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.

The following table indicates the existing and planned capacity of water supply facilities in the Objective Area.

Water Supply Facilities in the Objective Area
(at present and plan under PELITA-V)

Kecamatan Capital	Capacity (lit/s) Existing	Plan	Water Source	Remarks
Duri	-	80	Rangau (Rokan)	design completed
Bagansiapiapi	20	40	canal	design in progress
Bagan Batu	-	20	Buaya (Rokan)	implementation in 91/92, 92/93
Kota Lama	-	10	Rokan Kiri	design completed
Ujung Batu	5	20	Rokan Kiri	design in progress
Kota Tengah	-	10	Lubuk	design completed
P. Pangarayan	10	60	Lubuk	design in progress
Dalu Dalu	-	10	Sosa	design completed
Sedinginan	-	10	Rokan	design in progress

(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.

Kecamatan	Segment	Length (km)
Kepenuhan	Sp. Kumu - Kota Tengah	36
Kunto Darusalam	Ujung Batu - Kota Lama	23
Rokan IV Koto	Ujung batu - Rokan	29
Kubu	Bangko - Tj. Lumba Lumba	33
Tanah Putih	Ujung Tanjung - Sedinginan	17
	Total:	138

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 (kemacatan Tambusai) and Sedinginan (kemacatan Tanah Putih).

b) A 94 km road (including 58 km of existing provincial highway) along the Rokan Kiri river to connect Kotalama (kemacatan K.Darusalam) and Duri(kemacatan 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 nos. 1 (67 kW) and 2 (65 kW), and Rokan Kanan nos. 1 (46 kW) and 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 as explained in Chapter 2 (2.2.1). 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 as explained in Chapter 3 (3.2.2).

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 3.7% 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 w/ development restrictions	Land suitable for farming Developed	New	Total
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

(1) Land Unsuitable for Agriculture

a) Slopes in excess of 25%

109,300 ha distributed with barisan soil in the southern part of the Objective area slopes at an average of more than 40%, and is unsuitable for farming.

b) Highly Saline Soil

Tidal swamp soil distributed in the area fronting on the Straits of Malacca is highly saline as a result of salt water intrusion. This area totals 41,000 ha.

c) Swamp with Thick Peat Layer

On the basis of development experience to date in swampy areas of Indonesia, it is reported that locations where the peat layer is in excess of 1 m are not practical for agricultural development. In line with this criteria, it is estimated that around 84% (520,600ha) of the total swampy area of 622,200 ha within the Objective area is unsuitable for farming on the basis of existing data.

(2) Area Restricted for Development

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 as mentioned in (1) above.

(3) Land Suitable 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

As discussed previously, swamp where peat layer does not exceed 1 m thickness is considered suitable for development as farmland. On the basis of available data, such area totals an estimated 39,900 ha (excluding designated forest) in the Objective area. However, a long term approach is necessary in view of the need to perform the following in formulation of a development plan:

-- detailed soil survey

-- study on need for soil improvement measures, and technical and economic analysis of the same

-- study on suitable crops that fulfill the requirements of farm economy, and cultivation techniques for the same

-- study on potential subsidence resulting from soil drainage, and impact assessment for the same

-- study on water source and development method for domestic water supply due to poor quality of both surface and ground water

-- assessment of development impact on surrounding eco-system

b) Area subject to flooding

Of alluvial plain, 14,300 ha in the vicinity of the confluence of the Rokan Kanan and Rokan Kiri rivers is subject to flooding. Development of this area will require engineering considerations such as polder construction,etc.

Detailed topographical survey and long term water level observations must be carried out in assessing the development potential of the subject area. This is because a polder type approach will require precise understanding of water levels inside and outside the envisaged embankment.

c) Alluvial plain in coastal area

A 47,000 ha belt of river alluvial soil (RAS) extends on the interior side of area distributed with tidal swamp soil. This belt is tidally affected, and development therein is possible applying the approach used in the Rokan and Kubu districts near the mouth of the Rokan river (utilizing the differential in tide level).

However, cropping intensities and unit yields are extremely poor in these already developed areas. This is particularly true in the case of Kube district, where almost all of the land goes unutilized. The principal reason for this the poor water quality of nearby rivers and groundwater, making potable water difficult to obtain and thereby discouraging settlement.

Accordingly, development of the foregoing belt of RAS area will require securing a stable source of domestic water (including both identification of source and engineering method for development), in addition to selection of suitable crops and cropping method.

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

Classification	Total Area	Development Potential Developed	Development Potential 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

(1) Long term flow

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 estimated the tide may intrude until Sedinginan, about 60 Km far from the estuary, no data for salinity in river are available. Therefore, long term observation on tidal variation and salinity is essential for the utilization of river water in the downstream of the Rokan river.

As mentioned above, the annual quantities of water in non-exceeding of 5 years for irrigation use are as follows;

1) Rokan Kiri river : 4,506 Million m^3/year
2) Lubuk river : 4,692 Million m^3/year
3) Kumu river : 4,513 Million m^3/year

(2) Flood flow

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

(1) New Schemes

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.

1) Summary of new schemes

The summary of each scheme is mentioned as follows:

a) The Bt.Lubuk project

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, the following existing projects will be incorporated because they are located along the right bank of the Bt.Lubuk river and near the Bt.Lubuk project.

(1) Sei Perak scheme
(2) Sei Menaming scheme, and
(3) Kaiti-Samo scheme

The command areas for the Sei Perak and the Sei Menaming projects are located on lower area along the Batang Lubuk river, while the command area of the Kaiti-Samo project is expanding over the comparatively high hilly terrain area with 80m to 50m above the sea level where rises sheer from

the right bank of the Bt.Lubuk.

It is said that river discharges of the Sei Perak and Sei Menaming are enough to cover even the dry season paddy cultivation, while even the wet season paddy cultivation is unstable in the Samo project. Consequently, the Kaiti-Samo supply weir had already been constructed on the Kaiti river to supply water to the Samo weir. However, about 9.4 km of the connecting canal has not been constructed yet from the Kaiti-Samo supply weir to the Samo weir. Even though the connecting canal would be completed, it is said that the Kaiti-Samo project can not attain the target.

To stabilize both dry and wet season cultivations for the Kaiti-Samo project and to cover irrigation water for the Batang Lubuk project, water will be supplied from the main water source, the Bt.Lubuk river.

On the other hand, the area is raised in undulations as mentioned above. Therefore, the irrigable area for the Batang Lubuk scheme will be dotted over the area.

b) The Upper Sosa project

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 plantations. 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.

2) **Topographically irrigable area**

Considering the conditions mentioned in 4.3 (2), 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
	Total	46,960

Remarks Lower Rokan Kiri project

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

3) Scale of development

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(ha)		Irrigable Area(ha)	
	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	13,900
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

4) Alternative considerations for irrigation water supply to existing schemes

Among newly identified 5(five) irrigation schemes, additional water supply can be expected from the Bt.Lubuk, Upper Sosa (water source is Bt.Lubuk), and Lower Rokan Kiri irrigation schemes to their neighboring schemes that topographically can receive irrigation water. As for irrigation water supply areas, the following cases are considered:

(1) Case 1: New irrigation scheme only,
(2) Case 2: Supplemental water supply to the existing irrigation scheme with a water shortage problem in its water source,
(3) Case 3: Water source conversion of the existing irrigation scheme with the same condition of Case 2, and
(4) Case 4: Maximum utilization of newly developed water source by the neighboring schemes as much as possible.

The new schemes and existing schemes with alternative cases are shown in Table 6.1.1.

(2) Improvement of Existing Irrigation System

As described in Section 3.3.2, there exist 10 semi-technical irrigation systems in the Objective Area.

An important increase occurs when technical irrigation has been introduced. This assures the water input. Once the water input is assured, substantial additional production increases may be realized by such program as SUPRA INSUS.

Effective utilization of limited river discharge cannot be achieved by semi-technical irrigation system. Technical irrigation requires facilities that are properly operated and maintained. This applies to the diversion facilities, the primary, secondary and tertiary canal irrigation systems and the drainage system.

In the case of the existing irrigation schemes in the Objective Area, it is necessary to improve canal systems and to take consistent measures in proper operation and management to make it possible to flow water to tertiary level for timely, uniform and efficient supply and distribution of water. These prerequisites are summarized as follows:

1) Measurement facility for water intake just below intake ports.

2) Structures which can measure and control flow in canal systems.

3) Tertiary networks to be thoroughly furnished in all schemes.

4) Independent setting of irrigation and drainage canals on farm level.

5) Systematic and technical support systems for operation and maintenance.

(3) COST ESTIMATES

Necessary cost for upgrading and development works for each irrigation scheme is calculated on the basis of "Basic Price in November, 1990-March, 1991" published by CIPTA KARYA DPUP in Riau.

Table 6.1.1 shows costs required for upgrading of the existing schemes and development of the new schemes, respectively. As for alternative considerations from the newly developed water sources, additional costs required are also summarized in Table 6.1.1.

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.6.2.1. The following are the basic conditions for the calculation;

1) Hydroelectric power generation projects can offer constant water flow to the downstream. So, these projects are not considered for the calculation.

2) If the projects are located in the downstream of each sub-basin, the required water will be taken from the end of each sub-basin.

3) Each sub-basin has own river run-off model, i.e. Tank Model, established based on the measured river discharge and rainfall data. Therefore, run-off pattern from rivers in the sub-basin will be the same.

4) Rainfall data of the representative station in the sub-basin will be used for the calculation.

5) Irrigation water requirement obtained by the proper cropping pattern in the base year, 1984 is applied.

6) Return flow from irrigation water is considered as 25 %.

7) An aim of maintenance flow of each river is q = 0.3m^3/s/ 100Km^2.

The detail calculation results are presented in ANNEX and Fig.6.2.2 shows the result in the base year, 1984 for each sub-basin. 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 in the Rokan River Basin

6.3.1 Purpose of the Selection

The irrigation development plans (18 cases in 5 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. The development plan(s) indicating 10% or more EIRR shall be considered feasible for its implementation.

6.3.2 Basic Assumptions

The basic assumptions underlying the calculation of the EIRR are as follows.

1) The current prices as of June 1991 are used in the cost estimate as well as benefit calculation. The exchange rate is set at US$1.00 = Rp 1,945.

2) Project cost includes all direct construction cost. It does not include such indirect costs as administration, price and physical contingency, taxes and duties for imported goods, and interest during construction.

3) Economic life of the project facilities is assumed as 25 years and therefore no replacement cost of the facilities is considered.

4) Only direct tangible benefits are quantified for the calculation of the EIRR. The net value of rice production accruing from the project is considered as the benefits.

5) The economic price of paddy (unhusked rice) is estimated as Rp.310 per kg.

6.3.3 Result of the Evaluation

The result of the economic evaluation is summarized below. (See details in ANNEX-E.)

Name of the Plan	Irrigable Area (ha)	EIRR (%)
1) Batang Lubuk Case-1	460	- 8.9
2) Batang Lubuk Case-2	1,482	- 4.4
3) Batang Lubuk Case-3	2,155	- 1.3
4) Batang Lubuk Case-4	2,673	- 0.4
5) Upper Sosa Case-1	3,600	1.6
6) Upper Sosa Case-2	3,967	2.2
7) Upper Sosa Case-3	4,020	2.4
8) Upper Sosa Case-4	4,020	2.4

9)	Lower Rokan Kiri Case-1	19,300	11.7
10)	Lower Rokan Kiri Case-2	19,454	11.7
11)	Lower Rokan Kiri Case-3	19,488	11.8
12)	Lower Rokan Kiri Case-4	19,488	11.8
13)	Btg. Lubuk + Upper Sosa Case-1	4,060	- 0.1
14)	Btg. Lubuk + Upper Sosa Case-2	5,499	0.6
15)	Btg. Lubuk + Upper Sosa Case-3	6,175	0.8
16)	Btg. Lubuk + Upper Sosa Case-4	6,693	1.8
17)	Mahato	9,000	10.7
18)	Lower Sosa	11,800	12.6

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

6.4.1 Increased Production of Rice

The total irrigated area in the Rokan River Basin will be approximately 47,000 ha with the implementation of four (4) Irrigation Development Projects: the Batang Kumu (7,000ha), Lower Rokan Kiri (19,488ha), Lower Sosa (9,000ha) and Mahato (11,800ha). 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

Rice Demand and Supply Forecast in the Objective Area				Rice Deficit in the Province
Year	Demand	Supply	Balance	
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.

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.

6.4.2 Increased Production of Palawija Crops

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.

6.4.3 Socio-economic Impact

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 Development Plan in the Priority Area

6.5.1 Criteria for Selection

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.

Water source is evaluated depending on the availability of water volume for irrigation purpose. Water source with a larger irrigable area has a higher point. Soils and topographical conditions are evaluated concurrently. The highest point is given to the area with soils suitable for rice cultivation and with flat or gentle slope. A lower point is given to the area with undulating or hilly slopes even if the area is covered with soils suitable for rice cultivation. A higher point is given to the area containing the existing farmland as the land ownership is clear. A lower point is given to the area containing the existing estate or forest. A higher point is also given to the area with a higher percentage of transmigrants as promotion of transmigration program is considered vital for promotion of regional development. Point for accessibility depends on the availability and conditions of roads and bridges which are necessary for the transportation of construction materials during construction stage and of agricultural inputs and outputs after the completion of construction works. Economic viability is evaluated by the construction cost per ha as well as EIRR.

Criteria for priority ranking and weighted points of each criterion item are presented in Table 6.5.1.

6.5.2 Priority Ranking of Irrigation Development Plans

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.

Priority ranking of the 3 development plans is presented in Table 6.5.2.

7. CONCLUSION AND RECOMMENDATION

7.1 Conclusion

In recent years, many large scale plantation projects have been developed in the Objective Area. On the other hand, self-sufficient of food crops is the urgent subject in the Riau Province including the Objective Area. The Objective area is rich in natural resources such as abundant water resources and natural forest with habitats of protected flora and fauna. Under this circumstances, well balanced development plan among production increase of food crops, plantation development and protection of natural resources shall be established.

As the Rokan River Overall Irrigation Development Plan, the following four(4) projects are recommended. Among them, three(3) projects are selected in this study and the feasibility study was already carried out for another one(1) project.

1) Bt. Kumu Irrigation Project (F/S Study finished in 1989)
2) Lower Rokan Kiri Irrigation Project
3) Lower Sosa Irrigation Project
4) Mahato Irrigation Project

The completion of the proposed four projects would enable to produce 420,000 tons of rice (polished rice) annually in the target year 2020, and this amount would satisfy rice demand in the Objective Area and cover a deficit in the Riau Province of about 61 percent.

Development priority ranking is given to the foregoing four project. As a result, the Lower Rokan Kiri Irrigation Project is selected as a priority project. Since the present study in Phase I is on the master plan study level, the feasibility study for the Lower Rokan Kiri Irrigation Project will be carried out in Phase II study.

7.2 Recommendation

For the further development of the Rokan River Basin, the following are recommended.

1) To promote agricultural development including irrigation practice, agricultural supporting service such as,
   a) establishment of agricultural verification farm,
   b) training for members of agricultural extension service,
   c) strengthening of agricultural cooperation service for credit and input supply, and
   d) improvement of agricultural marketing and processing shall be proceeded.

2) For early realization of irrigation agriculture, the Bt. Kumu Irrigation project for which the feasibility study has been carried out shall be implemented as earliest possible date.

3) To improve the existing irrigation schemes, technical irrigation system shall be introduced for the appropriate irrigable area based on proper water balance study.

4) With regard to swamp development, long range research and study on soil, selection of suitable crops, tidal effect, protection of flora and fauna etc. is required.

5) As a inland fishery development measures,
   a) training of farmers concerned and establishment of cooperation service,
   b) promotion of fish culture in natural water area, and
   c) improvement of incubation facility
   shall be undertaken.

6) As social infrastructure, improvement of the existing roads especially access roads between capitals of regencies scattered over the Objective Area shall be proceeded.

7) From basin conservation view point, afforestation in wasteland and leaving areas after shifting cultivation, where are scattered over the natural conservation forest and protected forest shall be promoted.

Moreover, to encourage regional inhabitant's participation in the development of the Objective Area, the following actions are required.

1) For paddy farmers, a)uniform operation and maintenance by organized water users' associations, b)active contribution for operation and maintenance expenditures, c)actions of KUD, and d)clear understanding to increase income through intensive farming and active use of animal power, and

2) About fishermen, establishment of fishermen organization.

TABLES

Table 2.1.1 Land and Population Distribution of Indonesia(1990)

Region	Area		Population (1990)		Population Density
	km2	%	millions	%	(persons/km2)
Sumatra	481,780	24.7	36.4	20.3	76
Java 1/	130,398	6.7	107.5	60.0	824
Nusa Tenggara	87,693	4.5	10.2	5.7	116
Kalimantan	549,032	28.2	9.1	5.1	17
Sulawesi	194,441	10.0	12.5	7.0	64
Irian Jaya 2/	505,388	25.9	3.5	2.0	7
Total	1,948,732	100.0	179.2	100.0	92

Source: (1) Statistik Indonesia 1989
(2) 1990 Population Census

Note: 1/ including Madura Island
2/ including Maluku Islands

Table 2.1.2 Economic Growth by Sector of Indonesia(1983-1988)
(Based on Fixed Price in 1983)

Industry	1983		1988		Annual Growth Rate (%)
	Billion Rp	%	Billion Rp	%	
Agriculture	17,692.2	22.8	21,007.6	21.1	3.5
Food crops	11,057.4	14.2	12,796.9	12.8	3.0
Non-food crops	2,294.9	3.0	2,832.9	2.8	4.3
Estate crops	375.3	0.5	576.8	0.6	8.9
Livestock	1,754.3	2.3	2,211.7	2.2	4.7
Forestry	994.2	1.3	1,013.0	1.0	0.4
Fisheries	1,220.1	1.6	1,576.4	1.6	5.2
Mining & Quarrying	16,107.4	20.7	15,934.0	16.0	-0.2
Oil and gas	15,103.0	19.4	14,691.2	14.7	-0.5
Other	1,004.4	1.3	1,242.8	1.2	4.3
Manufacturing	9,896.4	12.7	18,339.9	18.4	13.1
Non-oil/gas	7,666.3	9.9	13,758.2	13.8	12.4
Oil refinery	358.9	0.5	980.4	1.0	22.3
Natural gas	1,871.2	2.4	3,601.3	3.6	14.0
Utilities 1/	313.9	0.4	547.5	0.5	11.7
Construction	4,597.2	5.9	5,119.1	5.1	2.2
Trade, hotels, etc.	11,540.7	14.9	15,662.3	15.7	6.3
Wholesale, retail	9,932.5	12.8	12,998.5	13.0	5.5
Hotel, restaurant	1,608.2	2.1	2,663.8	2.7	10.6
Transport/commun.	4,098.1	5.3	5,225.2	5.2	5.0
Transport	3,693.7	4.8	4,637.5	4.7	4.6
Communications	404.4	0.5	587.7	0.6	7.8
Banking	2,358.6	3.0	3,597.2	3.6	8.8
Dwelling ownership	2,355.5	3.0	2,762.2	2.8	3.2
Public services	5,711.5	7.4	7,932.1	8.0	6.8
Services	3,000.8	3.9	3,569.8	3.6	3.5
GDP Total	77,676.3	100.0	99,696.9	100.0	5.1

Source: Statistik Indonesia 1989

Note: 1/ Utilities include electricity, gas and water

Table 2.2.1 Population in Riau Province(1980-1990)

Kabupaten/ Katamadya	Population in 1980	Population in 1990	Annual Growth Rate (%)
Indragiri Hulu	227,885	367,470	4.89
Indragiri Hilir	398,214	477,958	1.83
Kepulauan Riau	384,049	458,463	1.79
Kampar	311,036	567,790	6.20
Bengkalis	566,377	903,919	4.79
Pekanbaru	237,672	398,621	5.31
Batam	38,663	106,825	10.70
Total	2,163,896	3,281,046	4.25

Source: Kantor Statistik Propinsi Riau

Note: Total population does not include such temporary settlers as homeless, sailers, etc.

Table 2.2.2 GDP in Riau Province(1985-1988)

	1985	1986	1987	1988
Gross Regional Domestic Product (GRDP) in Billion (Bn) Rp				
GRDP at Current Market Prices				
Including Petroleum (Bn Rp)	7,433.1	7,538.9	9,392.9	9,225.4
Excluding Petroleum (Bn Rp)	1,266.2	1,399.0	1,628.0	1,923.5
GRDP at 1983 Constant Prices				
Including Petroleum (Bn Rp)	6,500.6	7,336.3	8,197.6	8,551.8
Excluding Petroleum (Bn Rp)	1,071.5	1,125.9	1,212.6	1,319.4
Growth Rate (%)				
Including Petroleum (Bn Rp)	-4.2	12.8	11.7	4.3
Excluding Petroleum (Bn Rp)	4.6	5.1	7.7	8.8
Per Capita GRDP				
Including Petroleum (Rp)	453,114	484,257	546,787	620,382
Excluding Petroleum (Rp)	383,672	389,902	407,587	427,610
GRDP Share by Sector at CMP (Including Petroleum)				
Agriculture (%)	4.7	5.0	4.7	5.5
Mining (%)	79.1	75.3	77.1	73.2
Manufacturing (%)	4.7	6.6	5.9	6.7
Trade & Commerce (%)	6.0	7.0	6.6	7.5
Others (%)	5.5	6.1	5.7	7.1
GRDP Share by Sector at CMP (Exclxcing Petroleum)				
Agriculture (%)	27.7	26.8	26.9	26.2
Mining (%)	6.2	6.0	6.3	6.1
Manufacturing (%)	7.7	7.7	8.2	8.5
Trade & Commerce (%)	26.6	26.4	25.1	24.9
Others (%)	31.8	33.1	33.5	34.3

Source: Pendapatan Regional Provinsi Riau 1983-1989
Kantor Statistik Provinsi Riau

Note: 1/ Bn = Billion
2/ CMP = Current Market Prices

Table 3.1.1 Soil of the Study Area

	SOIL	CLASSIFICATION
Eastern Coastal Swamp Lands	Alluvial Plain Soil	(1) Tidal Swamp Soil (2) Riverine Alluvial Soil (3) Mender Belt Alluvial Soil (4) Alluvial Valley Soil (5) Fan Alluvial Soil
	Peat Soil	(6) Shallow Peat Swamp Soil (7) Peat Swamp Soil (8) Deep Peat Swamp Soil
Eastern Plain and Hills	Old Marine Terrace Soil	(9) Marine Terrace Soil
	Undulating Plain Soil	(10) Undulating Plain Soil
	Hillocky Plain Soil	(11) Hillocky Plain Soil
Barisan Mountains	Barisan Soil	(12) Barisan Soil (1) (13) Barisan Soil (2)

Table 3.1.2 Name and Characteristics of Classified Soil

Soil Classification	Dominant Slope (%)	Organic Contents	Soil Layer Development	Dominant Soil Classification (Soil Taxonomy)
Tidal Swamp S	< 2	±	±	Hydroaquents
Riverine Alluvial S	< 2	±	±	Tropaquepts Fluvaquents
Hender Belt Alluvial S	< 2	±	±	Tropfluvents
Alluvial Valley S	< 2	±	+	Tropaquepts Fluvaquents Eutropepts
Fan Alluvial S	< 15	±	+	Dystropepts
Shallow Peat Swamp S	< 2	++	+	Fluvaquents Tropaquepts Tropohemists
Peat Swamp S	< 2	+++	−	Troposaprists Tropohemists
Deep Peat Swamp S	< 2	+++	−	Tropohemists Tropofibrists
Marine Terrace S	< 2	+	+	Tropaquepts
Undulating Plain S	10-15	±	++	Tropudults
Hillocky Plain S	15-25	±	++	Paleudults
Barison Soil	> 40	±	+ or ±	Tropudults Dystropepts

Organic Contents (±: Low、 +: Medium、 ++: High、 +++: Very High)

Soil Layer Development (−:Non、 ±: Weak、 +: Medium、 ++: Strong)

Table 3.1.3 Areas of Soil Classification

Soil 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 Allivial 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
Barison Soil	446,900	20.2
Barison Soil(1)	126,900	5.7
Barison Soil(1)	320,000	14.5
	2,210,000	100.0

Table 3.2.1 Administrative Divisions and Feature of the Objective Area

Kabupaten	Kecamatan	Area (km2)	Village No.	Population (1990)	Population Density
Kampar	(Objective Area)				
	Tambusai	1,629.09	21	30,660	19
	Kepenuhan	918.82	9	14,627	16
	Kunto Darussalam	1,179.47	10	17,943	15
	Rambah	1,029.60	26	72,711	71
	Rokan IV Koto	1,114.31	11	20,094	18
	Tandun	203.31	2	7,334	36
	Sub-total	6,074.60	79	163,369	27
	(Other Area)	21,733.72	182	404,421	19
	Kampar Total	27,808.32	261	567,790	20
Bengkalis	(Objective Area)				
	Bangko	2,528.35	36	97,491	39
	Kubu	3,023.59	25	97,090	32
	Tanahputih	3,329.65	19	43,326	13
	Mandau	1,397.09	38	25,623	18
	Sub-total	10,278.68	118	263,530	26
	(Other Area)	20,368.15	233	640,389	31
	Bengkalis Total	30,646.83	351	903,919	29
Objective Area Total:		16,353.28	197	426,899	26

Source: Kantor Statistik Propinsi Riau

Table 3.2.2 Population Change and Density in the Objective Area(1980-1990)

Kecamatan	Area (km2)	Population 1980	Population 1990	Growth Rate(%)	Density (1990)
(Bengkalis)					
Bangko	2,528.35	70,643	97,491	3.27	39
Kubu	3,023.59	36,392	97,090	10.31	32
Tanahputih	3,329.65	24,055	43,326	6.06	13
Mandau	1,397.09	12,992	25,623	7.03	2
Sub-total	10,278.68	144,082	263,530	7.44	26
(Kampar)					
Tambusai	1,629.09	10,097	30,660	11.75	19
Kepenuhan	918.82	6,974	14,627	7.69	16
Kunto Darussalam.	1,179.47	6,869	17,943	10.08	15
Rambah	1,029.60	42,866	72,711	5.43	71
Rokan IV Koto	1,114.31	10,824	20,094	6.38	18
Tandun	203.31	2,051	7,334	13.59	36
Sub-total	6,074.60	79,681	163,369	8.17	27
T o t a l	16,353.28	223,763	426,899	7.00	26

Source: Kantor Statistik Propinsi Riau

Table 3.2.3 Public Roads in the Objective Area

:km

Section	Distance	Section	Distance
* National Road *		* Provincial Road *	
SP.Batang / SP.Balam	47.28	Tandun / Pasir Pangarayan	56.00
SP.Balam / Bagan Batu	26.32	Pasir Pangarayan/prov.boundary	43.52
Bagan Batu/ prov.boundary	38.50	Pasir Pangarayan/prov.boundary	21.59
Duri / SP.Kulim	15.00	Bagan Siapiapi /Sei. Benar	77.03
		Bagan Siapiapi /Sinaboy	31.58
Total	127.10	Total	229.72
* Kabupaten Road*			
(Kabupaten Bengkalis)		(Kabupaten Kampar)	
Bagan Batu / Bagan Sinenba	22.0	Ujung Batu / Rokan	29.0
Tl. Merbau / Rt.Panjan Kiri	6.0	Ujung Batu / Kotalama	23.0
Rt.Panjan Kiri/ Sei Pinang	4.0	Sp.Kumu / Kota Tengah	36.0
Rt.Panjan Kiri/ Tl.Nirap	4.0	Pekan Tabih / Batu Sasah	2.0
Tl. Nirap / Pinang Road	9.0	Pekan Tabih / Lb. Soting	3.0
Pinang Road	33.0	Lb. Soting / Dalu dalu	12.0
Ujung Tanjung / Sediginang	17.0	Kota Tengah / Pasir Pandak	5.0
Sediginang / Sp. Berkat	19.0	Kota Tengah / Muala Dilam	13.0
Sp. Berkat / Si Arangarang	8.0	Muala Dilam / Sontang	16.0
Si Arangarang / Pujut	15.0	Kotalama / Muala Dilam	14.0
Duri / Sei Rangau	28.0	Dalu dalu / Kota Bangun	6.0
		Kota Bangun / Kuala Mahato	22.0
		Pasir Pangarayan/ Pawan	14.0
		Pasir Pangarayan/ Kubang Buaya	19.0
		Kubang Buaya / Simpang	10.0
		Simpang / Rokan	12.0
		Rokan / Pankalian	6.0
		Pankalian / Siberuang	9.0
		Tandun / Pankalian	11.0
Sub-Total	165.0	Sub-Total	262.0
		Total	427.0

National Road	127.10
Provincial Road	229.72
Kabupaten Road	427.0
Total	783.82

Table 3.3.1 Present Land Use

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 3.3.2 Areas of Forest Classification in the Study Area

Classification	Area (Km2)			
	Riau	W.Sumatra	N.Sumatra	Total
Protected Forest	160	27	430	617
Conservation Forest	387	1,503	0	1,890
Limited Production Forest	4,113	328	3,232	7,673
Fixed Production Forest	3,326	0	0	3,326
Conversion Forest	3,380	0	0	3,380
Others	4,693	490	32	5,215
TOTAL	16,059	2,347	3,694	22,100

Table 3.3.3 Statistics of Food Production in Riau Province(1984-1989)

	1984			1985			1986			1987			1988		
	Harvested Area (Ha)	Production (ton)	Yield (t/Ha)	Harvested Area (Ha)	Production (ton)	Yield (t/Ha)	Harvested Area (Ha)	Production (ton)	Yield (t/Ha)	Harvested Area (Ha)	Production (ton)	Yield (t/Ha)	Harvested Area (Ha)	Production (ton)	Yield (t/Ha)
Wet Paddy	89165	258148	2.8952	90171	264971	2.9385	98943	292319	2.9544	103339	296273	2.8670	99038	295677	2.9855
Dry Paddy	52683	70648	1.3410	50531	71956	1.4240	48898	73738	1.5080	42574	72518	1.7033	53415	97876	1.8286
Maize	6471	9791	1.5131	10687	17441	1.6320	12916	20782	1.6090	11033	20813	1.8864	13321	24292	1.8237
Cassava	6842	78683	11.5000	6177	69182	11.1999	5855	68504	11.7001	6814	84161	12.3512	8525	92893	10.8914
Peanut	1775	1933	1.0890	2388	2396	1.0034	4190	4240	1.0119	3976	4127	1.0380	4479	4233	0.9451
Sweet Potatoes	2148	15036	7.0000	2218	16635	7.5000	2106	16216	7.6999	2548	19759	7.7547	2037	17887	8.7811
Soybeans	2316	1709	0.7379	5036	3968	0.7879	11983	9850	0.8220	9115	7553	0.8286	6524	5252	0.8050
Green gram	1686	2095	1.2426	3721	5631	1.5133	3372	4441	1.3170	3025	3031	1.0020	2667	3539	1.3270
Chily	2106	4420	2.0986	5522	5790	1.0485	5870	5358	0.9128	6323	6373	1.0079	4078	5704	1.3987
Cucumber	1139	7292	6.4021	2447	11677	4.7720	2756	11663	4.2319	4068	15065	3.7033	3441	12151	3.5312
Egg Plant	1073	2922	2.7232	3376	6427	1.9037	3556	5641	1.5863	3885	5867	1.5102	2739	4712	1.7203
Vegetable beans	*	*	*	4605	5179	1.1246	5450	5749	1.0549	5560	6457	1.1613	3508	5653	1.6115
Spinach	745	2696	3.6188	1388	4799	3.4575	1608	4880	3.0348	1788	6127	3.4267	1722	5398	3.1347
Kangkung	410	2186	5.3317	2870	8879	3.0937	3320	10304	3.1036	4256	13245	3.1121	2938	9016	3.0688
Fruit															
Banana		69069			77970			82001			68295			58876	
Durian		3625			12576			11542			7782			9048	
Orange		49848			71389			74785			66197			12686	
Rambotan		3082			6524			7283			16685			4862	
Pineapple		44043			23413			38705			24502			29824	

*: Data not available

Source: RIAU IN FIGURES 1988/1989

Table 3.3.4 Statistics of Food Crops in the Objective Area(1989)

		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	32,686	69,063	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	4,667	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)	1,648	182	1,730	2,453	361	4479
	Production (ton)	2,906	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 3.3.5 Fishery Production in Riau Province (1984-1988)

Unit: ton

Category	1984	1985	1986	1987	1988	A.G.R. (%)
Marine Fishery (A)	145,346	148,950	151,185	157,466	159,499	2.35
Inland Fishery (B)	10,753	11,810	11,929	12,561	12,699	4.25
Inland Open Water	10,482	11,425	11,491	12,015	12,122	3.70
Aquaculture (Brac.)	58	47	33	90	93	12.53
Aquaculture (Fresh)	213	338	405	456	484	22.78
Total (A+B)	156,099	160,760	163,114	170,027	172,198	2.48

Source: Riau Dalam Angka 1988/1989

Note: 1. A.G.R. = Average Annual Growth Rate
2. Brac. = Brackish water
3. Fresh = Fresh water

Table 3.4.1 Agricultural Population Projection in the Objective Area(1990)

Kecamatan	Population 1990	Total H.H.	Family Size	Share of Farm HH	No. of Farm HH	Farm Population
Bangko	97,491	18,620	5.24	75.40	14,039	73,508
Kubu	97,090	18,228	5.33	81.20	14,801	78,837
Tanahputih	43,326	9,144	4.74	73.70	6,739	31,931
Mandau	25,623	5,204	4.92	38.50	2,004	9,865
Sub-total	263,530	51,196	5.15	63.32	37,583	193,459
Tambusai	30,660	6,892	4.45	87.90	6,058	26,950
Kepenuhan	14,627	3,342	4.38	85.60	2,861	12,521
Kunto Darus.	17,943	4,364	4.11	94.90	4,141	17,028
Rambah	72,711	16,087	4.52	88.70	14,269	64,495
Rokan IV K.	20,094	4,848	4.14	92.00	4,460	18,486
Tandun	7,334	1,617	4.54	78.00	1,261	5,721
Sub-total	163,369	37,150	4.40	87.34	33,051	145,343
Total	426,899	88,346	4.83	72.38	70,634	338,802

Source: 1. 1990 Population Census, Riau
2. 1983 Agricultural Census, Riau

Note: Share of farm households is based on the 1983 Agricultural Census Data.

Table 3.4.2 Food Balance in Riau Province(1989)

	Product-ion	Feed, Waste & Seed	Total Supply	Populat-ion 7/	Total Demand	Surplus (Deficit)
Rice 1/	393,353	35,206	243,540	3,147,286	443,767	-200,228
Maize 2/	24,293	2985.27	21307.73	3,147,286	56651.154	-35,343
Soybeans 3/	5,252	660.564	4591.436	3,147,286	15736.432	-11,145
Cassava 4/	92,893	12076.1	80816.91	3,147,286	157364.32	-76,547
Sweet Potato5/	17,887	2146.44	15740.56	3,147,286	25178.291	-9,438
Ground Nuts 6/	4,233	484.869	3748.131	3,147,286	11015.502	-7,267

Source: 1. Pedoman Penyusunan Neraca Bahan Makanan, 1989
2. Laporan Tahunan Dinas Pertanian Tanaman Pangan, Kampar, 1989
3. Laporan Tahunan Dinas Pertanian Tan. Pangan, Bengkalis, 1989

Note: 1. Feed = 0.02 x total paddy production;
Waste = 0.054 x total paddy production;
Seed = Area planted x 40 kg;
Per capita consumption = 141 kg;
Per capita available rice in 1989 = 77 kgkg
2. Feed = 0.06 x total maize production;
Waste = 0.05 x total maize production;
Seed = Area planted x 23.5 kg;
Per capita consumption = 18 kg
3. Waste = 0.05 x total soybeans production;
Seed = Area planted x 61 kg;
Per capita consumption = 5 kg
4. Waste = 0.13 x total cassava production;
Per capita consumption = 60 kg
5. Waste = 0.13 x total sweet potato production;
Seed = Area planted x 61 kg;
Per capita consumption = 8 kg
6. Waste = 0.05 x total ground nuts production;
Seed = Area planted x 61 kg;
Per capita consumption = 3.5 kg
7. Population in 1989 = (population in 1990) divided by 1.0425

Table 4.3.1 Re-estimate Irrigable Areas of the Existing Irrigation Projects

Project	DPUP's Planned Irrigation Area(ha)	Re-estimated Irrigable Area(ha)	
		Wet Season	Dry Season
(Bt. Lubuk basin)			
1. Sei Perak	95	238	146
2. Sei Menaming	423	959	596
3. Kaiti-Samo	1,695	1,082	673
4. Aek Tangun	420	82	53
(S. Rokan Kiri basin)			
5. Sei Kijang	516	405	162
6. Sei Palis	400	358	142
7. Kota Intan	188	81	34
(Bt. Kumu basin)			
8. Medang Mahato	324	963	920
(S. Rokan Kanan basin)			
9. Siarang-arang	464	326	338
(S. Rokan basin)			
10. Teluk Retti	1,000	93	86
Total	5,525	4,587	3,159

Table 4.4.1 Hydrological Power Generation in Riau Province

POWER STATION		ROKAN KIRI No.1 *	ROKAN KIRI No.2 *	ROKAN KANAN No.1	ROKAN KANAN No.2 *
LOCATION		Riau	Riau	West Sumatra	North Sumatra
TYPE OF DAM		Fill	Gravity	Gravity	Fill
CATCHMENT AREA	km2	2.300	2.805	210	605
GROSS STORAGE CAPACITY	mil.cu.m	3.041	1.200	-	-
EFFECTIVE STORAGE CAPACITY	mil.cu.m	1.150	252	30	300
RESERVOIR AREA	km2	101	230	-	-
CRFST ELEVATION	m	171	100	450	160
HIGHEST WATER LEVEL	m	160	100	450	152
LOWEST WATER LEVEL	m	147.5	94	-	-
DAM HIGHT	m	68	47	40	44
100-YEAR FLOOD DISCHARGE	m3/s	(2.200) 1.800	2.200	160	(570) 470
20-YEAR FLOOD DISCHARGE	m3/s	1.270	1.500	120	330
5-YEAR FLOOD DISCHARGE	m3/s	870	1.100	80	230
TYPE OF POWER STATION		Reservoir	Reservoir	Pondage	Reservoir
MAXIMUM DISCHARGE	m3/s	155	190	30	40
MEAN DISCHARGE	m3/s	105	129	10	28
FIRM DISCHARGE	m3/s	-	-	3	-
INTAKE WATER LEVEL	m	160	100	450	152
OUTLET WATER LEVEL	m	105	57	250	120
GROSS HEAD	m	55	43	200	32
EFFECTIVE HEAD	m	52	41	185	30
MAXIMUM OUTPUT	MW	(134) 67	(130) 65	46	(20) 10
FIRM OUTPUT	MW	(102) 51	(124) 62	14	(14) 7
ANNUAL GENERATED ENERGY	GWH	353	376	74	37

Where:
1. Power stations of * are planned 16-hour peak power stations and the values in () indicate the future extension plan.
2. Rokan Kanan No.1 station is planned as 8-hour peak power station.

Source: KAMPAR AND ROKAN HYDROELECTRIC POWER DEVELOPMENT PROJECT IN RIAU. TOKYO ELECTRIC POWER SERVICES CO..LTD. CONSTRUCTING ENGINEERS. TOKYO.JAPAN PRE FEASIBILITY REPORT.1980

Table 4.4.2 Plan of Generation of Electricity in Riau and West Sumatra Provinces

(UNIT: MW)

Region	Project		Type	1988	1993	1998	2003	2008	Completion Year	Status	Remarks
Wilayah III	*System Peak*	P		133.2	333.6	436.3	601.3	949.8			
(W.Sumatra/	*Required Cap.*	A		285.0	444.8	581.7	707.4	1,117.5			
Riau)	Existing										
	Total existing			285.0	285.0	125.0	118.5	108.5		Operation	
	Scat.Diesel		Diesel	206.5	206.5	40.5	34.0	24.0		Operation	
	Batang Agam	*	Hydro	10.5	10.5	10.5	10.5	10.5		Operation	
	Maninjau	*	Hydro	68.0	68.0	68.0	68.0	68.0		Operation	
	Mini hydro										
	Add.Required										
	Kerinci		Geo.ther			5.0	5.0	5.0	1997		
	Scat.Diesel		Diesel		34.4	44.4	42.7	42.7	1990		
	Ombilin	1	COAL		65.0	65.0	65.0	65.0	1992	U. const.	
	Ombilin	2	COAL		65.0	65.0	65.0	65.0	1993	U. const.	
	Ombilin	3	COAL				100.0	100.0	2004	PRE F/S	
	Ombilin	4	COAL					100.0	2005	PRE F/S	
	Bi-steam Duri							1,000.0	2006		
	Mini hydro				8.5	15.4	22.2	22.2	1993	F/S	
	New&Renewable					6.0	6.0	6.0	1995		palm/husk
	Kotapanjang	*	Hydro			114.0	114.0	114.0	1995	D/D	
	Singkarak	*	Hydro			175.0	175.0	175.0	1997	D/D	
	Sinamar	1	Hydro					89.0	2004	RECN.S	
	Kuantan	1	Hydro					109.0	2007	RECN.S	
	Merangin	2	Hydro					232.0	2008	RECN.S	
	Rokan Kiri	2	Hydro					65.0	2005	RECN.S	
	Rokan Kiri	1						67.0	2004	RECN.S	
	TOTAL CAP.	B		285.0	458.0	608.8	707.5	2,359.5			
	B-A			*0.0*	*13.2*	*27.1*	*0.0*	*1,242.0*			
W I+II+III	GRAND TL CAP.			967.1			3,270.6	5,861.6			
(Interconn by	G. TOTAL-REQD			*0.0*			*0.0*	*39.3*			
2003)	TOTAL PEAK			460.2			2,780.1	4,948.9			
	Available hydro										
	Sangir		Hydro	27.0							
	Bajang	1		29.0							
	Bajang	2		48.0							
	Bajang	3		22.0							
	Merangin	1		41.0							
	Merangin	3		57.0	224.0						

Table 6.1.1 Comparison of New Irrigation Schemes

(1) New Schemes with Incorporated Existing Schemes

New Scheme	Case	Irrigable Area (ha)		Total Area (ha)	Construction Cost(mil. Rp.)		Total Cost (mil. Rp.)	Incorporated Existing Schemes
		New Scheme	Existing Scheme		New Scheme	Existing Scheme		
(1) Bt.Lubuk	1. Case 1	460	0	460	59,690	0	59,690	
	2. Case 2	460	1,022	1,482	68,470	1,980	70,450	(1) Kaiti-Samo=1,022 ha
	3. Case 3	460	1,695	2,155	84,970	4,760	89,730	(1) Kaiti-Samo=1,695 ha
	4. Case 4	460	2,213	2,673	86,230	5,820	92,050	(1) Sei Perak=95 ha, (2) Sei Menaming=423 ha, (3)Kaiti-Samo=1,695 ha
(2) Upper Sosa	5. Case 1	3,600	0	3,600	92,870	0	92,870	
	6. Case 2	3,600	367	3,967	93,010	1,010	94,020	(1) Aek Tangun=367 ha
	7. Case 3	3,600	420	4,020	93,050	1,160	94,210	(1) Aek Tangun=420 ha
	8. Case 4	3,600	420	4,020	93,050	1,160	94,210	(1) Aek Tangun=420 ha
(3) Lower Rokan Kiri	9. Case 1	19,300	0	19,300	192,520	0	192,520	
	10. Case 2	19,300	154	19,454	192,570	270	192,840	(1) Kota Intan=154 ha
	11. Case 3	19,300	188	19,488	192,570	430	193,000	(1) Kota Intan=188 ha
	12. Case 4	19,300	188	19,488	192,570	430	193,000	(1) Kota Intan=188 ha
(4) Bt.Lubuk-Upper Sosa(Unification of Water Source)	13. Case 1	4,060	0	4,060	147,440	0	147,440	
	14. Case 2	4,060	1,389	5,449	156,360	2,990	159,350	(1) Kaiti-Samo=1,022 ha, (2) Aek Tangun=367 ha
	15. Case 3	4,060	2,115	6,175	172,910	5,920	178,830	(1) Kaiti-Samo=1,695 ha, (2) Aek Tangun=420 ha
	16. Case 4	4,060	2,633	6,693	174,160	6,980	181,140	(1) Sei Perak=95 ha, (2) Sei Menaming=423 ha, (3)Kaiti-Samo=1,695 ha
								(4) Aek Tangun=420 ha

(2) New Schemes without Incorporated Existing Schemes

New Scheme	Irrigable Area (ha)	Construction Cost(mil.Rp.)	Remarks
(5) Mahato	9,000	87,170	
(6) Lower Sosa	11,800	106,200	
Total		193,370	

(3) Existing Schemes with Re-estimated Area

Existing Scheme	Irrigable Area (ha)	Construction Cost(mil.Rp.)	Remarks
1. Sei Perak	95	120	
2. Sei Menaming	423	940	
3. Kaiti-Samo	1,082	2,100	
4. Aek Tangun	82	170	
5. Sei Kijang	405	3,170	
6. Sei Palis	358	520	
7. Kota Intan	81	110	
8. Medang Mahato	324	1,410	
9. Siaran-arang	338	390	
10. Teluk Retti	93	340	
Total	3,281	9,270	

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Table 6.5.1 Criteria for Priority Ranking

Criteria	Weightage	Priority Grade	Weighted Points
Water Source (Irrigable Area)	10	5: more than 10,000ha	50
		4: 5,000 - 10,000ha	40
		3: 2,000 - 5,000ha	30
		2: 500 - 2,000ha	20
		1: less than 500ha	10
Soil/Topographical Conditions	8	5: lowland soil	40
		3: upland soil	24
		1: mountain soil and deep peat layer	8
Land Ownership	6	5: farmland 1/	30
		3: ladang/grass land 2/	18
		1: forest/estate 3/	6
Percentage of Transmigrants	8	5: more than 50%	40
		3: 20 to 50%	24
		1: less than 10%	8
Accessibility (Transportation)	6	5: good conditions	30
		3: fair conditions	18
		1: bad conditions	6
Construction Cost (per ha cost)	10	5: less than US$5,000	50
		3: US$5,000-10,000	30
		1: more than US$10,000	10
Economic Viability (EIRR)	10	5: more than 10%	50
		3: 6 to 9%	30
		1: less than 5%	10

Note: 1/ Land ownership is clear.
2/ Land ownership is not very clear.
Ladang = upland including land for shifting cultivation
3/ Land is already reserved for other purposes.

Table 6.5.2 Priority Ranking of New Irrigation Schemes

Criteria/ Points	Lower Sosa Project	Mahato Project	Lower Rokan Rokan Project
Irrigable Area	11,800 ha	9,000 ha	19,300 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 oof Farmers	0 %	0 %	25 %
Points	8	8	24
Accessibility	Bad	Bad	Fair
Points	6	6	18
Construction Cost per ha (US$/ha)	4,165	4,532	4,631
Points	50	50	50
Approximate EIRR	12.6 %	10.7 %	11.8 %
Points	50	50	50
Total Points	210	200	262
Ranking	2	3	1

FIGURES

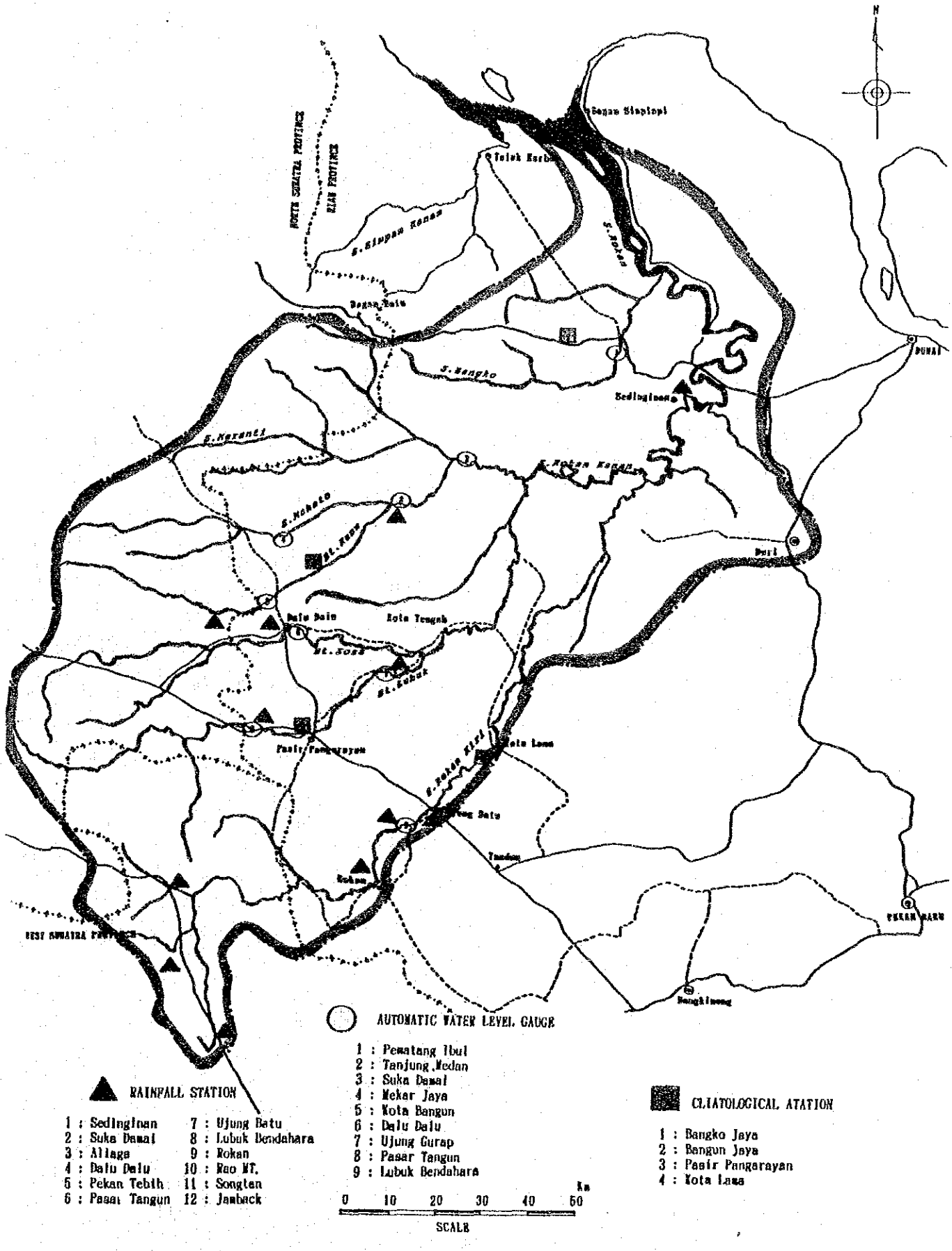
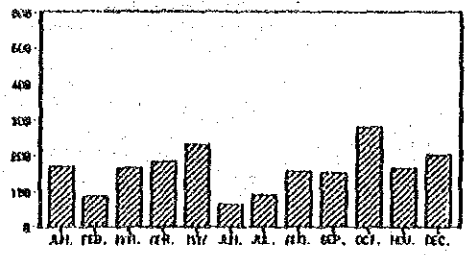


Fig. 3.1.1 Location of Hydro-meteorological Stations

Unit : mm



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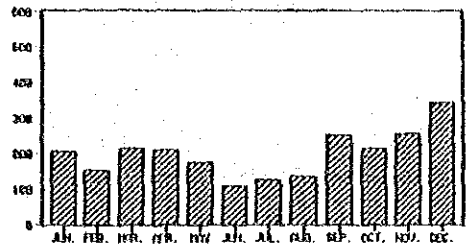

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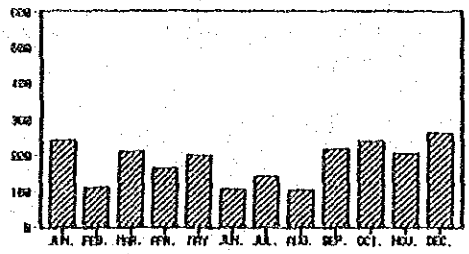

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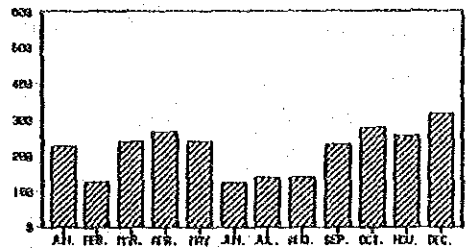

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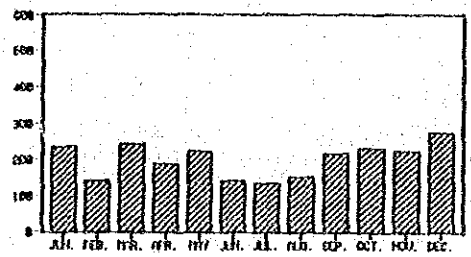

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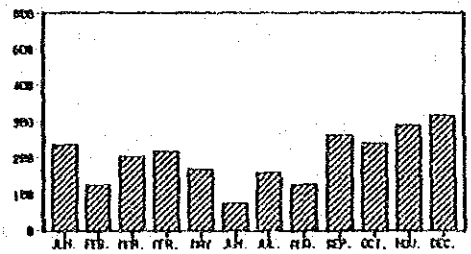

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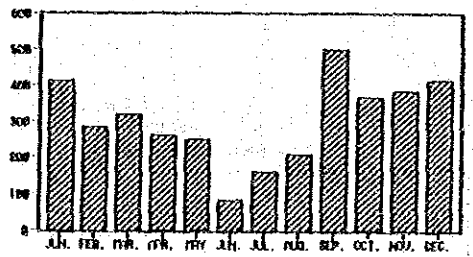

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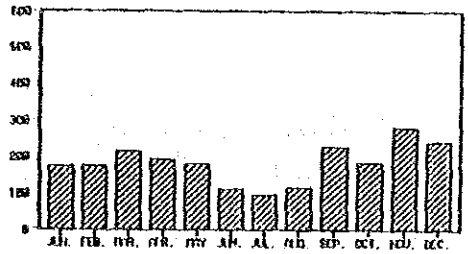

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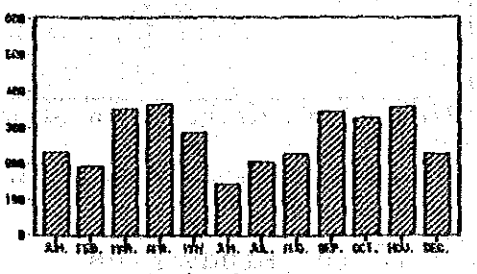

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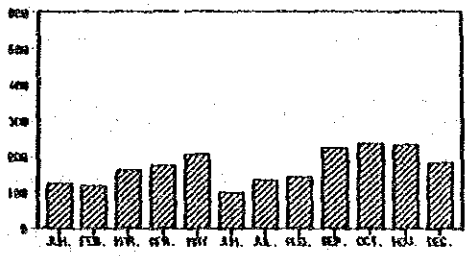

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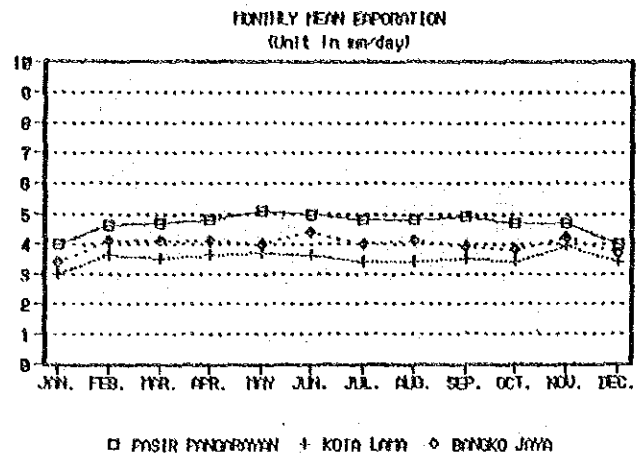
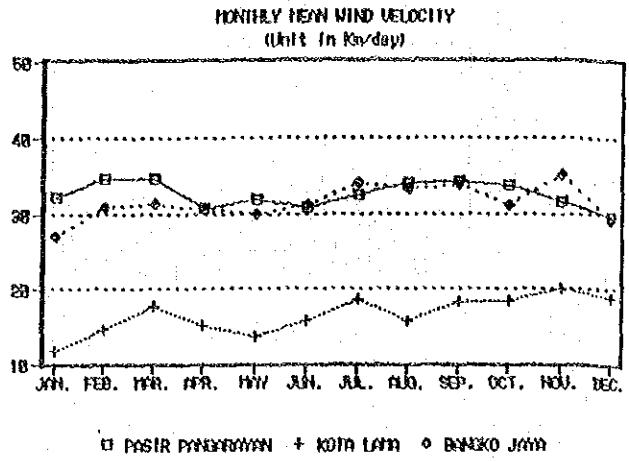
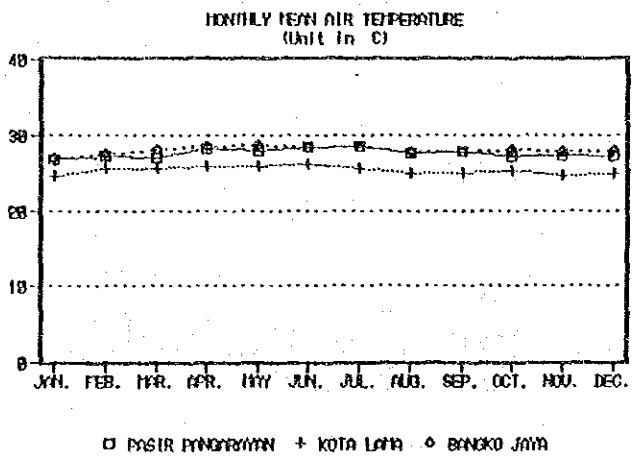
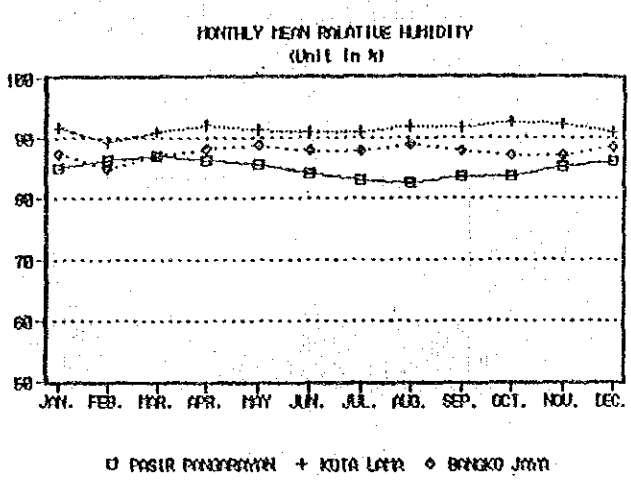
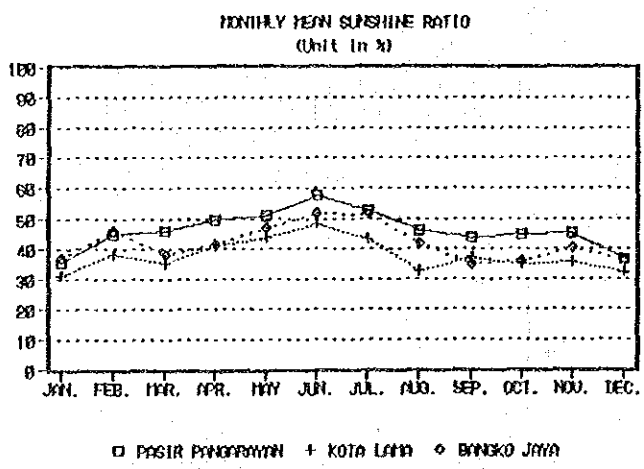
Fig. 3.1.2 Mean Monthly Rainfall in the Study area











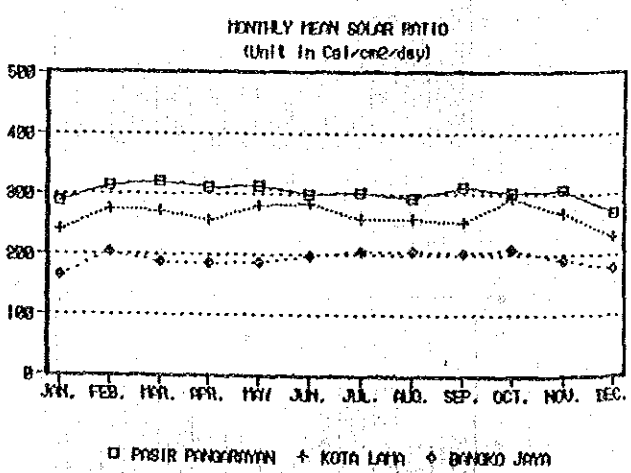


Fig. 3.1.3 Monthly Climatic Feature in the Study Area

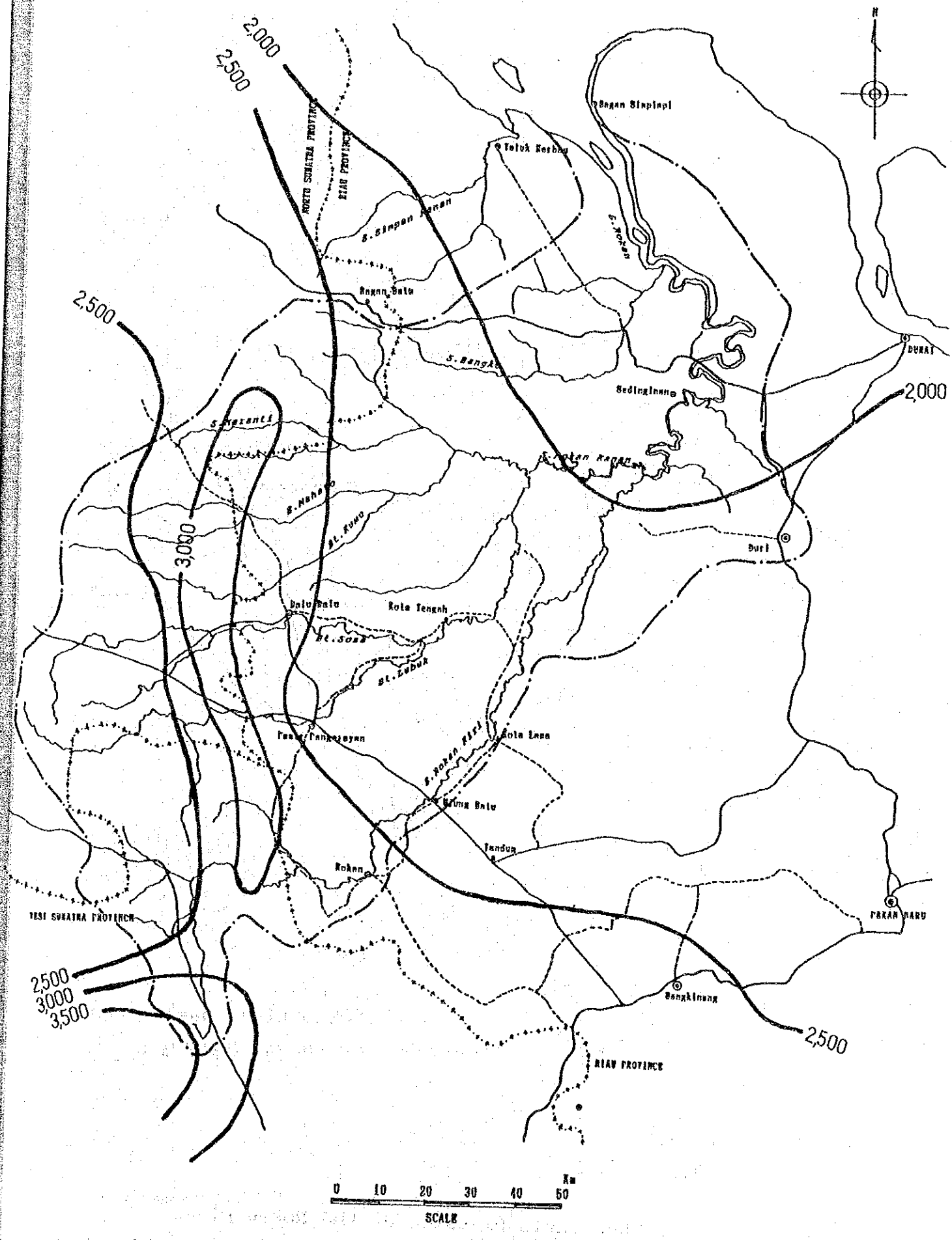


Fig. 3.1.4 Isohyetal Map for the Study Area

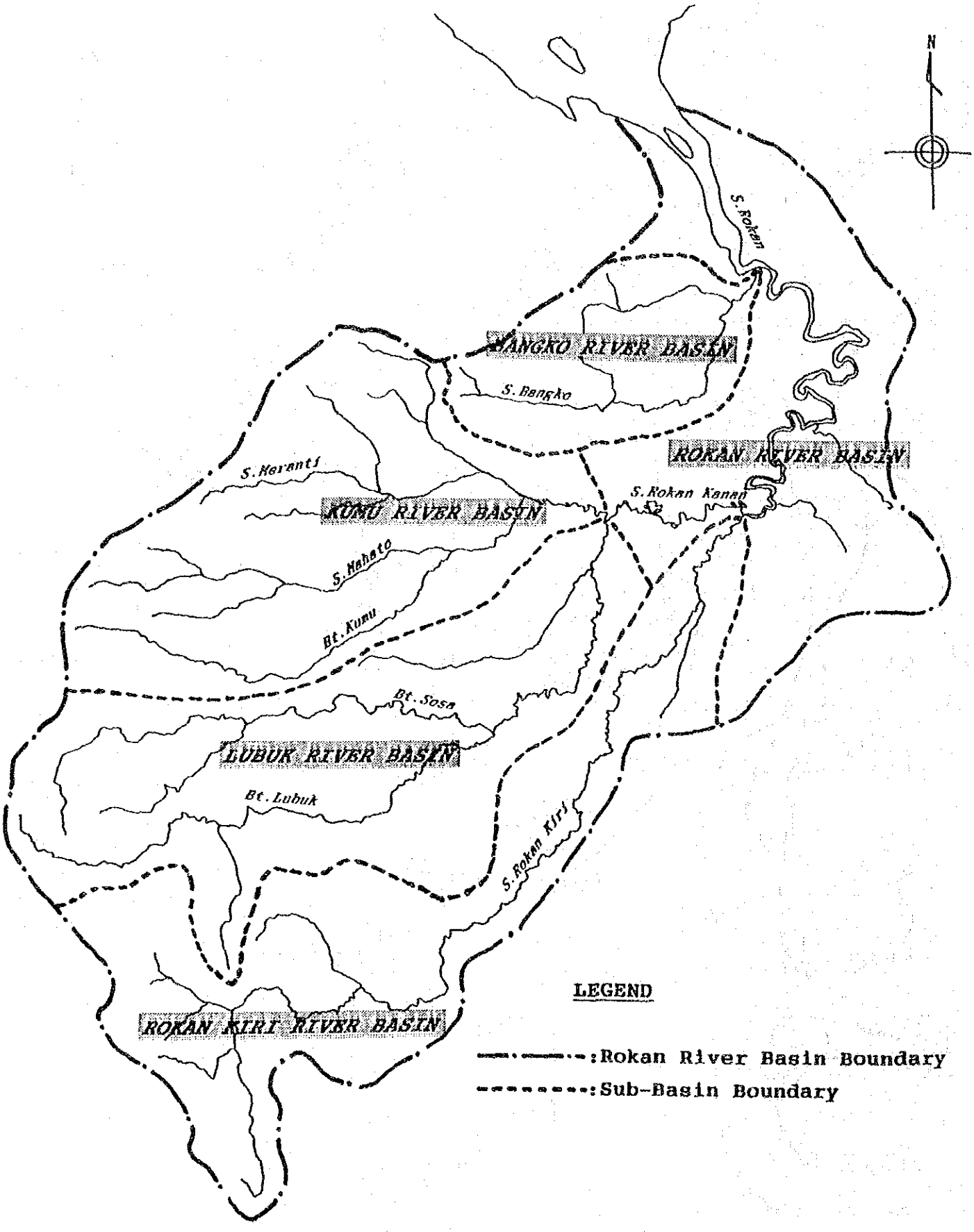


Fig. 3.1.5 Sub-basin Division of the Rokan River

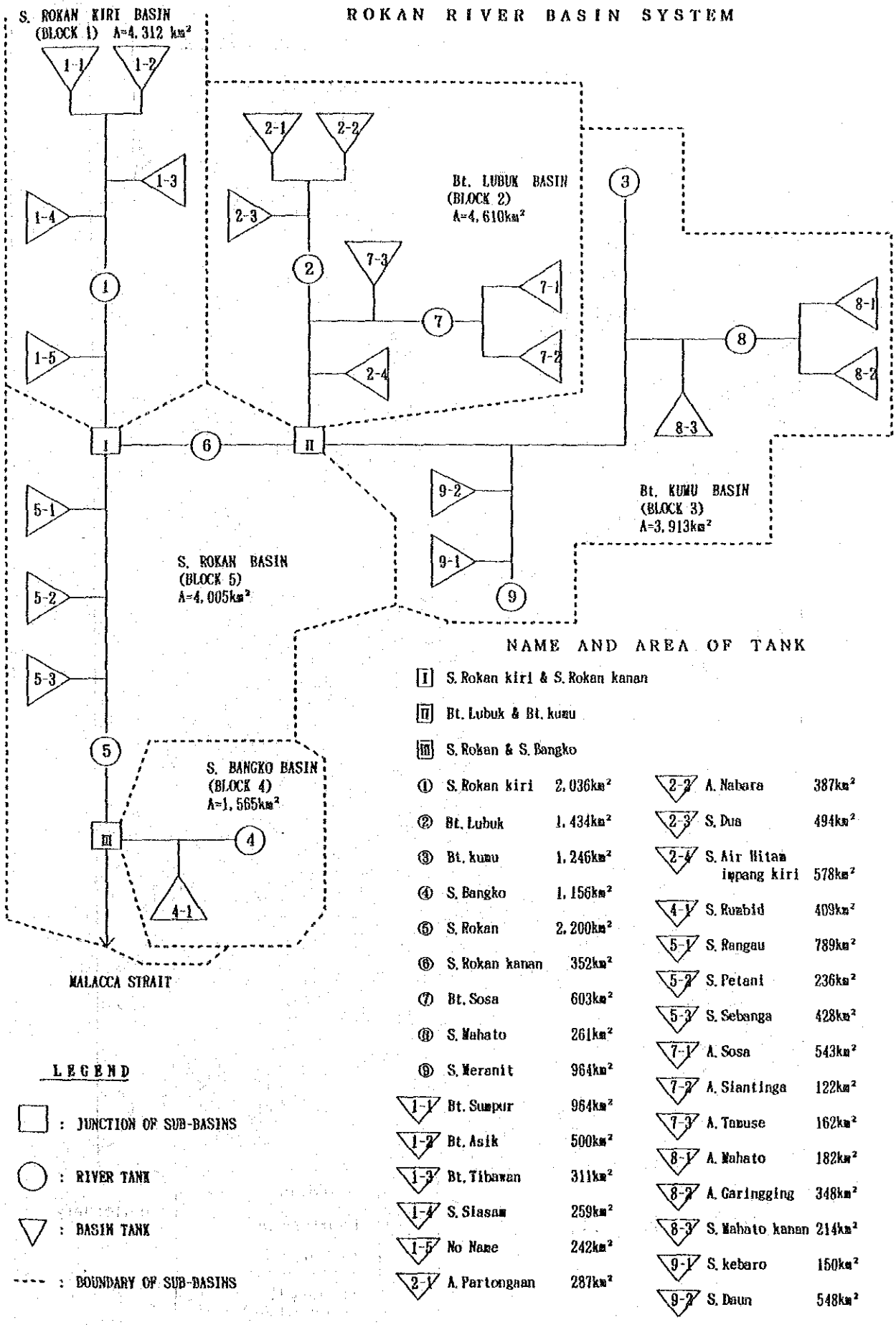
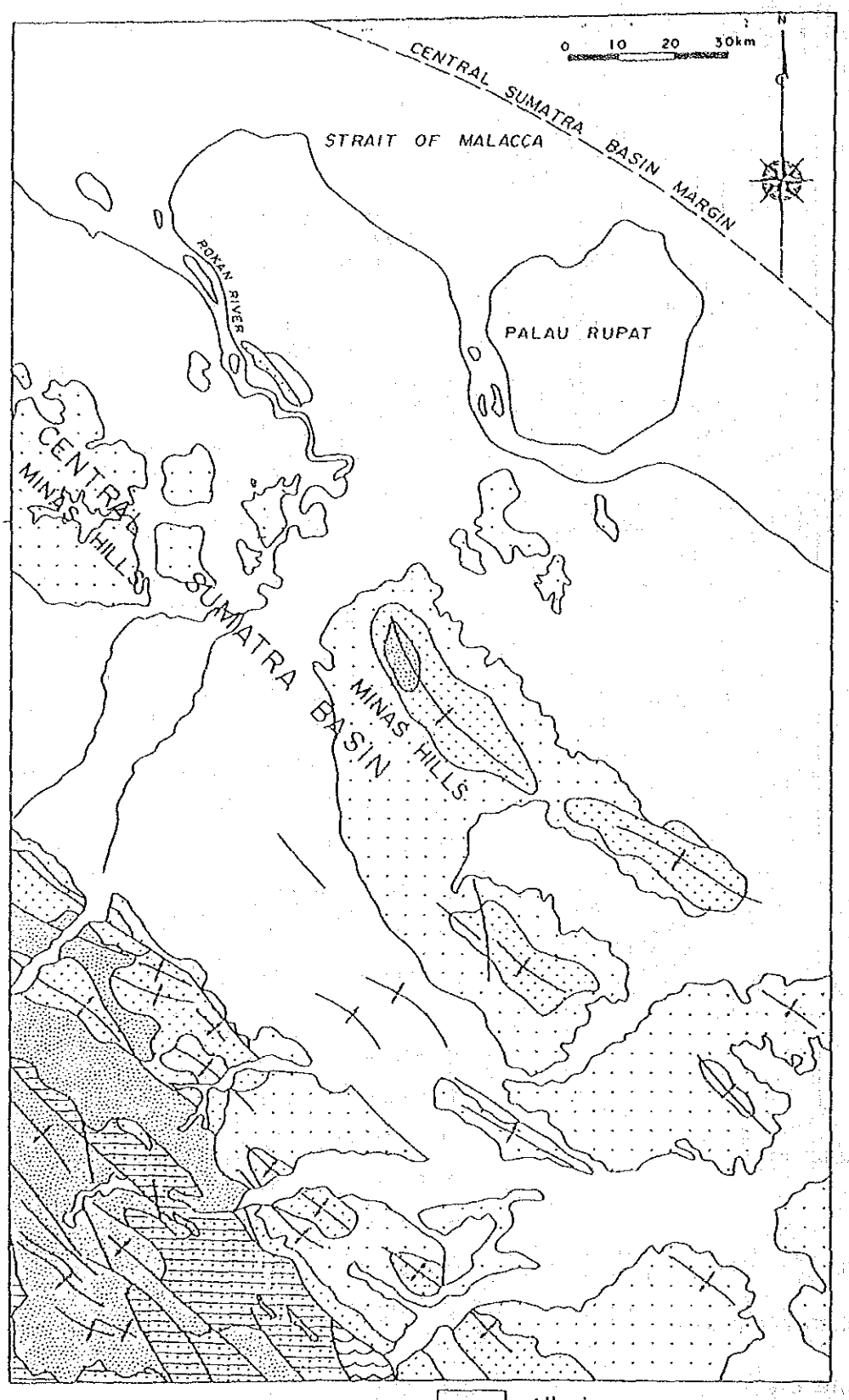


Fig. 3.1.6 Configuration of the Rokan River Basin

Fig. 3.1.7 Geological Map of The Study Area



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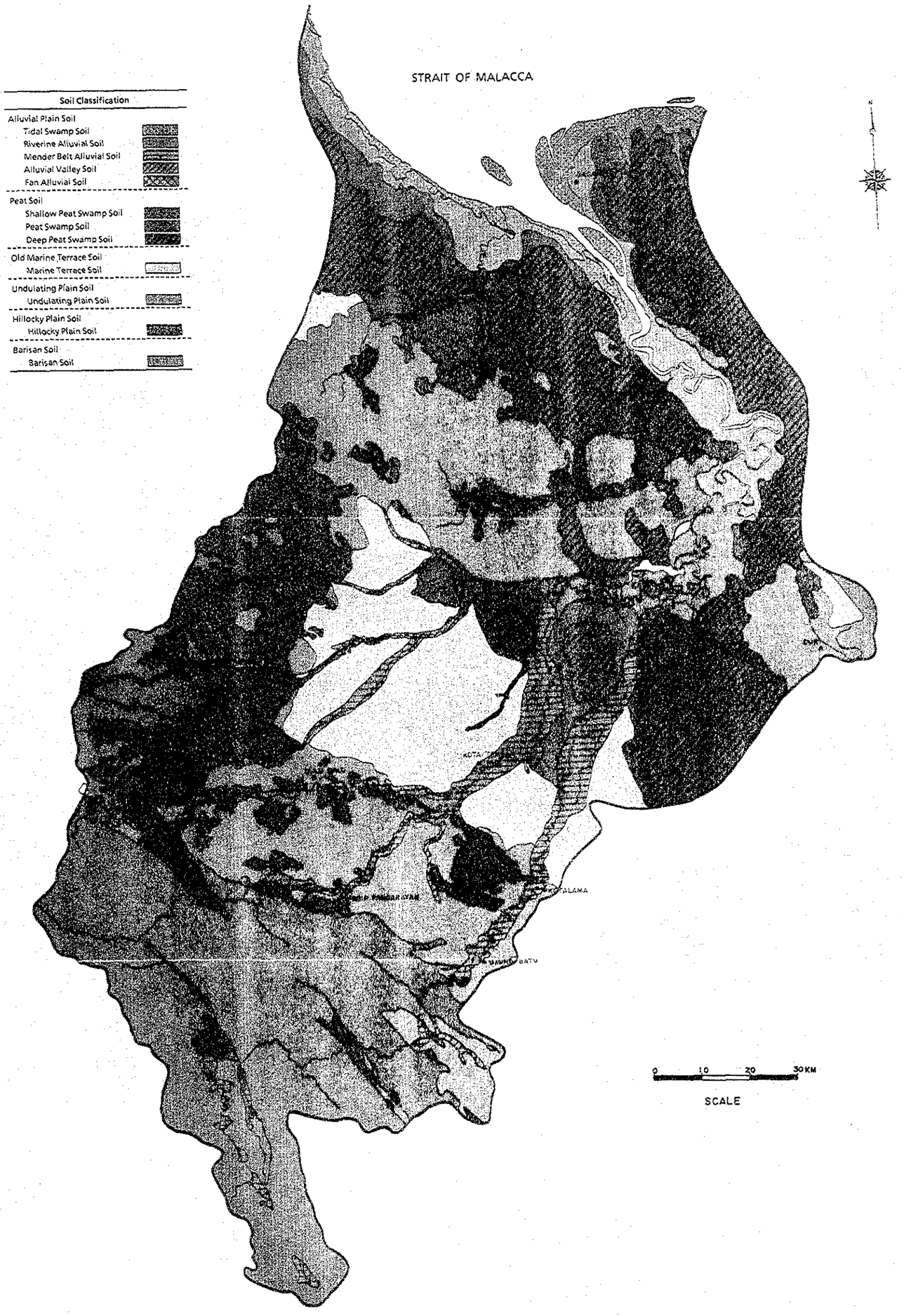

Fig. 3.1.8 Soil Distribution Map

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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

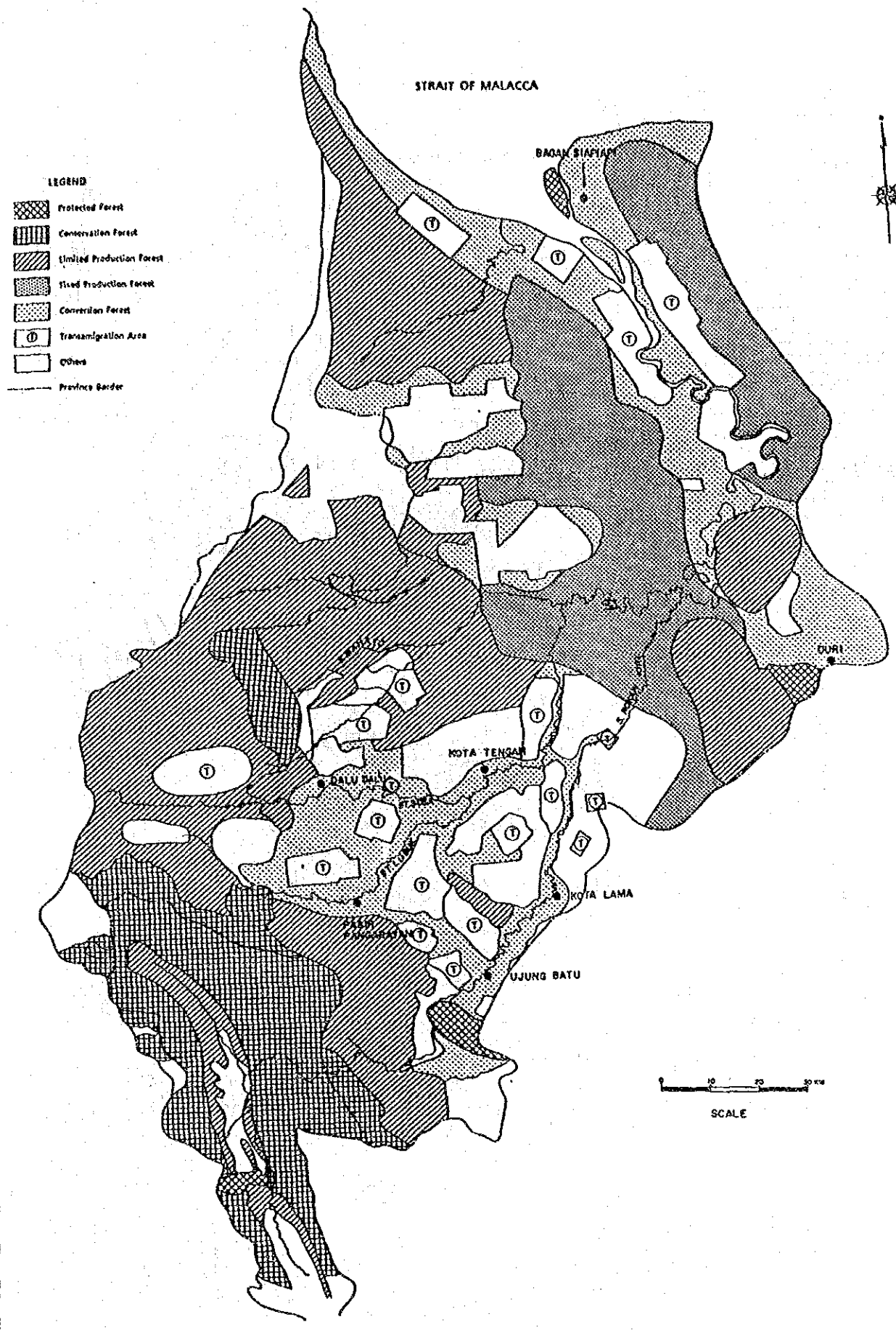

Fig. 3.1.9 Forest Classification Map

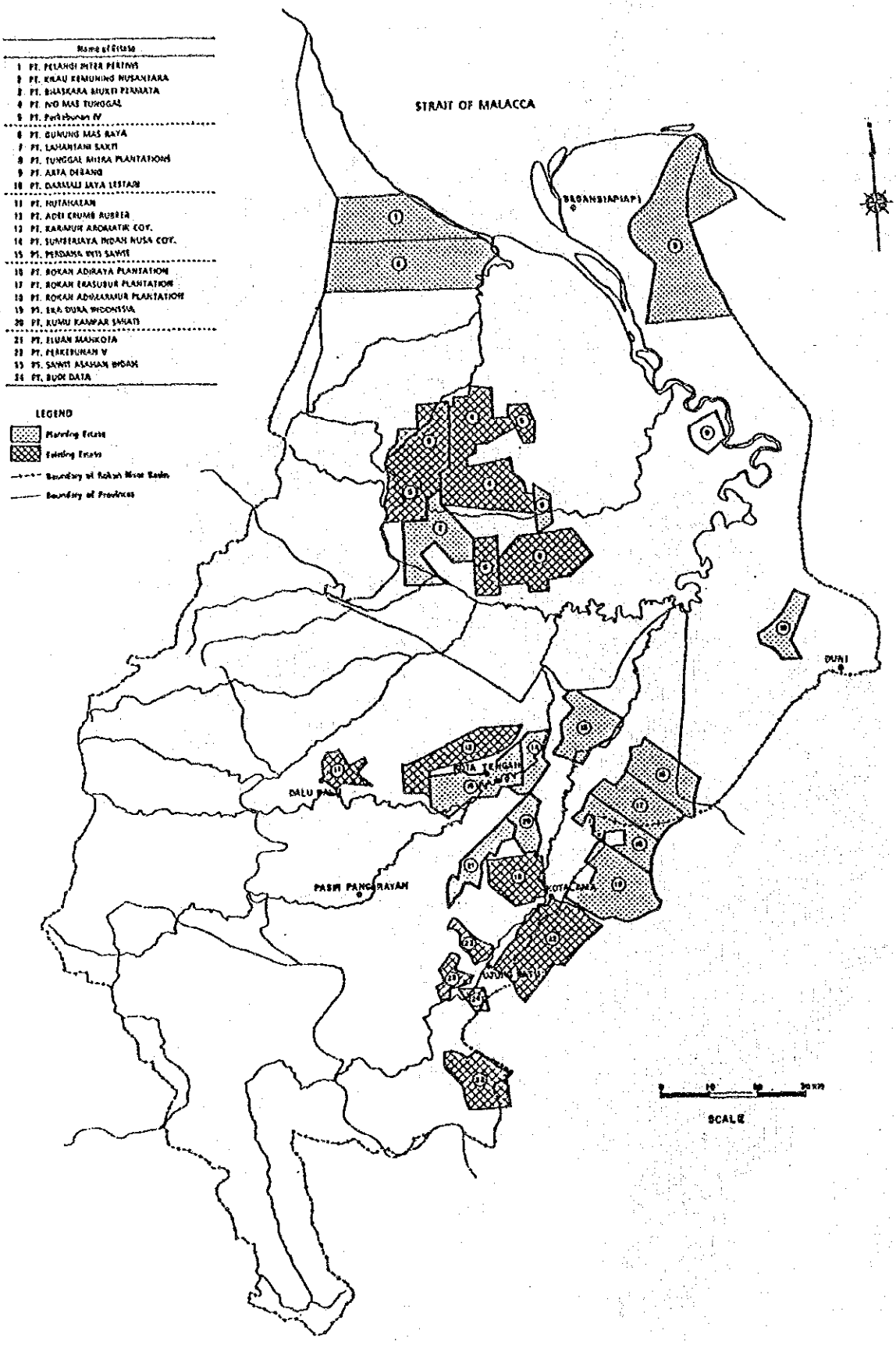

Fig.3.1.10 Distribution of Present and Planning Estate

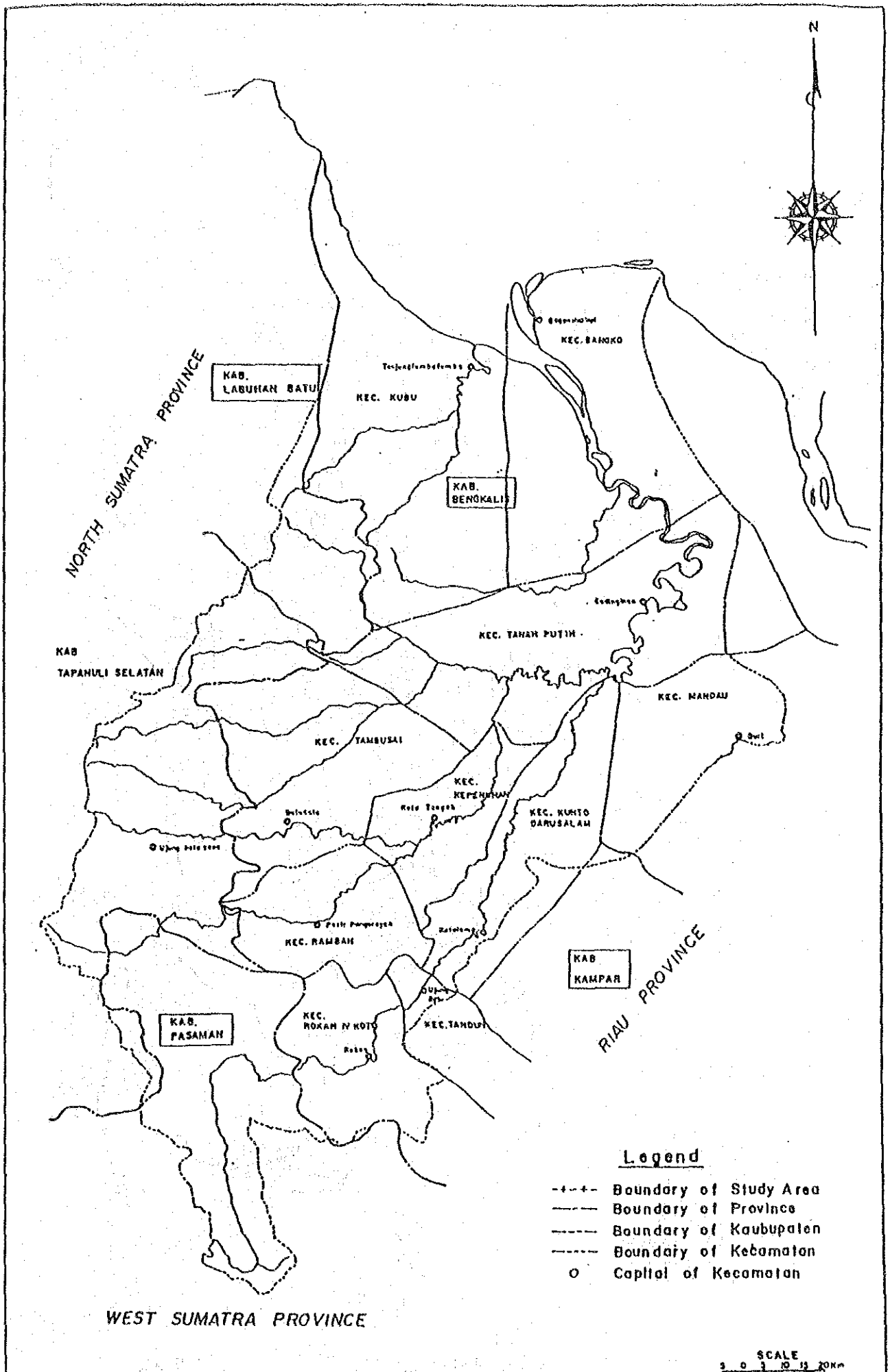

Fig. 3.2.1 Administrative Divisions

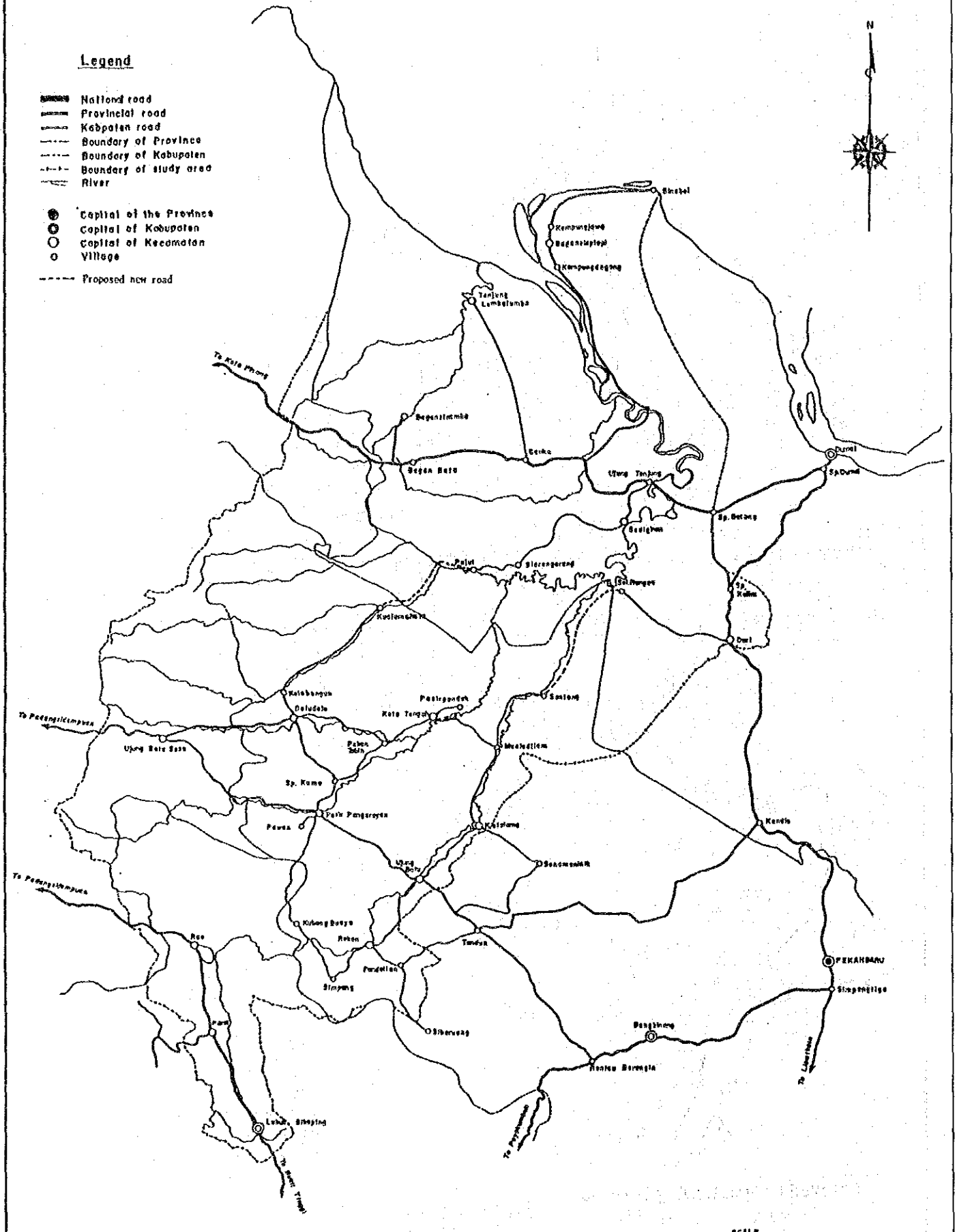

Fig. 3.2.2 Road Network