


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

FEASIBILITY STUDY
ON
BATANG KUMU IRRIGATION PROJECT
IN RIAU PROVINCE

VOLUME I
MAIN REPORT

MARCH 1989

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO, JAPAN

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PREFACE

In response to a request from the Government of the Republic of Indonesia, the Japanese Government decided to conduct a study on Batang Kumu Irrigation Project and entrusted the study to the Japan International Cooperation Agency(JICA).

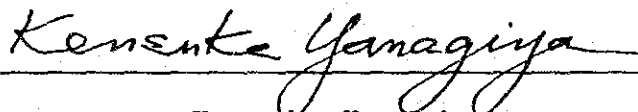
JICA sent to the Republic of Indonesia a study team headed by Mr. Takeshi Nomoto, Japan Irrigation and Reclamation Consultants Co., Ltd., from June, 1988 to January, 1989.

The team held discussions with the officials concerned of the Government of the Republic of Indonesia and conducted a field survey in Riau Province. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the development of the Project and to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Republic of Indonesia for their close cooperation extended to the team.

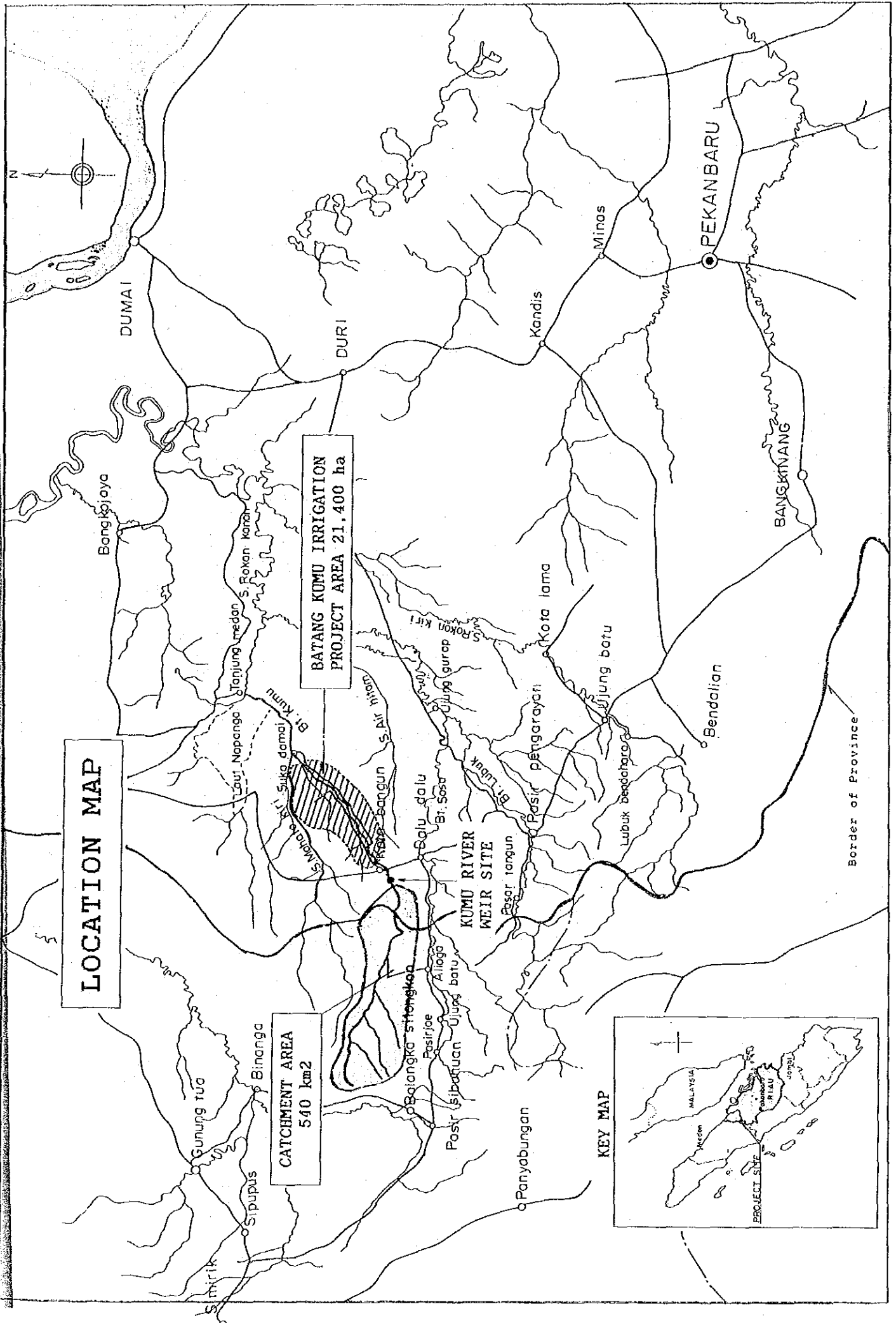
March, 1989



Kensuke Yanagiya

President

Japan International Cooperation Agency



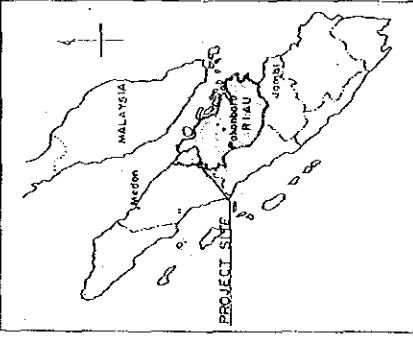
LOCATION MAP

**BATANG KUMU IRRIGATION
PROJECT AREA 21,400 ha**

**CATCHMENT AREA
540 km²**

**KUMU RIVER
WEIR SITE**

KEY MAP



Border of Province

GLOSSARY OF TERMS, ABBREVIATION AND SYMBOLS

1. Length

mm : millimeter
 cm : centimeter
 m : meter
 km : kilometer

2. Area

cm² : square centimeter
 m² : square meter
 ha : hectare
 km² : square kilometer

3. Volume

lit. : liter (=1,000 cm³)
 m³ : cubic meter
 m³/sec : cubic meter per second
 MCM : million cubic meter

4. Weight

mg : milligram
 g : gram
 kg : kilogram
 t : ton (=1,000 kg)
 t/ha : ton per hectare

5. Time

s (sec.): second
 min : minute
 hr : hour

6. Currency

US\$: US Dollar
 Rp. : Indonesian Rupiah
 (US\$ 1.00=Rp.1,710)
 ¥ : Japanese Yen

7. Other Measures

% : percent
 PS : horse power
 pH : scale for acidity
 °C : centigrade
 ppm : part per million
 EC : electric conductivity
 CEC : cation exchange capacity
 No. (Nos.): number(s)

8. Technical Terms

EL : elevation above
 M-D : man-day

ADB	Asian Development Bank
Agraria	Directorate General of Agrarian Affairs
BAPPEDA	Badan Perencana Pembangunan Daerah - Provincial Development Planning Board
B/C	Benefit Cost Ratio
B-C	Benefit minus Cost
BIMAS	Bimbingan Massal - Mass guidance for self sufficiency in food stuffs
BPH	Brown Plant Hopper
BPP	Balai Penyuluh Pertanian - Rural Agricultural Extension Center
BRI	Bank Rakyat Indonesia - Indonesian People's Bank

BULOG	Badan Urusan Logistik - National Food Logistics Agency
BUUD	Badan Usaha Unit Desa - Village Unit Executive Body
CRIA	Central Research Institute of Agriculture
DK	Desa Kucil - Small Village
Desa	Administrative Sub-division of a Kecamatan (Sub-district) administered by a Kepala desa (desa chief) representing the Camat
DOLOG	Depot Logistik-Food Procurement Agency
DPU	Department Pekerjaan Umum - Ministry of Public Works
DSP	Dry Season Paddy
DU	Desa Utama - Central Village
EIRR	Economic Internal Rate of Return
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GRDP	Gross Regional Domestic Product
IBRD	International Bank for Reconstruction and Development
IFAD	International Fund for Agricultural Development
INMAS	Intensifikasi Massal - Mass Intensification
INSUS	Intensifikasi Khusus - Special Intensification
JICA	Japan International Cooperation Agency
Kab. (Kabupaten)	District
Kec. (Kecamatan)	Sub-district
Kelompok	Farmers' Group
Kontak Tani	Key farmer or leading farmer
KIK	Small Investment Credit
KIOSK	Small shop
KK	Families
KMKP	Pre-financing Loan for Working Capital
KUD	Koperasi Unit Desa - Village Unit Cooperative Body

Kupedes	General Credit for Rural Area
Lahan Usaha I (LH-I)	First Arable Farm Land
Lahan Usaha II (LH-II)	Second Arable Farm Land
LAKU	Sistem Kerja Latihan dan Kunjungan - Training and Visit System
O&M	Operation and Maintenance
P3A	Water User's Association
P3SA	Proyek Perencanaan Pengembangan Sumber-sumber Air - Water Resources Development Planning & Project Division
Palawija	Second crop planted after harvest of wet season paddy
PPL	Penyuluh Pertanian Lapangan - Agricultural Field Extension Worker
PPM	Penyuluh Pertanian Madya - Agricultural Extension Officer
PPS	Penyuluh Pertanian Spesialis - Agricultural Extension Specialist
Repelita	Rencana Pembangunan Lima Tahun - Five Year Development Plan
Rural Irrigation	Irrigation system with or without head works in which the flows can not be controlled/measured by permanent structures
Sawah	Paddy field
SRDP	Small Holder Rubber Development Project
SSDP	Second Stage Development Program
T.S.P.	Triple Superphosphate
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNDP	United Nations Development Program
Ulu-Ulu	Water Master
WFP	World Food Program
WSP	Wet Season Paddy

FEASIBILITY STUDY
ON
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IN
RIAU PROVINCE

MAIN REPORT

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CONCLUSION AND RECOMMENDATION

A. SUMMARY OF CONCLUSION

INTRODUCTION

1. The feasibility study (Second Stage) on the Batang Kumu Irrigation Project in the Riau Province of the Republic of Indonesia has been carried out since June 1988 as a final step of the study, for which the first stage one had been done in 1985, in accordance with the Scope of Work agreed upon in November 1984 between the Government of Indonesia and the Government of Japan. This report presents the results of the field survey and the analysis in Japan for the feasibility study on the Project.

2. The Government of Indonesia has embarked on the fourth five-year development plan (REPELITA IV; 1984/85-1988/89), of which the development plan for the agricultural sector puts primary emphasis on the following major objectives:

- a) To increase agricultural production to meet domestic requirements for food and industry,
- b) To promote the export oriented crops,
- c) To improve and stabilize farmers' income,
- d) To support regional development, and
- e) To promote transmigration activities.

3. It is said that the above major objectives will be continued in the coming fifth five-year development plan (1989/90-1993/94) and the Riau Provincial Government has expected that the agricultural sector would continue to play more important role for promotion of agro-industrial development and achievement of a more balanced economy in the Riau Province.

4. The Project area is the transmigration area where about 3,070 households of transmigrants have settled since 1981. The transmigration program has played an important role in sparsely populated area in the outer islands for agricultural development and contributed in the regional development. Especially in the Riau Province, GDP excluding oil and gas has remained lower in comparison with those of other provinces and the rice production could not meet it's demand. Therefore, the Provincial Government aims at the realization of a balanced development among agricultural sector and other sectors in the Province.

5. The Project area is situated on the both sides of the Kumu river near Kota Bangun at the most upstream part of the benefited area and has 21,400 ha on the mostly terrace with flat topography which is hardly found in the Riau Province. The transmigration program has been proceeded allocating 0.25 ha for homeyard, 1.0 ha for paddy field and 0.75 ha for tree crops (rubber, hybridcoconut, etc.) per one family of the transmigrants in the Project area. Judging from possible intake discharge on the Kumu river, the net irrigable area is estimated at 7,300 ha of paddy in the wet season, and 3,100 ha of paddy and 2,700 ha of polowijo (groundnut, soybean and maize) in the dry season. The intake facility is a weir with 5.5 m in height and 50.0 m of width, and is located near the benefited area and the irrigation

water can be efficiently conveyed through the linking canal of 4.60 Km.

6. As the net irrigable area for paddy is 7,300 ha and the number of family of existing transmigrants is 3,070, it is possible to newly settle about 4,200 families of transmigrants. As for the re-settlement, about 2,000 families are scheduled from the submerged area due to the construction of a hydroelectric power dam with the height of 58 m planned on the Kampar Kanan river near Kota Panjang about 80 Km to the south from the Project area, and other re-settlements will be planned from the higher part near the project area and other areas.

7. In the Project area, the Second Stage Development Program has been carried out by the Ministry of Transmigration under the finance and technical cooperation of the World Bank. The Project aims to improve the welfare and low income of large numbers of transmigration and includes the support for tree crop cultivation for which 0.75 ha is allocated per one family in the Area, and the urgent delineation of irrigated area has been expected.

8. Moreover, the Program Highway Six of the Asian Highway is now carried out with the IBRD loan near the Project area and in the north outside the Project area, the construction of trunk road connecting Dumai port to the North Sumatora Province has been planned. After the completion, the above roads will be very effective for taking out the agricultural products from the Project area.

9. Therefore, to promote irrigation development in the Project area situated in the agricultural region contemplated by the Provincial Government is not only to promote agricultural production including export oriented crops and to contribute to the economic stabilization of the transmigrant in the Project encourage the transmigration scheme and the regional development.

GENERAL ECONOMIC AND AGRICULTURAL BACKGROUND

10. The agricultural sector has a dominant role in the Indonesian's economy. About 55% of the total labor force is engaged in the agricultural sector, and two-thirds of the total population are depending on agriculture for their livelihood. In 1986, the sector contributed about 26% of GDP, and accounted for about 27% of total exports or about 55% of non-oil exports.

11. The relatively high rate of growth in agricultural production during 1981-1986 was largely due to record paddy. Paddy production increased by an annual rate of 3.9% during the same period to reach 39.7 million tons in 1986.

Cash crops such as rubber, palm oil, coconut and coffee are major export crops. The exports of rubber and coffee are particularly important. In 1986, the production of these two crops was estimated at 1.5 million tons, and these export value was about US\$ 1.5 billion or 20.8% of non-oil exports.

12. Until recently, Indonesia had imported its staple food, rice. However, the situation has improved, and now country has attained self-sufficiency. However, there is a forecast that a deficit of about one million tons at the lowest estimate will occur in the year, 2,005. It can be said that the increase in rice production through a continuous expansion of irrigation area and a powerful extension of crop intensification programs would be prerequisite to meet domestic demand increasing along with population growth.

13. The Riau Province is located in the northern part of Sumatra island and has an area of 94,560 km². The total population in 1986 was estimated at about 2.7 million with population growth of 3.9% on average from 1981 to 1986, which is considerably higher than an average growth rate of 2.15% per annum in the country. Of the total workforce, about 60% were in the agricultural sector.

14. In 1986, out of the Gross Regional Domestic Product (GRDP) at current market prices in this province, 67% was derived from the mining sector including petroleum production and the agricultural sector only accounts for 6.7%. Per-capita GRDP at current market prices was estimated at Rp.2.04 million or US\$ 1,233 in 1986, which is higher than the national average figure of Rp.574,000 (US\$ 347) in the same period, but per-capita GRDP excluding petroleum amounted only to Rp.522,000 (US\$ 315).

15. Because half of the land in Riau Province is covered by swamp, with the exception of some perennial crops such as oil palm and coconut, the crop production in this province are limited in the mountain slope and high land areas distributed along the border of the Provinces of West Sumatra, North Sumatra and Jambi. During the previous 3 years from 1984 to 1986, the harvested area of wet land paddy only averages about 97,000 ha.

Recently, the planted area of rubber and oil palm have increased rapidly. These planted areas expanded 354,000 ha and 95,400 ha in 1986, respectively.

16. Although the production of rice in Indonesia attained a self-sufficiency, rice production in the Riau Province could not meet its demand. In Riau Province, about 384,000 tons of rice were consumed in 1986, on the contrary, total supply of rice was about 254,000 tons with a deficit of 130,000 tons in the same year.

17. Total families of transmigrants in the country has amounted 616,000 since 1950 and during the previous 3 years from 1984 to 1986, about 15,700 families accounting for 14.4% in the country settled in this Province.

In Riau Province, it has rendered significant services to promote transmigration, in order to develop the agricultural sector. About 65,000 families accounting for 10% of total families in this province are migrants who had been settled as farmers during the past 19 years from 1969/1970 to 1987/1988. In addition, the Government of Riau Province has planned to be settled about 56,000 families between 1989/1990 and 1993/1994.

THE PROJECT AREA

18. The Project area is situated in the Tambusai district (Kecamatan), Kampar regency (Kabupaten) in the northwest about 230 Km far from Pekanbaru, the capital of Riau Province along the road, and the center of the Area is located at 1°15' North Latitude and 100°20' East Longitude.

The Project area belongs to the northern area of Riau Province and is near the boundary to the North Sumatra Province. Proposed weir site is located at the place of about 5 Km in the downstream of the Kumu river from the boundary to the North Sumatra Province and the center of the benefited area of the Project is about 25 Km far from the boundary.

The Project area is about 21,400 ha in total dividing into about 11,400 ha on the left side of the Kumu river and about 10,000 ha on the right side of the river.

19. The left side area for the Project is terrace and alluvial plain and the right side area is terrace. The elevation of the above areas gradually changes from 75 m to 15 m to the direction of northeast and the slope of the ground is averagely about 1 to 700 to the northeast.

20. The geological conditions at the proposed weir site are favorable in foundation of the weir to be constructed because the Top Formation of bed rock is overlaid by some 5 meters thick of the alluvial sediments. However, the sediments consisting of coarse to fine textured materials with white color, are widely found below 60-120 cm from the ground surface, especially on the terraces in the Project area. The special attention should be given to excavating works for canal construction and clearing, grading and leveling works for making fields especially on the terrace.

21. In the light of the morphological characteristics, the soils in the Project area are classified into 9 soil units, according to the national soil classification system in Indonesia. Generally speaking, irrigated paddy is recommendable as the land use type for the Project area taking into account the low natural fertility and high acidity. On the other hand, the soils in the Project area are not or marginally suitable for upland crops due to the low soil fertility and the risk of aluminum toxicity.

22. Average annual rainfall in the Project area is approximately 2,500 mm. Generally, the year may be divided into the wet season from September to February and the dry season from March to August, but the rainfall distribution is about 60% to 40% and does not vary so much. Average annual air temperature is 27.6°C with small fluctuation. Average annual relative humidity, sunshine duration, solar radiation and wind velocity are respectively, 80%, 46%, 311 Cal/cm²/day and 35,2 km/day. Annual pan evaporation is about 1,720 mm and the average daily one is 4,7 mm/day.

23. The catchment area of the proposed weir site is estimated at 540 km² of which 475 km² belongs to the North Sumatra Province. The catchment area in the North Sumatra has undulated area with the highest elevation of 280 m. Annual average run off at the proposed weir site is 15.5 m³/sec. The maximum monthly runoff of 29.2m³/sec in December and the minimum of about 9.2 m³/sec in July are estimated. The annual sediment transport is roughly estimated at about 8,000 m³/year. The water in the Kumu river can be used for irrigation, but it is not suitable for drinking judging from evaporated residue and the amount of KMnO₄ demand.

24. The Project area is the transmigration project area called WPPXIIB Tanjung Medan SKP-C and SKP-D, where the settlement started in December 1981. In the Project area, farmers account for 3,070 families. The farm population is estimated at 15,100 and average size of a farmer's family is 4.9 persons. The family labour force per a farm household averages 2.5 persons.

25. No irrigation paddy field is found in the Project area demarcated to be 21,400 ha in total and rain-fed paddy field accounts for only 180 ha. In the upland field estimated at 2,120 ha (9.9%), dry land paddy, corn, soybean, groundnut, etc. are cultivated. About 70% or 15,030 ha in the Project area are covered with forest, and remaining 19% consist of grass land, village (home yard) and others such as river and road. A private company had the right to cut trees of the forest in the left side area of the Project area, but the Ministry of Forest approved to develop the area for Transmigration in July 1988.

26. According to the standard of the Transmigration Office, the area of land to be allocated to the transmigrants is 2.00 ha per one family, which consists of 0.25 ha of home yard, 1.00 ha for paddy field (first arable farm land) and 0.75 ha for tree crops (second arable farm land). The land clearing for the first arable farm land is done by the Ministry of Transmigration and, that for the second arable farm land is carried out by the transmigrants themselves. Moreover, the land of 0.25 ha per one family is generally kept for public land. Each transmigration village has public facilities such as mosque, school, market and government offices nearly in the center, home yards surrounding them, the second arable farm land surrounding first. More than 80% of the first arable farm land were already cleared by the Government, but the land reclamation in the second arable farm land has been hardly performed by the transmigrants and its progress is about 40%.

27. All the farm fields in the Project area are put under rainfed condition. The cultivation pattern is generally affected by seasonal distribution of rainfall, and the harvested and/or planted areas fluctuate year by year, depending on the available rainfall water. In the Project area, the cultivation of wet land paddy is concentrated in the wet season, while dry land paddy and polowijo crops are generally planted in the both seasons. In general, most of wet season crops are sown in August and September and harvested from December to February. The dry season crops start in February/March, after harvest of the wet season crops. Mixed culture of polowijo crops is common practices in the Project area.

28. In the farming practices for wet land and dry land paddy, plowing is made by using animal and man power, and fertilizers and agro-chemicals are commonly applied. The cultivation method of polowejo crops are very simple, but fertilizers and insecticides are actually applied, except for cassava.

29. Present crop yields in the Project area very low. Of these, the biggest constraint is water stress such as drought. The average crop yield in the Project area is 2.8 ton/ha for wet land paddy, 1.2 ton/ha for dry land paddy, 1.3 ton/ha for maize, 0.9 ton/ha for groundmeat, 0.7 ton/ha for soybeans and 7.0 ton/ha for cassava. The total production of crop in the Project area is estimated at 1.673 ton for paddy, 760 ton for maize, 280 ton for soybeans and 1.650 ton for cassava.

30. In the Project area, most paddy and polowejo crops are consumed by farmers themselves, and a small quantity is sold at local markets in and around the Project area either by the farmers themselves or through brokers in order to get some cash income. In the Project area, the net supply of rice was estimated at about 1,077 ton. On the contrary, the demand of rice for the total population of 15,100 was 1,963 ton. As a result, the rice shortage of about 886 ton was estimated in the area. This shortage quantity has been supplied mainly from North Sumatra Province.

31. The present farm gate prices of major farm products prevailing in the Project area are per Kg, Rp. 650 for rice, Rp 210 for dry grain paddy, Rp. 175 for maige, Rp 680 for groundnut, Rp 500 for soybeans, Rp 600 for greenbeans and Rp 50 for cassava. DOLOG controls the price of rice in the market.

32. The farmers' economy in the Project area remains at the subsistence level, the farmers have received a considerable amount of subsidy from WFP (FAO Project) through the transmigration office. It is equivalent to about Rp 220,000 per one family per year.

33. In the Project area, 6 KUDs have been organized so far. The total number of KUD members including candidates is about 49% of total farm household in the area. The Project area is covered by the Rural Extension Center (BPP) Dalu-Dalu located at Kota Bangung. The total number of staff in this BPP are 2 extension supervisors and 14 field extension workers.

34. There in no sub-branch office of the Indonesian People's Bank (BRI) in the Project area and the farmers/KUDs must go to Pasirpangarajan to receive credit services from BRI.

35. In the Project area, there are one FAO program, three World Bank projects and one private project as described below:

- a) WFP
The WFP has been executed by the Ministry of Transmigration with the objective of the food supply to settlers.

- b) **Second Stage Development Program (SSDP)**
 The Second Stage Development Program has been carried out by the Ministry of Transmigration under the finance and technical cooperation of the World Bank. The Project aims to improve the welfare and low income of large numbers of transmigrants. In the Project area, the following works have been planned by this project. (1) Rehabilitation of road between the center of transmigration area and Dulu-Dulu (2) Rehabilitation of road and bridge in each transmigration village, (3) Improvement of shallow wells, (4) Reconstruction of houses and (5) Land clearing and relocation of farm land. The feasibility study commenced from January 1987 and finished in February 1988, the detailed design started from August 1987 and the tender documents for a part of the objective area are completed. After the loan agreement scheduled in March 1989, the construction work is scheduled to be started. However, in the case of the Project area, it is necessary for the SSDP to revise a part of the plan due to the irrigable area, plan of irrigation and drainage canals, plan of road, etc. of the Batang Kumu Project because it is said that the World Bank has a concept to give priority to the irrigation project.
- c) **Smallholder Rubber Development Project (SRDP)**
 The executing agency of SRDP is the Bureau of Estate. The project period ranges from 1986 to 1990. In order to increase rubber production, SRDP has given credit to small farmers, which consist of rubber seedling and land reclamation cost of rubber estate in the Project area.
- d) **IFAD Project**
 The objective is to supply animal power to farmers in the Project area. The period of this Project is ten years from 1983 to 1992.
- e) **Plantation Project**
 A private firm, P.T. HUTAHAEN has a plan to construct a plantation of about 4,800 ha on the right side of the Kumu river in the Project area. The construction is scheduled to start from the end of 1988 or the beginning of 1989.

36. The higher land in the outside of the border in the southwest of the Project area is the protection area of the forest by the Forestry office. Other land surrounding the Project area consists of the permissible land in which the special trees could be cut, non-specified land, the land scheduled for transmigration, etc. In the catchment area of the North Sumatra Province, the transmigration area (Ujung Batu DK-I/V) of 5,625 ha in total was developed.

THE PROJECT

37. The objective of the Project is to implement an irrigation project mainly for paddy cultivation aiming at contributing to increase the yield for food products, to realize an economic stability in the region, and encourage the transmigration scheme and the regional development. For this purpose, it is necessary to realize prompt implementation of the following matters for the Project area to be transmigration area and with no irrigation and drainage facilities using water resources effectively.

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

38. The Project is formulated with the following concepts of

- a) The Project area is selected on the both sides of the Kumu river with transmigrants settled
- b) The water source facility and intake water level are planned so as not to give the influence of backwater to the North Sumatra Province
- c) The plan of supplemental facilities for irrigation is taken as the one for the future
- d) The irrigable areas are delineated taking into account the above intake facility and water level, possible intake discharge, land suitability, topography, etc.
- e) Taking into consideration the Government's policy for development, the farm land is allocated to be 1.0 ha for paddy field and 0.75 ha for tree crop land (rubber, hybridcoconut, etc.) per one transmigration family
- f) A general plan for new transmigration in the Project area is studied
- g) To introduce diversified cropping pattern, the irrigation for paddy and polowijo crops in the dry season is planned

- h) Considerable parts of canal are lined taking into account the soil mechanical condition in the Project area
- i) The Project is formulated taking into account the future operation and maintenance as much as possible
- j) The construction of mini-hydroelectric power plants is costly in comparison with the diezel generation.

39. The Project area is demarcated to be 21,400 ha in gross on the both sides of the Kumu river taking into account the possible intake discharge at the propose weir sits on the Kumu river, planning intake water level, cropping pattern, water requirement, irrigable area, present condition of transmigration, land use, land suitability, possible number of families of new transmigrants, allocated land, the Government's policy for development, etc. The proposed land use for the Project is as follows:

<u>Division</u>	<u>Left Side</u> (ha)	<u>Right Side</u> (ha)	<u>Total</u> (ha)
Gross Irrigation Area	5,000	3,110	8,110
Net Irrigation Area	(4,500)	(2,800)	(7,300)
Tree Crop Land	3,175	2,100	5,275
Home Yard	1,025	700	1,725
Public Land	1,025	700	1,725
Others	1,175	3,390	4,565

Total	11,400	10,000	21,400

40. The group system (nucleate agricultural village community) is adopted for the layout of new transmigration villages with about 400 households per each village. The numbers of transmigration families and villages are planned as follows:

<u>Division</u>	<u>Left Side</u> (ha)	<u>Right Side</u> (ha)	<u>Total</u> (ha)
Households			
Settled Already	1,619	1,451	3,070
New/Re-settlement	2,880	1,350	4,230
Total	4,499	2,801	7,300
Villages			
Settled Already	4	4	8
New/Re-settlement	6	3	9
Total	10	7	17

41. Wet season paddy is cultivated in the irrigation area of 7.300 ha in net and the dry season paddy is cultivated in 3,100 ha and polowijo crops (groundnut, soybeans and maize) in 2,700 ha are introduced taking into consideration the diversification of

agricultural products. The annual crop production under the future with project condition is estimated as follows, on condition that the unit yields will increase gradually from the present level to the anticipated yields in the 5th year after completion of the Project.

<u>Crops</u>	<u>Unit Yield</u> ton/ha	<u>Area</u> ha	<u>Production</u> ton
Wet season paddy	5.0	7,300	36,500
Dry season paddy	5.0	3,100	15,500
Groundnut	0.9	900	810
Soybean	0.7	900	630
Maize	1.3	900	1,170

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

43. Two alternative sites on the Kumu river for the weir were thoroughly surveyed and studied from the technical and economical viewpoints. As the results, the site at about 3.5 km in the upstream from Kota Bangun is recommendable for constructing diversion weir at an elevation of 60.50 m in its intake water level.

44. The irrigation water requirement for the Project is estimated for the proposed cropping pattern with irrigation efficiency to be 55%. As the results, the maximum ten days requirements are estimated at 1.28 l/sec/ha for wet season paddy, 1.54 l/sec/ha for dry season paddy and 0.32 l/sec/ha for polowijo crops respectively. The maximum diversion requirement at the proposed weir site is estimated at 9.34 m³/sec in the wet season and 4.77 m³/sec in the dry season.

45. The irrigation water is diverted by gravity method from the weir and conveyed through the linking canal of 2.61 km on the left side of the Kumu river, and then diverted to two main canals for the left side and the right side of the Kumu river. The right main canal crosses the Kumu river by a siphon structure.

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

- 1) Weir
 - Intake water level : EL 60.50 m
 - Weir height : 5.50 m
 - Weir width : 50 m
 - Flood way : 14 m x 3 spans
 - Scouring sluice : Undersluice (2 m x 2 spans)
 - Intake : Sluice gate (2.5 m x 3 spans)
- 2) Linking canal
 - Length : 2.61 km
 - Canal Slope : 1/5,300
 - Type of canal : Trapezoidal, lined
 - Width of canal base : 3.30 m
- 3) Main irrigation canals
 - Length left : 25.6 km
 - right : 18.7 km
 - Type of canal : Trapezoidal, 90% lined
 - Related structures, left : 114 Nos.
 - right : 74 Nos.
- 4) Secondary irrigation canals
 - Length, left : 50.1 km
 - right : 30.1 km
 - Type of canal : Trapezoidal, unlined
 - Related structures, left : 236 Nos.
 - right : 144 Nos.
- 5) Drainage canals
 - Drainage canal, left : 27.7 km
 - right : 28.7 km
- 6) Inspection roads and other roads
 - Main road : 44.3 km
 - Secondary road : 80.2 km
 - Other road : 33.3 km
- 7) Tertiary system and farm road
 - Irrigation canal : 486 km
 - Drainage canal : 192 km
 - Farm road : 146 km
- 8) Land reclamation
 - Land clearing : 1,000 ha
 - Land leveling : 5,000 ha
- 9) Operation and Maintenance
 - Equipment : L.S
 - Facilities : L.S

47. The Ministry of Public Works (DPU) is responsible for implementation of irrigation projects. For the construction works of these projects, the responsibility of DPU is generally limited up to the secondary canal and tertiary box. On-farm development within the tertiary irrigation block such as tertiary canal, quaternary canal, farm ditch, farm road and land reclamation of field are left to the farmer's hand. Because of the lack of fund and insufficient technique, however, this on-farm development is usually delayed in its commencements. Although there are various technical and credit services by the Ministry of Agriculture, the construction cost for the works described the article 46 should be included in the Project taking into consideration the lack of fund of the farmers in the Project area. On the other hand, the project cost for new transmigra-

tion/re-settlement of about 4,200 families including the costs for home yard, house, well, road, first arable farm land, etc. would be left to the Ministry of Transmigration.

48. First of all, the detailed design is needed for the implementation of the Project. The whole project works would be generally divided into two stages, that is, the first stage for the existing transmigration areas (six work divisions) and the second stage for the areas for new transmigration/re-settlement (two work divisions). It is recommendable to construct the weir and linking canal at first and then others facilities to the downstream in order taking into account the above stage plan.

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

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

51. The total project costs required are estimated to be about US\$43 million which comprise US\$23.9 million of foreign portion and US\$18.6 million equivalent of local portion, which include the physical contingency of about 5% of direct cost and price contingency of about 4% per annum for the foreign currency portion and 10% per annum for the local currency portion. The annual operation and maintenance costs are estimated at about Rp 162 million per annum. (US\$1.0 = Rp 1,710)

52. The agricultural net incremental benefit through the irrigation project is estimated at about Rp 8,563 million per annum. The economic feasibility of the Project is evaluated in terms of internal rate of return of the basis of a 50 years useful life including the project costs for new transmigration/re-settlement. The calculated internal rate of return is around 12.7% excluding the benefits from the tree crop areas, which indicates the economic soundness of the Project.

B. RECOMMENDATION

1. The Project is an irrigation project for the both transmigration areas already settled and newly settled, expects the implementation of new transmigration as planned. In addition, there are some related projects implemented in the Project area. Therefore, it is recommendable to establish a special committee to coordinate all activities of relevant Government agencies and regional administrative organizations in connection with the Project implementation.

2. For the successful implementation of the Project, the following works are required to be carried out particularly during the detailed design.

- a) Supplemental topographic survey on the parts of the right side of the Kumu river with the lack of topo-map of 1/5,000 should be carried out.
- b) The selection of the proposed canal routes and their survey on plan and profile of 1/2,000 scale should be performed.
- c) To assure soil profile, test pits with about 500 m intervals on the proposed canal routes should be done.
- d) The location of borrow pits for embankment materials and their soil mechanical properties should be studied for canal construction.
- e) For the confirmation of percolation loss of water on irrigated paddy field, the field percolation test and checking of surface soil depth should be carried out.
- f) It is recommendable to establish a climatological station in the center of the Project area and install some automatic rainfall recorders in the catchment area of the Kumu river.
- g) To select appropriate varieties, establish advanced farming practices and reduce production cost for polowijo crops to be introduced in the soil conditions with serious constraints of the Project area, it is recommendable to establish a pilot farm in the Project area.

3. The conservation of the catchment for the Kumu river is important, because it is indispensable to assure stable river discharge for the irrigation to the Project area. It is recommendable to propose the forest conservation and erosion prevention to the North Sumatra Province.

4. The plan of operation and maintenance for the weir and canal system should be studied in more details during the detailed design.

5. The plan of supplemental irrigation facilities for the Mahato river would suggest the possibility to develop the remaining area on the left side of the Kumu river in the future.

6. In order to increase agricultural production in the future, it is indispensable to arrange not only irrigation facilities, but institutional services such as agricultural extension, credit, farm input supply and marketing.

1. INTRODUCTION

1.1 BACKGROUND OF STUDY

The feasibility study (Second Stage) on Batang Kumu Irrigation Project in Riau Province, the Republic of Indonesia (hereinafter referred to as the Study) has been carried out as a final step of the Study, for which the first stage one had been done since June 1985, in accordance with the Scope of Work agreed upon on November 23, 1984 between the Directorate of Planning and Programming, Directorate of General of Water Resources Development (hereinafter referred to as DGWRD), Ministry of Public Works, the Government of the Republic of Indonesia and the Japan International Cooperation Agency (hereinafter referred to as JICA), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan.

At the first stage, topographic ground survey, shooting of aerial photograph and partial works of the feasibility study such as data collection and field survey including river discharge observation has been scheduled to be carried out as a prerequisite for the Study. However, the Study was suspended because of the difficulties about shooting and taking out of aerial photograph and the study report for the first stage was made by carrying out the tentative study on the project on the basis of collected data during the field survey for the first stage.

After that, the reopening of the Study using existing topographic map was requested by DGWRD in April 1988 and the Study for the second stage was started.

The plan of operation for the Study (Second Stage) was explained by the feasibility study team sent by JICA and finalized by DGWRD and the study team during the period from June 12 to June 23 in 1988. During that time, the addition of the study area of about 10,000 ha on the right bank side in which the transmigrants of about 2,100 households in total settled already was requested to study the feasibility for irrigation development and the Study on that area has been carried out within the scope of contract works by JICA to a firm in Indonesia, and the study report for the first stage was submitted on June 14 as an inception report for the second stage.

1.2 ACTIVITY OF THE STUDY TEAM.

The objective of the Study is to conduct a feasibility study on Batang Kumu Irrigation Project (hereinafter referred to as the Project) mainly for paddy cultivation aiming at contributing to increase the yield for food products to realize an economic stability in the region, and encourage the transmigration scheme and the regional development, in accordance with the Scope of Work agreed upon on November 23, 1984 between the Directorate of Planning and Programming, DGWRD and JICA and the Plan of Operation agreed upon June 21, 1988 between the Directorate of Irrigation II and the feasibility study team sent by JICA.

The field survey for the study (second stage) was carried out from July 17 to November 17 in 1988 and an interim report was submitted on November 16, 1988. The main works of the above field survey were as follows:

- (1) Study on the existing results of topographic survey, longitudinal and cross sectional survey, geological, geological, soil mechanical and soil survey and conducted by DGWRD
- (2) Checking of following contracts works with an Indonesian firm and analysis of the results
 - a. Topographic survey, longitudinal and cross sectional survey
 - b. Geological survey
 - c. Soil mechanical survey
 - d. Soil survey and other surveys
- (3) Hydrological and meteorological survey
 - a. River discharge observation
 - b. Water level gauging observation (by DGWRD)
- (4) Topographical survey
- (5) Soil survey
- (6) Geological and soil mechanical survey
- (7) Agricultural and agro-economy survey
- (8) Regional and socio-economy investigation
- (9) Irrigation and drainage survey including weir site and canal route
- (10) Investigation of construction material
- (11) Investigation of transmigration projects
- (12) Preliminary study and analysis

Successively, the detailed study and analysis were done in Japan from November 18, 1988 to January 16, 1988. The main works were as follows:

- (1) Soil evaluation for farmland in the Project area
- (2) Confirmation of river discharge
- (3) Planning of cropping pattern
- (4) Estimation of irrigation water requirement
- (5) Study of irrigable area and land use in the development area

- 4(6) Design of the new irrigation/drainage system
- (7) Study of agricultural and agro-economy
- (8) Study of alternative development plans
- (9) Study of construction materials
- (10) Cost estimation
- (11) Verification of feasibility as a project
 - a. Estimation of costs and benefits
 - b. Economic and financial evaluation
 - c. Implementation schedule
 - d. Development impact

The Draft Final Report was submitted in January 1989 for the review of the Government of Indonesia. The report described the development plan of the project, appropriate time schedule, preliminary estimate of investment cost and economic and financial viabilities of the proposed irrigation and agricultural development plan. The Final Report prepared taking into account the comments made by the Government of Indonesia on the Draft Final Report, was submitted in March 1989.

The team member and the counterpart personnel provided by the Government of Indonesia are listed in Table 1.1 and their activities are illustrated in Fig.1.1

Table 1.1 LIST OF FEASIBILITY STUDY TEAM AND
COUNTERPART PERSONNEL

(1) Feasibility Team

Takeshi NOMOTO	: Team Leader
Yoshitami ISEKI	: Irrigation & Drainage
Yasuyoshi SHIMIZU	: Meteorology & Hydrology
Tadaharu MURONO	: Agronomy, Agro-Economy & Project Evaluation
Akihiko SASAKI	: Soil & Land use
Toshiyasu MATSUOKA	: Geology
Akito OTA	: Dam (Diversion Works)
Shigeaki HOSHINO	: Canal Str. Design
Masataka YAMAGUCHI	: Construction Planning
Hajime GOTOH	: Topographic Survey

(2) Counterpart Personnel

Ir. T. Syamsul Bachri Dipl. HE	: Team Leader/Meteorology & Hydrology, D.P.U. Riau
Agus Jati Wiryono	: Irrigation & Drainage DOI-II, Jakarta
Ir. Janualis	: Agronomy, Agro economy, Project evaluation/Soil & land use, D.P.U. Riau
Ir. Bakri Hidayat	: Geology, D.P.U. Riau
Turkan BE	: Dam (Diversion Works)/Canal Structure design, D.P.U. Riau
M. Murni ME	: Construction Planning, DOI-II, Jakarta
Ir. Erwin Touran	: Topographic Survey, D.P.U. Riau

Fig. 1.1 SCHEDULE OF STUDY

Division	Work Item	1988/89											
		A	M	J	J	A	S	O	N	D	J	F	M
Study	Preparatory Survey			—									
	Field Survey					—————							
	Detailed Study												
	and Analysis in Japan								=====				
	Explanation of D.F.R.										—		
	Preparation of F.R.											-----△	
Contract Work	Topographic Survey				Field Preparation	—————							
	Other Surveyings					—————							
	Geology/Soil Mechanic Survey					—————							
	Soil Survey					—————							
	Water Quality Test						—						
Report	Plan of Operation				△								
	Interim Report										△		
	Draft Final Report (D.F.R.)											△	
	Final Report(F.R.)												△

————— Work in Indonesia

===== Work in Japan

2. GENERAL BACKGROUND

2.1 NATIONAL SOCIO-ECONOMY

2.1.1 Land and Population

The Republic of Indonesia is located between latitude 6 08' north and 11 15' south, and between longitude 94 45' and 141 05' east with an area of 1.92 million km². In 1986, the total population of the country was about 168.1 million with a population density of about 88 persons/km², which had increased at an average growth rate of 2.15% per annum during the period from 1980 to 1985. The total labor force in the whole country was estimated at about 70.2 million in 1986. The structure of employment comprises 55.1% for agriculture, 8.2% for trade and manufacturing and remaining 36.7% for others.

2.1.2 National Economy

In 1986, the gross domestic product (GDP) in Indonesia was Rp. 96,489 billion at current market prices or equivalent to US\$ 58.3 billion (see Table 2.1). In the same year, per capita GDP was about Rp. 574,000 or US\$ 347. During the previous three years from 1984 to 1986, GDP in real terms increased at a rate of 3.8% per annum. Of the GDP in 1986, about 26% was derived from the agricultural sector followed by 17% from the trade sector.

During the period from 1981 to 1982, the balance of payments position of the Indonesia deteriorated severely, with the result that export prices for Indonesian's oil and LNG remained on the whole stagnant and the export volume declined due to the depressed international oil market. In 1982, total exports of oil and LNG on a net basis were estimated to have declined to US\$ 3.9 billion or 17% below the 1981 level. At the same time, the total imports of capital and intermediate goods had increased. As a result, the trade balance registered a current account deficit of US\$ 5.5 billion in 1982. After accounting for other transactions such as capital inflows of the Government and private sector, however, the balance of payments recorded an overall deficit of US\$ 1.9 billion. In 1983, the overall balance was improved, but it again deteriorated in 1986.

2.1.3 Agriculture

The agricultural sector has a dominant role in the Indonesian's economy. About 55% of the total labor force is engaged in the agricultural sector, and two-thirds of the total population are dependent on agriculture for their livelihood. In 1986, the sector contributed about 26% of GDP, and accounted for about 27% of total exports or about 55% of non-oil exports. Food crop production is the major subsector constituting about 61% of total GDP added in agriculture. Livestock accounts for 10.7%, fishery 7.1% and forestry 3.9%.

Principal food crops in the country are paddy, maize, soybeans, groundnuts, cassava and sweet potatoes. The relatively high rate of growth in agricultural production during 1981-1986 was largely due to record paddy production. Paddy production increased at an annual rate of 3.9% during the same period to reach 39.7 million tons in 1986. Indonesia used to import rice, but the supply situation has improved since 1985, and now the country has attained self-sufficiency. Cash crops such as rubber, palm oil, coconut and coffee are major export crops. The exports of rubber and coffee are particularly important. In 1986, the production of these two crops was estimated at 1.5 million tons, and their export value was about US\$ 1.5 billion or 20.8% of non oil-exports.

2.1.4 Demand and Supply of Principal Food Crops

In order to clarify the marketability of principal food crops in the country, demand and supply forecasts are made on the basis of past trends in their production.

(1) Rice

Rice production has increased rapidly at a rate of 4.6% per annum on an average over the past 19 years from 1968 to 1987. Assuming that this upward trend will continue until 2005, it is forecast that Indonesia will increase its annual rice surplus over domestic demand by about 5 million tons in 2005.

Such probable growth of rice supply and a considerable amount of rice surplus were estimated on the basis of expected changes in irrigation area and extension of crop intensification programs. In this context, the sensitivity analysis of demand and supply for rice is examined as follows, on the assumption that annual growth rate of rice supply will decrease from 2.5% to 1.25% on average between 1990 and 2005.

(Unit: 10⁶ tons)

	1990	1995	2000	2005
1) Supply	26.5	28.1	29.8	31.5
2) Demand	26.3	28.7	31.1	33.3
3) Balance	+0.2	-0.6	-1.3	-1.8

As shown in the above table, a deficit of 1.8 million tons was estimated in 2005. Considering the recent aggravation of Indonesia's economy, it seems that this case is likely to occur, because of insufficient funds for implementation of new irrigation projects and for extension of crop intensification programs in the future.

According to the workshop report on the Secondary Food Crops

Development Project (SFCDP)*1, on the other hand, a rice deficit of about 0.5 million tons is forecast in 2000. In 2005, the deficit of rice will reach about 1.1 million tons*2.

As a result of the above forecast, a deficit of about one million tons at the lowest estimate would be forecast in 2005. It can be said that the increase in rice production through continuous expansion of irrigation area and powerful extension of crop intensification programs will be necessary to meet domestic demand increasing along with population growth.

(2) Upland Crops

Owing to fluctuations in rainfall, the trends in the supply of upland crops are erratic, but generally upward. It is forecast that these trends will continue until 2005, and by then total supplies of maize, groundnuts, soybeans and cassava will reach about 7.03, 0.78, 1.32 and 14.90 million tons, respectively. On the other hand, the demand for these four crops have also increased over the supply trends, and by 2005 will amount to about 7.17, 0.93, 1.71 and 16.7 million tons, respectively. As a result, by 2005 supply deficiencies will occur, which are estimated at 0.14 million tons for maize, 0.15 million tons for groundnuts, 0.39 million tons for soybeans and 1.80 million tons for cassava.

2.2 Regional Socio-economy

2.2.1 Location and Population

Riau Province is located in the northern part of Sumatra island and has an area of 94,560 km². The total population in 1986 was estimated at about 2.7 million with population growth of 3.9% on average from 1981 to 1986 (see Table 2.1). The population density is about 29 persons/km².

The workforce in the region was estimated at 859,000 in 1985. In the same year, the unemployment rate was estimated at 3.0% which was higher than the average rate for the whole country. Of the total workforce, about 60% were in the agricultural sector.

2.2.2 Regional Economy

The Gross Regional Domestic Product (GRDP) at current market prices of Riau Province was estimated at about Rp.5,583 billion

*1: Workshop SECDP, Direktorat Jenderal Pertanian Pangan dengan Departemen Pertanian, 1987.

*2: Forecast in 2005 was made by the team of the Batang Kumu Irrigation Project, based on SFCDP Forecast (1990-2000)

in 1986, which accounted for 5.8% of GDP in the whole country in the same year (see Table 2.1). Out of GRDP in 1986, 67% was derived from the mining sector including petroleum production, followed by 9.4% from the trade sector. The agricultural sector only accounted for 6.7%. Per-capita GRDP at current market prices was estimated at Rp.2.04 million or US\$ 1,233 in 1986, which is higher than the national average figure of Rp.574,000 (US\$ 347) in the same year. But per-capita GRDP excluding petroleum production amounted only to Rp. 522,000 (US\$ 315).

Annual economic growth from 1981 to 1986 was estimated at -1.8% in terms of GRDP at 1983 constant prices. This minus growth is attributable to stagnation of the mining sector due to the depressed international oil market. Economic activities in Riau Province are specialized to the mining sector, especially to petroleum production and its related industry. During the period from 1981 to 1986, more than 70% of GRDP was derived from petroleum production. With the exception of petroleum, annual economic growth had increased steadily, which was estimated at 6.2% on an average from 1981 to 1986.

2.2.3 Agriculture

The main crops grown in Riau Province are paddy, maize, cassava, soybeans and such perennial crops as rubber, oil palm, coconuts and banana. During the 3 years from 1984 to 1986, the harvested area and production of paddy in Riau Province averaged about 150,100 ha and 402,000 tons, respectively, of which production of wet land paddy accounted for about 79%. Recently, the planted areas of rubber and oil palm have increased rapidly. These planted areas were estimated at 284,000 and 18,400 ha in 1982 and in 1986 expanded to 354,000 and 95,400 ha respectively. Their production has also increased along with the expansion of area, and reached 86,200 tons for rubber and 76,300 tons for palm oil in 1986, which was 7.9% and 5.9% of the whole country, respectively.

Rice production in Riau Province could not meet its demand, though the production of rice in Indonesia as a whole has reached self-sufficiency level as mentioned in the preceding section. In Riau Province, about 384,000 tons of rice were consumed in 1986, whereas the total supply of rice was only about 254,000 tons with a deficit of 130,000 tons in the same year, as shown below.

	1973	1978	1983	1984	1985	1986
Supply of Rice (10 ³ t)	125	161	183	199	216	254
Demand (10 ³ t)	206	269	340	349	370	384
Balance (10 ³ t)	-81	-108	-157	-150	-154	-130

Sources: *1 Hasil-Hasil Pembangunan Daerah Tingkat I Riau - Selama PELITA IV, Pekanbaru 1988.

*2 Riau Dalam Angka 1987, Kantor Statistik.

2.3 Agricultural Sector in the Fourth and Fifth Five Year Development Plans

The Government of Indonesia is now engaged in fourth five-year development plan (REPELITA IV; 1984/85-1988/89), of which the development plan for the agricultural sector puts primary emphasis on the following major objectives:

- a) To increase agricultural production to meet domestic requirements for food and industry,
- b) To promote export oriented crops,
- c) To improve and stabilize farmers' income,
- d) To support regional development, and
- e) To promote transmigration activities.

In September 1988, REPELITA V was under preparation at both national and provincial levels. According to the BAPPEDA office in Riau Province, it is expected that the agricultural sector will continue to play an important role in the promotion of agro-industrial development and achievement of a more balanced economy in Riau Province.

2.4 Transmigration Program

The transmigration program has played an important role in providing manpower for labor-short areas outside Java, Bali and Lombok, so that these areas can develop as new centers of industry, especially of agricultural production. Since 1950, about 616,000 families have been settled in the whole country. During the three years from 1984 to 1986, the number of migrants settling in Riau Province amounted to 8,700 families which account for 14.4% of the whole country.

In Riau Province, transmigration has rendered significant service to developing the agricultural sector. About 65,000 families accounting for 10% of total families in this province are migrants who have been settled as farmers during the 19 years from 1969/1970 to 1987/1988. In addition, the Government of Riau Province plans to settle about 56,000 families between 1989/1990 and 1993/1994.

Table 2.1 NATIONAL AND REGIONAL SOCIO-ECONOMIC INDICATORS (1/2)

		1981	1982	1983	1984	1985	1986
I. NATIONAL SOCIO-ECONOMY							
1) Population	(10 ⁶)	150.7	153.9	157.2	160.6	164.6	168.1
- Growth Rate	(%)	2.15	2.15	2.15	2.15	2.15	2.10
- Population Density (Person/km ²)		79	80	82	84	86	88
2) Economically Active							
Population	(10 ⁶)	60.8	59.6	**1	*	63.8	70.2
- Employed	(%)	97.3	97.0	*	*	97.9	97.4
- Unemployed	(%)	2.7	3.0	*	*	2.1	2.6
3) Employment by Industry	(%)	100.0	100.0	*	*	100.0	100.0
- Agriculture	(%)	61.5	54.7	*	*	54.7	55.1
- Mining & Manufacturing	(%)	8.5	11.1	*	*	9.9	8.2
- Others	(%)	30.0	34.2	*	*	35.4	36.7
4) Gross Domestic Product (GDP)							
- GDP (Current Market) (Rp.10 ⁹)		54,027	59,633	73,698	87,055	94,492	96,489
- GDP (1983 Constant) (Rp.10 ⁹)		66,847	68,349	73,698	78,144	79,911	82,475
- Growth Rate	(%)	7.9	2.2	7.8	6.0	2.3	3.2
- Per Capita GDP at CMP**2 (Rp.10 ³)		359	387	469	542	576	574
	(US\$)	558	559	472	504	509	347
5) GDP by Industry at CMP	(%)	100.0	100.0	100.0	100.0	100.0	100.0
- Agriculture	(%)	25.3	26.3	24.0	23.4	23.7	25.8
- Mining	(%)	24.0	19.6	19.0	18.4	16.3	11.1
- Manufacturing	(%)	10.8	12.9	11.1	12.7	13.5	14.4
- Trade	(%)	14.7	14.9	16.3	16.1	15.4	16.7
- Others	(%)	25.2	26.3	29.6	29.4	31.1	32.0
6) Price Index							
- Wholesale*3 (1983=100)		*	*	100	109	115	121
Annual Change	(%)				9.0	5.5	5.2
- Consumer (Apr.1977 - Mar.1978 = 100)							
Jakarta		163	177	196	219	230	242
Pekanbaru		*	196	220	241	256	270
Whole Country		180	198	222	242	252	275
7) Exchange Rate*4 (US\$ 1.00=)		643	692	994	1,076	1,131	1,655
8) Balance of Payment (US\$ 10 ⁶)							
A. Goods & Services		-499	-5,458	-6,442	-1,970	-1,950	-4,099
Exports (FOB)		23,665	19,747	18,689	20,754	18,527	14,396
Imports (FOB)		-16,542	-17,854	-17,726	-15,047	-12,705	-11,938
Services		-7,622	-7,351	-7,405	-7,677	-7,772	-6,557
B. Special Drawing Rights (S.D.R)		62	-	-	-	-	-
C. Of Private Capital (net)		148	1,639	1,826	757	68	1,291
D. Transfer of Government Capital		1,963	4,117	4,776	2,865	1,739	3,074
E. Total (A through B)		1,674	298	160	1,652	-143	266
F. Net Errors & Omissions		-2,069	-2,229	494	-709	238	-810
G. Overall Balance		-395	-1,931	654	943	95	-544
H. Monetary Movement		395	1,931	-654	-943	-95	544
Net IMF Position		-100	-10	163	-6	-7	-10
Short Term Liabilities		-	-	1	1	-	-
Short Term Assets		495	1,941	-818	-938	-88	554

Remarks: *1 No data is available. *2 CMP: Current Market Price.
*3 Price index of construction for public work in agricultural sector.
*4 The Rupiah was devalued from US\$ 1.00 = Rp.703 to US\$ 1.00 = Rp.970 on March 30, 1983 and from US\$ 1.00 = Rp.1,134 to US\$ 1.00 = Rp.1,644 on September 12, 1986.

Sources: (1) Statistik Indonesia 1985, 1986 and 1987, Biro Pusat Statistik.
(2) Indonesia, Strategy for Economic Recovery, World Bank, 1987.

Table 2.1 NATIONAL AND REGIONAL SOCIO-ECONOMIC INDICATORS (2/2)

	1981	1982	1983	1984	1985	1986
II. REGIONAL SOCIO-ECONOMY (RIAU)						
1) Population (10 ³)	2,261	2,333	2,429	2,490	2,644	2,736
- Growth Rate (%)	4.2	3.2	4.1	2.5	7.0	2.7
- Population Density(Person/km ²)	24	25	26	26	28	29
2) Economically Active						
Population (10 ³)	**1	*	*	*	859	*
- Employed (%)	*	*	*	*	97.0	*
- Unemployed (%)	*	*	*	*	3.0	*
3) Employment by Industry (%)	*	*	*	*	100.0	*
- Agriculture (%)	*	*	*	*	59.7	*
- Mining (%)	*	*	*	*	1.6	*
- Manufacturing (%)	*	*	*	*	4.3	*
- Trade (%)	*	*	*	*	11.1	*
- Others (%)	*	*	*	*	23.3	*
4) Gross Regional Domestic Product (GRDP)						
- GRDP at Current Market Prices						
Included Petroleum (Rp.10 ⁹)	6,455	4,847	7,517	7,633	6,772	5,583
Excluded Petroleum (Rp.10 ⁹)	530	785	969	1,157	1,286	1,427
- GRDP at 1983 Constant Prices						
Included Petroleum (Rp.10 ⁹)	7,654	5,616	7,517	6,799	6,040	6,997
Excluded Petroleum (Rp.10 ⁹)	846	888	969	1,036	1,084	1,141
- Growth Rate						
Included Petroleum (%)	-0.4	-26.6	33.8	-9.6	-11.2	15.8
Excluded Petroleum (%)	7.0	5.0	9.1	6.9	4.6	5.3
- Per Capita GRDP at CMP*2						
Included Petroleum (Rp.10 ³)	2,855	2,078	3,094	3,065	2,542	2,041
(US\$)	4,440	3,003	3,113	2,849	2,248	1,233
Excluded Petroleum (Rp.10 ³)	234	336	399	465	483	522
(US\$)	364	486	401	432	427	315
5) GRDP by Industry at CMP - Included Petroleum						
- Agriculture (%)	2.9	4.9	3.7	4.3	5.2	6.7
- Mining (%)	87.9	83.5	85.4	82.4	77.0	66.6
- Manufacturing (%)	2.4	1.8	2.8	3.6	5.1	9.0
- Trade (%)	3.8	4.8	4.3	5.1	6.7	9.4
- Others (%)	3.0	5.0	3.8	4.6	6.0	8.3
6) GRDP by Industry at CMP - Excluded Petroleum						
- Agriculture (%)	35.3	30.0	28.7	28.1	27.2	26.3
- Mining (%)	8.3	6.3	7.5	7.5	7.6	7.9
- Manufacturing (%)	5.6	6.8	7.4	7.5	7.5	7.5
- Trade (%)	32.9	26.3	26.7	26.8	26.1	25.8
- Others (%)	18.0	30.6	29.7	30.1	31.5	32.4

Remarks: *1 No data is available.

*2 CMP: Current Market Price

Sources: (1) Statistik Indonesia 1987, Biro Pusat Statistik.

(2) Riau Dalam Angka 1983-1987, BAPPEDA dan Kantor Statistik Propinsi Riau.

(3) Perkiraan Pendapatan Regional, Riau 1975-1982, Kantor Statistik dan BAPPEDA, 1984.

(4) Perkiraan Pendapatan Regional, Riau 1983-1986, Kantor Statistik dan BAPPEDA, 1987.

3. THE PROJECT AREA

3.1 LOCATION

The Batang Kumu area is situated in the Tambusai district (Kecamatan), Kampar regency (Kabupaten) in the northwest about 230 Km far from Pekanbaru, the capital of Riau Province along the road, and the center of the area is located at 1°15' North Latitude and 100°20' East Longitude.

The study area belongs to the northern area of Riau Province and is near the boundary to the North Sumatra Province. Proposed weir site is located at the place of about 5 Km in the downstream of the Kumu river from the boundary to the North Sumatra Province and the center of the benefited area of the Project is about 25 Km far from the boundary.

The study area is about 30,000 ha in total dividing into about 20,000 ha on the left side of the Kumu river and about 10,000 ha on the right side of the river. The Kumu river to be a water sources for the Project is a tributary of the Rokan river, one of the four (4) big rivers in the Province. The Kumu river runs to the northeast in the center of the study area. The Mahato river flows on the left side boundary of the area and joins with the Kumu river in the north of the area. The study area consists of the left side area between the Mahato river and the Kumu river and the right area of the Kumu river and has a long stretch about 27 Km in length and about 10 Km in the broad part.

On the other hand, the catchment area of the proposed weir spreads in the Kecamatan Sosa, Barunun and Barunun Tengah of the Kabupaten Tapanuli Selatan of the North Sumatra Province.

3.2 Population and Labor Force

The study area belongs Kecamatan Tanbusai in Kabupaten Kampar, and includes one existing village (Rantau Kasai) and seven transmigration villages; viz. DU (Desa Utama - Central Village), DK (Desa Kecil - Small Village)-II, -III and -IV of Tanjung Medan SKP-C and DU, DK-I and -II of Tanjung Medan SKP-D.

In the study area, agriculture is the predominant activity, and more than 95% of the active population are estimated to be engaged in agriculture and its related activities. The number of families was about 3,280 in April 1988. Out of the total number of families, farmers accounted for 95% or 3,070 of the families. The farm population is estimated at 15,100 and the average size of a farmer's family is 4.9 persons. As for the age distribution, 46.6% of the farm population are fourteen years old and under, and only 1.4% are sixty years old and over. On the assumption that the age of farm laborers ranges between 15 and 59 years old, the family labor force per a farm household averages 2.5 persons.

3.3 PHYSICAL FEATURE

3.3.1 Topography

The Kumu river originates from the hilly area in the North Sumatra Province, in which the peak elevation is 280 m, runs to the northeast on the center of the study area, joins the Mahato Kiri river, a tributary of the Kumu river at the downstream part (Kuara Mahato), then become Lubuk river and then the Rokan Kanan river. After that, the river joins the Rokan Kiri river and pours into the Malaka strait as the Rokan river.

The total length of the river from the origin to the Malaka strait is estimated at about 260 Km. The study area is located on the both sides of the Kumu river about 240 to 270 km far from the estuary.

The left side area for the Study is terrace and alluvial plain and has a long stretch about 10 Km in the broad part and about 30 Km in length between the Kumu river and the Mahato Kiri and the Mahato rivers. The elevation of the above area gradually changes from 75m to 15m to the direction of northeast and the slope of the ground is averagely about 1 to 100 to the north east. In the left side area of the Kumu river, the Sitarus river, a tributary of the Kumu river runs about 20 Km in almost parallel with the Kumu river and the lower part between the Sitarus river and the Kumu river forms alluvial plain with about 1.5 Km width.

On the other hand, the right side area of the Kumu river has ground slope of about 1 to 700 similar to the left side area. The Hitam river which is an adjacent river to the Kumu river, flows about 12 Km to 20 Km far from the Kumu river in the south. However, the area between the both rivers forms swamp except the higher part with the width of 5 to 6 Km along the Kumu river.

The catchment area of the proposed weir is estimated at 540 Km². Out of this, 475 Km² belongs to the North Sumatra Province. The catchment area in the North Sumatra Province has the highest part with elevation of 280 m and is hilly and undulatated area with the specific height of 40 m to 100 m.

The study area consists of about 20,000 ha of the left side of the Kumu river and about 10,000 ha on the right and the elevation of its irrigable area is planned to be 20 m to 59 m. The acreage and slope at each elevation of the study area is estimated using the existing topographic maps (scale : 1 to 5,000, covering area : 220 Km²) and the new maps contracted by JICA in this time (Scale : 1 to 5,000 covering area : 90 Km²) as follows :

Ground Elevation (m)	Left Side			Right Side		
	Acreage	Accumulated acreage	Slope	Acreage	Accumulated Acreage	Slope
	ha	ha		ha	ha	
15 - 20	15	15				
20 - 25	206	221	1: 250			
25 - 30	716	937	1: 200			
30 - 35	1,083	2,020	1: 250			
35 - 40	2,298	4,318	1: 900	8965		
40 - 45	2,375	6,693	1:1000			
45 - 50	1,664	8,357	1: 600			
50 - 55	1,020	9,377	1: 500		8,965	
55 - 60	916	10,293	1: 250	896	9,861	
60 - 65	756	11,049	1: 400			
65 - 70	472	11,521	1: 550	174		
70 : 75	14	11,535			10,035	

3.3.2 Climate

The project area is located around of 1° of north latitude and belongs to the equator climate zone. On account of this location, the area is affected by the N.E. seasonal wind from October to January and S.W. seasonal wind from March to May. Seasonal wind causes much rainfall in the area. At Pasir Pengarayan which is the observatory position representing the objective area, the data on rainfall are shown in Table 3.4 and those for temperature, relative humidity, sunshine duration, solar radiation, wind velocity and evaporation are shown in Table 3.3

(1) Rainfal

The average yearly rainfall is about 2,500mm in the project area. It varies widely from year to year ranging from approximately 1,800mm to 3,000mm. The maximum daily rainfall was recorded to be 165 mm at Pasir Pengarayan in August 1933.

(2) Temperature

The average annual air temperature is 27.6° and it varies from 26.7° in January to 28.5°C in May with little seasonal variations. The variation for the day varies widely from 21.9°C to 33.6°C.

(3) Relative Humidity

The average relative humidity is about 80% and the monthly mean relative humidity reaches its maximum about 82% and its minimum about 77%.

(4) Sunshine Duration

The average annual sunshine duration is 46% and the monthly mean sunshine duration is 57% in June at the maximum and 36% in January at the minimum.

(5) Solar Radiation

The average annual solar radiation is 311 cal/cm²/day and the monthly mean solar radiations are 328 cal/cm²/day in April at the maximum and 279 cal/cm²/day in December at the minimum.

(6) Wind Velocity

The average annual wind velocity is 35.2 Km/day and the monthly mean wind velocities are in range from 31.7 Km/day to 38.2 Km/day.

(7) Evaporation

The annual pan evaporation is about 1720mm (4.7mm/day). The monthly mean evaporations are 5.1mm/day in September at the maximum and 4.1mm/day in December at the minimum and slightly varied throughout a year.

3.3.3 Hydrology

(1) Streamflow of the Kumeriver

The Kumu river has a catchment area of 540 Km² at the proposed weir site. The monthly average discharge of the Kumu river at the proposed weir site reaches its maximum in December ; 29.2m³/sec. The minimum occurs in July ; 9.2m³/sec. The seasonal patters of the streamflow of the Kumu river at the proposed weir site is as follows :

Mean Monthly Streamflow (m³/sec)

Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Aver- age
20.5	13.6	16.8	16.2	13.6	9.6	9.2	11.6	16.5	16.1	18.4	29.2	15.5

The maximum discharge recorded at kota Bangung with the catchment area of 558 Km² near the proposed weir site was 116m³/sec in December 1984. The flood discharge at the proposed weir site is estimated as follows :

<u>Return Period</u>	<u>Flood Runoff</u>	<u>Specific Discharge</u>
2 year	330 m ³ /sec	0.61 m ³ /sec/km ²
5	390	0.72
10	450	0.83
25	520	0.96
50	600	1.11
100	640	1.19
1,000	870	1.61

(2) Sediment transport

The annual sediment production at the proposed weir site is roughly estimated at 8,000m³/year based on the data of the suspended load at these places near the proposed weir site.

(3) Water quality

In order to check the water quality of the Kumu river, water sampling was carried out at the proposed weir site. A study of the chemical properties of water showed that the water could be used for irrigation. For drinking, the water was needed to be filtered to remove evaporated residue, and be boiled thoroughly to destroy all micro-organism which may exist in the water, judging from the amount of KMnO₄ demand.

Table 3.1

MONTHLY RAINFALL AT PASIR PENGARAYAN

(Unit: mm)

YEAR/MON.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
1970	259.0	128.0	207.0	207.5	244.0	40.0	199.0	143.0	196.0	300.0	259.0	320.0	2502.5
1971	223.0	55.0	91.0	225.0	216.0	93.0	80.0	319.0	189.0	67.0	205.0	445.0	2208.0
1972	265.0	60.0	110.0	214.0	115.0	56.0	20.0	30.0	205.0	261.0	400.0	495.0	2231.0
1973	222.0	127.0	264.0	75.0	139.0	175.0	55.0	305.0	200.0	122.0	192.0	329.0	2205.0
1974	140.0	137.0	164.0	118.0	84.0	113.0	94.0	85.0	340.0	33.0	150.0	362.0	1820.0
1975	116.0	277.0	252.0	210.0	118.0	95.0	204.0	99.0	302.0	118.0	234.0	235.0	2260.0
1976	271.0	78.0	219.0	236.0	164.0	161.0	115.0	95.0	195.0	236.0	285.0	410.0	2465.0
1977	158.0	210.0	152.0	184.0	147.0	220.0	85.0	177.0	128.0	225.0	372.0	403.0	2461.0
1978	125.0	224.0	345.0	319.0	105.0	55.0	75.0	40.0	110.0	186.0	246.0	426.0	2256.0
1979	330.0	205.0	164.0	236.0	39.0	130.8	185.0	175.5	137.0	260.7	366.8	302.3	2532.1
1980	155.1	215.0	208.9	340.8	214.6	165.3	221.5	212.2	127.0	256.1	257.8	321.4	2695.7
1981	433.6	171.4	243.2	124.3	252.0	75.0	155.1	37.2	330.0	210.1	147.5	139.0	2318.4
1982	132.0	114.8	242.3	439.5	247.0	139.0	112.5	85.0	178.0	249.5	243.5	335.3	2518.4
1983	272.0	191.5	155.0	213.5	109.5	270.0	242.0	159.0	296.0	201.5	148.5	450.0	2708.5
1984	302.5	159.0	212.0	233.5	111.0	108.0	124.5	40.5	161.0	147.4	140.5	107.0	1846.9
1985	98.0	76.0	295.5	141.5	299.5	25.0	78.5	71.5	344.0	144.5	413.0	404.2	2391.2
1986	282.4	173.0	345.6	351.2	131.8	87.1	66.6	44.0	282.3	278.9	430.9	320.8	2794.6
1987	123.7	64.9	287.3	247.0	275.3	43.1	170.8	326.0	334.2	507.2	176.9	476.3	3032.7
1988	227.4	496.6	282.0	107.7	153.1	131.8	332.8	379.2	—	—	—	—	—
MEAN	217.7	166.5	223.1	222.3	166.6	114.9	137.7	148.6	225.3	211.3	259.4	349.0	2442.3

Table 3.2

MONTHLY CLIMATOLOGICAL RECORD AT PASIR PENGARAYAN(1/2)

MONTHLY MAX. TEMP. AT PASIR PENGARAYAN

(Unit: °C)

ITEM/MON.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	AVERAGE
MAX. TEMP.	32.5	33.1	33.4	34.0	34.2	34.1	34.0	33.8	33.1	34.0	33.5	33.3	33.6

MONTHLY MEAN TEMP. AT PASIR PENGARAYAN

(Unit: °C)

ITEM/MON.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	AVERAGE
MEAN TEMP.	26.7	27.1	27.4	28.3	28.5	28.3	28.2	27.6	27.5	27.7	27.4	26.9	27.6

MONTHLY MIN. TEMP. AT PASIR PENGARAYAN

(Unit: °C)

ITEM/MON.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	AVERAGE
MIN. TEMP.	20.9	21.4	21.7	22.6	23.0	22.6	23.0	22.0	21.9	21.3	21.3	20.6	21.9

MONTHLY RELATIVE HUMIDITY AT PASIR PENGARAYAN

(Unit: %)

ITEM/MON.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	AVERAGE
REL. HUMI.	80	82	82	82	81	79	77	77	78	80	77	79	80

MONTHLY SUNSHINE DURATION AT PASIR PENGARAYAN

(Unit: %)

ITEM/MON.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	AVERAGE
SUN. DURA.	36	46	46	50	51	57	53	46	44	45	46	37	46

MONTHLY SOLAR RADIATION AT PASIR PENGARAYAN

(Unit: Cal/cm²/day)

ITEM/MON.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	AVERAGE
SOR. RADI.	299	321	317	328	308	318	303	306	304	321	322	279	311

Table 3.2

MONTHLY CLIMATOLOGICAL RECORD AT PASIR PENGARAYAN(2/2)

MONTHLY WIND VELOCITY AT PASIR PENGARAYAN

(Unit: Km/day)

ITEM/MON.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	AVERAGE
WIND VEL.	35.8	38.2	37.9	35.4	35.1	34.0	35.3	36.0	34.6	33.8	34.9	31.7	35.2

MONTHLY EVAPORATION AT PASIR PENGARAYAN

(Unit: mm/day)

ITEM/MON.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	AVERAGE
EVAPOR.	4.2	4.8	4.7	4.9	4.6	4.8	4.8	4.8	5.0	4.7	4.6	4.1	4.7

3.3.4 Soil and Land Suitability

(1) Soil

Soils on the terraces have been developed from the quaternary sediments and are very variable in texture, ranging from sandy loam to clay. Near the edges of the terraces, the soils are moderately well to well drained. But elsewhere they are somewhat poorly to very poorly drained due to the flat topography, permanently high water tables and the weakly developed drainage system. The groundwater table ranges from 30 cm - 120 cm throughout the year. Surface peat has developed on the poorly drained areas, but the peaty layer does not exceed 15 cm. The effective soil depth is moderately deep to deep and typically the soils overlie very thick, white sandy sediments found below 60-120 cm from the ground surface. The sediments are very compact but loose when wet.

Soils on the alluvial plain have been derived from recent riverine alluvium. The soils are generally clay loam to clay textured with dark colored topsoils and yellowish brown to grayish yellow subsoils and are somewhat poorly to poorly drained. Some soils are influenced by high groundwater table and/or periodic stagnant water from seasonal floods and heavy rainfall, and show hydromorphic properties.

In general, the soils in the survey area have been leached out their inherent bases through hydromorphic and oxidation weathering under the tropical humid climate, and then are acid to very acid with pH values ranging between 4.5 - 5.5 and have low to very low fertility.

According to the national soil classification system in Indonesia, the soils in the survey area are classified into 4 great soil groups and 9 sub-groups from the morphological characteristics and the results of laboratory analysis. They are :

- | | |
|-------------------|---|
| 1) Cambisols | Distric Cambisols
Umbric Cambisols
Gleyic Cambisols |
| 2) Alluvial Soils | Distric Alluvial Soils
Gleyic Alluvial Soils
Distric Alluvial Soils |
| 3) Gleysols | Distric Gleysols
Umbric Gleysols |
| 4) Podzolic Soils | Umbric Podzolic Soils
Humic Podzolic Soils |

The results of the soil survey are summarized in the Soil Map (Drawing 3.2)

(2) Land Suitability

The lands are assessed in terms of their potential suitability for both paddy and upland crops cultivations under irrigated condition and for perennial crops under rainfed condition.

a) Land Suitability for Paddy

Lands on the alluvial plain (Soil Mapping Unit 1) are moderately suitable for irrigated paddy cultivation. The degree of micro-relief, the somewhat poor drainage condition and the frequency of flood hazard are moderate limitation. Most of the land in the terraces (Mapping Unit 2, 3 and 4) are marginally suitable for paddy cultivation. The high degree of the micro-relief is a severe limitation and the land require leveling to a certain degree. While lands near or on the slopes are currently unsuitable for paddy due to rather steep topography and the moderately to well-drained condition.

b) Land Suitability for Upland Crops and Perennial Crops

The lands of poorly to very poorly drained area (Mapping Unit 3) are currently not suitable for upland crop cultivation especially in wet season. The extremely gentle slope gradient, permanently high groundwater table as well as the sandy subsoil would make drainage improvement difficult. The other lands (Mapping Unit 1, 2, 4 and 5) are marginally suitable for upland crops. The poor soil fertility, high aluminium contents, somewhat poor drainage condition and rather steep topography are major big limitations.

The soils in the survey areas are quite deficient in the essential nutrients, such as nitrogen, phosphorus and potash, acid to very acid throughout the profile, and are poorly drained. In order to realize the profitable farming, rather high capital investment and recurrent cost will be required for the land reclamation, drainage improvement and crop production.

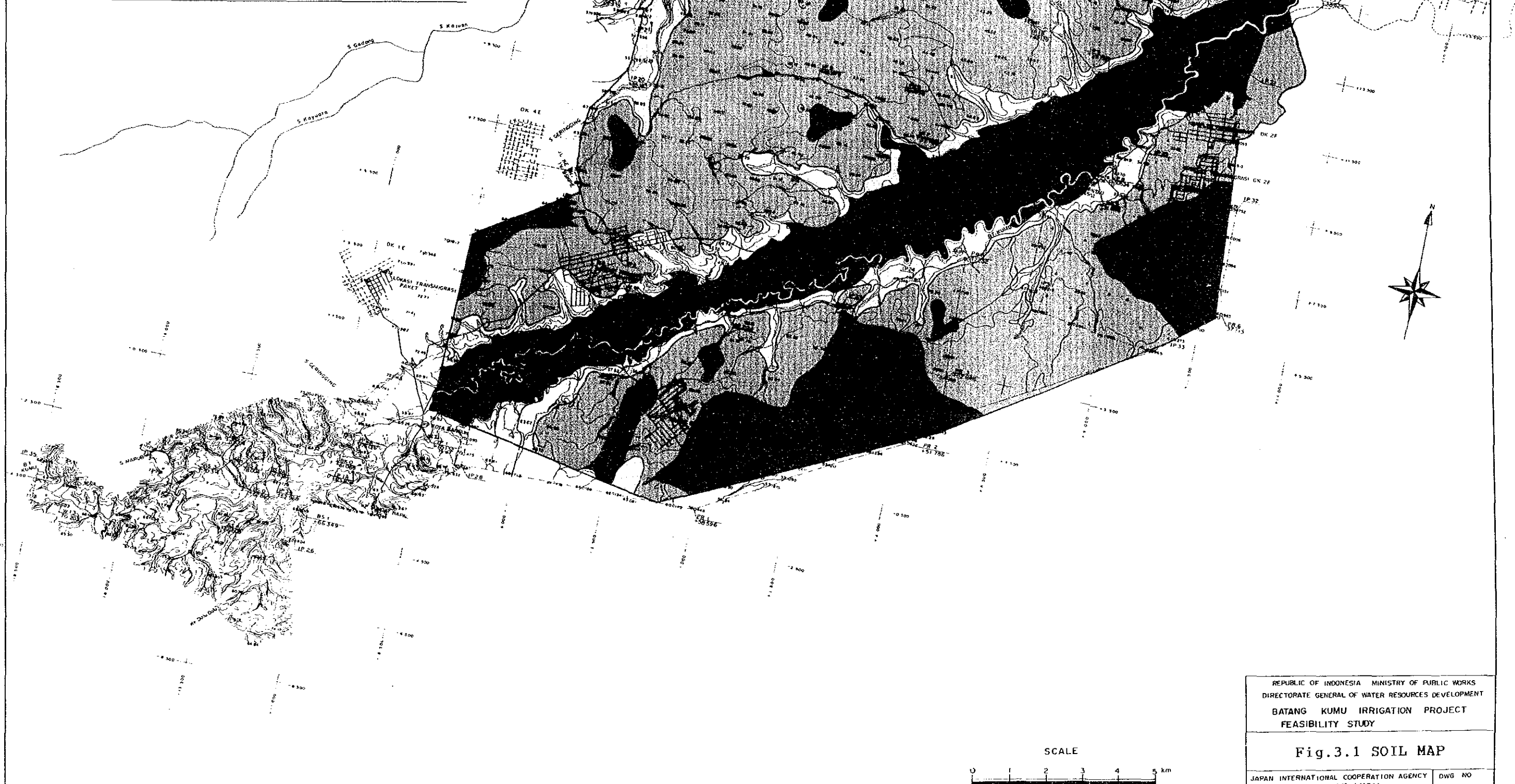
Paddy cultivation under irrigation is widely adaptable to soil environments and is recommendable as the land use type for the survey area, taking into consideration of the poor soil properties stated above.

Regarding the suitability of the land for upland crops, the quality is estimated to be lower than that for paddy from economical and technical points of view. Poor internal and external drainage, acid soil reaction and high content of exchangeable aluminium will prevent their vigorous growth. In Southern Sumatra, a rate of one ton/ha burned limestone has been adequate to sustain crop production on the soils with pH's (KCl) below 4.0 and low level of exchangeable Ca (< 1.0 me/100g soil).

This amount of lime become a standard to the survey area, though the requirement should be determined in detail in a field trial. In order to find out the most rational and profitable procedures for the upland crop cultivation, a pilot farm is recommended in the area in advance of the introduction of upland crops.

Meanwhile, on the terraces sandy sediment exists at shallow depth and the land has irregular micro-relief. This suggests that field plot will be limited to a small size and that special attention should be paid to land clearing, grading and leveling works so as not to expose the sandy subsoil.

Soil Mapping Unit	Soil Association	Physiography	Topography	Drainage	Right Bank		Left Bank		Total	
					Area (ha)	(%)	Area (ha)	(%)	Area (ha)	(%)
1	Dystric Alkuvial Soils Gleyic Alkuvial Soils Dystric Gleysols	Alluvial Plain	Flat (0 - 2%)	Somewhat Poorly	800	(8.0)	4,000	(20.3)	4,800	(18.2)
2	Dystric Cambisols Umbric Cambisols Umbric Podzolic Soils	Terrace	Flat (0 - 2%)	Somewhat Poorly	4,800	(48.0)	9,900	(50.3)	14,700	(49.5)
3	Umbric Cambisols Gleyic Cambisols Umbric Gleysols	Terrace	Flat (0 - 2%)	Poorly to Vary Poorly	3,000	(30.0)	800	(4.1)	3,800	(12.8)
4	Gleyic Alkuvial Soils Umbric Cambisols Umbric Gleysols	Foot of Terrace	Flat (0 - 2%)	Poorly	100	(1.0)	500	(2.5)	600	(2.0)
5	Umbric Podzolic Soils Humic Podzolic Soils Dystric Cambisols	Terrace	Undulating to Rolling (3 - 10%)	Moderately Well to Well	1,300	(13.0)	4,500	(22.8)	5,800	(19.5)
TOTAL					10,000	(100.0)	19,700	(100.0)	29,700	(100.0)



REPUBLIC OF INDONESIA MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
BATANG KUMU IRRIGATION PROJECT
FEASIBILITY STUDY

Fig.3.1 SOIL MAP

JAPAN INTERNATIONAL COOPERATION AGENCY TOKYO (JICA) DWG NO

3.3.5 Geology and Soil Mechanics

(1) General Geology

Sumatra island forms part of the Sundaland continental plate which includes most of south-east Asia. Ocean crust of Indian Ocean which is belonging to Indian-Australia plate is being subducted along the Sunda trench at the western margin of the Sundaland plate. Sumatra and its off-shore islands make form parallel and close to the Sunda trench. Magma generation is deeply and closely associating with subduction along the Sunda trench and has given rise to the Cenozoic Sumatra volcanic arc. This dominates Sumatra geology and forms the north west extension of Sunda volcanic arc. The oblique approach and subduction of the incoming ocean crust have been producing enormous stress. This stress has been released periodically by dextral fault movement parallel to the plate margin which resulted in the major Sumatra Fault System. The subduction seems to have been taking place intermittently since the Late Permian.

East of Sumatra is back-arc basin behind volcanic arc where thick sequence of Tertiary sediments accumulated and swampy coastal plain and peneplain are widely spreading at present.

Riau province is located east part of central Sumatra with the area of about 94,500 km². The main land and immediate off-shore islands occupy about 90% of the province. The remaining is consisting of Lingga arcipelago and some islands. The western border and southern border are faced on the Barisan range of mountain terrain occupies only 7% of the province.

More than half of the vast area in the north and east of the province comprises recently formed coastal swamps. The cost line is still advancing at the river mouths and deltaic islands. About one third of the province consists of undulating peneplain with elevation of around 30 to 100 m above sea level, rising locally to above 150m.

There exist four (4) major rivers in the province namely Roker, Siak, Kampar and Kuantan. The Kumu river, which runs in and along the project site, is one of tributary of Rokan river. The Kumu river has an origin at T. Dandan and its river length between an origin and confluence with the Mahato river at Kualamahato is about 117 Km with an average river slope of being estimated 1/745. The upstream-side average river slope of 10 Km from Kota Bangun is, however, very moderate and to be 1/2,000. As the Kumu river runs in the transitional part from the mountainous area to opened area, it has a characteristics that one side of river cross section is steep and the other side is flat and opened. And it has many meanders with dendritic small tributaries.

At the project site, geological and physiographical region consists of Coastal Plain, Minas Hills and Soda Drainage Basin (by the Geology of the Padangsidempuan and Sibolga). Coastal plain is low-lying alluvial plain. Most of the left plain of the

Kumu river forms coastal plain of younger Pleistocene to Holocene age Sands, silts and muds desiments make the surface and sub-surface geology. Bed rock might be thick Tertiary sedimentary rocks Minas hills forms peneplain at the upstream of the Mahato river. It is Pleistocene deposit which comprises semi and unconsolidated sands, gravels, minor muds and silts. Sometimes, it is kaolinised with tuttaceous horizons. Upstream of the Kumu river runs in Sida Drainage Basin which forms tertiary sedimentary rocks of Tup Formation and Tmt Formation. Tup formation is middle Miocene to upmost Pliocene sedimentary rocks which are bioturbated shales and silts, being often carbonaceous and greenish grey in color with minor tuffaceous horizons. Tmt Formation forms at transgressive stage of tertiary sedimentary cycle is Early to Middle Miocene. It is of calcareous siltstones, silty sandstones and calcareous mud stones with minor limestone interbeds.

Geological Age		Name of Formation		Symbol
Quaternary	Holocene	Young Alluvium		Qh
	Pleistocene	Older Alluvium		Qp
		Minas Fmn		Qpmi
Cenozoic	Tertiary	Petani Fmn		Tup
		Miocene	Kampar Group	Telisa Fmn Tmt Tipe
	Oligocene		Pematang Fmn	

(2) Geological Features in the Proposed Project Area

a) Downstream weir site

Geological features at the downstream weir site in the Kumu river are described as followings.

The weir site is located on the edge of Tup Formation in Tertiary, and the downstream area from this site is underlain by Quaternary sediments.

Terrain in the northern side at the weir site is steep slopes, and the height of the mountain top from the river water is about 20 meters. Weathering products of bed rock are remained on the greater part of steep slopes, and the outcrops of weak weathered bed rock are found partially.

Terrain in southern side at weir site is formed by three steps of terrace. Silt and fine sand of alluvial sediments make these terraces. The Tup Formation of bed rock is overlaid by some 5 metres thick of the alluvial sediments.

Present river deposits are overlaying on the ground surface within some 40 meters width of the southern side of the Kumu river.

b) Upstream weir site

Geological feature at the upstream weir site in the Kumu river is as followings.

This site is located at a distance of some 3 kilometers in direction of northeast from Daludata-Bangkinan anticline which have a direction from northwest to southeast, and it is also located on the edge of Tmt Formation. The Kumu river is meandered near this weir site. At the weir site, the river turns to south and northern side of the river is eroded. Consequently northern slops is relatively steep. Southern side of the river is formed wide and flat plain.

Alluvial sediments which are composed clay, silt and fine sand form the terraces on the both side of the river. Thickness of the sediments ranges from 2 to 7 meters. The area above some 70 meters in elevation is dominated by weathered products of bed rock.

c) Geology in the irrigated area along the main canal

The irrigated area is planned in the both banks of BT Kumu river.

Geology in this area is Qh-zone along the river and Qp-zone in the left of the area.

Qh-zone in the area is young alluvium in Holocene consisting of tutaceous fine sand, silt and clay. It consists of small round gravels in some places of the area. The continuation of these members are not recognized. This zone is in the loose state of alluvium, N-value is less than 10 Nos, and the moisture ratio is comparatively high. Thickness of the Qh-zone is within 5m that is rather thin, and under the layer, Putani Fmn. in Pliocene (Tup) is distributed.

Qp-zone in the area is older alluvium in Pleistocene consisting of sand, tifaceous fine sand, silt and clay. Sandy gravel layers consisting of round gravels of sandstone, andesite, chart, etc. are also found in some parts of the area. The continuation of these members are not recognized and the distribution study is not enough yet. However, generally speaking, the left-side area is fine-grained layer and the right-side area middle to coarse-graind layer. Though thickness of the Qp-zone is not confirmed, gravels over 10cm are observed in steep parts of BT. Kumu river.

Ground water level is high with 1-2m under the ground in this irrigated area in general.

(4) Construction Materials

(a) Impervious materials

Weathering products of the bed rock of Tup or Tmt Formation are suitable for impermeable materials of the weir. It will be able to obtain from northern slopes at the downstream weir site and from both slopes at the upstream weir site.

Impervious materials for canals will not be able to obtain along the canal route. The largest area of the sediment of Pleistocene contains silty clay in some portion, and the thickness expected less than 1 meter.

Weathering products of shale in Tup Formation will be able to use for impervious materials in upstream portion of main canal.

(b) Semipervious Materials

Semipervious materials are used for embankment of downstream side of weir or of canals except channels. Sands and gravels of Pleistocene sediments are suitable for semipervious materials. Sand and gravel layer dots in the project area and it exists on the right side of the Kumu river and Mahato river. The sands and gravels are well graded.

(c) Rock Materials

Paleozoic slates and sandstones (Puku) and Mesozoic volcanics are suitable for rock materials. Tertiary sedimentary rocks are unsuitable because of their susceptibility of weathering.

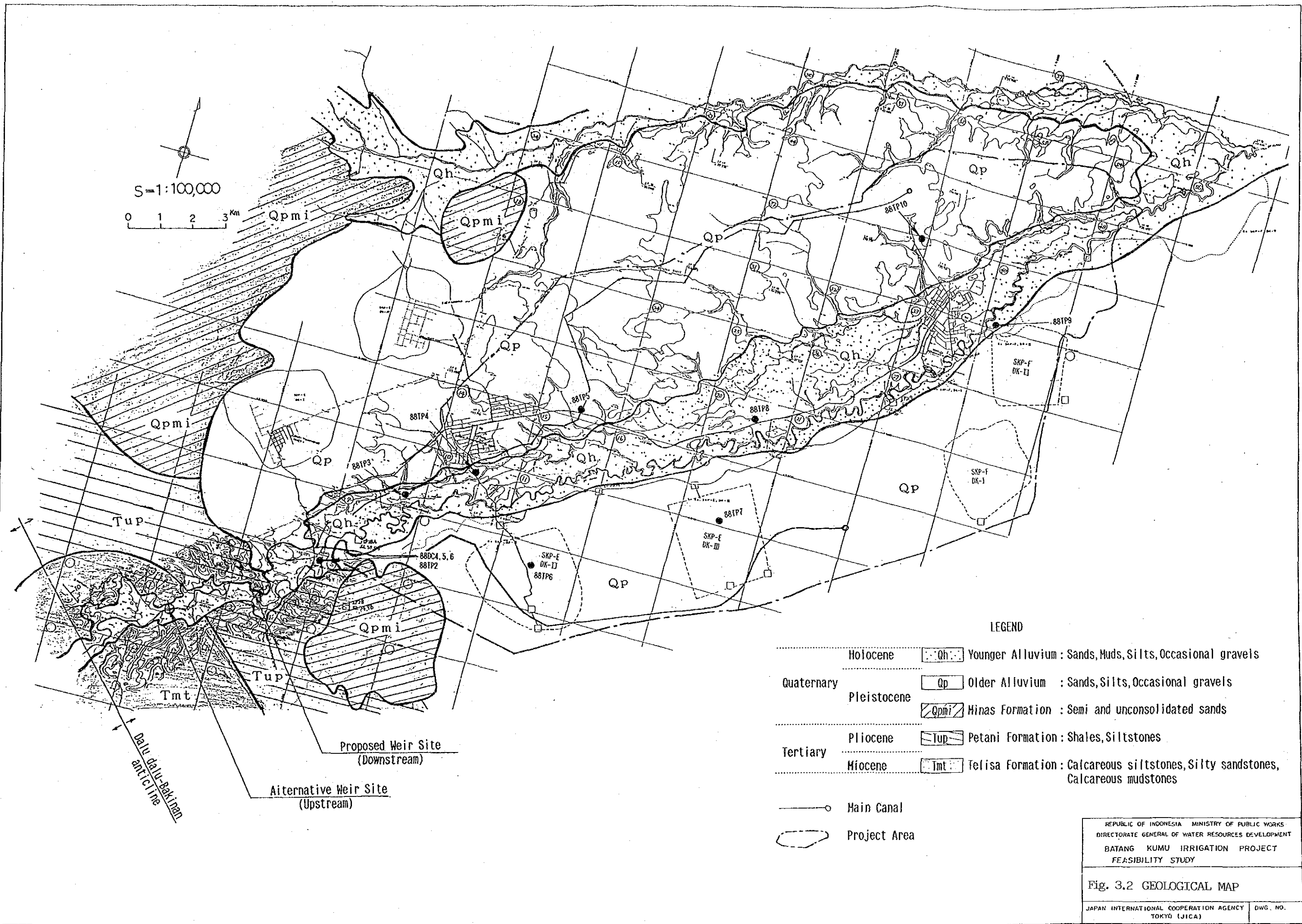
Rock materials can not obtain within the project area. Paleozoic slates and sandstones exist some 70 kilometers west of Daludalu, but there is no quarry for these rocks. Sands and gravels originated in these rocks are used as materials.

Metamorphic limestones and volcanics (Pukup), pegmatites and granites exist some 10 kilometers west of Pasirpangarayan. There is no quarry.

(d) Sand and gravel in the Kumu river

Sands and gravels produced from the Kumu river in the project area classify into gravelly sands. It is generally low gravel content and its maximum particle size is about 10 centimeters. Sand and gravel which contains relatively high gravel exists at riverside in DU of SKP-F.

Sand and gravel produced near the proposed weir site in unsuitable for aggregate.



3.4 INFRASTRUCTURES

3.4.1 Transportation and Communication

The important means of transportation in the study area are road and the Kumu river.

The road length from Pekanbaru, the capital of Riau Province to Dalu-Dalu, the beginning point of the transmigration road is 218 Km. Out of this, the length of national road is 80 Km and the one of provincial road 138 Km. This provincial road is connected with the North Sumatra province and now under construction of the rehabilitation work at the second stage by the IBRD loan as a part of the Program Highway Six of the Asian Highway Route No. 25. At present, the work from Rantau Berangin to the boundary to the North Sumatra Province is divided into three (3) packages and scheduled to be contracted. Actually, the construction works of two (2) packages were already started and completed until June 1990. The existing asphalt paved road becomes two (2) lane road with the width of 4.5 m to 5.0 m.

The road from Dalu-Dalu to the study area is transmigration road paved by crushed stone with the width of 3.0 m, but damaged by the transportation of heavy vehicles for taking out cutting trees and the transportation during the rainy season takes a lot of time. At present, the improvement works of the road is scheduled as a part of Second Stage Development Program for the transmigration area by the IBRD loan. The improvement works for the roads in the transmigration areas, SKP-C and D cover 36 Km in total and contain the crushed stone pavement with the width of 4.5 m. The above roads are called access road and about 45.4 Km of the main village road from the above access road to the transmigration area was already constructed and then the branch roads to each house are connected.

In addition, there are many roads for forestry in the northern part of the benefited area and rice, food and necessities of life are carried into the transmigration area using the above roads.

Moreover, the construction of the trunk road connecting Dumai port to the North Sumatra Province using the loan from the Government of Japan has been scheduled in the north side of the study area and after the completion, the road will be very effective for taking out the agricultural products from the Project area.

As described in the above, the road conditions in and around the Project area will be improved so much in the near future, the agricultural products from the Project area can be brought out to Pekanbaru, the capital of the Riau Province, the West Sumatra, the North Sumatra and any place.

Further at Tanjung Medan in the downstream of the confluence of the Kumu river and the Mahato river, transportation for food products, timber and necessities of life is carried out so much by using the water way.

3.4.2 Electric Supply

Electrification and telecommunication in the study area, which are important for the transmigrants welfare, security and health, are very poorly facilitated at present.

At Pasir Pengarayan, the important city adjacent to the study area, PLN supplies electricity from 5 o'clock in the evening to 7 o'clock in the morning using the diesel generator with the capacity of 246 KW.

At Dalu-Dalu located at the beginning of the transmigration road, the electric supply to about 400 households is operated by the village using the generator of 7.5 KW. At other villages, the use of private gasoline generator or the use of battery is found at some places.

The construction of a hydroelectric power dam with the height of 58 m has been planned on the Kampar Kanan river near Kota Panjang about 80 Km far from the study area to the south and its detailed design started since Feb. 1987 and was completed in Aug. 1988. The capacity to produce electricity by this dam is 114 MW and the distribution of electricity to Pekanbaru, the capital of the Province has been planned.

3.4.3 Domestic Water Supply

The transmigrants in the study area are using cooperative wells and some local inhabitants use river water as domestic water.

At the transmigration area (Pasir Pengarayan, SKP-A) adjacent to the study area, surplus water of irrigation canal is drawn to a small river and a cooperative washing place is equipped by making a low dam.

3.4.4 Irrigation and Drainage System

Irrigation plan is not included in the transmigration projects in the study area. Rain-fed paddy is cultivated at some lower places in the study area.

There are small scale irrigation projects planned by the Provincial Office around DK-V of SPK-F in the downstream part of the study area, and diversion weirs with the width of about 10 m and canal are now under construction. Actually however the projects are not progressed because of the difficulty of the budget and no paddy fields development is found at present. The water sources for the above projects are small rivers, namely the Muruk river and Megumpal river, the tributaries of the Kumu river.

At present, the excavation for drainage canal with the width of 1.0 m and the depth of 0.5 m to 1.0 m is carried out by transmigrants at some places in swampy area.

Small drainage canals in the study area are inundated for two or three days due to the influence of back water of the Kumu river after continuous precipitation.

The afore-mentioned Second Development Program for the transmigration area aims at improving the drainage conditions of ground surface and farm land as one of the strengthening works for the transmigration area and plans the construction of main and secondary drainage canals. Almost all of them are planned around home yard of transmigrants, but the coordination between the above works and irrigation projects will be required in the future to avoid the duplicated works.

The biggest irrigation and drainage project in the neighbourhood of the study area is the Kaiti-Samo Irrigation Project getting the IBRD loan which is located about 6.0 Km in the south of Pasir Pengarayan. Out of the planning area of 1,500 ha, 640 ha is operated as technical irrigation area. The project has a plan to construct two (2) diversion weirs at the Kaiti river and the Samo river, to change the catchment area and to irrigate the transmigration area that is, Pasir Pengarayan SKP-A. The construction of the weir on the Samo river and canals were completed and that of the weir at the Kaiti river is scheduled to be completed within this fiscal year.

3.5 Land Use and Agricultural Production

3.5.1 Present Land Use

The land in the study area is classified into 5 land use categories, comprising farm land, grass land, forest land, village area and others, as shown below.

Land Use Category	Area (ha)	(%)
Farm land	3,100	10.4
- Paddy fields	(190)	(0.6)
- Upland fields	(2,410)	(8.1)
- Perennial crop fields	(500)	(1.7)
Grass land	2,600	8.8
Forest	21,800	73.4
Villages	1,610	5.4
Others	590	2.0
Total	29,700	100.0

The farm land including paddy fields, upland fields and perennial crop fields amounts to about 10.4% or 3,100 ha of the total area. Paddy fields occupy only 0.6% or 190 ha of the total area. Upland fields of about 2,400 ha extend in each transmigration area, which are presently used for cultivation of dry land paddy, maize, groundnuts, soybeans, etc.

Perennial crop fields are located mainly on the land between the Kumu river and DK-I and -II of SKP-D. Rubber is the predominant perennial crop in the study area. About 73.4% or 21,800 ha of the study area is covered with forest, and 16.2% consists of grass land, village (home yard) and others such as river and road. Part of the grass land was originally farm land, but this land has been abandoned by the farmers after cultivation two to three times, because of poor soil fertility.

3.5.2 Land Holding and Land Tenure

Land tenure in the study area may be broadly divided into two types; i.e. national land and private land. National land represents 78% of the total study area.

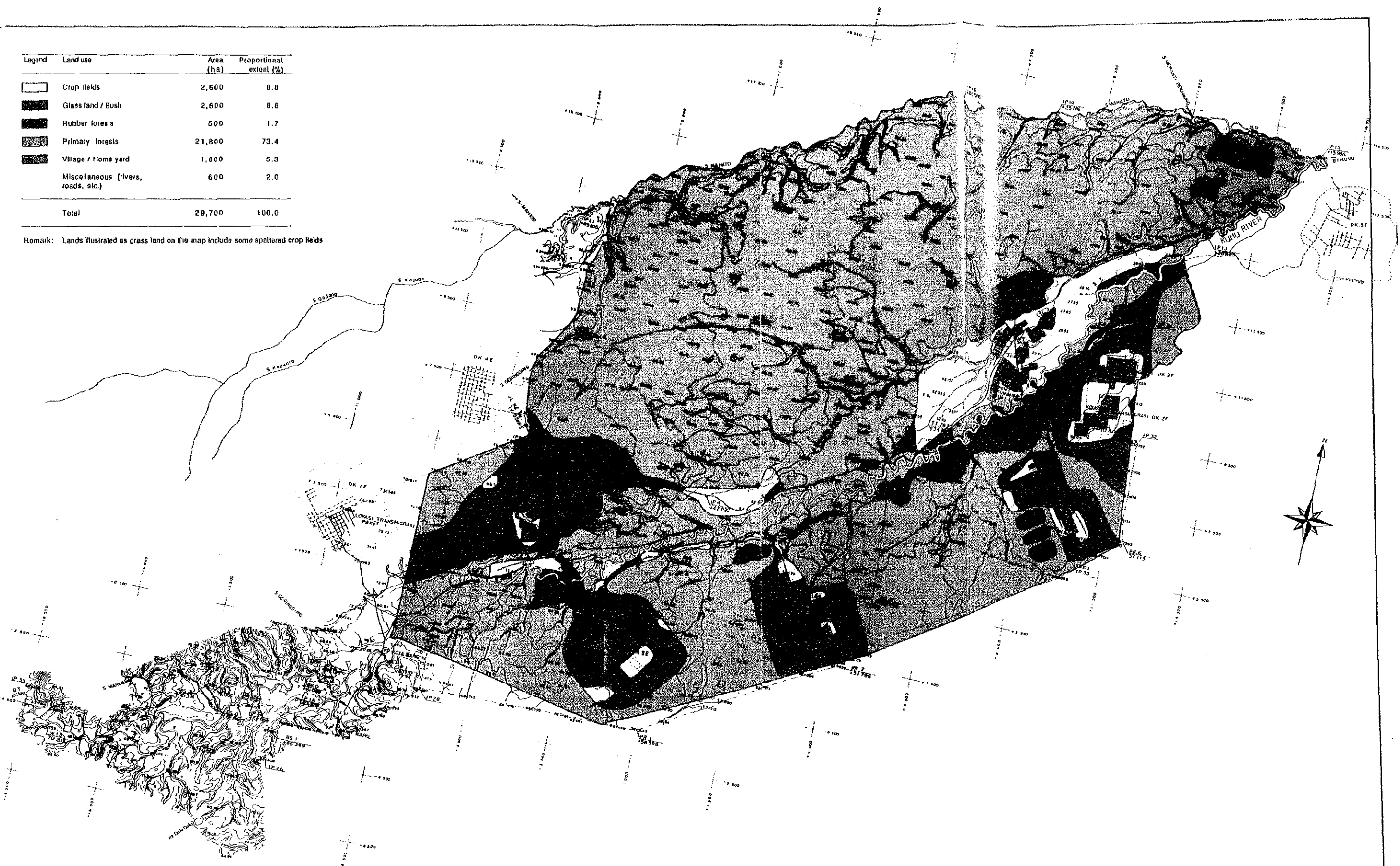
The farmers in the study area hold 2.00 ha/household, as allocated by the Government after settlement. This land consists of 1.75 ha for farm field and 0.25 ha for home yard. According to the results of interview surveys, all of the farmers occupy their own farm land as initially allocated by the Government, and almost no lease land is found in the study area.

3.5.3 Cropping Pattern

The present cropping pattern is illustrated in Fig. 3.1. In

Legend	Land use	Area (ha)	Proportional extnt (%)
	Crop fields	2,600	8.8
	Glass land / Bush	2,600	8.8
	Rubber forests	500	1.7
	Primary forests	21,800	73.4
	Village / Home yard	1,600	5.3
	Miscellaneous (rivers, roads, etc.)	600	2.0
	Total	29,700	100.0

Remark: Lands illustrated as grass land on the map include some spattered crop fields



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Fig.3.3
PRESENT LAND USE MAP

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