canal	13.0 Km	13.0 Km	13.0 Km
Main canal, left	16.1 Km	16.1 Km	16.1 Km
' , right	16.7 Km	19.1 Km	19.1 Km
Cecondary canal, left	19.4 Km	24.3 km	67.1 Km
' , right	2.2 Km	5.2 Km	38.0 Km
Tertiary system, left	3,445 ha	5,485 ha	10,225 ha
' , right	915 ha	2,815 ha	6,915 ha
Drainage canal, left	23.3 Km	38.3 Km	58.6 Km
' , right	10.0 Km	17.9 Km	17.9 Km
Access road	2.5 Km	2.5 Km	25.0 Km
Construction cost per ha	Rp.15.1 Mill.	Rp.12.2 Mill.	Rp. 7.6 Mill.
Approximate EIRR	7.8 %	12.0 %	15.3 %

As a result of the comparative study on the above three(3) Alternatives, the Alternative-2 and the Alternative-3 allow to be adopted for development plan. As an urgent measure to stabilize the livelihood of the transmigrants and the former occupant farmers, however, the comparative study leads to the conclusion that the Alternative-2 is the appropriate scale at the present stage.

Riau provincial government has already formulated the Project Area as rice production base because affluent water resources and land resources can be expected. Therefore, looking far into the future of the Project Area, the ultimate scale of the development target will be the Alternative-3 properly.

Accordingly, in adopting the Alternative-2 for this study, facility plan is drawn up taking the following factors into account so that the Alternative-2 can be shifted to the Alternative-3 as easy as possible in the future:

1) The location of headwork and crest elevation
2) The alignment of the main irrigation canals to be expanded
3) The alignment of the main drainage canals to be expected

7.2.3 Agricultural Development Plan

In order to increase the unit yield and outputs of crops, preparation of proper irrigation and drainage facilities and draw up of proper land use plan are required. Based on the following conditions concerning soil, present land use and other physical and social conditions, land use plan is drawn up:

a) The land around hilly area and the land on precipice or hillside are protected from soil erosion by conserving the present vegetative cover.

b) Alluvium is given high priority as land suitable for agricultural development because of high crop productivity compared to other soil.

c) The primary forest in the project are is conversion forest which is converted to agricultural land. However, it fulfills its important duty from environmental view point. Furthermore, the primary

forest is fuel sources for residents. Consequently, conservation of the primary forest is taken this study into account.

Implementation of irrigation scheme enable to irrigate paddy fields in the Project Area throughout a year. Thus, the present land use will be changed as follows:

Classification	Present (ha)	Plan (ha)
Primary forest	5,268	304
Secondary forest	3,094	751
Bush/grass/alang²	2,857	244
Cultivable land (paddy/upland field)	639	8,300
Houseplot/garden	342	2,026
Right-of-way	-	539
Total	12,200	12,200

Land allocated to a settlement family unit is as follows:

- Houseplot/garden	0.25 ha
- 1st arable land	1.00 ha
- 2nd arable land	0.75 ha
Total	2.00 ha

In addition to the above land allotment, 0.25 ha for public land and 0.11 ha for right-of-way per family are taken planned land use into consideration.

Hence, 2,643 ha is used by 1,120 households of the existing transmigration settlement according to the planned land use. In addition, land of 2,938 ha is allotted to 1,216 ha households of the former occupant farmers and local people in Kotalama. Further, land of 300 ha is allotted to farmers in Kota Intan. Land not suitable for forming counts up 1,299 ha. As a result, new settlement plan is required settlement of 2,254 households of farmhouses for the remaining 5,320 ha.

Crops to be introduced are decided considering agricultural

development strategy in the Project Area. Thus, paddy for wet and dry seasons, and soybeans and peanuts for secondary crops are recommended. The selected crops coincide with the crops selected by SUPRA INSUS which is pushed forward by the government.

Cropping patterns are drawn up considering double cropping irrigation per year. However, introduction of secondary crops are taken cropping pattern into account according to scatter in labor forces. The cropping pattern is formulated as shown in Fig.7.2.4 based on the prevailing cropping patterns, meteorological conditions, growing specificity of paddy, water management, etc. in and around the Project Area.

In crop culture method, introduction of high yielding variety and sufficient input of fertilizer are planned under the condition of proper irrigation. The target of unit yield after implementation of the scheme are established as follows with reference to the present yield and prospective yields of other projects.

Crop	Target of Unit Yield(t/ha)	
	With project	Without project
(1) Wet season paddy		
with irrigation	5.0	3.5
rainfed	-	0.9
upland paddy	-	1.0
(2) Dry season paddy		
with irrigation	5.5	-
rainfed	-	0.9
upland paddy	-	1.0
(3) Soybeans	1.6	0.7
(4) Peanuts	1.8	0.6

As a result, it is estimated that the increased yield of 62,200 ton of rice and 7,300 ton of second crops a year can be realized in the Project Area after implementation of the scheme.

Besides, one of the most important object of the plan is to increase the farmers' income. In order to attain this object, the basic strategy is to increase the farming size by expanding the cropping area, allocating the labor forces effectively, and introducing the mechanization for agriculture as well as to raise

and to stabilize the productivity of crops by introducing the effective farming method and draft animals.

Strengthening of the existing farmers' association and improving the quality of farmers and staff for operation and maintenance through training are essential so that the scheme can be carried out satisfactory. KUD should be strengthened by the government guideline and support because the channel for agricultural finance is limited in the Project Area.

7.2.4 Irrigation and Drainage Plan

Irrigation and drainage plan is decided considering the following three items on the basis of the appropriate scale of the development plan and agricultural development plan:

1) The effective use of the fund, and the maximum utilization of land resources, water resources and labor forces.

2) Accord with environment

3) Introduction of gravity irrigation system

Irrigation plan is drawn up by the water sources of the Rokan Kiri river. As a result of the study, the maximum potential development area which was assessed by the use of the Rokan Kiri river water source is larger than the planned area of the Alternative-2. Therefore, special consideration is paid on future plan so that the area can be developed to the utmost limit with the labor forces is being increased after the implementation of the Alternative-2 plan in the Project Area. The general layout of the Project is shown in GENERAL PLAN.

1) Irrigation plan

Water requirement for paddy is calculated according to the Irrigation Design Standard published by the Directorate General of Water Resources Development, Ministry of Public Works(DGWRD). Evapotranspiration is obtained using the Modified Penman Method. Effective rainfall is calculated by multiplying 70% of 1/5 year non-exceedance of rainfall in the Project Area. An irrigation efficiency of 55% for paddy is assumed, while irrigation efficiency of 50% for upland crops is adopted. The maximum diversion requirements calculated according to the above

conditions is 1.16 l/sec/ha for 1st crop, and 1.58 l/sec/ha for 2nd crop. River discharge used for irrigation is flows occurring once in five(5) years non-exceedance at the proposed weir site. As a result of study, the annual discharge at the proposed weir site is estimated at 4,600 million ton, while the annual irrigation requirement is 120 million ton. Thus, coefficient of utilization is estimated at 2.6%.

2) Drainage plan

Drainage plan is drawn up according to the Irrigation Design Standard published by DGWRD as well. The design drainage discharge is calculated by dividing drainage discharge for paddy fields and that for non-paddy fields. Drainage plan is centered on widening and improvement of the existing drainage rivers and small drainage canals. Then new drainage system is formulated.

3) Facility plan

Facility plan for irrigation and drainage is made based on irrigation and drainage canal alignment maps, topographical maps for weir site obtained by entrusted work to Indonesian consultant, and topographic maps with scale of 1:5,000 prepared by JICA. The principal facilities consist of (1) weir and intake, (2) headreach canal, (3) main and secondary canals, (4) tertiary system, and (5) main drainage system.

The location of headwork is selected based on topographic maps and field survey so that water level required for irrigation, deriving water, stability of structure, and easiness of construction can be ensured. Considering the extent of inundation due to backwater after completion of weir, movable type weir is employed. The alternative water source facilities for irrigation such as free intake without a weir, headwork, rubber dam, and pumping station are studied from the technical and economical point of view. As a result, movable weir with steel gates is adopted from view point of economy, easiness of maintenance.

The headreach canal and main canals are lined by thin concrete because of the importance, need to ensure its security, and soil conditions. The secondary and tertiary canals are to be earthen canals from economical point of view. As for canal length, the headreach canal is 13.0 Km, two(2) main canals for both right and left irrigable areas are 35.2 Km in total, and 12 secondary canals are 29.5 Km. All the main drainage canals are earthen canal and the total length of their 11 canals are 56.2 Km.

Operation and maintenance road with 5.5m wide of which 3.5m is paved with gravel metalling is provided on all canals except for tertiary canals.

7.2.5 Construction Plan

Construction is performed in five(5) years from 1996/97 to 2000/2001 in consideration of economy and construction scale. All construction works are divided into six(6) work divisions. Construction of headwork, the headreach canal and the main drainage canals are performed prior to other work divisions so that benefit is brought as early as possible.

7.3 Implementation Program

The implementation period of this project is about seven(7) years including two(2) years of preparation period. The preparation period includes the detailed design, preparation of tender documents, procurement and the preparatory period for construction. Construction period is five(5) years. Implementation schedule is shown in Fig.7.3.1.

Directorate General of Water Resources Development, Ministry of Public Works(DGWRD) is execution body, has responsibility for design, facility construction and construction supervision and coordinate and negotiate with authorities concerned concerning implementation of the project. In the Province, the Riau provincial government coordinate the provincial authorities concerned in the place of the Ministry of Public Works. For smooth implementation of the project, the construction supervision office is to be established at Ujun Batu, the seat of sub-district office. The planned organization chart for implementation of the project is shown in Fig.7.3.2.

After completion of facilities, the construction supervision office is transferred to the Riau provincial government, and turns into the operation and maintenance office. It has responsibility for operation and maintenance of all the facilities including tertiary block. After tertiary block, operation and management is entrusted by water users' association and farmers.

In view of the need for farmers' involvement from early stage of the Project, it is essential that formation of Water Users' Association(WUA) commence during the pre-construction stages. Before completion of the project facilities, a WUA will be established in each village with technical and operational guidance from the O&M office and the agricultural extension office.

A WUA is usually established along administrative boundaries which do not necessary coincide with tertiary unit boundaries, covers an area of 30 ha to 100 ha and has 20 to 60 members. In addition to O&M responsibility, WUAs are also responsible for drawing up seasonal programs for equitable distribution of water within their respective command areas.

7.4 Project Cost

The approximate project cost is estimated based on the following conditions:

1) The exchange rate is set at US$1.0=Rp.2,010.
2) Construction of facilities is carried out under contract basis(ICB in principle).
3) The unit price is based on the material costs and labor costs as of June 1992.
4) Construction cost is divided into local portion and foreign portion. They include the following items:

   Local portion : labor, fine and coarse aggregate, petroleum and oil(crude oil), etc.

   Foreign portion : structural steel such as reinforcement and steel gate, etc., cement except for raw materials, petroleum and oil except for crude materials, depreciation for heavy equipment and vehicles, etc.

5) Land development costs consisting of clearing cost and land levelling cost for forest and bush are included.
6) Physical contingency is added up 5% of direct construction cost. Price contingency is set at 10% for local portion and 3% for foreign portion as annual price rise.
7) Cost for strengthening of agricultural support services (training cost) is included but facility cost for water users' association is not included.

Project cost consists of preparatory cost, direct construction cost, costs of materials and mechanical equipment for operation and maintenance cost, land acquisition cost, administrative cost, Training cost, engineering services cost, contingencies and value added tax.

The project cost for this irrigation project is estimated at US$25.4 million of local portion, US$36.8 million of foreign portion and US$62.2 million in total. Detailed cost estimate is shown in Table 7.4.1.

The annual disbursement schedule is given in Table 7.4.2 and

summarized as follows:

Fiscal year	Local portion (US$)	Foreign portion (US$)	Total (US$)
1994/95	470	779	1,249
1995/96	1,172	1,352	2,524
1996/97	3,616	5,561	9,177
1997/98	6,504	9,916	16,420
1998/99	9,238	13,723	22,961
1999/2000	3,015	3,890	6,905
2000/01	1,367	1,561	2,928
Total	25,382	36,782	62,164

In the case that, for the reference, the foreign loan is provided by the OECF's manner, the components of the project cost are US$9.3 million of Rupiah portion and US$52.8 million of loan portion as mentioned in Table 7.4.3.

7.5 Project Evaluation

7.5.1 Project Benefit

The project will contribute to attain the target of agricultural development plan for the state and the province. Namely, the project will contribute to the following items:

1) An increased yield of food crops for attainment of self-sufficiency of crop,
2) An increased yield of agricultural products corresponding the increase in manufacturing of agricultural products,
3) Improvement of agricultural productivity and step-up of value added of agricultural products,
4) Increase of farmers' income, and
5) Regional development.

In the case when the project is completed, the following annual increase of agricultural products can be expected:

1) Rice : 62,200 tons
2) Upland crops : 7,300 tons (soybeans and peanuts)

These prices are estimated at Rp.6,370 million at price level of 1992.

The implementation of the project enables most farmers to obtain high income and other benefit. The annual income of standard farmer possessing 2.0 ha of land is about Rp.516,800 at present. However, the farmer's annual income can be increased to Rp.5,200,000 if the project is implemented.

7.5.2 Financial Evaluation

Financial evaluation is made using project cost calculated on the basis of market price in the Project Area. As mentioned in 7.4, the project cost as of June 1992 is as follows:

Item	Conversion in Rp. (million Rp.)	Conversion in US$ (million US$)
Local portion	51,020	25.4
Foreign portion	73,931	36.8
Total	124,951	62.2

The finance plan mentioned above, is estimated on the assumptions that foreign currency portion of the project cost will be financed by the concessional loan under aid or international lending arrangement, and the local currency portion of the same will be financed by the Government budget. The foreign loan is assumed to be provided on the conditions of a repayment period of 30 years including 10-year grace period with interest rate of 2.5% per annum. It is also assumed that local portion of the project cost will be financed by the budget allocation oh the Government without any interest and repayment of the principal.

On the basis of the above finance plan, a cash flow statement on the fund requirement and repayment of the interest and principal of the loan has been prepared as shown in Table 7.5.1.

7.5.3 Economic Evaluation

Economic evaluation for the project is made according to the following conditions:

1) The exchange rate is set at US$=Rp.2,010.
2) Economic life of the project facilities is assumed as 30 years.
3) Only direct tangible benefits are quantified. Indirect benefits are qualitatively evaluated.
4) The economic farm gate price of paddy(unhusked rice) is estimated as Rp.322/Kg based on world market price projection in 2000.
5) A shadow wage rate of 0.8 is applied to the financial farm labor cost.
6) Agricultural development period is 5 years.
7) Discount rate is 10%.
8) Price rise ratio affects the project cost and benefit. Therefore, it is not considered in economic evaluation.

Economic project cost is calculated using conversion rate on the basis of financial project cost. Economic benefit of the project is assumed to be the benefit of net crop product which is expressed the difference between with project and without project. The project plan is so drawn up that the benefit from irrigation shows a yearly increase and will reach to the target benefit in 5 years after the completion of the project, with the implementation of the project. In the construction planning, development is proceeded by work division, and benefit from irrigation will be brought in 4 years after the commencement of

the construction, and will reach to the target benefit in 10 years.

Economic internal rate of return(EIRR), Cost-benefit ratio(B/C), and Net present value(NPV) are calculated as follows:

EIRR	:	12.0%
B/C	:	1.18 (Discount rate 10%)
NPV	:	Rp. 10,275 million (Discount rate 10%)

Economic cost benefit flow is shown in Table 7.5.2.

In order to evaluate economic elasticity of the project to which the cost and benefit vary disadvantageously, the sensitivity analysis on the following cases is made, and the conditions and results of 3 cases are as follows:

Case	Conditions	EIRR (%)	B/C	NPV (Rp.mil.)
Case-1	when cost increases 10%	10.8	1.07	4,507
Case-2	when benefit decreases 10%	10.7	1.06	3,480
Case-3	when construction is 2 years behind schedule	10.6	1.06	2,919

In view of the results so far studied, it is concluded that the Lower Rokan Kiri project is the project with priority and with adequacy of implementation from economical point of view. As a result of sensitivity analysis, the project is so profitable that EIRR is over discount rate for variation of cost and benefit.

7.6 Environmental Impact Assessment

The implementation of the project will bring benefit directly to the Project Area. However,it is expected that it influences on environment and socio-economy. The environmental impact caused by the implementation of the project is assessed in accordance with the guideline on environmental impact assessment recommended by the Ministry of Population and Environment.

The study is to extract the expected items which may influence environment with the implementation of the project, and more

detailed necessity on environmental impact assessment for the implementation is studied.

Prediction and assessment are studied regarding the following 3 elements:

1) Physical and chemical elements: Weather condition, physiography, geology, topography, land resources, rivers, water quality, discharge of well, and atmosphere
2) Biological elements: vegetation, animal, and aquatic plant
3) Socio-economic or cultural elements: population, socio-economy, culture, social organization, and facilities

The above studies are studied in the following three periods: 1) construction preparatory period, 2) construction work period, and 3) operation and maintenance period.

The main points of environmental assessment in this study are given as follows.

1) Physical and chemical elements

The water quality is expected to be the most effective impact against the physical and chemical elements. Water pollution due to construction, fertilizer and agricultural medicine is feared during and after construction of the Project.

The appropriate treatment for polluted water due to construction and soil disposal shall be considered. For the increment of use of fertilizer and agricultural medicine, a proper guidance for the usage is required. The construction of drainage system and its proper operation can improve the present water inundation in the downstream of the irrigable area. Moreover, strengthening of city water supply and medical facilities and implementation of improvement program for the conscious against sanitation are essential for the population.

2) Protected flora and fauna

In Indonesia, useful trees in forest with diameter of less than specified one are designated as protected flora. It signifies to reserve natural resources. Trees, however, in the conversion forest are excepted from the protected flora. Since the Project

area is located in the conversion forest, this project offers no problem against the protected flora.

The protected faunas are designated whole Indonesia to protect precious species. In the Project area, it is certified that the elephant inhabit and other inhabitants to be protected are expected to exist. From a legal point of view, such protected fauna in a development area can be shifted to surrounding areas in order to conserve a species. In formulating a development plan, it is necessary to consider for wild animals not to disturb their free action by isolating. In construction stage, a flight way for wild animals is required.

For the planning, data on wild animals, such as location of habitat, thickness etc. are indispensable. In case of large animals, the action territory is rather wide, so it is feared that overlapping territories of different animals caused by shifting their inhabiting area brings decreasing number of animals and invasion upon other than forest. Therefore, in this context, the particular assessment survey is required for the protected fauna.

3) Deforestation

The primary forest in which effective large-size trees have been cut down occupies about 40% of the study area and assumes virgin forest because of its outward form. Since such primary forest is rich in natural resources and essential for inhabiting fauna and growing flora, it shall be protected as much as possible. On the other hand, deforestation for farm land by this irrigation project is estimated at about 5,000 ha i.e. about only 0.2% against the total forest in the Rokan River Basin. Therefore, it can be said that this project offers few influence with forest.

As the primary forest is unsuitable for fuel, the secondary forest is used for fuel sources by the local population. Since this circumstances will continue in the future,the forestation for fuel shall be considered.

4) Socio-economic element

The implementation of the project will bring positive impact for the socio-economic element such as increment of income and working opportunity etc. On the contrary, negative impact is comparatively small. Since uneasiness and/or questions for the implementation of the project by the local population and

conflict between new transmigrants and former habitants are expected, enough pre-information of the project shall be given. Moreover, the Government shall make effort to participate the project formulation with local population.

The impact assessment on environment caused by the implementation of the project is summarized in Table 7.6.1, and evasion and alleviating measures on negative effect in Table 7.6.2. Since negative effect is expected,it is concluded that more detailed environmental impact assessment survey is necessary.

TABLES

Table 3.1 Area of Soil Classification for the Objective Area

Classification	Area(ha)	Ratio(%)
Alluvial Plain Soil	297,900	13.5
Tidal Swamp Soil	41,000	1.9
Riverine Alluvial Soil	168,200	7.6
Mender Belt Alluvial Soil	59,900	2.7
Alluvial Valley Soil	20,200	0.9
Fan Alluvial Soil	8,600	0.4
Peat Soil	623,500	28.2
Shallow Peat Swamp Soil	40,200	1.8
Peat Swamp Soil	374,300	16.9
Deep Peat Swamp Soil	209,000	9.5
Old Marine Terrace Soil		
Marine Terrace Soil	187,200	8.5
Undulating Plain Soil		
Undulating Plain Soil	451,800	20.4
Hillocky Plain Soil		
Hillocky Plain Soil	202,700	9.2
Barisan Soil		
Barisan Soil	446,900	20.2
TOTAL	2,210,000	100.0

Table 3.2 Present Land Use in the Objective Area

Classification		Area(ha)	Ratio(%)
Forest		1,318,200	59.6
1	Natural Forest	386,500	17.5
2	Peat Swamp Forest	647,100	29.3
3	Tidal Forest	26,700	1.2
4	Logged Primary Forest	257,900	11.7
Bush & Grassland		417,800	18.9
5	Bush	240,000	10.9
6	Bush + Alang-alang	58,600	2.7
7	Alang-alang	68,000	3.1
8	Savannah	35,000	1.6
9	Savannah + Bush	1,500	0.1
10	Others	14,700	0.7
Shifting Cultivation		94,700	4.3
11	Shifting Cultivation	94,700	4.3
Upland Permanent Cultivation		60,800	2.8
12	Upland Crop	50,800	2.3
13	Upland Crop + Tree Crops	10,000	0.5
Wetland		76,000	3.4
14	Wetland Rice	55,500	2.5
15	Tidal Wetland Rice	20,500	0.9
Tree Crops/Estate		238,400	10.8
16	Rubber Tree Crops	33,000	1.5
17	Coconut Tree Crops	23,600	1.1
18	Oilpalm Tree Crops	170,000	7.7
19	Other Tree Crops	11,800	0.5
Settlement		4,100	0.2
20	Settlement	4,100	0.2
	Total	2,210,000	100.0

Table 3.3 Statistics of Food Crops in the Objective Area

		STUDY AREA			WHOLE	WHOLE	
		KAB. KAMPAR	KAB. BENGKALI	Rokan River Basin	KAB. KAMPAR	KAB. BENGKALIS	WHOLE PROVINCE IN 1988
Wet Land Rice	Harvested Area (Ha)	1,596	13,386	14,982	14,031	32,379	99038
	Production (ton)	5,983	47,564	53,547	62,071	110,736	295677
	Yield (t/Ha)	3.75	3.55	3.57	4.42	3.42	2.99
Upland Rice	Harvested Area (Ha)	11,549	1,663	13,213	31,345	6,489	53419
	Production (ton)	29,473	3,213	32,685	69,053	12,371	97676
	Yield (t/Ha)	2.55	1.93	2.47	2.20	1.91	1.83
Maize	Harvested Area (Ha)	2,786	458	3,244	4,657	980	13321
	Production (ton)	8,511	638	9,149	13,349	1,557	24293
	Yield (t/Ha)	3.05	1.39	2.82	2.87	1.59	1.82
Soybeans	Harvested Area (Ha)	2,373	224	2,597	3,023	574	6524
	Production (ton)	3,052	201	3,253	3,803	585	5252
	Yield (t/Ha)	1.29	0.90	1.25	1.26	1.02	0.81
Cassava	Harvested Area (Ha)	1,178	750	1,928	2,819	3,000	8529
	Production (ton)	17,254	12,009	29,263	41,589	45,625	92893
	Yield (t/Ha)	14.65	16.01	15.18	14.75	15.21	10.89
Sweet Potato	Harvested Area (Ha)	244	247	491	414	602	2037
	Production (ton)	1,795	1,267	3,061	2,947	3,839	17887
	Yield (t/Ha)	7.36	5.14	6.24	7.12	6.38	8.78
Ground Nuts	Harvested Area (Ha)	1,548	182	1,730	2,453	361	4479
	Production (ton)	2,905	185	3,092	3,997	334	4233
	Yield (t/Ha)	1.88	1.02	1.79	1.63	0.93	0.95
Green Gram	Harvested Area (Ha)	758	143	901	1,159	236	3508
	Production (ton)	907	134	1,040	1,331	215	5653
	Yield (t/Ha)	1.20	0.93	1.15	1.15	0.91	1.61

Table 7.1.1 Present Land Use in the Survey Area

Present Land Use	Left Bank		Right Bank		Total	
	Area(ha)	(%)	Area(ha)	(%)	Area(ha)	(%)
Primary Forest	17,406	46.8	6,089	35.9	17,495	42.3
Secondary Forest	4,995	20.5	5,306	31.3	10,301	24.9
Bush/Grass Lands	4,225	17.3	1,713	10.1	5,938	14.4
Alang Alang Lands	908	3.7	1,131	6.7	2,039	4.9
Paddy	25	0.1	2	0.0	27	0.1
Upland Crops	1,125	4.6	318	1.9	1,443	3.5
Plantation Area	891	3.7	2,202	13.0	3,093	7.5
Residential Area	807	3.3	193	1.1	1,000	2.4
	24,382	100.0	16,954	100.0	41,336	100.0

Table 7.2.1 Proposed Land allocation in the Gross Area

Proposed Land Allocation	Left Bank		Right Bank		Total	
	Area(ha)	(%)	Area(ha)	(%)	Area(ha)	(%)
Existing Transmigration Area (1,120H/H)						
SKP-A(190H/H)			448		448	
SKP-B(345H/H)	814				814	
SKP-G(400H/H)	944				944	
SKP-F(185H/H)	437				437	
Sub-Total	2,195	27.2	448	10.8	2,643	21.7
Area for Old Village People (1,216H/H)						
Teluk Sono (133H/H)	314				314	
Muara Dilam (617H/H)	1,456				1,456	
Kota Lama - 1 (133H/H)	248				248	
Kota Lama - 2 (333H/H)			620		620	
Sub-Total	2,018	25.0	620	15.0	2,638	21.6
New Transmigration Area (2,254H/H)						
New Village - 1 (400H/H)			944		944	
New Village - 2 (380H/H)			898		898	
New Village - 3 (450H/H)			1,062		1,062	
New Village - 4 (345H/H)	814				814	
New Village - 5 (235H/H)	554				554	
New Village - 6 (360H/H)	850				850	
New Village - 7 (84H/H)	198				198	
Sub-Total	2,416	30.0	2,904	70.2	5,320	43.6
Area for the People from Kota Intan	300	3.7	0	0.0	300	2.5
Other Lands (Bad Lands etc.)	1,133	14.1	166	4.0	1,299	10.6
Total	8,062	100.0	4,138	100.0	12,200	100.0

Table 7.2.2 Proposed Land Use in the Gross Area

	Present Land Use		Proposed Land Use		
	Survey Area	Gross Area	Area to be Developed	Non Development Area	Total Proposed Land Use
Paddy Fields	27	2	5,926	-	5,926
Upland Crops	1,443	637	2,374	-	2,374
Primary Forest	17,495	5,268	-	304	304
Secondary Forest	10,301	3,084	-	751	751
Bush/Grass Lands	5,938	2,325	-	244	244
Alang Alang Lands	2,039	532	-	-	-
Plantation Area	3,093	-	-	-	-
Village Areas	1,000	342	1,720	342	2,062
Right of Way	-	-	539	-	539
Total	41,336	12,200	10,559	1,641	12,200

Table 7.2.3 Proposed Land Use and Anticipated Crop Production

	Present						Future in Gross Area					
	Survey Area			Gross Area			With Project			Without Project		
	Area (ha)	Yield (t/ha)	Prod'tn (t)	Area (ha)	Yield (t/ha)	Prod'tn (t)	Area (ha)	Yield (t/ha)	Prod'tn (t)	Area (ha)	Yield (t/ha)	Prod'tn (t)
Rainy Season												
Paddy	1,266			548			5,926			548		
Irrigated	10	3.1	31	0	3.1	0	5,926	5.0	29,630	0	3.5	0
Rainfed	17	0.8	14	2	0.8	2	-	-	-	2	0.9	2
Upland	1,239	0.9	1,115	546	0.9	491	-	-	-	546	1.0	546
Secondary Crop*	204	0.7	143	91	0.7	64	2,374	1.6	3,798	91	0.7	64
Sub-total	1,470			639			8,300			639		
Dry Season												
Paddy	116			34			5,926			34		
Irrigated	0		0	0		0	5,926	5.5	32,593	0	3.5	0
Rainfed	44	0.8	35	12	0.8	10	-	-	-	12	0.9	11
Upland	72	0.9	65	22	0.9	20	-	-	-	22	1.0	22
Secondary Crop*	444	0.7	311	339	0.7	237	2,374	1.6	3,798	339	0.7	237
Sub-total	560			373			8,300			373		
Total												
Paddy	1,382		1,260	582		522	11,852		62,223	582		581
Secondary Crop	648		454	430		301	4,748		7,596	430		301

*: Production of secondary crops is estimated in terms of soybean.

Table 7.4.1 Summary of Project Cost

(Unit in Million Rp)

Work Item	Project Cost		
	Foreign Portion	Local Portion	Total
1. Preparatory Work	1,646	705	2,351
2. Irrigation & Drainage Costruction	49,732	15,571	65,303
2.1 Access Road	452	138	590
2.2 Head Works	14,455	4,896	19,351
2.3 Head Reach Canal	6,366	1,950	8,316
2.4 Main Irrigation System(Left)	9,354	2,866	12,220
2.5 Main Irrigation System(Right)	4,398	1,347	5,745
2.6 Drainage System	6,935	2,124	9,059
2.7 Tertiary Networks	7,772	2,250	10,022
3. Land Development Cost	2,681	1,149	3,830
4. O & M Facility Cost	1,225	408	1,633
5. Land Acquisition Cost	-	888	888
6. Administration Cost	-	1,698	1,698
7. Training Cost for WUA	34	15	49
8. Engineering Service	4,702	522	5,224
Sub-Total(1 to 8)	60,020	20,956	80,976
9. Physical Contingency	3,001	1,048	4,049
Sub-Total(1 to 9)	63,021	22,004	85,025
10. Value Added Tax	-	8,503	8,503
Total(1 to 10)	63,021	30,507	93,528
11. Price Contingency	10,910	20,513	31,423
Grand Total(Mill Rp.)	73,931	51,020	124,951
US$ Equivalent(Thousand US$)	36,782	25,383	62,165

Table 7.4.2 Annual Disbursement Schedule of Financial Cost

Unit in million Rp.

Item	Total Cost			1994/95		1995/96		1996/97		1997/98		1998/99		1999/2000		2000/01	
	F/C	L/C	Total	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C
1. Preparatory work	1,646	705	2,351	-	-	1,481	635	165	71	-	-	-	-	-	-	-	-
2. Civil works																	
1) Access road	452	138	590	-	-	-	-	452	138	-	-	-	-	-	-	-	-
2) Head work	14,455	4,896	19,351	-	-	-	-	4,337	1,469	4,337	1,469	5,059	1,714	723	245	-	-
3) Head reach canal	6,366	1,950	8,316	-	-	-	-	1,592	488	2,546	780	2,228	683	-	-	-	-
4) Main irrigation system(Left)	9,354	2,866	12,220	-	-	-	-	-	-	3,742	1,146	3,742	1,146	1,871	573	-	-
5) Main irrigation system(Right)	4,398	1,347	5,745	-	-	-	-	-	-	1,759	539	2,639	808	-	-	-	-
6) Drainage system	6,935	2,124	9,059	-	-	-	-	2,081	637	2,427	743	2,427	743	-	-	-	-
7) Tertiary system	7,772	2,250	10,022	-	-	-	-	-	-	777	225	4,663	1,350	1,554	450	777	225
3. Land development cost	2,681	1,149	3,830				-	-	-	-	-	536	230	938	402	1,206	517
4. O & M facilities	1,225	408	1,633	-	-	-	-	-	-	-	-	490	163	490	163	245	82
5. Land acquisition	-	888	888	-	-	-	311	-	266	-	266	-	44	-	-	-	-
6. Administration	-	1,698	1,698	-	340	-	255	-	255	-	255	-	255	-	255	-	85
7. Training cost for WUA	34	15	49	-	-	-	-	-	-	-	-	10	5	10	5	14	5
8. Engineering services	4,702	522	5,224	1,176	131	705	78	705	78	705	78	705	78	470	52	235	26
9. Phyisical contingency	3,001	1,048	4,049	300	105	300	105	600	210	900	314	600	210	300	105	-	-
Sub-total	63,021	22,004	85,025	1,476	575	2,487	1,383	9,931	3,611	17,194	5,816	23,100	7,429	6,357	2,250	2,477	940
10. Value added tax	-	8,503	8,503	-	205	-	387	-	1,354	-	2,301	-	3,053	-	861	-	342
Sub-total	63,021	30,507	93,528	1,476	780	2,487	1,770	9,931	4,965	17,194	8,117	23,100	10,481	6,357	3,110	2,477	1,281
11. Price contingency	10,910	20,513	31,423	90	164	231	586	1,246	2,304	2,739	4,956	4,483	8,087	1,461	2,951	661	1,465
Total	73,931	51,020	124,951	1,565	944	2,717	2,356	11,177	7,269	19,932	13,073	27,583	18,569	7,818	6,061	3,138	2,747

Table 7.4.3 Summary of Project Cost
(In case of OECF loan)

(Unit in Million Rp)

Work Item	Project Cost		
	Loan Portion	Rupiah Portion	Total
1. Preparatory Work	705	1,646	2,351
2. Irrigation & Drainage Costruction	65,303	0	65,303
2.1 Access Road	590	0	590
2.2 Head Works	19,351	0	19,351
2.3 Head Reach Canal	8,316	0	8,316
2.4 Main Irrigation System(Left)	12,220	0	12,220
2.5 Main Irrigation System(Right)	5,745	0	5,745
2.6 Drainage System	9,059	0	9,059
2.7 Tertiary Networks	10,022	0	10,022
3. Land Development Cost	1,915	1,915	3,830
4. O & M Facility Cost	1,633	0	1,633
5. Land Acquisition Cost	-	888	888
6. Administration Cost	-	1,698	1,698
7. Training Cost for WUA	34	15	49
8. Engineering Service	4,702	522	5,224
Sub-Total(1 to 8)	74,292	6,684	80,976
9. Physical Contingency	4,049	0	4,049
Sub-Total(1 to 9)	78,341	6,684	85,025
10. Value Added Tax	-	8,503	8,503
Total(1 to 10)	78,341	15,187	93,528
11. Price Contingency	27,867	3,556	31,423
Grand Total(Mill Rp.)	106,208	18,743	124,951
US$ Equivalent(Thousand US$)	52,840	9,325	62,165

Table 7.5.1 Financial Cash Flow Statement

Unit : Million Rp.

	Cash Outflow					Cashoutflow			
Project Year	Project Cost	O & M Cost	Loan Interest	Repay-ment	Total Outflow	Foreign Loan	Government Budget	Government Subsidy	Total Inflow
1	2,509	0	39	0	2,548	1,565	944	39	2,548
2	5,073	0	107	0	5,180	2,717	2,356	107	5,180
3	18,446	0	386	0	18,832	11,177	7,269	386	18,832
4	33,005	0	885	0	33,890	19,932	13,073	885	33,890
5	46,152	0	1,574	0	47,726	27,583	18,569	1,574	47,726
6	13,879	1,578	1,770	0	17,227	7,818	6,061	3,348	17,227
7	5,885	1,786	1,848	0	9,519	3,138	2,747	3,634	9,519
8	0	1,874	1,848	0	3,722	0	0	3,722	3,722
9	0	1,874	1,848	0	3,722	0	0	3,722	3,722
10	0	1,874	1,848	0	3,722	0	0	3,722	3,722
11	0	1,874	1,756	3,697	7,327	0	0	7,327	7,327
12	0	1,874	1,663	3,697	7,234	0	0	7,234	7,234
13	0	1,874	1,571	3,697	7,142	0	0	7,142	7,142
14	0	1,874	1,479	3,697	7,049	0	0	7,049	7,049
15	0	1,874	1,386	3,697	6,957	0	0	6,957	6,957
16	0	1,874	1,294	3,697	6,865	0	0	6,865	6,865
17	0	1,874	1,201	3,697	6,772	0	0	6,772	6,772
18	0	1,874	1,109	3,697	6,680	0	0	6,680	6,680
19	0	1,874	1,017	3,697	6,587	0	0	6,587	6,587
20	0	1,874	924	3,697	6,495	0	0	6,495	6,495
21	0	1,874	832	3,697	6,402	0	0	6,402	6,402
22	0	1,874	739	3,697	6,310	0	0	6,310	6,310
23	0	1,874	647	3,697	6,218	0	0	6,218	6,218
24	0	1,874	554	3,697	6,125	0	0	6,125	6,125
25	0	1,874	462	3,697	6,033	0	0	6,033	6,033
26	0	1,874	370	3,697	5,940	0	0	5,940	5,940
27	0	1,874	277	3,697	5,848	0	0	5,848	5,848
28	0	1,874	185	3,697	5,756	0	0	5,756	5,756
29	0	1,874	92	3,697	5,663	0	0	5,663	5,663
30	0	1,874	0	3,697	5,571	0	0	5,571	5,571
Total	124,949	46,471	29,713	73,930	275,063	73,930	51,019	150,114	275,063

Table 7.5.2 Economic Analysis (Base Case)

Unit: Rp million

Proj. Year	Incremental Net Benefit	Incremental Costs			Net Cash Flow	Discount Factor at 10%	Present Value at 10%
		Investment Cost	O & M Cost	Total Cost			
					0.12		
1	0.0	2600.0	0.0	2600.0	-2600.0	0.909	-2364
2	0.0	1924.0	0.0	1924.0	-1924.0	0.826	-1590
3	0.0	4359.0	0.0	4359.0	-4359.0	0.751	-3275
4	0.0	19450.0	0.0	19450.0	-19450.0	0.683	-13285
5	0.0	27458.0	0.0	27458.0	-27458.0	0.621	-17049
6	2951.2	22479.0	836.9	23315.9	-20364.7	0.564	-11495
7	5902.4	1722.0	1174.1	2896.1	3006.4	0.513	1543
8	8853.6	0.0	1199.9	1199.9	7653.7	0.467	3571
9	11804.8	0.0	1199.9	1199.9	10604.9	0.424	4498
10	14756.0	0.0	1199.9	1199.9	13556.1	0.386	5226
11	14756.0	0.0	1199.9	1199.9	13556.1	0.350	4751
12	14756.0	0.0	1199.9	1199.9	13556.1	0.319	4319
13	14756.0	0.0	1199.9	1199.9	13556.1	0.290	3927
14	14756.0	0.0	1199.9	1199.9	13556.1	0.263	3570
15	14756.0	0.0	1199.9	1199.9	13556.1	0.239	3245
16	14756.0	0.0	1199.9	1199.9	13556.1	0.218	2950
17	14756.0	0.0	1199.9	1199.9	13556.1	0.198	2682
18	14756.0	0.0	1199.9	1199.9	13556.1	0.180	2438
19	14756.0	0.0	1199.9	1199.9	13556.1	0.164	2217
20	14756.0	0.0	1199.9	1199.9	13556.1	0.149	2015
21	14756.0	0.0	1199.9	1199.9	13556.1	0.135	1832
22	14756.0	0.0	1199.9	1199.9	13556.1	0.123	1665
23	14756.0	0.0	1199.9	1199.9	13556.1	0.112	1514
24	14756.0	0.0	1199.9	1199.9	13556.1	0.102	1376
25	14756.0	0.0	1199.9	1199.9	13556.1	0.092	1251
26	14756.0	0.0	1199.9	1199.9	13556.1	0.084	1137
27	14756.0	0.0	1199.9	1199.9	13556.1	0.076	1034
28	14756.0	0.0	1199.9	1199.9	13556.1	0.069	940
29	14756.0	0.0	1199.9	1199.9	13556.1	0.063	855
30	14756.0	0.0	1199.9	1199.9	13556.1	0.057	777
	339388.0	79992.0	29608.2	109600.2	0.120		10275

EIRR: 12.0 %
NPV: 10,275 million
B/C: 1.18

Table 7.5.3 Sensitivity Analysis
(Cost Increase 10%)

Unit: Rp million

Proj. Year	Incremental Net Benefit	Incremental Costs			Net Cash Flow	Discount Factor at 10%	Present Value at 10%
		Investment Cost	O & M Cost	Total Cost			
					0.108		
1	0.0	2860.0	0.0	2860	-2860.0	0.909	-2600.0
2	0.0	2116.4	0.0	2116.4	-2116.4	0.826	-1749.1
3	0.0	4794.9	0.0	4794.9	-4794.9	0.751	-3602.5
4	0.0	21395.0	0.0	21395.0	-21395.0	0.683	-14613.1
5	0.0	30203.8	0.0	30203.8	-30203.8	0.621	-18754.2
6	2951.2	24726.9	920.6	25647.5	-22696.3	0.564	-12811.4
7	5902.4	1894.2	1291.5	3185.7	2716.7	0.513	1394.1
8	8853.6	0.0	1319.9	1319.9	7533.7	0.467	3514.5
9	11804.8	0.0	1319.9	1319.9	10484.9	0.424	4446.6
10	14756.0	0.0	1319.9	1319.9	13436.1	0.386	5180.2
11	14756.0	0.0	1319.9	1319.9	13436.1	0.350	4709.3
12	14756.0	0.0	1319.9	1319.9	13436.1	0.319	4281.2
13	14756.0	0.0	1319.9	1319.9	13436.1	0.290	3892.0
14	14756.0	0.0	1319.9	1319.9	13436.1	0.263	3538.2
15	14756.0	0.0	1319.9	1319.9	13436.1	0.239	3216.5
16	14756.0	0.0	1319.9	1319.9	13436.1	0.218	2924.1
17	14756.0	0.0	1319.9	1319.9	13436.1	0.198	2658.3
18	14756.0	0.0	1319.9	1319.9	13436.1	0.180	2416.6
19	14756.0	0.0	1319.9	1319.9	13436.1	0.164	2196.9
20	14756.0	0.0	1319.9	1319.9	13436.1	0.149	1997.2
21	14756.0	0.0	1319.9	1319.9	13436.1	0.135	1815.6
22	14756.0	0.0	1319.9	1319.9	13436.1	0.123	1650.6
23	14756.0	0.0	1319.9	1319.9	13436.1	0.112	1500.5
24	14756.0	0.0	1319.9	1319.9	13436.1	0.102	1364.1
25	14756.0	0.0	1319.9	1319.9	13436.1	0.092	1240.1
26	14756.0	0.0	1319.9	1319.9	13436.1	0.084	1127.4
27	14756.0	0.0	1319.9	1319.9	13436.1	0.076	1024.9
28	14756.0	0.0	1319.9	1319.9	13436.1	0.069	931.7
29	14756.0	0.0	1319.9	1319.9	13436.1	0.063	847.0
30	14756.0	0.0	1319.9	1319.9	13436.1	0.057	770.0
	339388.0	87991.2	32569.0	120560.2	0.108		4507.3

EIRR: 10.8 %
NPV: 4,507.3 million
B/C: 1.07

Table 7.5.4 Sensitivity Analysis
(Benefit Decrease 10%)

Unit: Rp million

Proj. Year	Incremental Net Benefit	Incremental Costs			Net Cash Flow	Discount Factor at 10%	Present Value at 10%
		Investment Cost	O & M Cost	Total Cost			
					0.107		
1	0.0	2600.0	0.0	2600.0	-2600.0	0.909	-2364
2	0.0	1924.0	0.0	1924.0	-1924.0	0.826	-1590
3	0.0	4359.0	0.0	4359.0	-4359.0	0.751	-3275
4	0.0	19450.0	0.0	19450.0	-19450.0	0.683	-13285
5	0.0	27458.0	0.0	27458.0	-27458.0	0.621	-17049
6	2656.1	22479.0	836.9	23315.9	-20659.8	0.564	-11662
7	5312.2	1722.0	1174.1	2896.1	2416.1	0.513	1240
8	7968.2	0.0	1199.9	1199.9	6768.4	0.467	3157
9	10624.3	0.0	1199.9	1199.9	9424.4	0.424	3997
10	13280.4	0.0	1199.9	1199.9	12080.5	0.386	4658
11	13280.4	0.0	1199.9	1199.9	12080.5	0.350	4234
12	13280.4	0.0	1199.9	1199.9	12080.5	0.319	3849
13	13280.4	0.0	1199.9	1199.9	12080.5	0.290	3499
14	13280.4	0.0	1199.9	1199.9	12080.5	0.263	3181
15	13280.4	0.0	1199.9	1199.9	12080.5	0.239	2892
16	13280.4	0.0	1199.9	1199.9	12080.5	0.218	2629
17	13280.4	0.0	1199.9	1199.9	12080.5	0.198	2390
18	13280.4	0.0	1199.9	1199.9	12080.5	0.180	2173
19	13280.4	0.0	1199.9	1199.9	12080.5	0.164	1975
20	13280.4	0.0	1199.9	1199.9	12080.5	0.149	1796
21	13280.4	0.0	1199.9	1199.9	12080.5	0.135	1632
22	13280.4	0.0	1199.9	1199.9	12080.5	0.123	1484
23	13280.4	0.0	1199.9	1199.9	12080.5	0.112	1349
24	13280.4	0.0	1199.9	1199.9	12080.5	0.102	1226
25	13280.4	0.0	1199.9	1199.9	12080.5	0.092	1115
26	13280.4	0.0	1199.9	1199.9	12080.5	0.084	1014
27	13280.4	0.0	1199.9	1199.9	12080.5	0.076	921
28	13280.4	0.0	1199.9	1199.9	12080.5	0.069	838
29	13280.4	0.0	1199.9	1199.9	12080.5	0.063	762
30	13280.4	0.0	1199.9	1199.9	12080.5	0.057	692
	305449.2	79992.0	29608.2	109600.2	0.107		3480

EIRR: 10.7 %
NPV: 3,480 million
B/C: 1.06

Table 7.5.5 Sensitivity Analysis
(2 years delay in construction)

Unit: Rp million

Proj. Year	Incremental Net Benefit	Incremental Costs			Net Cash Flow	Discount Factor at 10%	Present Value at 10%
		Investment Cost	O & M Cost	Total Cost			
					0.106		
1	0.0	2600.0	0.0	2600.0	-2600.0	0.909	-2364
2	0.0	1924.0	0.0	1924.0	-1924.0	0.826	-1590
3	0.0	4359.0	0.0	4359.0	-4359.0	0.751	-3275
4	0.0	9725.0	0.0	9725.0	-9725.0	0.683	-6642
5	0.0	9725.0	0.0	9725.0	-9725.0	0.621	-6038
6	0.0	13729.0	425.0	14154.0	-14154.0	0.564	-7990
7	0.0	13729.0	630.9	14359.9	-14359.9	0.513	-7369
8	2951.2	22479.0	836.9	23315.9	-20364.7	0.467	-9500
9	5902.4	1722.0	1174.1	2896.1	3006.4	0.424	1275
10	8853.6	0.0	1199.9	1199.9	7653.7	0.386	2951
11	11804.8	0.0	1199.9	1199.9	10604.9	0.350	3717
12	14756.0	0.0	1199.9	1199.9	13556.1	0.319	4319
13	14756.0	0.0	1199.9	1199.9	13556.1	0.290	3927
14	14756.0	0.0	1199.9	1199.9	13556.1	0.263	3570
15	14756.0	0.0	1199.9	1199.9	13556.1	0.239	3245
16	14756.0	0.0	1199.9	1199.9	13556.1	0.218	2950
17	14756.0	0.0	1199.9	1199.9	13556.1	0.198	2682
18	14756.0	0.0	1199.9	1199.9	13556.1	0.180	2438
19	14756.0	0.0	1199.9	1199.9	13556.1	0.164	2217
20	14756.0	0.0	1199.9	1199.9	13556.1	0.149	2015
21	14756.0	0.0	1199.9	1199.9	13556.1	0.135	1832
22	14756.0	0.0	1199.9	1199.9	13556.1	0.123	1665
23	14756.0	0.0	1199.9	1199.9	13556.1	0.112	1514
24	14756.0	0.0	1199.9	1199.9	13556.1	0.102	1376
25	14756.0	0.0	1199.9	1199.9	13556.1	0.092	1251
26	14756.0	0.0	1199.9	1199.9	13556.1	0.084	1137
27	14756.0	0.0	1199.9	1199.9	13556.1	0.076	1034
28	14756.0	0.0	1199.9	1199.9	13556.1	0.069	940
29	14756.0	0.0	1199.9	1199.9	13556.1	0.063	855
30	14756.0	0.0	1199.9	1199.9	13556.1	0.057	777
	309876.0	79992.0	28264.3	108256.3	0.106		2919

EIRR: 10.6 %
NPV: 2,919 million
B/C: 1.06

Table 7.6.1 Matrix of Impact Prediction

Environmental Component	Activity Component	Pre-construction			Construction							Operation and Maintenance				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Hydrology	-Ground water	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-
	-Surface water	-	-	-	-	-	-	-	-	-	X	X	-	X	-	-
	-Water quality	-	-	-	-	X	-	-	-	-	X	X	X	-	X	-
	-Water quantity	-	-	-	-	-	-	-	-	-	X	X	X	X	-	X
	-Back water	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-Sedimentation	-	-	-	-	-	-	-	X	-	X	-	-	-	-	-
Cimate	-Air quality	-	-	-	X	X	-	-	-	-	-	-	-	-	X	-
	-Noisiness	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-
	-Temperature	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-Micro climate	-	-	-	-	-	-	X	X	-	X	-	-	-	-	-
Land	-Erosion/sliding	-	-	-	X	-	-	X	-	-	X	X	-	-	-	-
	-River morphology	-	-	-	-	-	-	-	X	-	X	-	-	-	-	-
	-Land stability	-	-	-	-	X	-	-	-	X	X	X	-	-	-	-
Biology	-Trees	-	-	-	-	X	X	-	X	X	X	-	-	-	-	-
	-Schrubs	-	-	-	-	X	X	-	X	X	X	-	-	-	-	-
	-Farm land	-	-	-	-	-	-	-	X	X	X	X	-	X	-	-
	-Water animal	-	-	-	-	-	-	-	X	-	X	-	-	X	X	-
	-Land animal	-	-	-	-	X	X	-	X	X	X	X	-	-	-	-
Sosio-Economics and Culture	-Opportunity of employmeny	-	-	-	X	X	X	X	X	X	X	X	X	X	-	-
	-Education	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-Population of mobility	-	X	-	-	-	-	-	-	-	X	-	-	-	-	-
	-Health	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
	-Income	-	X	-	X	X	X	X		X	X	X	X	X	-	-
	-Social unrest/ tension	X	X	X	-	-	-	-	X	X	X	-	-	X	-	X
	-Social jealousy	-	X	-	-	-	-	-	X	X	X	-	-	X	-	X
	-Compensation	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Facility and Pre-facility	-Ground transportation	-	-	-	X	X	-	-	X	X	-	-	-	-	-	-
	-Water transportation	-	-	-	-	-	-	-	X	-	X	-	-	-	-	-

Pre-construction
1. Feasibility study survey and detailed design
2. Earmaking area
3. Land acquisition

Construction
4. Mobilization of heavy duty machine and man power
5. Supporting facilities construction
6. Land clearing at coupure
7. Transportation of materials
8. Weir construction
9. Irrigation system construction

Operation and Management
10. Weir operation
11. Irrigation system operation
12. Maintenance
13. Rice field development
14. The use of agriculture input production
15. Distribution of irrigated water

X : Impact, - : No impact

Table 7.6.2 Environmental Identification Matrix

STAGE	ACTIVITIES POTENTIALLY TO OCCUR THE IMPACT	ENVIRONMENTAL COMPONENTS PREDICTED TO BE IMPACTED	EVALUATION OF IMPACTS	SOLUTION OF IMPACTS
Pre-Construction	1. Field Survey of Feasibility Study	Socio-economic and cultural condition	-Emergence of social unrest/tension -Speculation in the management of land	-Extension and information servise regarding project to people and related offices -Extension services
	2. Land Acquisition	Socio-economic condition	-Emergence of social unrest -Double ownership ot the same plot of land -Appearance of profiteering middleman selling land -Disappointment concerning the process and amount of compensation money	-Give information regarding land acquisition privately -Cooperation with other authority administration of land ownership -Compensation to be given directly to the people/owner -The process and amount of compensation money to be negosiated
Construction	1. Mobilization of Heavy Duty Machine	Settlement	-Increase of air pollution (dust) and noisiness	-Arrangement of implementation -Regulation of the use of vehicles -Regulation of speed of vehicles -Periodic water spraying
		Public road facilities	-Damage of public roads	-Maintaining of road facilities -Regulation of the use of vehicles
	2. Mobilization of Employers	Socio-economic condition	-Emergence of social jealousy -Exchanges of culture	-Recruitment of local workers
	3. Preparatory and Construction of Supporting Facilities	Socio-economic condition	-Emergence of social jealousy	-Recruitment of local workers
		Biological resources	-Decrease of plants at surroundings	-Limitation of cutting trees

STAGE	ACTIVITIES POTENTIALLY TO OCCUR THE IMPACT	ENVIRONMENTAL COMPONENTS PREDICTED TO BE IMPACTED	EVALUATION OF IMPACTS	SOLUTION OF IMPACTS
Construction			-Decrease of wild animal habitat -Migration of wild animal	-Anticipation of new habitat for wild animal -Further study of ANDAL
		Water resources	-Watter polluted by increasing dirt/debris in the river	-Not throwing rubbish and dirt in the river -Private lavatory, bathing and washing facilities
	4. Land Clearing of Coupure	Biological resources	-Decrease of wild animal habitat caused by disappearance of cover plant	-Reforestation of the idle land
			-Migration wild animal to new habitat	-Anticipation of new habitat for wild animal
	5. Transportation of Materials and Stocking Soil	Environmental condition	-Increase of dust concentration in the dwelling area passed by	-Periodic water spraying
			-Increase of noisiness	-Regulation of speed of vehicles
		Land resources	-Change of river morphology and increase of potentiality of erosion/sliding of river banks in the borrow area	-Reforestation for soil conservation at the river banks -Further study of ANDAL
			-Change in landscape due to inundation on borrow pits	-Backing fill the holes and cultivate the idle land
		Biological resources	-Increase of turbidity of river water	-Further study of ANDAL
			-Decrease of wild animal habitat due to clearing trees in borrow area	-Reforestation of the idle land
			-Migration of wild animal	-Anticipation of new habitat for wild animal

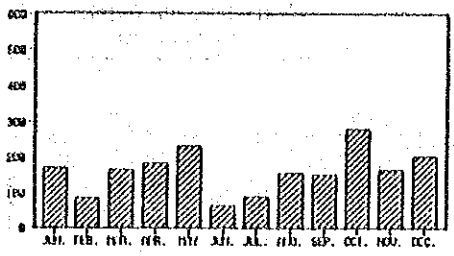
STAGE	ACTIVITIES POTENTIALLY TO OCCUR THE IMPACT	ENVIRONMENTAL COMPONENTS PREDICTED TO BE IMPACTED	EVALUATION OF IMPACTS	SOLUTION OF IMPACTS
Construction		Water resources	-Increase of turbidity of river water	-Further study of ANDAL
		Air quality	-Decrease of air quality due to increase noisiness and dust concentration	-Regulation speed of vehicles -Periodic water spraying
		Road network	-Road/bridge damage by project vehicles	-Regulation of the use of vehicles -Road maintaining
	6. Weir Construction	Socio-economic and cultural condition of people	-Emergence of social jealousy -Change of social perception on the project -Interaction of culture and social custom	-Recruitment of local workers -Private information -Use of outside village employment recieved by people
		Water resources	-Dcrease of river water quality caused by increasing pollution	-Provide lavatory, bathing and washing facilities -Not throwing rubbish and dirt in the river
		Air quality	-Increase of noisiness -Increase of CO, dust and co2 concentration	-Further study of ANDAL -Further study of ANDAL
	7. Irrigation System Construction	Socio-economic condition	-Emergence of social jealousy	-Recruitment of local workers
		Land resources	-Change of land use -Increase of erosion potentiality	-Reforestation of the idle land -Reforestation of the idle land

STAGE	ACTIVITIES POTENTIALLY TO OCCUR THE IMPACT	ENVIRONMENTAL COMPONENTS PREDICTED TO BE IMPACTED	EVALUATION OF IMPACTS	SOLUTION OF IMPACTS
		Biological resources	-Disappearance of wild animal habitat due to clearing trees	-Reforestation of the idle land
			-Migration of wild animal	-Anticipation of new habitat for wild animal
		Public roads	-Damage of public transportation facility/road caused by heavy vehicles and heavy duty machines	-Regulation of the use of vehicles
	8. Cutting Trees and Rice Field Development	Biological resources	-Disappearance of vegetation due to develop rice field	-Limitation of cutting trees
			-Wild animal migration (elephant etc.) due to decreasing of habitat	-Anticipation of wild animal habitat (especially for elephant) -Further study of ANDAL
Operation and Maintenance	1. Operation of weir	Biological resources	-The death of trees and crop not resisted to inundation	-Planting swamp trees
			-Migration of wild animal from inundated area	-Anticipation of wild animal habitat especially dangerous kind for people
		Water resources	-Conflict among water users, especially during dry season between agriculture and domestic use	-Regulation of cropping pattern and area in dry season
			-Worsening of water quality caused by rottening plants leftover	-Maintainig and cleaning of upstream parts
			-Distrurbance of environmental condition	-Environmental health care

STAGE	ACTIVITIES POTENTIALLY TO OCCUR THE IMPACT	ENVIRONMENTAL COMPONENTS PREDICTED TO BE IMPACTED	EVALUATION OF IMPACTS	SOLUTION OF IMPACTS
Operation and Maintenance	2. Operation of Irrigation System	Socio-economic and cultural condition	-Change of farming activity pattern from upland field to irrigated rice field	-Giving guidance and extension services
			-Conflict among water users in developing area of irrigation	-Regulation of cropping pattern and area
		Biological resources	-Plant disease epidemy due to monocultural way of farming	-Integrated pest controll i.d : Biological, physical and chemical
		Environmental quality	-Decrease of environmental quality due to the overuse of fertilizers, pesticide	-Application of intensification such as using fertilizer, pesticide, etc.
			-Cutting trees in the forest due to the lack of the wood for fuel	-Reforestation for fuel
	3. Operation and Maintenance of Weir and Irrigation System	Socio-economic condition	-Use of river water disturbed during maintenance of the irrigation system	-Giving information to the people
		Water quality	-Decrease of water quality in the upstream	-Rubbish cleaning in the upstream
		Public health	-Appearance of disease epidemic such as diarrhea, malaria etc. due to decreasing of water quality	-Giving information to the people in using the raw water

FIGURES

Unit : mm



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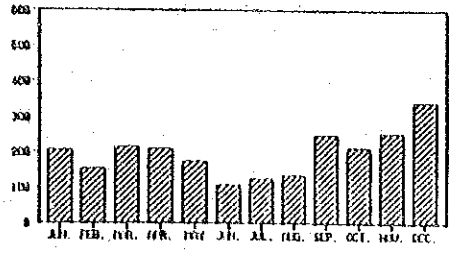

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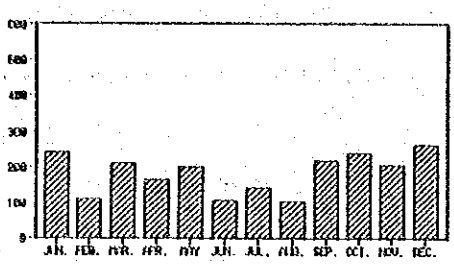

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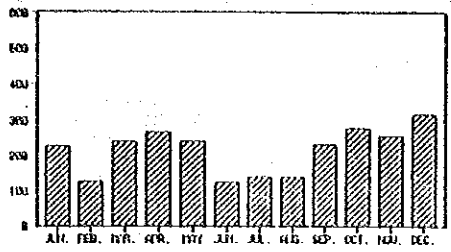

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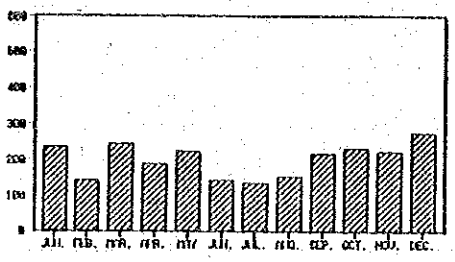

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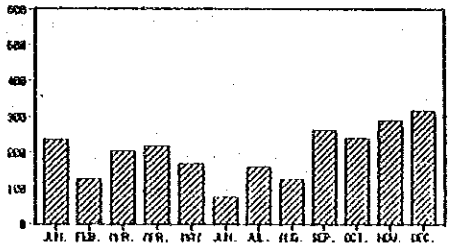

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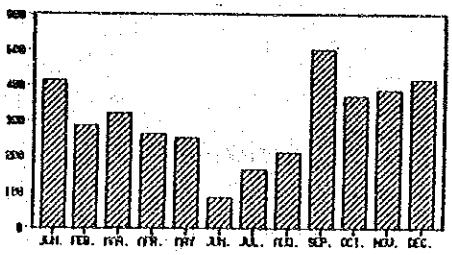

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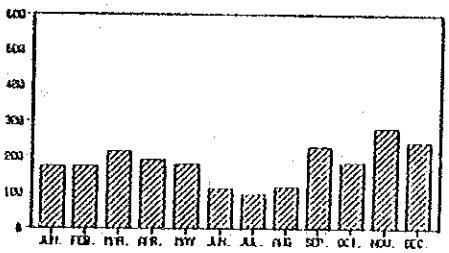

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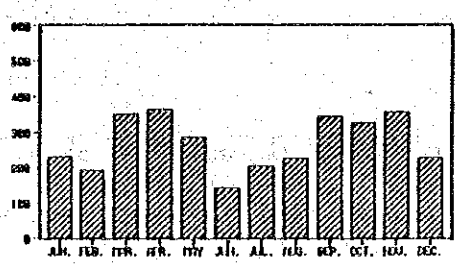

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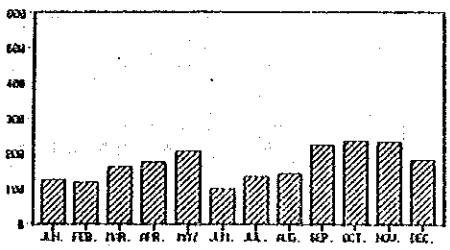
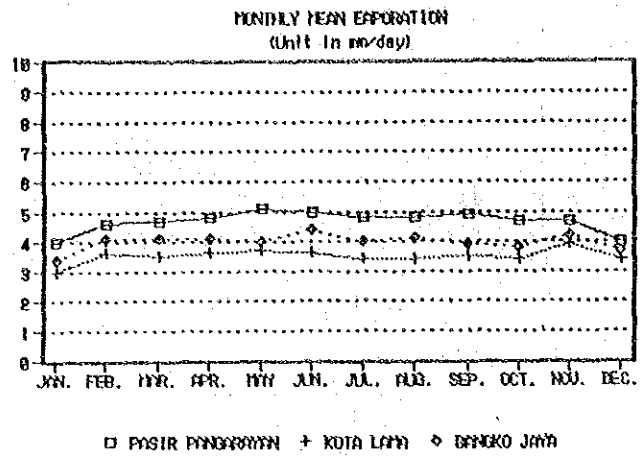
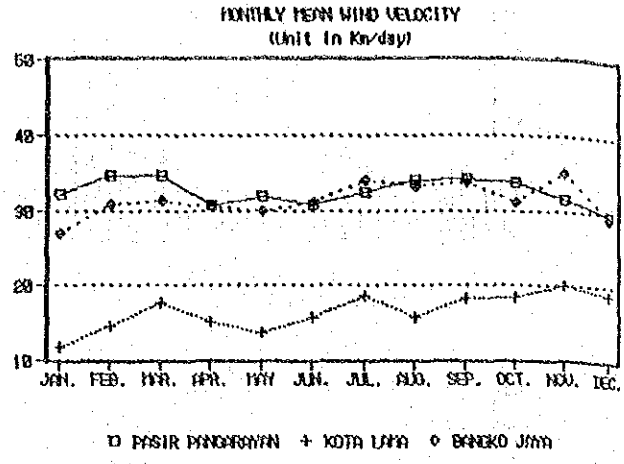
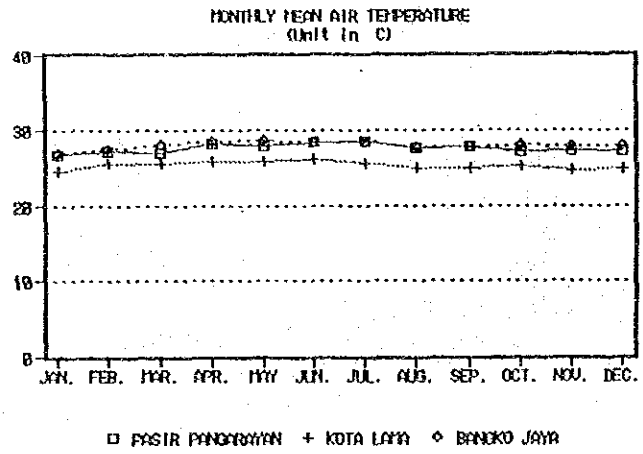


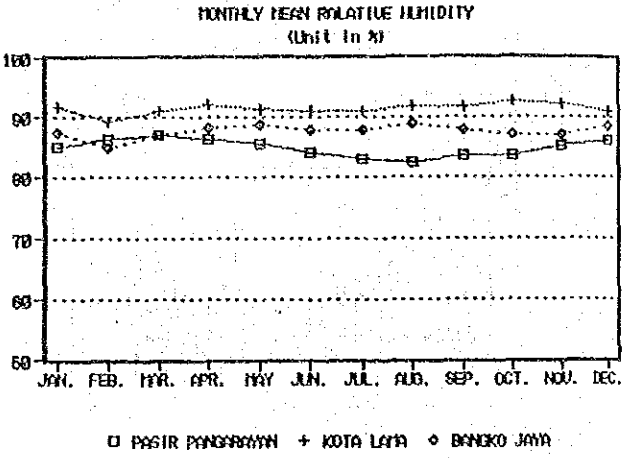
Dumai

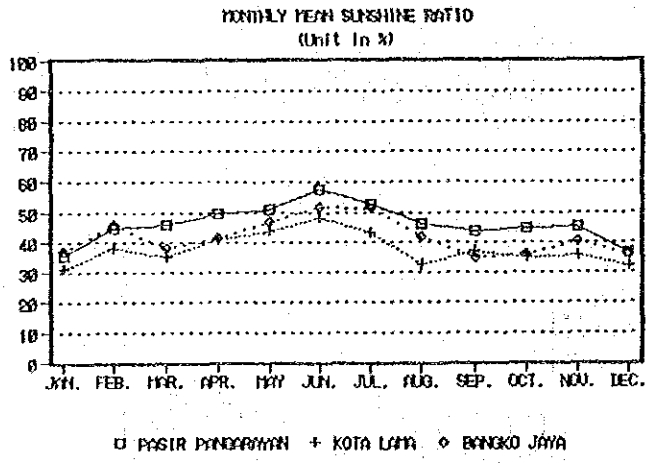
Fig. 3.1 Mean Monthly Rainfall in the Objective Area











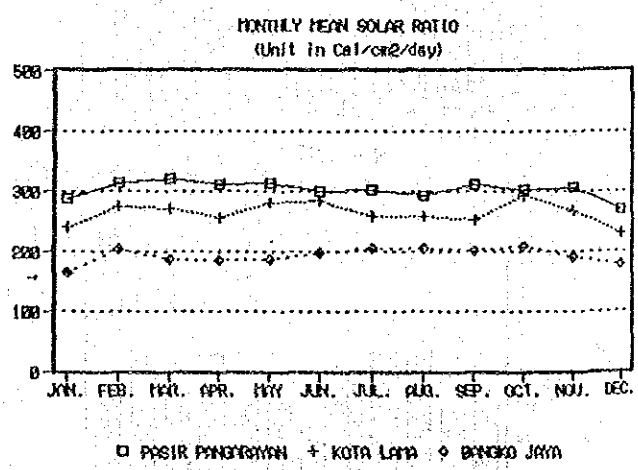


Fig. 3.2 Monthly Climatic Feature in the Objective Area

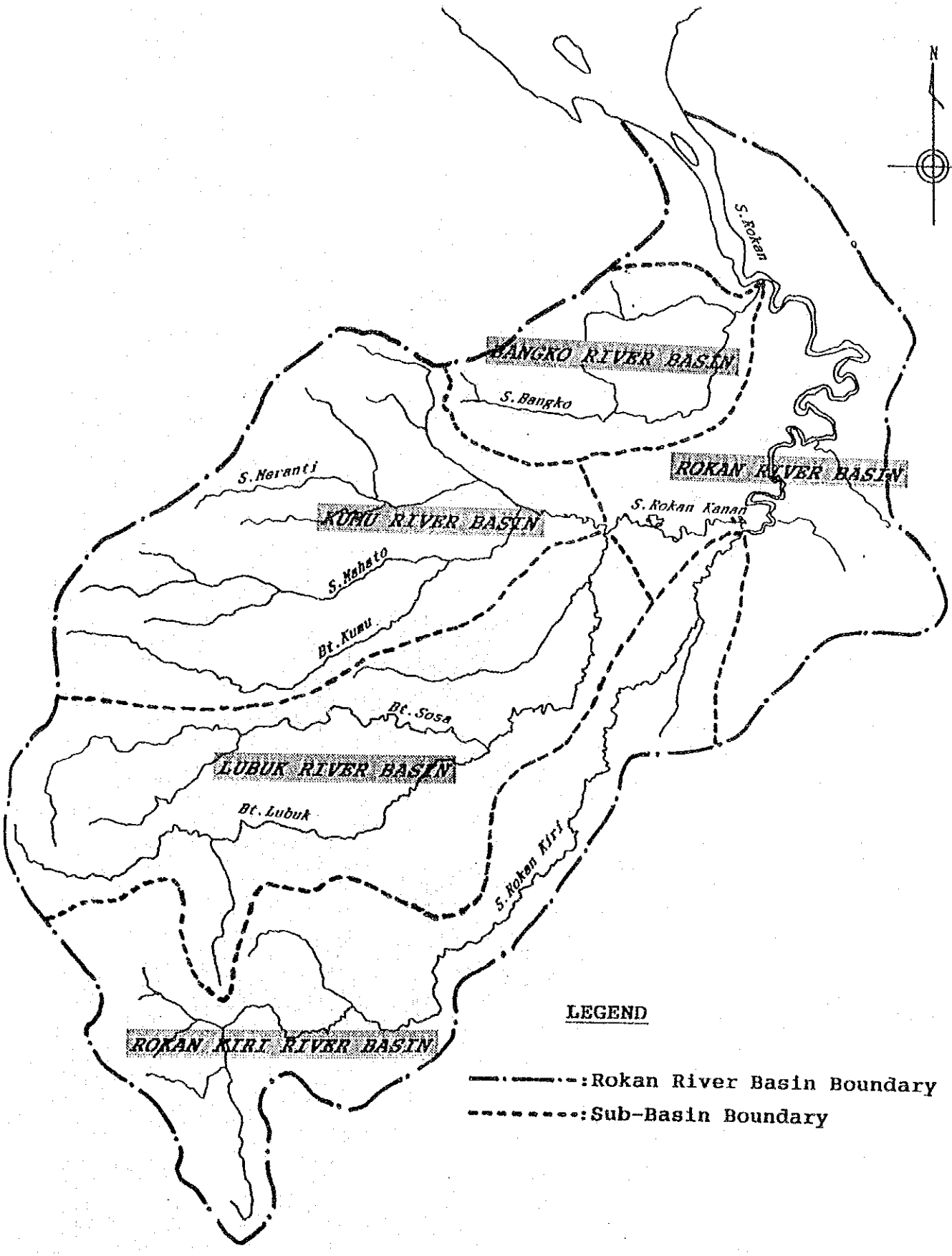


Fig. 3.3 Sub-Basin Division of the Rokan River

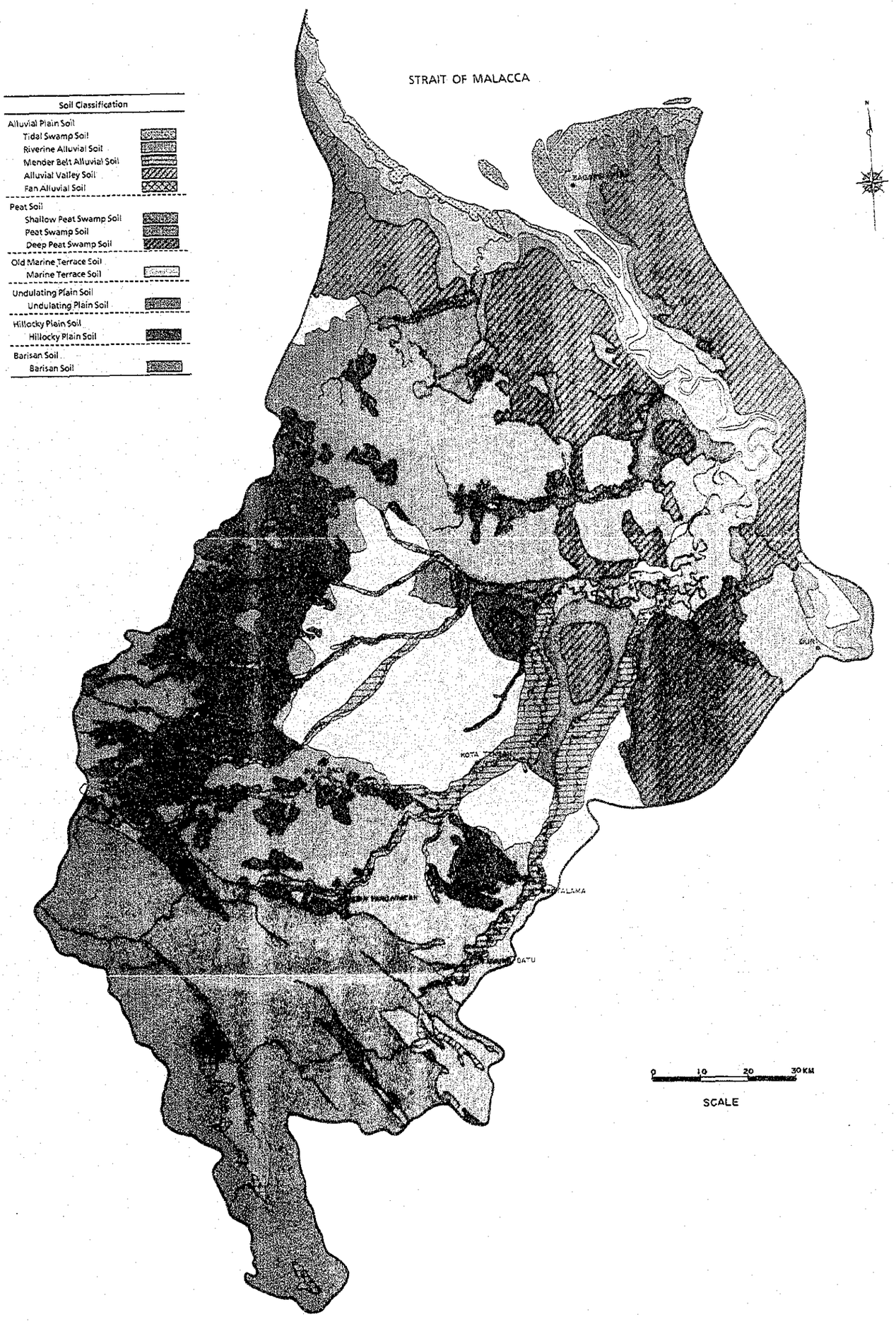


Fig. 3.4 Soil Distribution Map in the Objective Area

REPUBLIC OF INDONESIA MINISTRY OF PUBLIC WORKS DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT FEASIBILITY STUDY ON LOWER ROKAN KIRI IRRIGATION PROJECT	
SOIL DISTRIBUTION MAP (OBJECTIVE AREA)	
JAPAN INTERNATIONAL COOPERATION AGENCY TOKYO (JICA)	DWG. NO. 3