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Folder ID:	30093732
Series:	Indonesia project and research reports (English)
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REPUBLIC OF INDONESIA

MINISTRY OF PUBLIC WORKS

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

INVESTIGATIONS ON EXISTING SWAMP DEVELOPMENT FOR UPGRADING IN JAMBI, SOUTH SUMATRA, CENTRAL AND SOUTH KALIMANTAN PROVINCES

Final Report, Volume III

FEASIBILITY STUDIES, PROGRAMMES

June 1984

NEDECO - EUROCONSULT

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Volume III

Feasibility studies
Programmes

Code 4.61.128
June 1984

Nedeco - Euroconsult, Arnhem, the Netherlands
in association with P.T. Indra Development Consultants, Jakarta, Indonesia

This report consists of the following volumes :

Volume I	-	Executive summary
Volume II	-	Surveys, evaluation of project schemes
Volume III	-	Feasibility studies, programmes
Volume IV	-	Designs
Volume V	-	Annexes
Volume VI	-	Photographic record

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ABBREVIATIONS

AASS	Actual Acid Sulphate Soil
AWLR	Automatic Water-Level Recorder
BRI	Bank Rakyat Indonesia; People's Bank of Indonesia
DPMA	Direktorat Penyelidikan Masalah Air, Directorate of Hydraulic Research
GPV	Gross Production Value
GS	Government-Sponsored scheme
HM	High-lying Mineral soils
HP	High-lying Peat soils
HYV	High Yielding Variety
IBRD	International Bank for Reconstruction and Development
INSUS	Intensifikasi Khusus; Special Intensification
IPB	Institut Pertanian Bogor; Bogor Agricultural Institute
IRR	Internal Rate of Return
KUD	Koperasi Unit Desa, Village cooperative
LM	Low-lying Mineral soils
LMG	Lembaga Meteorologi dan Geofisika; Institute for Meteorology and Geophysics
PASS	Potential Acid Sulphate Soil
PPL	Penyuluhan Pertanian Lapangan; Field Extension Worker
P3S	Proyek Pengairan Pasang Surut; Tidal Swamp Reclamation Project
P4S	Proyek Pembukaan Persawahan Pasang Surut, Tidal Swamp Land Development Project
PRL	Project Reference Level
SAE	Survey Agro Ekonomi, Jakarta
SP	Spontaneous/local scheme
UGM	Universitas Gajah Mada, Yogyakarta
UNLAM	Universitas Lambung Mangkurat, Banjarbaru, South Kalimantan
UNSRI	Universitas Sriwijaya, Palembang, South Sumatra

Gogorancah	Cultivation method, in which rice is seeded under dryland conditions, and is cultivated under wetland conditions in later stages
Kolam	Huge pond at the end of secondary canals
Marga	Traditional territorial unit in South Sumatra
Paddy	Riceplant/Rice crop
Palawija	Secondary, dry-season crop grown on ricefields after the wet-season rice crop
Sorjan system	Mixed cultivation of upland crops on raised beds, wet rice in troughs in between

REFERENCES

DPMA, 1978 — Pemboran Explorasi Delta Upang.

DPMA, 1979 — Hydraulic Survey Barambai Unit 1978, Report No.PS.642.

DPMA, 1979, 1980, 1981, 1982 — Registrasi AWLR (Records of automatic water-level recorders, yearbooks).

IPB, 1973 — Laporan survey dan pemetaan tanah daerah pasang surut Batang Berbak-Pamusiran Laut Sub P4S Jambi. Institut Pertanian Bogor (IPB), Bogor, Indonesia.

JWT, 1983 — Jawatan Hidro-Oceanografi, 1983 Daftar Pasang Surut 1983 (Tide Table 1983)

Mettana, P.T, 1977 — Penjelasan Pelaksanaan Pemetaan, Daerah Delta Upang, Sumatera Selatan (Results of mapping of bench-marks at Delta Upang)

Nedeco-Euroconsult, 1981 — Tidal Swamp Land Development Project in Lampung, South Sumatera and Central Kalimantan Provinces, Volume I, General Report, Volume III, Feasibility study of the Karang Agung area (40,000 ha)

UGM, 1973 — Studi Hidrometri di Barambai.

UGM, 1973 — Survey Tanah Tinjau Mendalam Kawasan Barambai, Kalimantan Selatan

UGM, 1982 — Pembuatan Perencanaan Teknis Peningkatan Sistim Tata Air, Barambai (Technical Planning for Improved Watermanagement System at Barambai)

UNLAM, 1983 — Pengembangan Lahan Pasang Surut Kalimantan Selatan dan Kalimantan Tengah; Ringkasan Laporan Penelitian Tim Peneliti Universitas Lambung Mangkurat (on cover : 1982).

UNSRI, 1983 — Pengembangan Daerah Pasang Surut Sumatera Selatan dan Jambi, Laporan Survai Sosial dan Ekonomi, Tim Lembaga Penelitian - UNSRI.

World Bank, 1980 — IBRD Commodity Price Forecasts.

SUMMARY AND RECOMMENDATIONS

General

Short feasibility studies were made for two government-sponsored and one spontaneous project scheme. These schemes were selected from 18 schemes under review following a set of selection criteria.

Rantaurasau

In Rantaurasau the land potential is relatively well utilized but, to accommodate the growing population, the income per holding has to increase in future. An upgrading project may be well received. There are three distinct sub-areas.

In an area with low-lying mineral soils flood protection and water retention measures will enable the cultivation of HYV*, short-duration rice on 2,140 ha net, yielding 2.4 t/ha as compared with present yields of 1.0 t/ha. The costs of water control structures at primary, tertiary and quaternary level, of bunding and levelling of fields, and of enlarging some canals are estimated to be Rp 618 million. Depending on the degree of farmer response, the internal rate (IRR) will be 15-25%.

In an area with 2,310 ha high-lying mineral soils the gogorancah** method of rice cultivation may yield 1.5 t/ha as compared with present yields of 1.0 t/ha. Changing the hydraulic infrastructure could lead to yields of 1.8 t/ha. However, these changes are not economically feasible because intensive farmer participation is not likely to be forthcoming as yet.

In an area with high-lying peat soils wet-season drainage will improve the conditions for coconut on 1,830 ha net, yielding 1.5 t copra/ha/yr as compared with 0.8 t/ha/yr at present. This requires changing the drainage base to another river. The costs of water control measures and quaternary ditches are estimated to be Rp 292 million. The IRR of the project is around 25%.

Upang (SP)

The Upang spontaneous (SP) scheme warrants government intervention if Upang Island is to attain a uniform agricultural productivity. A different cropping calendar in a neighbouring government-sponsored area has led to heavy rat infestation. Road connections are poor and there are few signs of a positive exchange of agronomic information between both areas.

The area is suitable for two farming systems; HYV, short-duration rice - palawija***, yielding 3.0 t/ha and 0.8 t/ha respectively, and coconut monoculture, yielding 2.5 t copra/ha/yr. Present yields are 1.5 t rice/ha/yr and 0.9 t copra/ha/yr. It is proposed that the

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* High Yielding Variety

** Cultivation method, in which rice is seeded under dryland conditions, and is cultivated under wetland conditions in later stages

*** Secondary, dry-season crop grown on ricefields after the wet-season rice crop farmers be consulted to determine how much rice and coconut they would like to cultivate along each tertiary canal. A water-control stucture will be necessary at the interface of the two crops. Other works are similar to those in Rantaurasau. Road connections will be improved, and 945 ha bush and forest cleared.

The costs of the hydraulic infrastructure for 2,320 ha net (50% rice, 50% coconut) are estimated to be Rp 690 million. The IRR of the project is assessed at 15-20% depending on what the development will be without government intervention.

Barambai

In Barambai the cropping intensity is high, and the recent introduction of HYV rice is succesful. Yields of local rice varieties have declined since the start of the project in 1969. At present there are clear indications of crop damage related to acid sulphate soils. Government assistance is warranted for economic and social reasons.

It appears that HYV, short-duration rice, under a water-management system which flushes toxic elements out of the topsoil, is able to cope with the prevailing conditions in the Kolamkiri west sub-area. The project aims at creating appropriate conditions for such a water-management system in an area of 1,760 ha net and to enable also water retention when desired. The average yields would be 2.4 t/ha as compared to present yields of 0.7 t/ha.

To this end, on-farm works comprise levelling, bunding, and digging of quaternary drains to enhance flushing of toxic elements and equal distribution of water available on the fields. Tertiary and, where possible, secondary canals will either have a supply or a drainage function. Water-control structures at all levels will improve the functioning of canals. Kolamkanan, presently the most affected area, will receive river water via a new supply canal. The tidal influence will be enlarged in the Muara area.

The costs of the works are estimated to be Rp 910 million. The IRR ranges from 17-28% depending on the degree of farmer response.

Recommendations

- Agricultural support should include the availability of seed and credit;
- Agricultural extension should also focus on water management;
- Research on gogorancah should be continued;
- Farmers should receive an incentive to perform the on-farm works;
- An operation and maintenance section should take care of the hydraulic infrastructure.

- The low-lying, mineral soils and the high-lying, peat soils of Rantaurasau should be included in an upgrading programme;
- The Government should approach the present farmers of Upang (SP) to discuss future land use both in terms of farming systems and the type of new settlers;
- An upgrading programme for Barambai should be implemented soon. Care must be taken not to deteriorate presently good areas.

1 INTRODUCTION

Nedeco-Euroconsult, the Netherlands, in association with Indra Development Consultants, Indonesia were retained to assist the Government of Indonesia in its programme for upgrading existing swamp development schemes.

The project deals with agricultural and technical aspects, and is complementary to the studies on the socio-economic conditions undertaken by Palembang (UNSRI*) and Banjarbaru (UNLAM**) Universities for the Directorate General of Transmigration.

On behalf of the Government, the Tidal Swamp Reclamation Project/Proyek Pengairan Pasang Surut (P3S)*** of the Directorate General of Water Resources Development, Ministry of Public Works, has liaised with the consultants. The project is assisted under IBRD (International Bank for Reconstruction and Development) loan no. 1958-IN.

The project started in April 1982. General field data on crop yields and the prevailing conditions of soil, water and infrastructure were collected in the period July 1982 to July 1983 from 18 project schemes. The three schemes in which feasibility studies were to be undertaken were selected using these data. In January 1983 P3S and project staff discussed this selection. In June 1983 an interim report was published. Since that time, project staff have discussed several aspects of upgrading the schemes with P3S on an ad-hoc basis.

Volume III deals with short feasibility studies for upgrading the hydraulic infrastructure of the Rantaurasau, Upang (SP)*** and Barambai project schemes, and with the work programme for follow-up surveys, designs and implementation.

Information about the designs for the hydraulic infrastructure in the mentioned schemes can be found in Volume IV of the Final Report.

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* Universitas Sriwijaya

** Universitas Lambung Mangkurat

*** Spontaneous/local scheme

**** Formerly: Tidal Swamp Land Development Project/ Proyek Pembukaan Persawahan Pasang Surut (P4S)

2 THE FEASIBILITY SCHEMES

2.1 The setting of upgrading

The Government aims at a step by step development of the tidal lands. Inherent in such a development concept are the goals of gradually removing development constraints in a balanced manner, of absorbing improvements immediately, and of utilizing resources with increasing efficiency.

The Ministry of Public Works is responsible for lifting the infrastructural constraints to tidal land development. This implies the construction of major infrastructural works creating a potential for further development which would gradually materialise through more intensive use of other production factors. Delayed availability of these other factors would hamper the effectiveness of the programmes of the Ministry of Public Works.

Upgrading is understood to mean bringing the water-management infrastructure in line with the land potential. It is assumed this potential has been increased by the development efforts of the settlers and their attention to land utilization. Such upgrading implies actions which are beyond the development capacities of the individual farmer or group of farmers, and hence necessitates government interference. The proposed improvements may differ from case to case depending on the present state of land development and farming operations.

It is understood that the Terms of Reference do not cover higher stage development projects. Such projects constitute a major departure from present development practices when, for example, an irrigation network is superimposed on an existing drainage network.

Reference should be made to Volume II, Section 9.4, of the Final Report, where related aspects are discussed in detail.

2.2 The feasibility schemes

2.2.1 Selection criteria

Short feasibility studies were made for upgrading two government-sponsored schemes and one spontaneous development scheme selected from the 18 schemes under review.

In order to determine whether the water-management infrastructure of a project scheme should be brought in line with its land potential, the full utilisation of at least the initially cleared holding (usually 1 ha) and the future population pressure were taken as the first criterion.

It was proposed that a first government-sponsored project to be selected for a short feasibility study was to be charactericed by full utilisation of the land, but with a relatively low input intensity. These features may be symptoms of technical problems which could be resolved in an upgrading programme. The second feasibility scheme was to be a government-sponsored project where holdings were fully cropped and the use of agricultural inputs relatively frequent. These features may be indicative of a need for increased farm income and consequently a fair degree of farmer response to technical improvements can be anticipated.

In our view, it remains to be seen whether spontaneous settlers will generally approve government technical intervention. Within the group of spontaneous/local schemes we looked for a scheme where farmers had only been able to partially solve technical constraints. The Government could then support the community by alleviating these constraints and such an action would have a relatively high chance of being wholeheartedly accepted by the community.

In the selection of a spontaneous/local scheme, the approach of P3S has been to include a Buginese scheme because such schemes contain useful solutions to tidal land problems. It is worthwhile studying their schemes and transferring certain features to government-sponsored schemes. A further consideration has been the desire to distribute government assistance more equally among different sectors of the tidal-land population. Spontaneous settlers did not receive government assistance when settling in the tidal lands.

2.2.2 Selected schemes

The data necessary to select the feasibility schemes were partly provided by the present project's surveys, see Volume II, Chapter 3 to 8, partly by the Universities' reports on socio-economic conditions, see UNSRI (1983) and UNLAM (1983). The data per project scheme were assembled in a data matrix, see Volume II, Section 9.3. The location of the project schemes is given in Figure 1.

Government-sponsored schemes

It is noted, that the data about Tambanluar are not fully consistent, and this scheme was left out of the selection procedure.

We initially eliminated those project schemes which do not have full utilisation of the initial land holdings. This feature is covered in the data matrix by item XI, cropping intensity of rice. Such schemes, in which less than 60% of land, cleared or uncleared, allocated to field crops is cropped to rice, are Saleh, probably Sugihan, Basarang, Tambanlupak and Purwosari Baru.

Project schemes where the contribution of off-farm income is still more than 50% of the total income are considered to have no population pressure. Item XIII of the data matrix refers. Following this criterion, the Telang, Saleh and Sugihan schemes are eliminated.

As third step we applied the second selection criterion, application of farm inputs other than seed. The Rantaurasau project scheme, being the only remaining project in which hardly any farmer apply inputs, was therefore selected.

As fourth step we considered the Upang (GS)*, Barambai and Belawang schemes in which moderate amounts of inputs are applied. The hydraulic infrastructure of the Upang (GS) scheme has been redesigned by P3S and upgrading measures have been carried out recently. These measures should be evaluated after some years and the scheme removed from consideration for the moment.

* Government-sponsored

LOCATION OF PROJECT SCHEMES

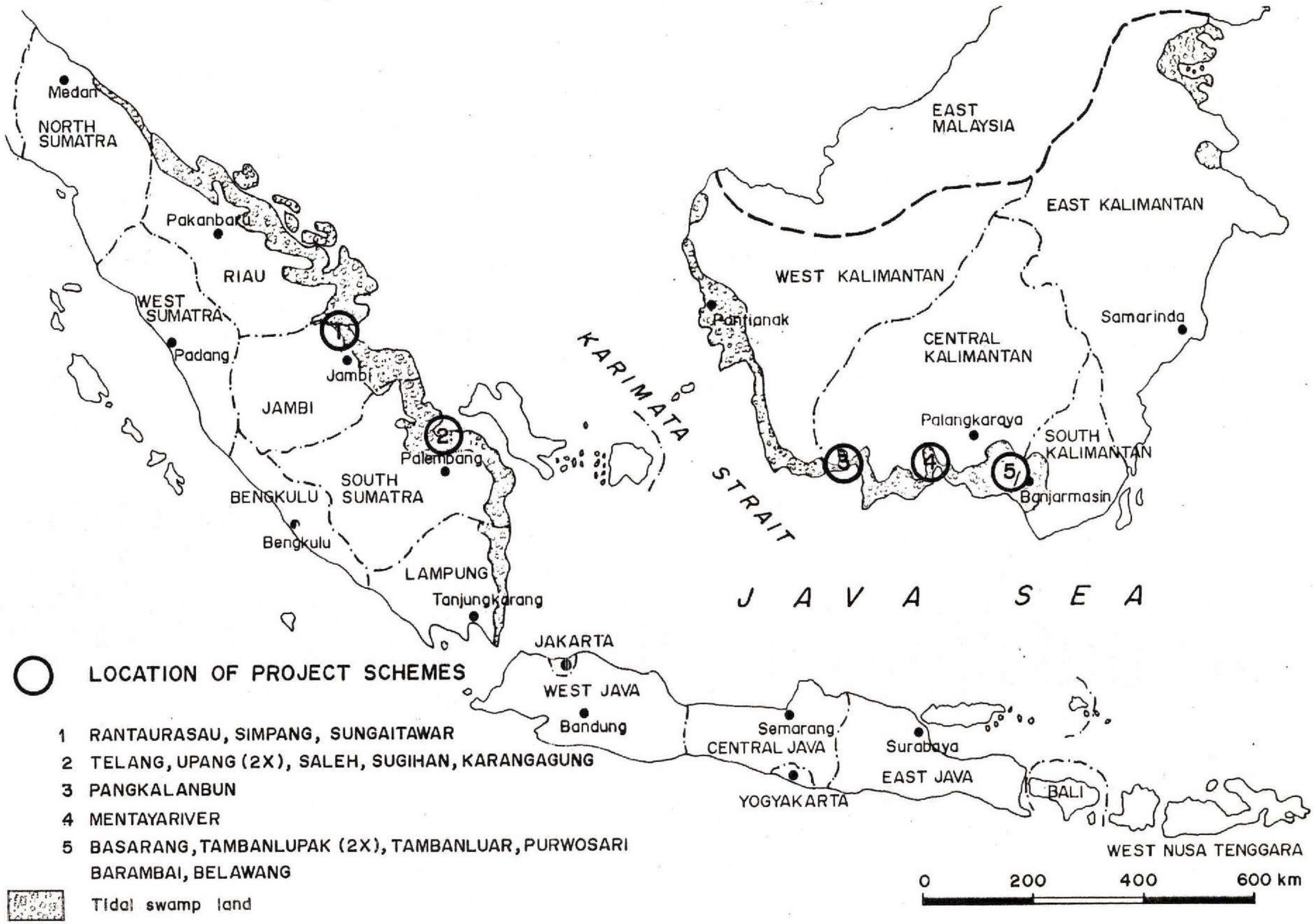

Figure 1

The choice between Barambai and Belawang was influenced by the amount of readily available information and an apparent geographical difference in introducing new rice varieties and related inputs. Both are found in Barambai.

Spontaneous/local schemes

We have blended the approach of P3S to include a Buginese scheme with mobility of the inhabitants. When mobility is low, there is a greater chance that the farmers will respond to government assistance. The choice then becomes Upang (SP), which meets P3S considerations for distributing assistance equally among the different population sections. The Upang spontaneous scheme is surrounded by Upang government-sponsored areas and farmers from both areas actually live together in the same villages.

2.2.3 Available data

The list of references contains data on reports and other publications which provided information on the present feasibility studies. Appendix I contains the list of climatic and hydrological data used for the present studies.

3 RANTAURASAU

3.1 Location of areas

The Rantaurasau project is located in Jambi Province, to the north-east of Jambi town on the Berbak Island between the Batanghari, Berbak and Pamusiran River, see Figure 2. It belongs to Subdistrict Rantaurasau of Tanjungjabung District. The area can be reached from Jambi town by river only. Within the Berbak Island roads are passable only by motorcycle.

The UNSRI socio-economic survey covered the area between tertiary canals SK 16 and SK 21 and between the main canal and primary canal FC II. The market of Bangunkarya and the IPB*/P4S testfarm Delta Berbak are situated in this area. Within the UNSRI survey area we selected two strips of land as the study area for general data collection purposes. One strip is bordered by SK 17 and SK 18, the other by SK 20 and 21, see Figure 2. The study area contains both higher- and lower-lying areas, and the crops cultivated here are considered representative for the UNSRI survey area. The area to which the feasibility study applies is also depicted in Figure 2. The size of the study area is 450 ha, of the feasibility area 6,700 ha.

The present project carried out routine surveys in the study area from August 1982 to January 1983, and in the feasibility area from February to August 1983.

3.2 Present conditions

3.2.1 Population

The larger part of the feasibility area is inhabited by government-sponsored transmigrants, their offspring, and induced migrants. One finds Buginese settlements in the northern part of the area between SK 16 and 28 and around FC II towards the Pamusiran River.

As the administrative boundaries do not coincide with those of the feasibility area, we do not have exact population data. Based on 1981 statistics, the number of people living in the feasibility area is estimated at 14,000 or some 2,400 families.

The population growth of Bangunkarya, the only area for which we have sufficient data, has been healthy. The number of families grew from 320 in 1971/72, to 600 in 1976/77, and to 716 in 1982/83.

3.2.2 Climate

According to Koppen's system, the climate of the area can be classified as Af; a tropical rainy climate with a temperature above 18 ^{o}C in the coldest month and no pronounced dry season (average rainfall per month never below 60 mm).

Tha rainfall records of the stations operated by the present project and by Lembaga Meteorologi dan Geofysika (LMG) at Muarasabak, 25 km downstream the Batanghari River, are given in Table 1.

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* Institut Pertanian Bogor, Bogor Agricultural Institute

LOCATION OF AREAS, RANTAURASAU

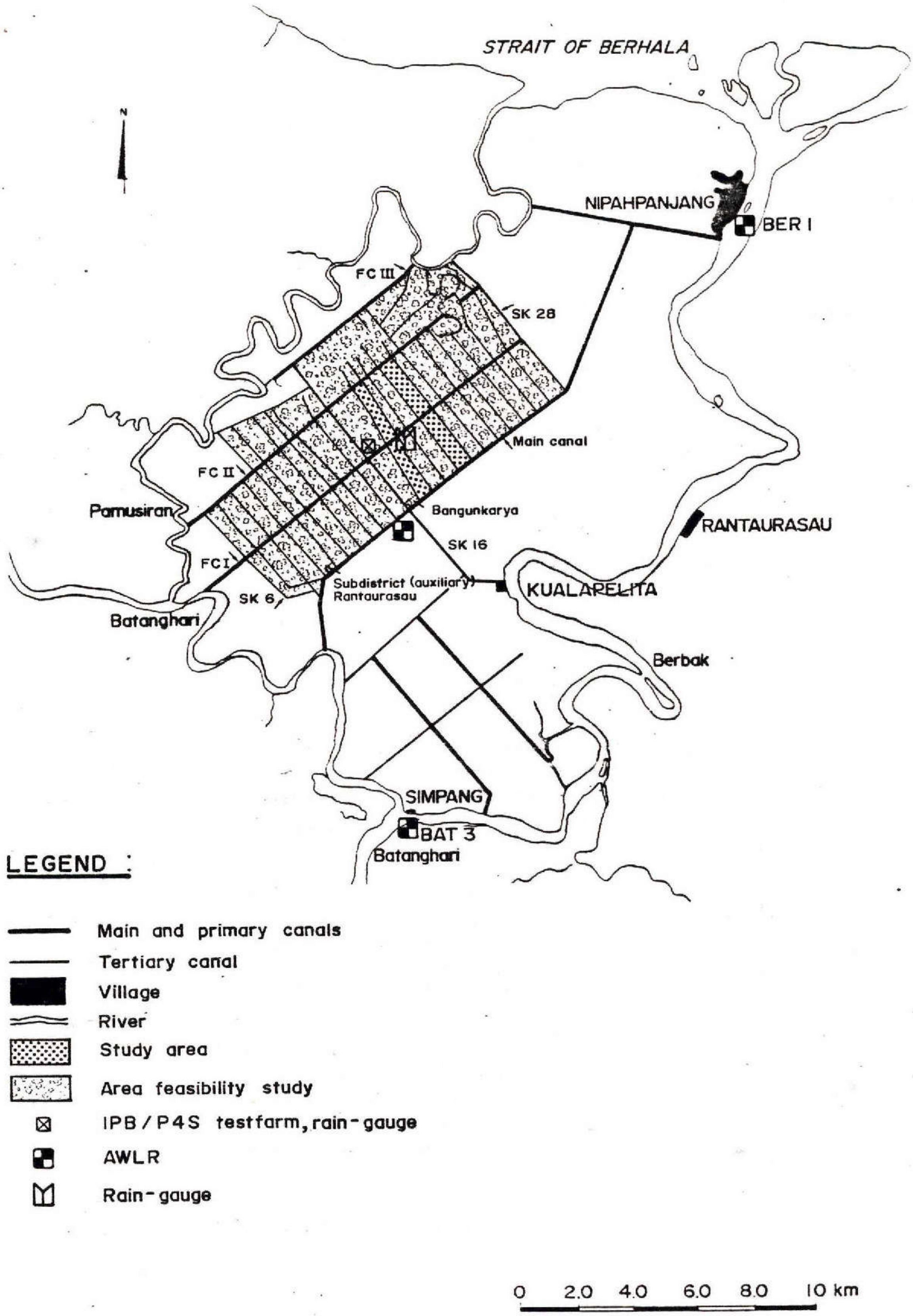

Figure 2

Table 1. Rainfall, Rantaurasau

Month	S	O	N	D	J	F	M	A	M	J	J	A	Total
Project, 1982/1983													
rainfall (mm)	143	237	150	515	620	53	2	326	156	89	41	98	2,430
rain-days	3	15	13	23	19	3	1	11	11	6	5	7	117
LMG.Muarasabak, 1982/83													
rainfall (mm)	28	213	148	473	318	110	32	132	287	134	98	-	1,973
rain-days	6	13	11	18	15	13	4	7	11	7	5	-	110
LMG,Muarasabak, 1974/82													
rainfall (mm)	184	192	341	568	244	223	260	198	196	180	97	70	2,753
rain-days	8	10	14	14	10	11	11	11	10	8	6	5	118

It appears that the period of our survey has been rather dry in comparison with the 9-year average. February and March 1983 have been extremely dry. Usually December is very wet, in the survey period January was wet as well.

3.2.3 Hydrology and hydraulic infrastructure

3.2.3.1 Description hydraulic system

The project area is part of the Berbak Delta which is formed by the Batanghari River and two of its branches, the Berbak and the Pamusiran Rivers.

The Batanghari is a large river with a total length of 637 km, a catchment area of 42,000 km^2 and a total discharge estimated at 64,000 Mm^3 per year (2,000 m^3/s). Average annual rainfall over the catchment area amounts to 2,750 mm. In front of the Berbak Island, near Simpang, the river turns sharply to the west and continues its winding course for another 50 km. Part of the water takes a short cut (25 km) to the sea via the much wider and deeper Berbak River. The Pamusiran River, which forms the western border of the project area, branches off from the Batanghari 15 km downstream from Simpang. It receives little water from the Batanghari.

The project area is served by an interwoven system of primary and tertiary canals that cross the island and interconnect the rivers. Old river courses and river levees are present.

One large main canal (width 10-20 m, depth 2-3 m) crosses Berbak Island from south to north connecting the river with its branches. Tertiary canals (SK 6 - SK 28) depart from the main canal. They are 500 m apart, 6,000 m long, and their cross-sections vary widely. They are interconnected by three primary canals (FC I, FC II and FC III) running parallel to the main canal at 2, 4 and 6 km distance. The primary canals are in open connection with the Batanghari or Pamusiran. Width varies from 5 to 10 m, and depth from 0.5 to 2 m.

3.2.3.2 Comparison water-levels and field-levels

River water-levels are governed by the tidal movements at sea. However, in the wet season (November-April) upland discharges influence the water-levels in the Batanghari considerably and the tidal fluctuations all but disappear, see Figure 3. The tide is mainly diurnal with a dry-season range of 2.00 - 3.30 m at sea and 1.00 - 1.40 m at Simpang. Water-levels in the Berbak and Pamusiran River are much less influenced by upland discharges and remain tidal throughout the year. Long-term water-level records from nearby stations are not available.

Water-flow and water-levels in the canals are influenced by the three rivers, each with a different regime, causing complicated flow patterns. However, the canal sections where the river flows meet have silted up so much that the actual volume of water flowing from one river to the other is small. In the dry season the primary canals FC I, II and III get little river water. The tertiary canals SK 6 - SK 28 receive hardly any river water in this period. Water-levels are summarized in Table 2. The locations of recording stations* are presented in Figure 2.

Table 2. Maximum and minimum water-levels 1982/1983, Rantaurasau (m + PRL**)

Location	Dry season		Wet season (Jan-Feb)	
	Max.	Min.	Max.	Min.
Berbak, BER 1	2.20	0.10	2.40	0.70
Berbak, Kualapelita	2.20	<1.00	3.10	2.10 [a]
Batanghari, BAT 3	2.00	<1.00	3.20	2.50
Main canal	2.00	dry	2.80	2.30

a) on 28/29.1.83

Field-levels were determined by a reconnaissance topographical survey. The reference level was taken from benchmark SK 18, with a level of 3.360 m + PRL*. The area can be roughly divided into a higher-lying part, with field-levels of about 2.75 m + PRL, in the south along the main canal, and a lower-lying part, with field-levels of 2.00 to 2.25 m + PRL, in the north close to the Pamusiran River, see Figure 4.

Water-levels remain below field-levels in the dry season. Water from the Batanghari may reach the lower-lying fields in the northern part of the project area during the wet season.

3.2.3.3 Drainage capacity

The exact drainage capacity of the canals cannot be given. During high river discharges and heavy rainfall the possibility of draining excess water towards the Batanghari River is lost. Water from this river actually enters the canals and drainage conditions deteriorate. It may even enter some of the ricefields. Excess water has to drain via the main canal to the Berbak River. The main canal has sufficient capacity, but primary and tertiary canals do not have sufficient capacity to convey the water to the main canal.

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* Automatic Water-Level Recorder (AWLR)

** Project Reference Level

WATER-LEVELS RANTAURASAU

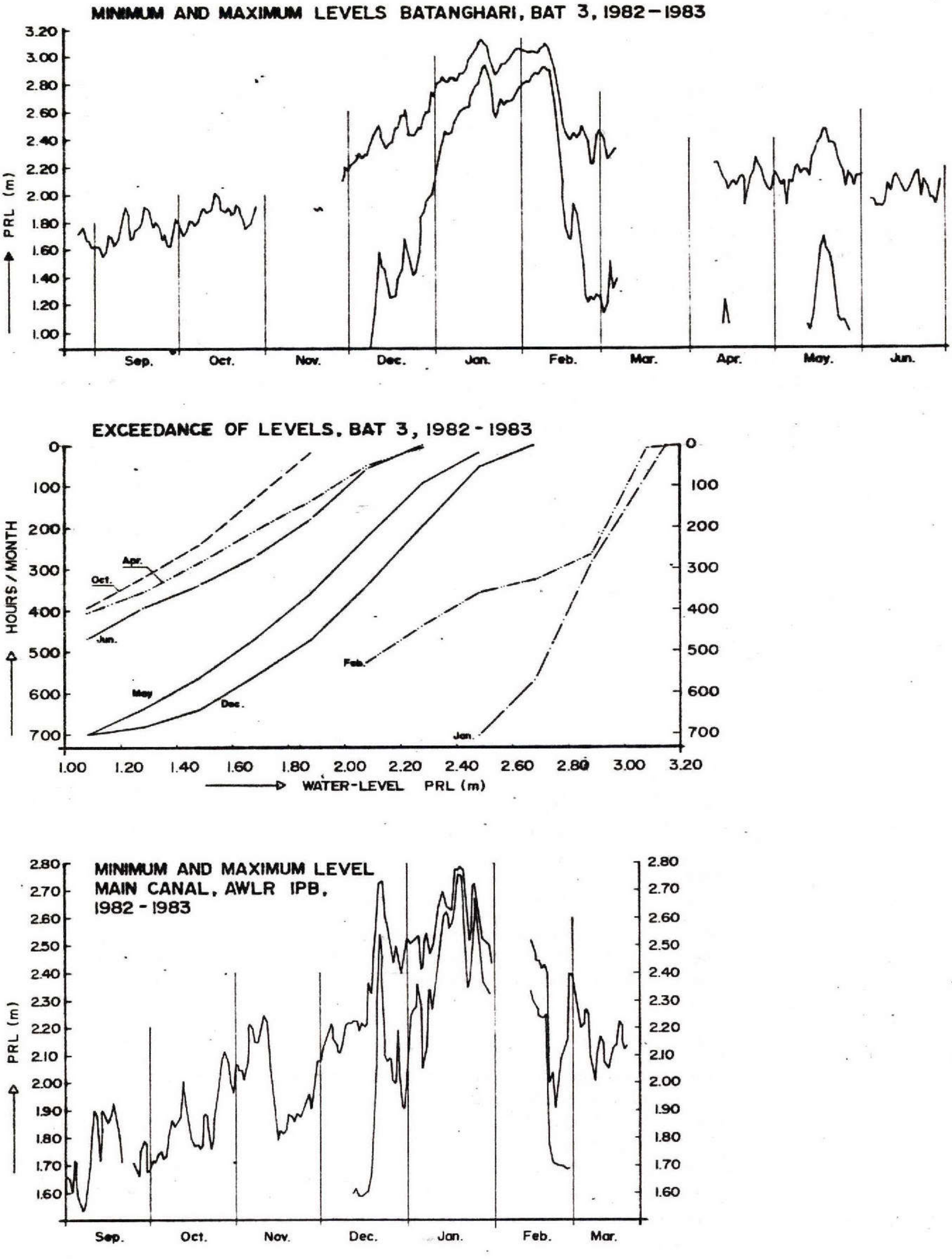


Figure 3

FIELD-LEVELS, RANTAURASAU

Figure 4

The primary canals are full of weeds and have irregular cross-sections which produce a low velocity of flow. This is especially the case in those parts which are dry for several months in the dry season (2/3 of their full length). The main canal always has water and does not suffer from weed growth. The tertiary canals between primary canals FC I and FC II look poor. The ones between the main canal and primary canal FC I look slightly better. Apparently, cleaning at the start of the rainy season is not deemed necessary under present cropping.

3.2.3.4 Quality surface water

Saline water does not enter the project area on a large scale. Only the canals under the influence of the Pamusiran River, serving about 950 ha, are in contact with saline river water (6o/oo). See Figure 5 for results of surveys.

In the dry season the tertiary canals are dry. The water in the tertiary canals is acid after the first rains when groundwater rises and surface flow starts. In tertiary canals SK 6 to SK 16, the pH-value of the outflowing water is 4 or lower. In the other canals the pH-value is above 4.

At the end of the wet season pH-values rise to 5. However, when it starts raining after a dry period, canal water soon becomes acid, pH 3. This is also the case in the area of tertiary canals SK 21-SK 25. Results are shown in Figure 5. In the main canal only the central section is acid. The exchange with fresh river water is fair because there is a net inflow of water from the Batanghari to the Berbak through the main canal.

3.2.3.5 Maintenance

The routine maintenance that has actually been carried out in the past cannot be expressed in figures. According to reports the main canal and primary canals FC I, II and III have not been rehabilitated since their construction. The tertiary canals are usually cleaned by the farmers once a year. In 1983 the Government started deepening the primary canals.

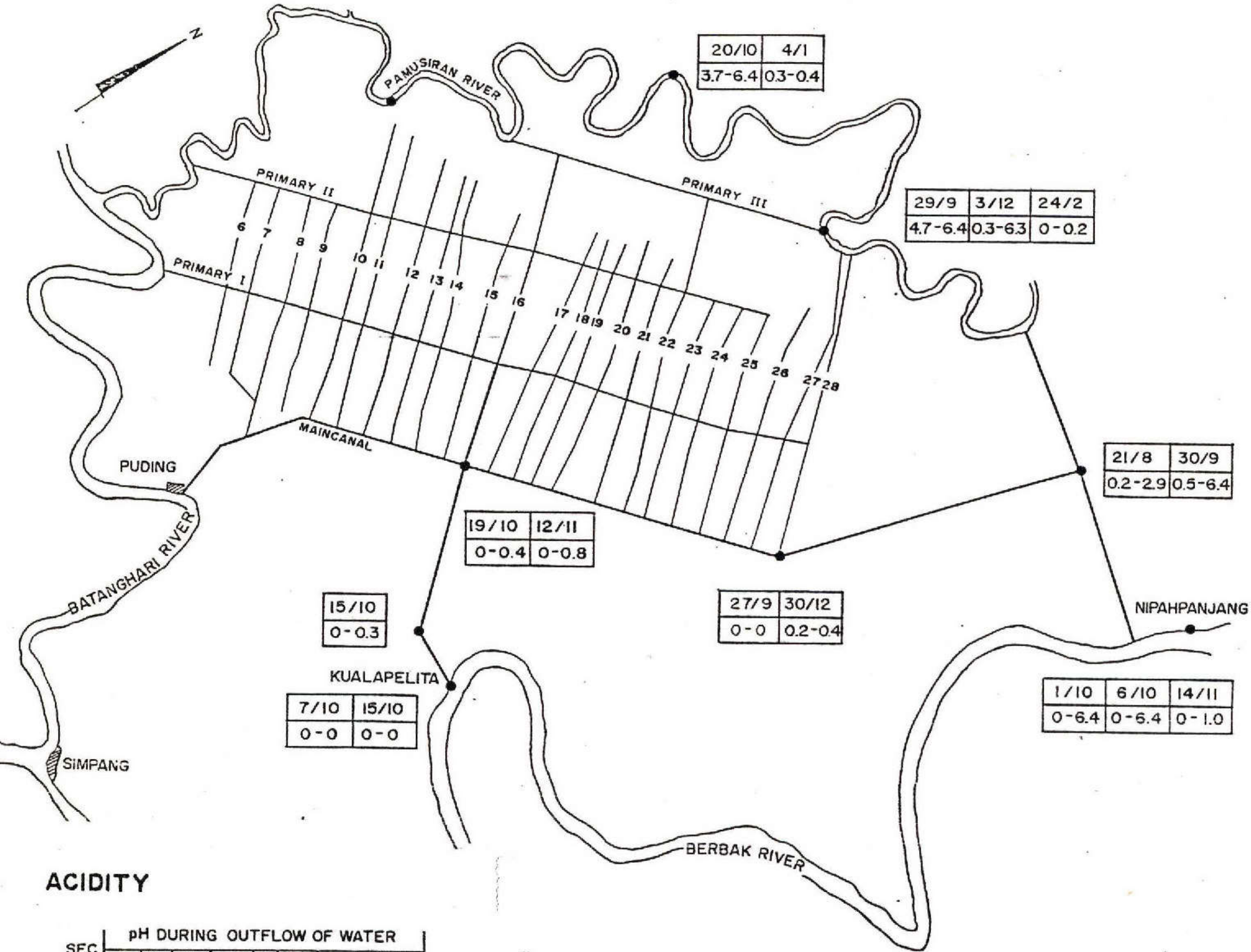
Considering the present condition and performance of the main canal, its future maintenance may consist of deepening the central part around the market place every 5 to 10 years. Deepening should be done with care as sideslopes may easily collapse. Sediment contents of the Batanghari River and of the main canal, measured in June 1982 during maximum ebb flow (30-40 ppm), are relatively low and should not cause excessive sedimentation. In the wet season this value will be higher, but at this time there is a constant flow from the Batanghari to the Berbak through the canal.

3.2.3.6 Transport

The main canal-section Bangunkarya-Nipahpanjang can be navigated about ten hours each day. The sections Bangunkarya-Puding and Bangunkarya-Kualapelita, however, can only be traversed for a few hours per day. Other canals have insufficient water for navigation.

Man-pulled carts are commonly used as transport from fields to the rice mill, and from the marketplace to the river at Kualapelita. The roads along the main canal, primary canals and some tertiary canals are suitable for this type of transport even in most of the wet season, but the bridges are steep and difficult to cross.

QUALITY CANAL WATER, RANTAURASAU



ACIDITY

SEC. CANAL	pH DURING OUTFLOW OF WATER											
	9/12/82				4/3/83				21/4/83			
	1	2	3	4	1	2	3	4	1	2	3	4
6	-	-	-	-	-	6	6	-	-	5	5	4
7	-	-	-	-	-	5	5	-	4	5	5	3
8	-	-	-	-	6	5	5	6	4	4	5	4
9	4	6	6	5	6	5	5	-	3	4	4	-
10	5	5	5	4	5	5	5	5	4	4	4	4
11	4	5	5	5	5	4	-	5	4	4	4	3
12	4	4	4	6	5	4	-	-	4	3	3	-
13	4	4	4	6	5	-	-	-	3	3	-	4
14	4	4	4	6	5	-	-	-	3	3	-	5
15	4	4	4	5	5	-	-	6	4	3	4	4
16	4	4	4	4	5	4	4	5	4	3	3	4
17	5	5	5	6	5	-	-	-	5	4	-	3
18	6	5	5	6	6	-	-	-	5	4	4	4
19	6	6	6	6	6	5	5	5	5	4	4	4
20	6	6	6	6	6	5	5	5	5	5	5	5
21	6	5	5	6	6	5	5	5	5	5	4	5
22	5	6	6	6	6	5	5	5	4	4	4	5
23	5	-	-	-	-	-	-	6	4	4	4	5
24	5	-	-	-	5	-	-	6	5	3	4	5
25	5	-	-	-	6	-	-	6	5	5	4	5
26	6	-	-	-	6	5	5	-	-	-	-	-
27	5	-	-	-	4	-	-	-	-	-	-	-
28	4	-	-	-	-	-	-	-	-	-	-	-

LEGEND :

SALINITY : CANAL/RIVER WITH SURVEY POINT

DATE 1982 - 1983
‰ MIN. AND MAX. SALINITY

ACIDITY : LOCATION OF SURVEY POINTS IN TABLE
1 = OUTFLOW FROM SECONDARY INTO MAINCANAL
2 = OUTFLOW FROM SECONDARY INTO PRIMARY I
3 = OUTFLOW FROM SECONDARY INTO PRIMARY I
4 = OUTFLOW FROM SECONDARY INTO PRIMARY II
pH MEASURED WITH LITMUS - PAPER

Figure 5

3.2.4 Soil conditions

3.2.4.1 General description

In the major part of the feasibility area peat overlays clay or medium-textured soils. The clay is physically ripened to at least 0.5-0.7 m below surface, as can be seen in the oxidation of the soil profile. Peat is concentrated in the middle of the Berbak Island. Some of the peats have a higher elevation. When one gets closer to the Pamusiran River, peat is either absent or shallow and the topsoil consists of silty clay to silty loam.

One finds layers of sandy material at different depths throughout the feasibility area. The sand-layers have not been touched everywhere.

Information on soils is given in Figure 6. Further details are dealt with in the following Subsections.

3.2.4.2 Peat

The most commonly found peat is saprist. It has very strong to complete humidification and plant remains cannot be distinguished. These saprist peats occur in the upper soil layer and, when mixed with mineral soil, also in lower layers sometimes to a depth of 2 m.

In the study area fibrist peat, with no to slight humification, occurs below saprist peat when the peat thickness is more than 0.5 m. This occurs particularly along the main canal between the tertiary canals SK 17 and SK 21.

Peat thickness is very irregular in the study area. Thickness can differ 0.25 m over short distances, making proper mapping difficult. The phenomenon enables crop diversification within one farm holding.

The areas which are covered by each class of peat thickness are given in Table 3.

Table 3. Peat thickness, Rantaurasau

Thickness peat (cm)	0-25	26-50	51-100	101 and over	Total
Area covered, study area only (ha)	75	150	75	150	450
Area covered, study area only (% of total)	17	33	17	33	100
Area covered, feasibility area (ha)	3,625	1,375	950	750	6,700
Area covered, feasibility area (% of total)	54	21	14	11	100

The organic carbon content of the upper 25 cm is very high, 40-50% of the solids. In the layer 26-50 cm this content varies between 5 and 50%. The degree of ripeness of peat layers has been estimated Using the above features as basis, we also assessed the settling which can be expected with deeper drainage. Half of the locations with peat present may settle by an additional 25 cm . The remaining half will be even less affected.

We have compared the present peat thickness with the situation in 1973, as reported by IPB (IPB, 1973). In 1973 the part of the feasibility area covered with a peat thickness between 0.1 and 0.3 m was 22%, the area covered with a peat thickness between 0.3 and 1.0 m was 70%, and 8% had peat thicker than 1.0 m. As a consequence of the construction of drainage canals, the process of subsidence and oxidation has considerably reduced the areas with deep peats.

Peat with thickness of 0.5 m or more is concentrated in the area between the main canal and the primary canal FC II, between the tertiary canals SK 10 and SK 22.

3.2.4.3 Sand-layer in subsoil

In the profiles where we found a sand-layer, the layer continues till the end of the auger hole, 1.2 m or 2 m. It is not known whether the sand-layers are interconnected via a deeper lying widespread sand-layer.

The size of the areas in which sand-layers were found is given in Table 4. The occurrence of the shallower sand-layers is indicated in Figure 6.

Table 4. Sand-layer, Rantaurasau

depth top of sand-layer (cm below surface)	0-50	51-100	101 and over	no sand in profile of		Total
				120	200	
Area (ha)	300	1,700	1,000	3,100	600	6,700
Area (% of total)	5	25	15	46	9	100

3.2.4.4 Soil acidity and salinity

Samples have been taken at 79 locations and analysed for potential acid sulphate soils (PASS). Half of the samples show the existence of PASS equally distributed over depth classes. Each depth class, 0-25 cm, 26-50 cm, 51-75 cm, 76-100 cm, and below 100 cm, is represented by about 10% of the samples. It is noted that one quarter of the PASS is found below the permanently reduced soil-layer. Such PASS will hardly ever become dry enough to oxidize. As the present peat-layers are not assumed to diminish significantly, the depth of PASS below surface will not change drastically in future.

In both August and October 1983 we tried to find actual acid sulphate soils (AASS) at the spots were PASS had been found. We did not find AASS because the groundwater-levels had been too high to allow pyrite oxidation. Even in spots where the groundwater-table had fallen below the soil-layer with PASS for some time, the pH-values of the soil were consistently higher than expected. This confirmed the picture obtained in September/October 1982, when soil-pH in the study area didnot indicate AASS either.

We found AASS at only two locations where both layers were already submerged by the groundwater. It is possible however, that the reduction process of AASS material takes some months. Data are given in Table 5 and the two locations have been added to Figure 6

SOILS, RANTAURASAU

Figure 6

Table 5. Data AASS profiles, Rantaurasau

Number location	R 56	R 90
Depth soil-layer, cm below surface	20-56	30-60
Lowest pH-value after induced oxidation	2.7	2.8
Period in which groundwater-level was not above soil-layer (1983)	10.7-10.9	10.7-10.9
Date sampling for actual pH-value (1983)	30.10	30.10
Actual value pH-H_2O (1:5), minimum oxidation	3.4	2.9
Total SO_4 content (m mol/kg)	49	478

Low salinity occurs in the upper 0.75 m. Salinity becomes high (>450 micro S/cm) at a depth of more than 0.75 m in most of the soil profiles, and especially at depth of more than 1.0 (> 2,400 micro S/cm).

3.2.5 Water conditions

3.2.5.1 Gley phenomena

Soil-layers which are nearly continuously submerged are permanently reduced and have monotonous grey colours. From the depth of such layers in the soil profiles, usually 0.7 m or more below surface, we conclude that the groundwater drops too low to allow the cultivation of a dry-season crop dependant on groundwater only. The reduction layers begin at 0.5 m below surface in only a few augerholes in the north-west close to the Pamusiran River. The thickness of the permanently oxidized layers of the soil profiles shows a complicated pattern over the feasibility area. This pattern cannot be easily explained. Statistical data on the oxidation layer are given in Table 6.

Table 6. Oxidation layer, Rantaurasau

Thickness oxidation layer (cm)	0-25	26-50	51-75	76 and over	Sand or peat*	Total
Area (ha)	45	2,550	1,765	480	1,860	6,700
Area (% of total)	1	38	26	7	28	100

* The oxidation layer cannot be determined in sand or peat layers

3.2.5.2 Groundwater

The project monitored groundwater-levels in a large number of augerholes; 30 in the study area and another 70 in the feasibility area. The most striking phenomenon was the huge fluctuation of the groundwater-level. At the end of the 1982 dry season, levels were all more than 0.5 m below the surface and nearly half were more than 1.0 m below surface. These groundwater-levels were also lower than the permanently reduced soil layers, and hence such low levels may be the exception rather than the rule.

After a huge rainstorm in mid-September the groundwater-levels rose to 0.2 - 0.5 m below surface within a 10-day period. Thereafter, the levels rose gradually and generally reached above-surface levels in December.

The depth of the standing water was 0.05 - 0.25 m, and duration varied from one to more than two months. As was explained earlier, these high water-levels are caused by high water-levels in the Batanghari River and high rainfall in the area concerned.

In February and March 1983, in a period with exceptionally low rainfall, the groundwater-levels dropped again, often to levels somewhat lower than those of September 1982. Our field staff were in Jakarta during this period and we do not know exactly how swift the fall was. The levels rose again within 10-15 days following the April rains.

In the period May to July the groundwater-levels tended to fall, but there were frequent fluctuations of 0.2 m within 10-15 days. It should be noted that the minimum levels of the 1983 dry season were only slightly below the levels in previous months in the majority of the area. The levels dropped to more than 1.0 m below surface only in the southern part, in the area of Harapanmakmur.

The pH-value of the groundwater dropped below 4 during the groundwater rise in September 1982, at the beginning of the 1982/83 wet season. However, the pH-value was back to acceptable levels, 5 to 6, before the groundwater reached the rice root zone.

A similar drop in pH occurred in April 1983 when the groundwater level rose after having dropped to 1.0 m or more below field-level. This time, however, pH-values remained low for some months. It could be that in 1983 the relatively low rainfall, part of which was used for crop evaporation, was less effective in flushing out acid elements from the groundwater than was the case in 1982.

The quick, deep drops in groundwater-levels which occurred in September 1982 and March 1983 cannot easily be explained. It appears that the groundwater-level dropped below the bottom-levels of the nearby tertiary canals and also below the bottom-levels of the nearest primary canals FC I, II or III. It also dropped to or even below the mean water-level in the main canal and the mean water-level in the Batanghari River, and came close to mean sea-level. This suggested deep drainage through very permeable layers. These layers were indeed found in the form of sandy clays often less than 2 m deep. In the higher-lying areas (field-level 2.50 to 3.25 m + PRL) sand was often found at 1.50 to 2.00 m + PRL. In the lower-lying areas (field-levels 2.25 m + PRL) sandy clay was often found below 1.00 m + PRL. Mean sea-level was assumed at 1.00 m + PRL.

In order to understand the influence of field-levels and canal water-levels, groundwater-levels were monitored in three selected locations in lines perpendicular to canals. Areas with high field-levels and little tidal water in the canals (junction of canals FC I and SK 6), areas with low field-levels and daily tidal water intrusion in the canals (junction of canals FC II and SK 23) and a location where tidal influence is strong (along main canal at SK 22) were compared.

The daily fluctuations of water-levels caused by tidal fluctuations in the canals were negligable in all locations. However, the groundwater-levels reacted strongly to rainfall. The drop of groundwater-levels after periods of rainfall were more pronounced and to a deeper level in locations with deep canals than in locations with shallower canals. This occurred even when the tidal water entering the canal and maximum water-levels during high tide were in the same order at both locations. The tentative conclusion is that the drop in groundwater-levels could be retarded if water-retention measures in the canals are implemented.

3.2.5.3 Farmers' efforts

Canals

Farmers usually dig quaternary canals to their home yards along the tertiary canals. Sometimes the ricefield behind the home yard is also connected with the tertiary canal via a quaternary canal. The spacing of the quaternary canals is irregular, but is less than 100 m which is the width of farm plots. As the area has been under development for ten years, farm plots are sometimes divided into smaller plots, mostly for relatives, and here the quaternary canal system is denser. The cross-section of the quaternary canals is small; width of 0.4 to 0.5 m and depth of 0.5 to 1.0 m with very steep slopes. The maintenance of the quaternary canal is usually carried out once a year, before the rainy season really starts or in the rainy season. The tertiary canals are also cleaned at this time.

Structures

Some farmers have built small dams, actually obstructions in the tertiary canal, to raise the water-level in the canal so that water from the canal can flood their ricefields just after transplanting. These obstructions are usually left in place.

In the area close to the Pamusiran River, where the tidal influence is large enough to allow supply to ricefields at high tide, some farmers have built simple structures to retain water in the ricefield. The effect of these structures is not yet known.

In the area between tertiary canals SK 6 and SK 12 with primary canal FC I and FC II farmers are constructing quaternary canals and some simple structures, and bunding their fields.

Land preparation

Land preparation in the form of making bunds and levelling ricefields is hardly done by the farmers because they do not see the need and they have no certainty as to their title to the land.

In a few areas farmers have begun the sorjan* system.

3.2.5.4 Hydraulic conductivity

The project determined the hydraulic conductivity of soil layers according to the Hooghoudt method. The permeability of clayey soils was found to be more than 2 m/day and still higher for medium-textured soils and peat.

3.2.6 Agriculture

3.2.6.1 Cropping systems

Rice cropping is the main stay of agricultural production in the feasibility area. The area under rice is 75% of the total and that under coconut is 15%. The non-cultivated area, either fallow or bush, accounts for the remaining 10%. It is evident that there is an expansion of coconut cultivation, at the cost of rice, particularly in areas with deep peat layers and in areas where Buginese farmers have settled.

* Mixed cultivation of upland crops on raised beds, wet rice in troughs in between

The cropping systems differ somewhat according to prevailing soils. The difference mainly pertains to the ratio rice/coconut cropping. The area with deep peat along the main canal shows the lowest ratio.

Rantaurasau is one of the few tidal land projects with a fairly high intensity of palawija**, 20% in the feasibility area. More than 50% of the farmers cultivate part of their fields with maize, soya bean, groundnut or cassava after rice cropping. One of the reasons for this relatively high cropping intensity is the stimulation of agriculture by the village head.

Apart from their field crops, farmers grow fruit trees and some minor crops in their home yards. Cassava is an important crop. The farming population consists of spontaneous Buginese settlers and Javanese transmigrants. The average farm size is 2.5 to 3 ha, including the home yard.

The growing season for the main crop, a local, tall variety of rice, is from October/November to March/April and is adapted to the possibility of flooding during the month of January. After harvesting the paddy crop, palawija is planted in May when the soil has lost its excess moisture. This second crop is harvested three to four months later depending on the type of crop. Excessively wet soil conditions may force the farmer to plant his palawija late thus risking crop failure because of drought later in the growing season.

3.2.6.2 Yields and related inputs

The project has interviewed farmers to obtain data on yields of rice and palawija. The results are given in Figure 7.

Paddy

The average paddy yields in the feasibility area are around the 1.0 t/ha with the better yields on mineral soils, marginal production on the deeper peats, and approaching zero levels when the peat-layer reaches one meter. It should be stressed that there are great variations in yields from year to year, depending on the annual rainfall, and from one farmer to the other. At a certain ricefield, yields may be 2.5 t/ha in some years, while total crop failure occurs in others.

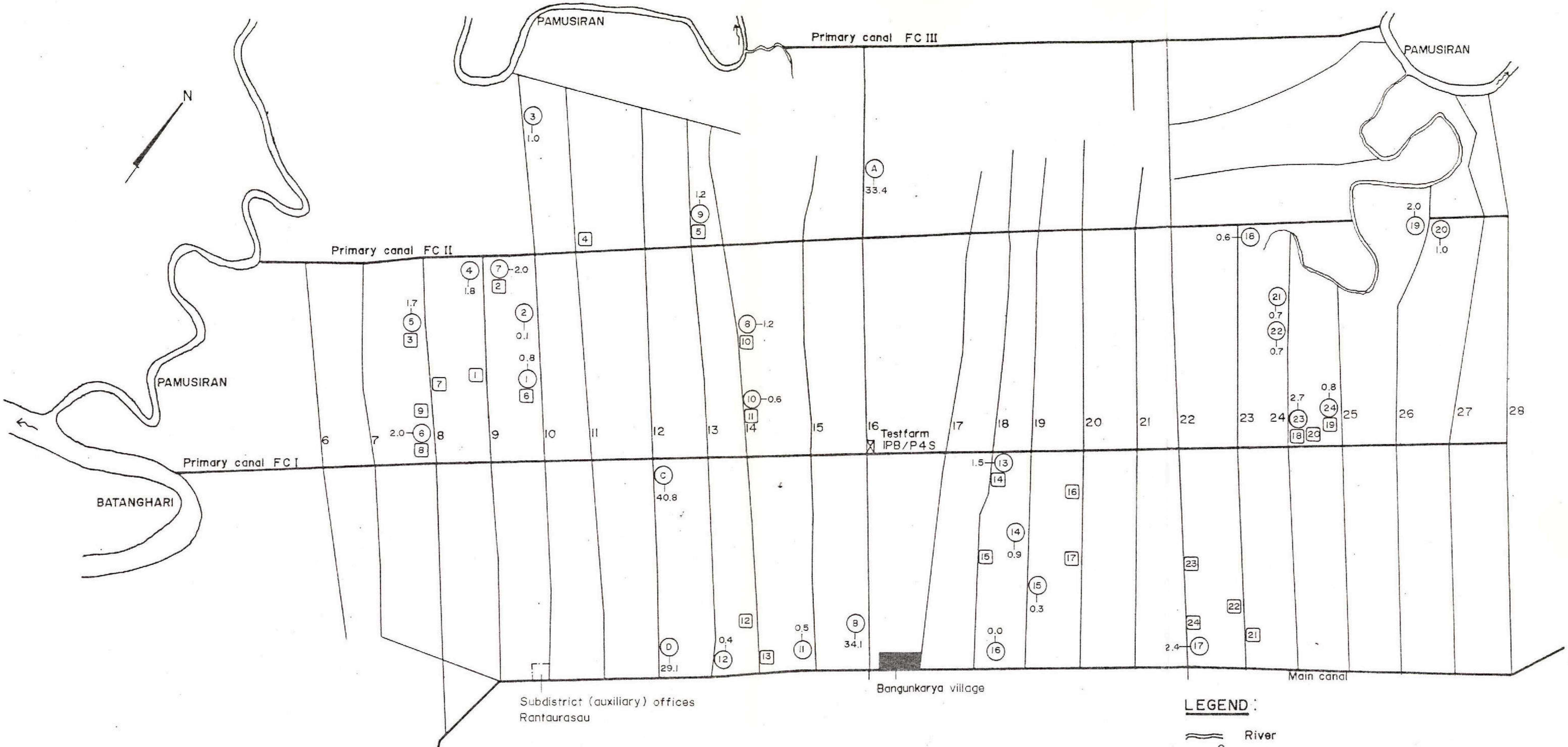
The input level for the rice crop is low. Local, tall varieties are adapted to cope with both the dry-land conditions at the start of the rice growing period which cause abundant weed growth, and with the later flooding conditions caused by high water-levels in the Batanghari River. The alternate occurrence of water stress and flooding explains the absence of high yielding rice varieties. The risks involved in rice cropping prevent sufficient use of fertilizers. There is some application of agro-chemicals against insects and rats.

Palawija

All the palawija yields are low, and they hardly exceed the subsistence level. Moreover, the strong fluctuations in yields are related to the start of the growing season and the severeness of the dry season.

** Secondary, dry-season crop grown on ricefields after the wet-season rice crop

REPORTED YIELDS, RANTAURASAU



YIELD 1982 DRY SEASON, TONNE / HA

PALAWIJA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Maize	0.9	-	0	0.1	0.4	0.2	0.6	0.4	0.7	0.7	0.3	0	0.1	1.5	0.9	1.4	0.1	-	0	0	0.6	0	0.5	0.1
Soybean	-	-	0	0.1	0.3	0	-	0.2	0	-	-	-	-	-	0	-	0	0.9	-	-	-	-	0.6	0.3
Cassave	3.5	-	10.5	-	-	-	-	2.8	10.5	2.6	-	3.3	2.3	-	1.3	-	17.8	-	2.5	-	-	17.5	6.0	-
Vegetable	-	-	-	0.2	0.2	-	-	0.7	0.3	-	0.1	0.1	0.8	0.5	-	3.6	-	-	-	-	-	0.7	-	-

0 0.4 0.8 1.2 1.6 2.0 km

LEGEND:

River

9 Tertiary canal SK 9

5 / 1.7 Location sawah of interviewed farmer and sequence number
Reported paddy yield 1982/83 wet season, t/ha

A / 33.4 Location of coconut sample counting (20 trees), sequence letter
Yield, nuts/tree/year

24 Location sawah of interviewed farmer and sequence number
Reported palawija yield 1982 dry season, see table

DATE OF SURVEY:
June 1983 (paddy)
September 1983 (coconut and palawija)

Figure 7

Maize yields vary from nil to 1.5 t/ha, soya bean yields vary from nil to 0.9 t/ha and a five-month cassava crop yields 3 to 5 t/ha. Inputs for palawija are limited to seed or planting materials.

Coconut

Only a relatively small number of trees, of a local variety, are in the bearing stage. The yields of 30 nuts/tree/year (equivalent to 0.8 t copra/ha/yr) are only half of those reported in the good coconut areas in the tidal lands. However, such yields are still favourable when compared to the marginal rice yields on these deep peat soils.

3.2.6.3 Diagnosis of the present low yields

Even though most of the soils in Rantaurasau are not highly suitable for paddy because of their high permeability (peat, sand-layer), rice is grown because the Batanghari River causes high water-levels in the area from mid-December to mid-February. The resulting saturated soil conditions, often combined with flooding during the middle of the wet-season growing period, force the farmers to cultivate rice. Although there is adequate water during part of the growing period, these periods are preceded and followed by periods with regular water stress to plant production induced by the high permeability of the soils.

Both onset and end of the wet-season rains are unpredictable. Nevertheless, the rice crop has to be planted early so it can withstand possible floods later in the season. The early planting risks severe water stress during the initial growing stages of the crop. After the recession of the Batanghari water, these is the risk of drought influencing grain setting in the local, tall, medium-duration varieties being used in the project area. The floods themselves do not harm these varieties.

Peat in excess of 0.5 m impairs paddy yields. Crop failures accompanied by the phenomenon of empty panicles, which is often associated with micro-nutrient deficiencies, are common.

The low palawija yields are directly related to the hazard of excess water at the optimal planting time as defined by rainfall, and to the risk of drought as the dry season progresses. For these reasons farmers treat palawija as a subsistence crop and apply few inputs.

Permeable soils, unexpected drops in groundwater-levels and a fairly pronounced dry season are the reasons that perennial crops also suffer from water shortage. If this is severe, fruit-fall will result. The peat on which coconut is grown is in most cases sapric in nature and therefore suitable if constant groundwater-levels can be maintained.

Farmers did not mention acidity as a factor contributing to the low yields. Still, attention has to be paid to the fact that the groundwater is fairly acid in the month of October when the rising groundwater-levels are still low.

3.2.7 Socio-economy

3.2.7.1 History of the project

Berbak Island was inhabited by local settlers and Buginese prior to the settlement of the government-sponsored transmigrants. The former arrived from Riau and Mandahara in the early sixties and occupied the borders of the Pamusiran River.

The settlement of transmigrants from Java started in 1967 with 50 families. In March 1969 a second group of 200 families arrived. The largest influx of people took place in the period up to 1976. The primary canals were constructed in 1973 and labour was supplied by the transmigrants.

Originally, primary canal FC III was the formal border between the Buginese and the transmigration area. Later on, the Buginese moved southwards and mingled with the transmigrants.

The local inhabitants moved into the transmigration settlement area as merchants and stayed in the market place. The development of the Bangunkarya market, which burnt down in early 1982, is proof that Rantaurasau has known prosperous years.

Initially, the Rantaurasau transmigration scheme, covering the larger part of Berbak Island, was divided into 7 settlement units. The feasibility area covered units III-VI.

The area was transferred to the Ministry of Home Affairs by the Ministry of Manpower and Transmigration in 1980. An auxiliary Subdistrict was established at SK 10 for administration. Land titles have already been awarded to the transmigrants.

3.2.7.2 Incomes*

Animal husbandry and off-farm incomes are in the same order of magnitude, each 15% of the total income. Off-farm activities comprise farm labour, trading, carpentry, lumbering, and collecting rattan. The household size is 5.9 persons. Income figures are given in Table 7.

Table 7 Incomes, Rantaurasau (Rp'000/household/year)

Cropping	Animal husbandry	On-farm income	Off-farm income	Total
333	68	401	77	478

Farmers carry their produce, either on foot or by bicycle, to canal intersections for marketing. They sell their rice mainly to brokers (77%), but also to rice mill owners (23%). The role of cooperatives in this respect is negligable. The majority of harvested coconuts (80%) are sold for direct consumption. Only some are sold to middlemen. None of the nuts end up in oil factories. Half of the banana yield is sold to the KUD** cooperatives which in turn sell the bananas at retail in the market.

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* Source: UNSRI,1983

** Koperasi Unit Desa, Village cooperative

3.2.7.3 Infrastructure

The centre of activities is the market of Bangunkarya, located near the crossing of the main canal and the major tertiary canal SK 16. This location is accessible by road and, during high tide, via waterways from Puding, Nipahpanjang and Kualapelita. Besides this well-stocked main market, Rantaurasau has several smaller markets spread over the other villages.

The area has four rice mills but no copra processing units. Education opportunities (primary and junior high schools) are widely provided by the Government and private agencies. The nearest hospital is about 100 km away at Jambi, but there are health and sub-health centres at Rantaurasau. A post-office in Bangunkarya takes care of post and money transfers. The BRI* has a village unit here.

There are three field extension workers (PPL's) posted in the area; viz in Harapanmakmur, Bangunkarya and Rantaujaya.

3.2.7.4 Drinking-water

The usual sources of drinking-water are rain-water and water from rivers and canals. Wells dug by hand produce poor quality water.

A deep well drilled in the very centre of the area proved successful and produced 5 l/s. In 1981 a distribution system was designed. It consists of 72 ferrocement tanks, of 3 m^3 each, regularly distributed over the whole area and connected by PVC-pipes. Its capacity was designed to be sufficient until the year 2005 when 34,000 people will receive water from public taps and 8,500 houses will have private connections. The first public standpoints were constructed in 1983.

3.3 Development prospects

Having described the present state of affairs in Rantaurasau, we will now discuss whether upgrading is warranted, whether it is possible, and what its outline should be.

3.3.1 The need for upgrading

The present cropping intensity is high for government-sponsored tidal land development schemes, taking into account the rather large farm size, averaging 2.5 to 3 ha. Palawija cultivation contributes significantly to this high cropping intensity. Off-farm income plays only a modest role. The total income per household, Rp 480,000 per year, is not high in absolute terms. Rainfall and soil conditions permit only moderate yield-levels.

The resulting incomes per holding cannot support a larger number of people in future, however. It follows that the area is in need of further government intervention to raise the land potential enabling higher incomes per holding. As the farmers are industrious, an upgrading project may be well received and reacted upon.

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* Bank Rakyat Indonesia, People's Bank of Indonesia

3.3.2 Agricultural prospects

Rice will remain the most suitable crop for development in the areas with peat-layers less than 0.5 m thick. The progress in development depends both on physical and organizational improvements. Physical improvements will be determined by the extent and time needed to eliminate water shortage and flooding. Water shortage is the major constraint and has a direct impact on the production level of the paddy crop. Flood control is essential for the introduction of HYV* rice to replace the present local varieties which are low yielding but can deal with flood conditions in most years of occurrence. Improvements in the organization of input supply, credit, pest control, agricultural extension, and marketing facilities are similarly indispensable.

When floods are under control, the prevailing water regime precludes the cultivation of HYV as wetland rice. Soils cannot be kept under saturated or submerged conditions long enough to reap the benefits of wetland cultivation. The soil-moisture situation is much more suitable to growing HYV under gogorancah cultivation. This method is able to cope with both dry-land conditions (early October to mid-December) and wet-land conditions (from mid-December onwards). The crop should be directly sown in the field in early October and harvested towards the end of February. In the lower areas, yields up to 1.8 tonne paddy per hectare are attainable after ten years. Although this level is a substantial improvement over the 1.2 t/ha produced by local varieties, it is still constrained by sub-optimal moisture conditions during the period early October to mid-December when the unreliability of rainfall is aggrevated by the presence of permeable soils. While gogorancah rice is more tolerant to such conditions than wetland rice, the crop will still suffer from water stress during the first two months of its development. Water stress in the period after the receding of the Batanghari River can be avoided by growing short-duration, HYV gogorancah rice, planted early in the season.

It will also be possible to cultivate HYV, wetland rice in the lower areas when, in addition to flood control, water-retention measures are taken to prolong the period in which the soils are submerged or saturated with moisture. Such requirements can be met over the period mid-December to end of March, allowing HYV wetland rice transplanted in mid-December so that it will mature during April. Yields of 2.4 t/ha can be attained after 10 years.

In higher-lying areas gogorancah rice can be grown without flood protection measures. It is expected to yield 1.5 t/ha after 10 years. This yield could increase to 1.8 t/ha when water retention measures are taken to improve the water availability during the period mid-December to mid-February. Without such measures saturated moisture conditions on higher-lying soils cannot always be guaranteed. The cultivation of HYV, wetland rice is not anticipated on these soils as water cannot be retained in sufficient quantities after the Batang-hari River starts receding.

In areas with mineral soils, palawija can follow the paddy crop as presently occurs. However, measures should be taken to solve the problem of soil which is too moist after the rice harvest to allow an early sowing of palawija. Early sowing is required to make optimal

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* High Yielding Variety

use of the low dry-season rainfall, particularly in view of the permeable soil. Desirable growing conditions for early palawija can be met, allowing yield levels of 0.6 t/ha soya bean equivalent in higher-lying areas. Enforced late planting will limit the yields to 0.4 t/ha in lower areas.

When peat-layers surpass 0.5 m and rice yields become marginal, the most feasible crop seems to be coconut. It is a preferred crop in the tidal lands because of its comparatively good yields, low labour demands and long productivity period. It is an ideal crop for smallholders. Present coconut yields are equivalent to 0.8 t copra/ha/yr. Yields are impaired by high groundwater-levels in December to February, and by a heavy drop in groundwater-levels in September/October and sometimes around March. Groundwater-level should be as constant as possible to develop an effective root system. The high groundwater-levels can be lowered by drainage but the drop in levels is hard to check. In spite of uncontrollable dry-season groundwater, improvements in the wet-season situation will be such that copra yields could increase to 1.5 t/ha/yr taking into account the fairly pronounced dry season and the permeability of soils.

Once soils are drained, coconut is also an alternative for the cropping system rice-palawija in the higher-lying areas with mineral soil. When this is feasible, yields of 1.5 copra/ha/yr are also attainable.

3.3.3 Prospects of water management

It is relatively easy to reduce one of the two mentioned constraints to improved agricultural production, viz the flood hazard in the feasibility area.

From the previous Subsection it is apparent that the major improvement in rice production depends on supplying water to ricefields or on the possibility of retaining water on the ricefields. To assess the hydro-topographical situation which could result from improving the hydraulic infrastructure, we estimated the water-levels which would be attained in the tertiary canals. In doing so, we compared a system without water-management structures at tertiary level with a controlled system including such structures. The water management at primary and farm level are similar in both alternatives. The resulting figures, see Table 8, are based on only one year of observations (1982/83) and are therefore only tentative.

Table 8 Potential water-levels tertiary canals, Rantaurasau (m + PRL)

month	S	O	N	D	J	F	M	A	M	J	J	A
Uncontrolled, max. level	1.6	1.6	1.6	2.2	2.8	2.8	1.8	1.8	2.1	1.8	1.6	1.6
Uncontrolled, mean level	1.1	1.2	1.3	2.0	2.7	2.4	1.4	1.5	1.8	1.4	1.3	1.1
Controlled, mean level	1.8	1.8	1.9	2.4	2.9	2.8	2.3	2.1	2.2	1.9	1.8	1.8
Supplying river*	1,2	1,2	1	1	1	1	1	1	1	1,2	1,2	1,2

* 1 - Batanghari 2 - Berbak

The field-levels vary between 1.75 m and 3.25 m + PRL. The size of the areas between contour lines (Figure 4, page 13) is given in Table 9.

Table 9 Size of areas between contour lines, Rantaurasau

Field-level (m + PRL)	1.75		2.00		2.25		2.50		2.75		3.00		3.25
Size of area, ha		330		1,610		1,340		1,400		1,610		400	
Ditto, cumulative, ha		330		1,940		3,280		4,680		6,290		6,690	
Ditto, cumulative, % of total		5		29		49		70		94		100	

When comparing field-levels with possible water-levels in tertiary canals, one has to account for a required head of 0.1 - 0.2 m in the canals to ensure an effective water supply to the remote parts of the ricefields. It appears that the differences between the systems are crucial for relieving the water shortage in the beginning (December) and end (March/April) of the cropping season. Without structures, water-levels remain below field-level in all but 5% of the area. With structures, river water reaches 30% of the area.

When necessary, the drainage of the present coconut area could be improved, although this implies a change in drainage base. At present the area is influenced by water-levels in the Batanghari which are too high in the wet-season when an improvement in drainage is required.

It should be noted that tidal water supply is not possible on large scale. Supplying water with low-lift pumps is not feasible because of the huge percolation losses which will occur.

3.3.4 Soil potential

Flood protection may have an adverse effect. However, this risk cannot be quantified. The area has potential acid sulphate material (PASS) and, by reducing the amount of water entering the area, one may disturb the present balance between PASS, noxious oxidation products and the flushing of such products.

Although the soils are not advantageous for rice growing, rice still is the best crop for most the area taking into account soil, water and socio-economic conditions. The exceptions are areas with a peat thickness of over 0.5 m. These areas are unsuitable for rice cropping, certainly when an increase in productivity is aimed at. The saprist characteristics make this peat suitable for tree crops such as coconut. The water-holding capacity of the saprist peat is considered sufficient to carry coconut through dry spells in the wet season.

It should be noted that the deep peats, which were reclaimed ten years ago, will not be reduced to depths which would render such areas suitable for rice cultivation. Future subsidence will be limited to 0.1 - 0.2 m only.

3.3.5 Scope for upgrading

Fulfilling the requirements of HYV, wetland rice requires flood control, water retention and the flushing of potential acid sulphate soils when these turn hazardous. The latter measure delimits the area for this type of rice to that with field-levels below 2.40 m + PRL.

The conditions for coconut cultivation can be met in the area with peat thickness more than 0.5 m.

The combination of all aspects led to a division of the feasibility area in three zones, the LM, HM and HP area:

LM area - low-lying mineral soils. Field-levels below 2.40 m + PRL. Thickness of peat 0.5 m or less. The area covers 2,390 ha;

HM area - high-lying mineral soils. Field-levels above 2.40 m + PRL. Thickness of peat 0.5 m or less. The area covers 2,370 ha;

HP area - high-lying peat soils. Field-levels above 2.40 m + PRL. Thickness of peat more than 0.5 m. The area covers 1,930 ha.

The scope for upgrading the distinguished zones can be summarized as follows:

LM area - The gogorancah method of rice cultivation can be introduced. Wetland cultivation of HYV rice requires flood protection and related water supply to the ricefields, and further water retention at the beginning and at the end of the growing season;

HM area - The gogorancah method of rice cultivation can be introduced;

HP area - Emphasis should be placed on coconut cultivation. Coconut require a relatively constant groundwater-level throughout the year.

It should be noted that the potential of palawija production will not surpass the subsistence level. It is therefore not a decisive crop although upgrading measures may increase yields to some extent.

3.4 The upgrading project

In this Section we describe the outlined upgrading project in detail and analyse its economic effects.

3.4.1 Agriculture

3.4.1.1 Farming systems

The following farming systems (wet season-dry season) are envisaged, depending on technical measures to be taken:

LM area - HYV gogorancah rice - palawija
HYV wetland rice - palawija;

HM area - HYV gogorancah rice - palawija
coconut monoculture;

HP area - coconut monoculture on deep peat, with limited cultivation of cassava for basic food production.

The cropping intensity of rice will be 100%. The intensity of palawija cultivation will vary according to the possibility of eliminating excessively wet soil conditions early in the dry season.

It is assumed that in the future nearly all farmers will grow a palawija crop, on only part of their fields, as it the case at present. This reflects the subsistence level of the envisaged palawija cropping. A cropping-intensity increase to 50% in the LM-area, and to 80% in the HM-area is anticipated.

Perennial tree crops grown under upland conditions will cover 100% of the land suitable for them. During the first 6 to 7 years, part of these fields will be planted to cassava to meet the food requirements during the unproductive stage of the coconut.

3.4.1.2 Yields

General

The anticipated yields for crops have been based on present production and its constraint analysis, on the assumption that present constraints, both physical and organizational, can be removed, and on results obtained in other countries where cropping on tidal lands is common. Yield trends are related to fairly low levels of management during the initial stages of the project. The management level, however, will improve in time. Estimates of yields and related inputs are given in Table 10.

Table 10. Yield and related input projections*, Rantaurasau

year	LM-area (low-lying, mineral soils)						HM-area (high-lying, mineral soils)					
	Gogorancah rice flood prot.		Wetland rice flood prot. water ret.		Palawija		Gogorancah rice		Gogoranjah rice water ret.		Palawija	
	yield	inp.	yield	inp.	yield	inp.	yield	inp.	yield	inp.	yield	inp.
1	2	3	4	5	6	7	8	9	10	11	12	13
1	1,300	15	2,000	20	300	15	1,250	15	1,300	15	400	15
2	1,400		2,100		300		1,300		1,400		400	
3	1,500		2,200		300		1,350		1,500		500	
4	1,550		2,250		350		1,400		1,550		500	
5	1,600		2,300		350		1,425		1,600		500	
6	1,650		2,325		350		1,450		1,650		600	
7	1,700		2,350		400		1,475		1,700		600	
8	1,750		2,375		400		1,500		1,750		600	
9	1,800		2,400		400		1,500		1,800		600	
10	1,800	15	2,400	20	400	15	1,500	15	1,800	15	600	20
Potentially	2,200	20	3,000	25	500	15	1,800	20	2,200	20	750	20

* yield of rice in kg paddy (14% moisture)/ha;
yield of palawija in kg soya bean equivalent/ha;
inp. - related inputs, as percentage of gross production value.

Gogorancah rice

The gogorancah method of rice cultivation is best suited to the alternating dryland and wetland conditions prevailing in the feasibility area. High yielding, short-duration varieties are available to make maximum use of the rainfall and related soil moisture conditions. Water-balance calculations have been used to assess the water deficits to crop production and their impact on yields under conditions in the

LM and HM-areas. Water deficits during dryland conditions are responsible for yield reductions of 30% when compared to full water supply under wetland conditions, see columns 2 and 10 of Table 10. If in the HM-area water retention is not capable of assuring saturated soil moisture conditions during the flowering and grain-formation stages, an additional reduction of 15% has to be made, see column 8 of Table 10.

In projecting yields it has been assumed that acidity is under control. The low pH-value of the groundwater in October will increase, when the groundwater rises, to pH-values that do not have harmful effects on paddy yields. If water retention measures are to be taken, allowance has to be made for flushing the upper 0.15 m of the soil with flood water or rain-water, should phenomena similar to those found in Barambai appear here as well.

Wetland rice

Yield projections have been based on the assumption that wetland conditions can be created for periods long enough to grow HYV, wetland rice. This appears to be possible only in the LM-area where water retention is enhanced by water supply from the river into tertiary canals. Here, wetland conditions, normally occurring from mid-December to mid-February, can be extended to the second half of March in four out of five years. The transplanting of a HYV, wetland rice crop should be done in the middle of December and the rice harvested during the month of April. Flushing with river water is essential should acid groundwater cause problems. Average yield reduction because of sub-optimal water retention will be in the order of 10% compared to yields under full water supply under wetland conditions, see column 4 of Table 10.

Palawija

The difference in the yield projections for palawija in the LM and HM-area is caused by excessively wet soil conditions after the paddy harvest in the former area. This prevents early sowing of the palawija which is essential to make maximum use of the already low dry-season rainfall. Taking into account rainfall, high permeability of soils, and the time of sowing, yields will hardly surpass subsistence levels even in the early-planting alternative, see column 6 and 12 of Table 10.

Coconut

Should perennial cropping be preferred to the rice - palawija cropping system, coconut seems to be the most suitable crop. Under the drainage measures possible in the feasibility area, yields of 1.5 t copra/ha/yr can be expected in the HM-area and in the HP-area when trees are mature. The first year of production will be 7 years after planting and full production will be attained from year 12 onwards. Inputs during the unproductive period will amount to Rp 200,000/ha (pre-devaluation). The annual production costs when trees are in bearing stage are Rp 20,000/ha (pre-devaluation).

During the immature period, it is assumed that cassava, with anticipated yields of 15 t wet tubers/ha for a 12-month crop,will be grown for food production. Production costs are estimated at 10% of the gross production value.

3.4.1.3 Inputs

To determine the quantities of seed, fertilizers and agro-chemicals needed, reference has been made to earlier studies (Nedeco-Euroconsult, 1981). The inputs are expressed as a percentage of the gross production value (GPV). The percentages are based on long-term experience.

3.4.1.4 Farm size and labour

The average farm size is 2.5 to 3 ha including the home yard. The available labour per family is adequate to deal with the proposed farming systems. Labour may still be hired for rice cultivation, although it is not actually required. Labour requirements for crops in the anticipated cropping systems are given in Table 11.

Table 11. Labour requirements, cropping (mandays/ha)

Wetland, HYV rice	175	Soya bean	135
Gogorancah, HYV rice	175	Cassava	140
Local variety rice	190	Coconut	60

3.4.1.5 Agricultural support

Upgrading of the project can only succeed when backed by agricultural support. Good quality seed of the appropriate varieties must be available in sufficient quantities and on time. Farmers should have access to credit to buy the necessary inputs, or should be aided by the INSUS* programme. Agricultural extension should focus on agricultural aspects such as pest control, and on water management. The Training and Visit approach will suit the project area. Research on the testfarm should pay special attention to gogorancah. Coconut trials should be carried out on the farmers' fields to relate peat depth and peat quality to yield performance under the prevailing water regime. The exchange of information between researchers, extension workers and farmers is the basis for introducing new farming systems or new cultivation methods.

3.4.2 Hydraulic infrastructure

Figure 8 depicts the layout of the hydraulic infrastructure. More detailed information is given in Volume IV, Designs, of this Report.

3.4.2.1 LM-area

General

The farming system HYV, gogorancah - palawija requires the elimination of floods in the area.

The system HYV, wetland rice - palawija also requires a water supply at two levels; to ricefields and to tertiary canals. The former is essential should potential acid sulphate soils produce noxious elements at the beginning of the wet season. Although it is not certain this

* Intensifikasi Khusus, Special Intensification.

LAYOUT HYDRAULIC INFRASTRUCTURE, RANTAURASAU

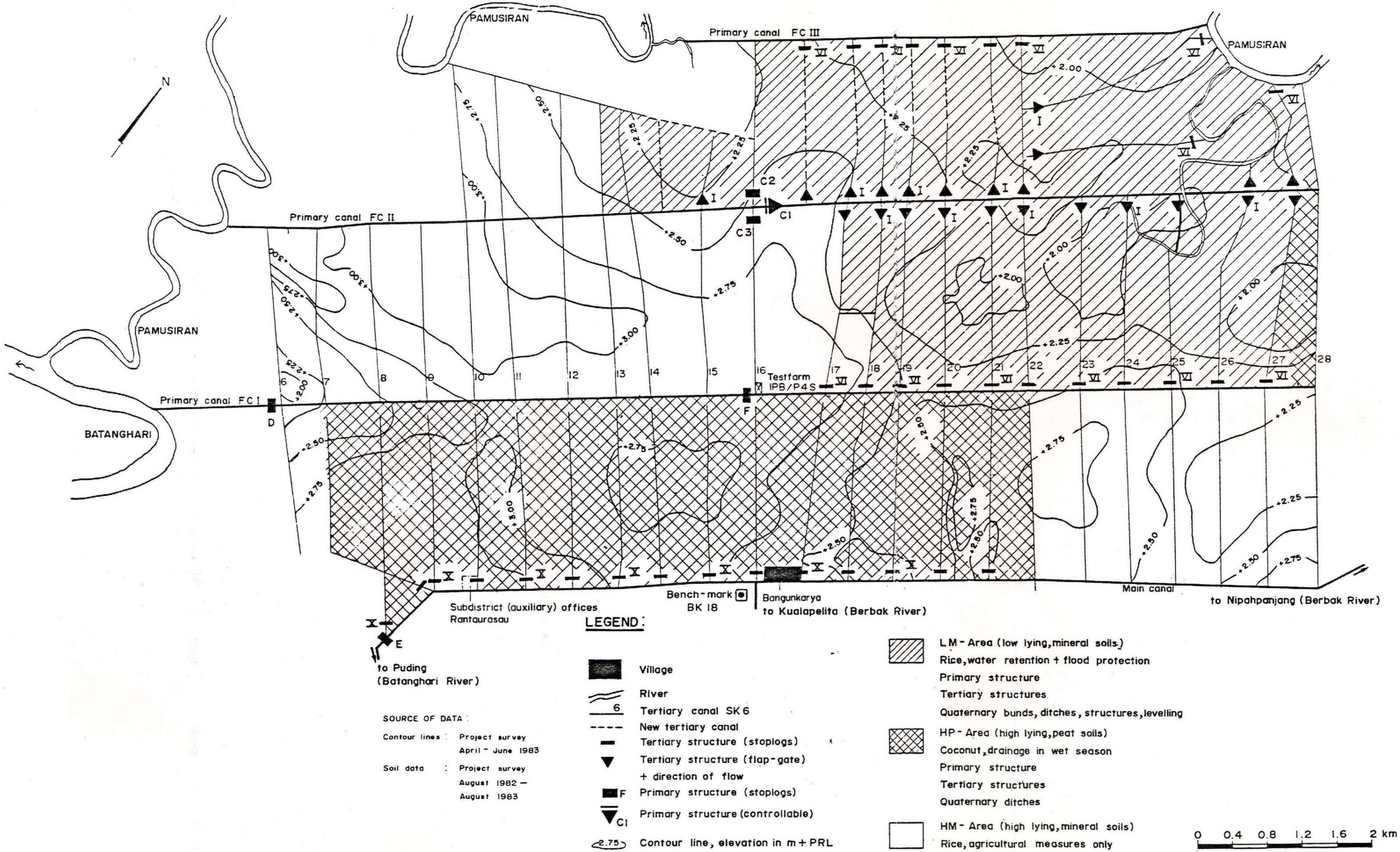


Figure 8

phenomenon will materialise, it may be a consequence of the improved drainage conditions in the area. Such elements have to be flushed out of the topsoil before roots can develop fully. However, a water supply to ricefields will be beneficial to rice cropping even if no noxious elements have to be flushed. By supplying water to the tertiary canals the drainage base of the water on the ricefields or of the groundwater is raised. This will retard the draining-off of earlier supplied water and rain-water, and hence contribute to retaining water on the ricefields. Both cropping systems require a proper farm infrastructure to enhance the water retention on the ricefields. This is more crucial in the wetland cultivation method than in the gogorancah method.

Twohundred hectares of forest have still to be cleared in the LM-area.

Flood protection

Our surveys indicate that flood water originates in the Batanghari River and enters the LM-area via the primary canals. The resulting high water-levels in the canal system impede proper drainage of rain-water and consequently the area is submerged. It should be noted that there is no overland flow from the rivers into the area. During flood periods, the water-levels in the Pamusiran and Berbak Rivers, at the confluence with main and primary canals of the area, are relatively low. These rivers do not contribute to the flood problems in the area.

The logical way of stopping these floods is to close the primary canals FC I and FC II during high water-level periods in the Batanghari. This can be done with stoplog structures when the canals do not function as supply canals at the same time. In the latter case, the gates should be controllable. The canal berms between the river and the flood-control structures have to be on flood-level plus required freeboard.

Water supply to tertiary canals

Only the Batanghari water-levels are high enough to provide water to ricefields. A suitable supply canal is primary canal FC II. Primary canals FC I and FC III could then be used as drainage canals. It should be noted that canal FC I runs along the boundary of the HP-area. Coconut cultivation, requiring low water-levels in the wet season, is envisaged here. This situation makes canal FC I less suitable as supply canal, having high water-levels. Primary canal FC III is connected to the Pamusiran, where water-levels are relatively low. Thus, canal FC III is also less suitable as a supply canal.

The part of the low-lying area between the main canal and primary canal FC I is too far from the Batanghari to assure a considerable raise of water-levels in the tertiary canals and a reasonable influence on water-levels on the ricefields. Consequently, this area has been shifted to the HM-area.

To obtain maximum water-levels in the tertiary canals it is important to prevent water flowing out of these canals into primary canals. This is accomplished by constructing water-control structures at both sides of the tertiary canal. At the supply side, around canal FC II, a flap-gate is necessary to allow water to enter the tertiary canal and to stop a return flow when the supply canal water-level is low at ebb. At the drainage side of the tertiary canal, near canal FC I and FC III, simple stoplog structures will suffice. The stoplogs have to be removed when drainage is required, usually only occasionally during the growing season.

The present tertiary canals are distributed rather regularly over the area with average distance of 500 m between canals. However, proper tertiary canals are absent in the area between primary canals FC II and FC III around tertiary canal SK 16. It is proposed that this area also be provided with tertiary canals.

The tertiary canals also serve as drainage network. As such they do not need to be upgraded and proper maintenance would be sufficient.

On-farm works

Farm layouts for both rice and coconut plots are given in Figure 9. The timely availability of water for the crop is the scarcest production factor in the area. To prevent a superficial run-off of water from the ricefields, be it rain-water or river water, properly laid-out clay bunds are warranted. The clay is obtained by digging ditches which could then function as quaternary supply and drainage canals. Water-logged spots and the rear sections of long fields can be quickly and completely drained into such ditches. The ditches are very effective in supplying water to the ricefields. Water might not reach the second half of the permeable ricefields without them. Farmers should keep the ditches filled with water so as not to loose valuable supply-time by filling up ditches at every high tide.

The bunds along the boundaries of a farm plot are designed to assure that a farm plot is not unduly influenced by the conditions in surrounding plots. The cost of bunds and ditches depends on the form and size of the farm plots. For costing, the farm plot has been taken to be 2.5 ha, with the depth of the plots equal to half the distance between tertiary canals.

Each plot is connected to the tertiary canal via two simple inlet/outlet culverts which can be closed and opened by the farmers. This provides the possiblity of raising the water-level in quaternary canals to maximum levels. Water supply to the fields can also be stopped if this is preferable. It should be noted that the farmers along one tertiary canal are far from independent as they all have to use the same level in the canal; either high for supply or low for drainage.

The micro-relief of the ricefields is irregular due to the unequal distribution of peat and its gradual disappearance. Land levelling is most important as it enables proper fertilizing and water application, and contributes to equal ripening of the harvest. Because of the still diminishing peat and a potentially hazardous subsoil, levelling has to be done as a continuous process and may take years to finalise.

FARM LAYOUTS, RANTAURASAU

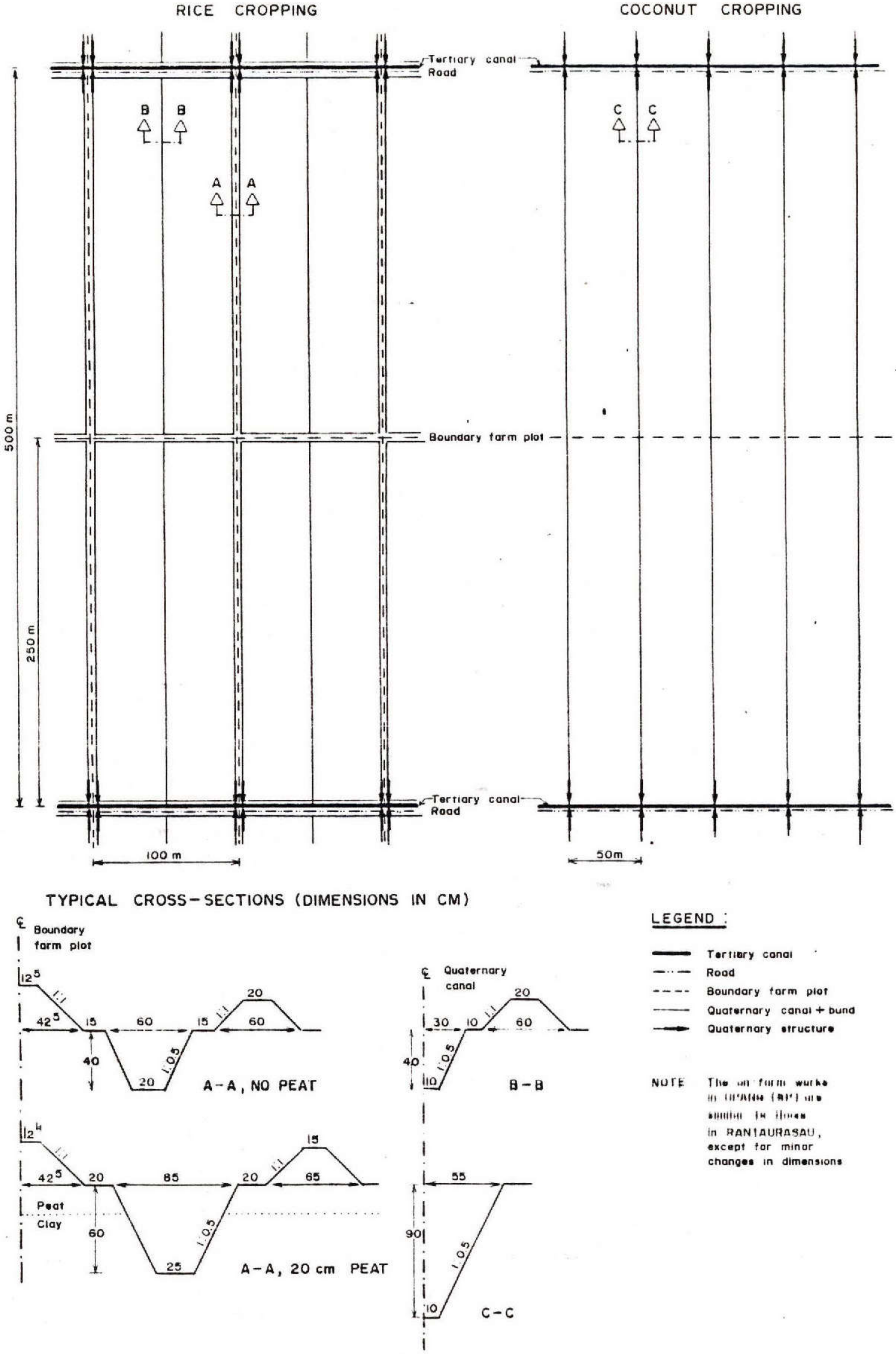


Figure 9

3.4.2.2 HM-area

The farming system HYV, gogorancah - palawija requires a proper farm infrastructure similar to the one described in the previous Subsection. The HM-area, being higher-lying than the LM-area, does not need flood protection, nor can river water be supplied to ricefields. Supplying river water to the tertiary canals would require the same set of structures as in the LM-area. However, the resulting water-level would still be so far below the retained water in the ricefields that the positive effects of the measures would be small.

The coconut monoculture farming system requires deeper wet-season drainage, see following Subsection. This will be hard to attain when combined with the demand for high water-level supply to the LM-area along the same primary canal. Preliminary economic analyses showed, however, that the coconut cropping system is inferior to the gogorancah system. This implies that farmers will continue to prefer growing rice. For this reason we have not further analysed technical solutions to meet coconut demands.

3.4.2.3 HP-area

General

The farming system coconut monoculture requires a groundwater-table which is at a far more constant level than is presently the case. Our survey data showed that the present dry-season groundwater-levels are considerably lower than the wet-season ones. As all surrounding rivers have low water-levels during the dry season, we cannot raise the dry-season groundwater-levels significantly through gravity supply. Pumping is prohibitively expensive on the highly permeable soils. One may delay the fall of the groundwater-table in the beginning of the dry season by using tertiary structures. The other solution is to lower wet-season groundwater-levels. Such lowering necessitates, first of all, on-farm works to drain the water from the upper soil-layers into the tertiary canals. Water then has to drain into primary or main canals. These canals, however, are under the influence of the high wet-season water-levels in the Batanghari. It follows that, to attain the required conditions for coconut, the drainage base of the HP-area has to be changed.

On-farm works

The on-farm works required in coconut cultivation are simple and consist of quaternary drainage canals at proper distances and related depths. Land levelling is not required under the prevailing cultivation method which includes planting on mounds when necessary.

The distance between quaternary canals was taken in accordance with present practise, viz 50 m. Having estimated the water-holding capacity of the soil-layers, we assessed the design groundwater-level at 0.7 m below surface. Design drainage discharge was taken as 50 mm/day, being a 2-day rainfall with occurrence frequency of once every two years, and also a 3-day rainfall once every five years (Nedeco-Euroconsult, 1981). The desired water-level in the quaternary canals, and further dimensions of such canals were calculated using these data.

The quaternary canals are connected with the tertiary canals via two simple outlet/inlet culverts which can be closed and opened by the farmers.

Tertiary structures

Tertiary structures provided with simple stoplogs are envisaged to stop the outflow of water from the tertiary canals when groundwater-levels start falling at the beginning of the dry season. In view of the permeable soils, it is considered useful to maintain high water-levels in the tertiary canals together with such levels in quaternary canals, as is already provided for via the above mentioned closeable culverts.

Lowering drainage base of area

The drainage base of the area can be lowered by closing off primary canal I and the main canal between the HP-area and the Batanghari, and improving the canals connecting the HP-area with the Berbak River. The latter feature does not pose any problem. Closing off the main canal, however, would stop its navigation function on this side of the Rantaurasau project. Navigation here is of local interest only as the main flow of goods is towards Nipahpanjang and Kualapelita. The water-levels in Bangunkarya will only drop in the wet season, although they will still be higher than dry-season levels.

3.4.2.4 Operation of the system

LM-area, rice cropping

At the beginning of the wet season the operation of the system should be geared to supplying a maximum water-layer to the ricefields. As the time required to fill the tertiary and quaternary canals is close to the duration of high water-levels in the supplying canal, it is paramount to maintain maximum water-levels in the canals. In this way the next high tide will start discharging water to the ricefields immediately, instead of just filling empty canals.

During flood periods, the primary structures C should be set so that the the available water can be properly utilized without producing hazardous water-levels in the protected area.

Drainage may be required during the rice ripening period, before the planting of palawija, if the C structures have not completely kept floods out the area, or if flushing of acids and related noxious elements is required in future. The duration of these measures should be geared to the purpose.

At the beginning of the dry season the operation of the system should be geared to maintaining as much water in the system as possible. This will retard and hopefully prevent oxidation of acid sulphate material in the soil.

HP-area, coconut cropping

In the wet season the system should be geared to keeping the groundwater-level low. In practice this means allowing the outflow of the water in quaternary and tertiary canals . However, as soon as the groundwater-table drops below the desired level, the system should be operated in reverse.

3.4.2.5 Land use

The improvements in infrastructure require land which could have been used for cropping. The size of the distinguised categories of land use before and after implementation of upgrading measures is given in Table 12.

Table 12. Size land categories, Rantaurasau (ha)

Land category	At present			After upgrading			Total
	LM	HM	HP	LM	HM	HP	
Cropping	2,130	2,310	1,870	2,140	2,310	1,830	6,280
Home yards, villages	-	-	10	-	-	10	10
Infrastructure	60	60	50	250*	60	90*	400*
Forest	200	-	-	-	-	-	-
Total	2,390	2,370	1,930	2,390	2,370	1,930	6,690

* Incl. on-farm works

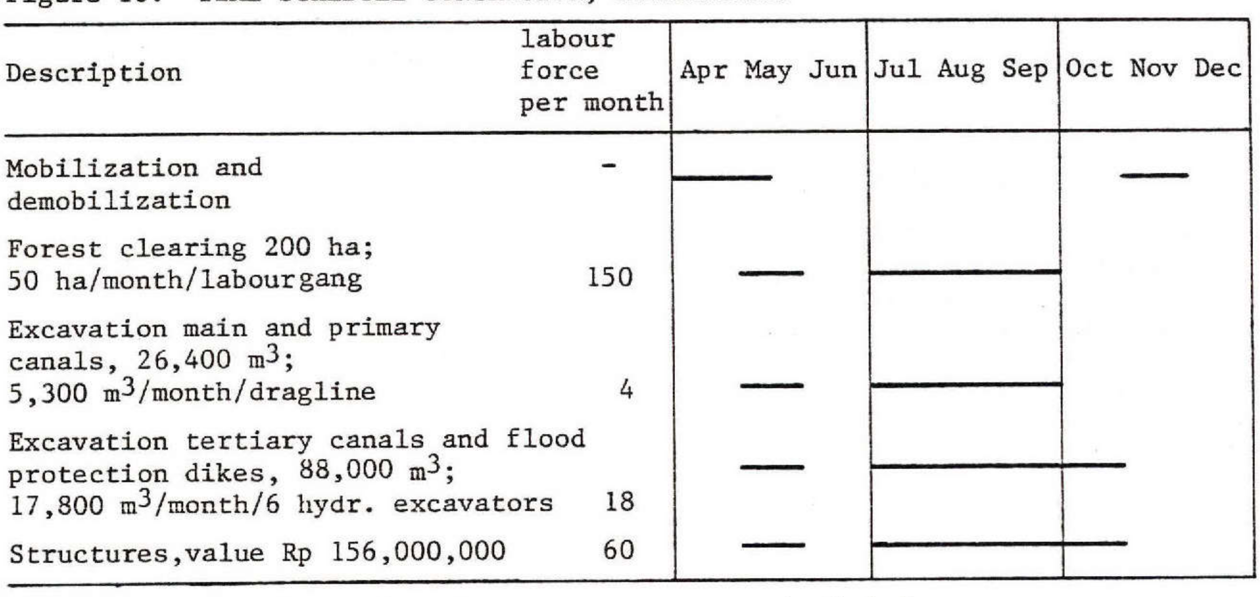
3.4.2.6 Construction

Constructing the envisaged components of the hydraulic infrastructure will not pose special problems to experienced contractors. Such components have already been carried out in other tidal-land development schemes. However,in these schemes the Government was reclaiming unused government land, and it will now be operating on cropped land, with the person entitled to crop the land and harvest its yield very much present. The method of construction is given in Volume IV, section 3.8.

It would not be practical to have all on-farm works executed by contractors or a government agency. These works demand a degree of detail, attention and care which can only be expected from the beneficiary, the farmer himself. Nevertheless,he has to be advised, on the background of the work, its usefulness, and the optimal sequence of construction. Efficiency will be increased if farmers are paid an incentive for the on-farm works.

The time-schedule for the contracted works is given in Figure 10.

Figure 10. TIME SCHEDULE CONTRACTOR, RANTAURASAU



Note: on-farm works, other than structures, not included

The costs of the envisaged works are given in Table 13. For details see Appendix II.

Table 13. Construction costs of project, Rantaurasau (Rp'000,000)

Area		LM		HM		Total
Contractor, direct costs	183		117		300	
Contractor, indirect costs	57		36		93	
Contractor, total costs		240		153		393
Farmers, total costs		378		139		517
Construction costs of project		618		292		910

3.4.3 Economic analysis

3.4.3.1 LM-area

The without-project case

During the wet season this area of 2,130 ha net is mainly cropped to a local rice variety yielding an average of 1.2 tonne paddy (14% moisture content) per hectare. In extreme cases, flooding leads to total crop failure. Only slow-maturing rice varieties with medium to long straw and a growing season extending far into the dry season can possibly produce yields in these conditions. The combination of too much water early in the cropping season and water shortage in the latter part of the cropping season constitutes the major constraint to higher land productivity.

An area of 200 ha still under forest is not utilized at all. There are no basic constraints on soil fertility, nor are problems with soil acidity encountered under the present hydrological conditions.

The project

The project aims at improving the overall drainage and supply capacity of the canal system and at preventing floods. Measures such as structures at tertiary level and levelling, bunding and ditches at farm level are foreseen. These project provisions will bring the cultivation of short-duration, high-yielding rice varieties within reach.

In principle agriculture is still rainfed. However, timely planting will make optimum use of rainfall when floods are eliminated and the growing season is much shorter. Land will have to be sacrificed for infrastructural provisions such as farm bunds and ditches, while the former forest area will be cleared under the project. The size of the cultivated area will remain the same with and without the project.

Project returns

It is assumed that farmers will have completed on-farm works and that the cropping intensity for high yielding, short-duration varieties of rice will have reached 100% after a brief adaptation period of about 4 years. Thereafter, yields will still increase to 2.4 t/ha after 10 years of operation, see Table 10. Related input levels are estimated to be 20% of the gross production value. The ultimate yield potential is estimated at 3.0 t/ha. After an initially rapid income increase for the farmers, growth will continue at a slower pace of 1 to 1¼% per year until the ultimate potential is reached 20 to 25 years after the start of the project.

The hydro-topographical conditions created by the project allow the cultivation of palawija following the rice crop. The introduction of a second crop generally takes a very long time. It is seriously doubted whether the farmers will utilize this potential within a period which is relevant in economic evaluations. This is especially so when it is taken into account that the returns on the main (rice) crop will almost immediately double. It is therefore unrealistic to consider the potential returns of palawija in the economic evaluation.

The total area under cultivation will be 2,140 ha, including 10% newly reclaimed land formerly under bush/forest. The newly reclaimed area has the same agricultural potential although initially it will yield less. Project benefits have therefore been reduced by 5%.

Project costs

The contractor component of the costs for the construction of flood protection and improvements of the drainage and supply system are Rp 240 million. The major infrastructural works can be completed within 1 year. The cost of improvements at farm level, bunding, levelling, ditches etc., is Rp 378 million. These works will be implemented by the farmers themselves under the guidance of the Ministry of Public Works (P3S). Farmers may receive an incentive to implement these works. An allocation of 6% for guidance has been included in the above cost of farm improvements. It is assumed that the works will be completed in four years. For operating and maintaining the system, 4% of the total development costs have been set aside on a yearly basis.

Evaluation

The package of measures foreseen in the upgrading project are very profitable. The interrelated measures aiming at the elimination of flood hazards and water retention open the possibility for a technical innovation; the planting of a short-duration, high yielding variety of rice with a good yield potential.

The project assumes the co-operation of the farmers in improving the infrastructure at farm level and switching from traditional to high yielding varieties. In this respect it must be mentioned that a large component of the area's farming population is of local or Buginese origin. By tradition these people are less rice-oriented than transmigrants from Java or Bali. Technical innovations geared to introducing modern varieties of rice may be absorbed gradually only. In evaluating the project, such delays have been accounted for.

Four alternative cases were evaluated:

- The farmers respond immediately to the upgraded conditions. They do not cultivate palawija. The internal rate of return (IRR) is 25% and the discounted value of future benefits is Rp 1,268 million (discount rate 10%).
- The farmers respond with a five-year delay to the upgraded conditions. The IRR is still attractive at 20% and the discounted value of future benefits is Rp 710 million (discount rate 10%).

- Half of the farmers respond to the upgraded conditions. The results are the same as the previous case, 20% and Rp 710 million.
- Half of the farmers respond with a five-year delay. The IRR drops to slightly below 15% and the discounted value of future benefits to Rp 209 million (discount rate 10%). This case is assumed to be the bottom line.

Extension services play a crucial role in the whole process. Farmers have to be instructed in growing new varieties and in water management in order to optimally utilize the newly created conditions. In the cost of operation and management of the hydraulic system two extra staff are foreseen. However, even if implementation of the project or its management fall short of expectations, the project margins are so large that the project will remain profitable.

To reduce the burden to the Government, it is suggested that the Government fund only the major infrastructural works and the construction of all structures. An incentive should be made available to the farmers who implement the necessary on-farm works.

3.4.3.2 HM-area

In the area with higher-lying, mineral soils no major improvements in the hydraulic infrastructure are foreseen. However, the income could be improved by introducing the gogorancah system of rice cultivation as this is better suited to dry starting conditions, irregular rainfall and high permeabilities. Introduction of the gogorancah method could lead to yields of 1.5 t/ha after 10 years, with a potential of further growth to 1.8 t/ha.

The additional effect of water retention measures on such improved yields is very questionable. Even if one assumes a positive effect, the growing conditions will only improve marginally and initially produce only small yield increments. In the first years the difference will represent a value of a few thousand Rupiah, but will incur costs of nearly Rp 50,000 per ha for on-farm works. It appears improbable that farmers will take the necessary action. In this case the project is deemed unfeasible, and water-retention measures should not be recommended.

The farmers' viewpoints, however, may change when intra-regional income disparities grow larger over time. The input supply in the feasibility area should be running smoothly by then. This will provide scope for sudden increases in yields once the physical infrastructure is maximal. Under such conditions, the demand for water-retention measures may arise. Instead of forcing the farmers into measures for which they do not see the benefits, it would be better to wait. If need arises, the Government can step in and stimulate such development by giving incentives.

3.4.3.3 HP-area

<u>Without-the-project case</u>

This area is depressed. Because of the thick peat-layers, the soils are not suitable, or are only marginally suitable, for rice cultivation. Exceptions are some small depressions within the peat area where peat is thinner or has a higher mineral content. Rice is grown here at present.

Farmers in the remaining area grow cassava or have started growing coconut. Most of the coconut are not yet in the bearing stage, and where they have reached this stage, yields are low, 0.8 t copra/ha/yr on average. Given the present drainage conditions, there is little hope that average coconut yields will become much higher.

The project

The area will be made better suited to coconut production through the lowering of wet-season groundwater-levels. This will be possible when the drainage base of the area is changed from the Batanghari to the Berbak River.

Project returns

Even after drainage, conditions will not be optimal and yields of mature coconut will not exceed 1.5 t copra/ha/yr. For existing immature plantations which have suffered adverse drainage conditions during their initial growth, the incurred damage may lead to persistent yield reductions. Yields of such coconut groves are assumed not to exceed 1.2 t/ha/yr.

Project costs

The project includes improvements to the main drainage canal, structures to control water-levels in main and tertiary canals, and farm ditches and culverts. The costs involved are Rp 153 million for major infrastructural works, and Rp 139 million for technical provisions at farm level. For operating and maintaining the system, 4% of the total development costs have been set aside on a yearly basis.

Evaluation

The case of coconut growing has been evaluated both for existing and new plantations.

The area presently planted has been approximated. As the growing stages on present plantations are not fully known, the evaluation has been carried out on a per-hectare basis. It is assumed that existing coconut holdings will reach the mature stage in 1986 or 1987, between two to three years after project implementation. The IRR of the project with existing plantations will settle between 20 and 25%, and the discounted value of future benefits is Rp 400,000 to 500,000 per hectare (discount rate 10%).

It is assumed that the coconut trees which have to be (re)planted will have a higher yield at maturity than the already damaged, existing stands. However, the newly planted coconut will bear fruit at a later stage and consequently the lead period involved in the project will be extended from 2-3 to 5-6 years. The fact that the new coconut plantations can initially be intercropped with cassava boosts the economic performance. However, a certain degree of conservatism from the farmers, who have been faced with serious hardship conditions over a long period of time, has to be anticipated. It should be taken into account that farmers will only respond with some delay. This does not mean that such an attitude will make the project unfeasible. Even if an additional delay of two years is considered after the project is implemented, the returns of this project with new plantations will still be good with an IRR of 25% and a discounted value of future benefits of about Rp 1 million per hectare (discount rate 10%).

From an economic viewpoint the upgrading project stands firm, although farmers' attitudes may be decisive to the success of the project. Again, giving the farmers a financial incentive to perform the necessary works at farm level should be considered.

4 UPANG (SP)

4.1 Location of areas

The Upang (SP) project is located in South Sumatra Province, to the north of Palembang town, along the eastern shore of the Musi River. It is bordered by this river and the secondary canal running mid-way through the Upang Island, see Figure 11. The area belongs to Banyuasin II Subdistrict (capital in Sungsang) of Musi-Banyuasin District (capital in Sekayu). The area can be reached by motorcycle from Makartijaya, the central market place of Upang Island and also via the Musi River. However, the people living along the river do not promote this approach.

We selected the strip of land between tertiary canal 10 and 12, between the Musi River and the secondary canal, as the study area for general data collection purposes. The IPB/P4S testfarm Delta Upang lies opposite the secondary canal, see Figure 11. The size of the study area is 490 ha.

The feasibility area is also bordered by the Musi River and the secondary canal, and by primary canals I and II. The size of the feasibility area is 2,885 ha.

The project surveys in the area were intensified after the area was selected as a feasibility scheme, and covered the period March till August 1983. Some routine surveys were carried out before this period.

4.2 Present conditions

4.2.1 Population

The project has interviewed the leaders of each tertiary canal area to obtain population figures. A special aspect of the Upang (SP) area is that only 55% of the farmers live along the tertiary canals close to their fields. The others live in concentrated settlements on the outskirts of the area, viz Tirtakencana and Makartijaya. The total number of farmers in 1983 is estimated at 500 to 550.

4.2.2 Climate

According to the Koppen's system, the climate of the area can be classified as Af; a tropical rainy climate as was the case in Rantaurasau.

The records of the rainfall station operated by the IPB/P4S testfarm close to the feasibility area are summarized in Table 14.

LOCATION OF AREAS, UPANG (SP)

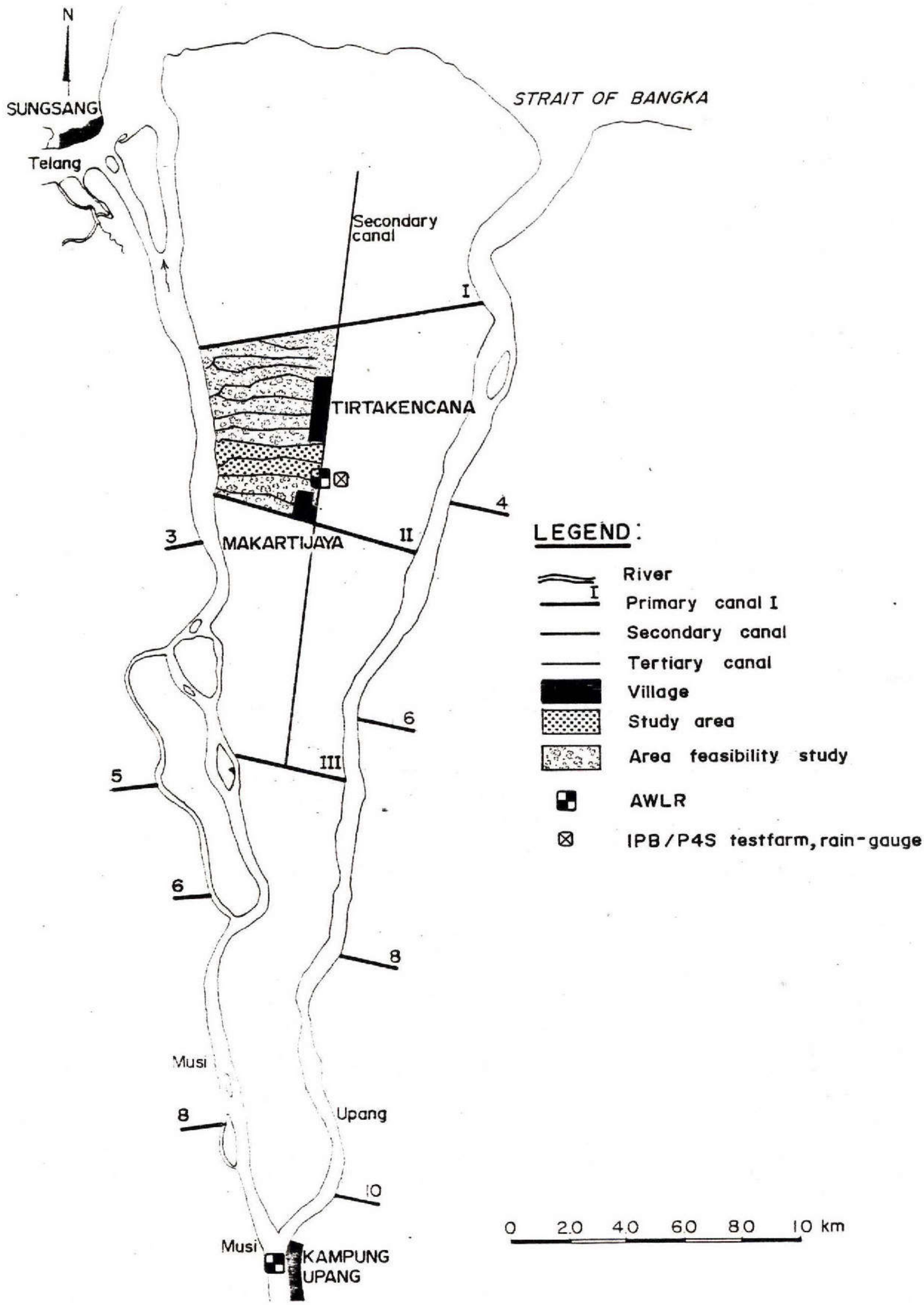


Figure II

Table 14. Rainfall, Upang

month	S	O	N	D	J	F	M	A	M	J	J	A	Total
Testfarm IPB/P4S, 1982/1983													
rainfall (mm)	67	101	123	168	401	74	32	184	178	202	284	-	1,814
rain-days	5	13	13	16	18	9	4	9	12	12	16	-	127
Testfarm IPB/P4S, 1976/1982													
rainfall (mm)	164	232	272	301	223	153	258	285	197	117	109	89	2,400
rain-days	12	16	18	18	14	16	14	18	15	13	11	8	173

When compared to the 7-year average, the 1982/83 wet-season rainfall started three months late, in December instead of in September, and continued until July instead of May. However, the extreme dry months February and March, with hardly 100 mm in total, were most important. The month of April was still relatively dry,though not so damaging in an absolute sense.

4.2.3 Hydrology and hydraulic infrastructure

4.2.3.1 Description hydraulic system

The fields of Upang (SP) are directly served by small tertiary canals which are in open connection with the Musi River on one side and with the secondary canal, crossing Upang Island, on the other. The tertiary canals have a length of 3-4 km, cross-sections of average 5 m^2 (from 2-10 m^2), and serve an average area of 275 ha. The project is located 18 km from the sea.

The Musi River is the major river of the area with, at the project site, a width of 600 m and a depth of 15 m. It has a catchment area of 56,000 km^2 which stretches into the Barisan mountain range. Average annual rainfall in the catchment area amounts to 2,900 mm. The Musi River forms a complex estuarine basin with the Telang, Upang and Saleh Rivers.

4.2.3.2 Comparison water-levels and field-levels

River water-levels are given in Figure 12, field-levels in Figure 13. River water-levels are mainly influenced by the tides and records show a distinct daily high and low water-level throughout the year. River discharges have only a small influence on high and low water-levels. However, the mean water-level at sea may be 0.3 to 0.4 m higher in the wet season than in the dry season, and this will effect the water-levels in the river and in the canals. This phenomenon is caused by the northern monsoon winds (Nedeco-Euroconsult, 1981), but the tide tables issued by Jawatan Hidro-Oceanografi do not mention this seasonal fluctuation. The tidal pattern is mixed-mainly diurnal, with the semi-diurnal component being more pronounced during neap-tides.

The reference levels of existing water-level recorders are not clear, nor are they tied to bench-mark levels in the project area. The testfarm operates an AWLR in the secondary canal. The locations of these stations are indicated in Figure 11.

WATER-LEVELS, MUSI RIVER

STATION : KAMPUNG UPANG

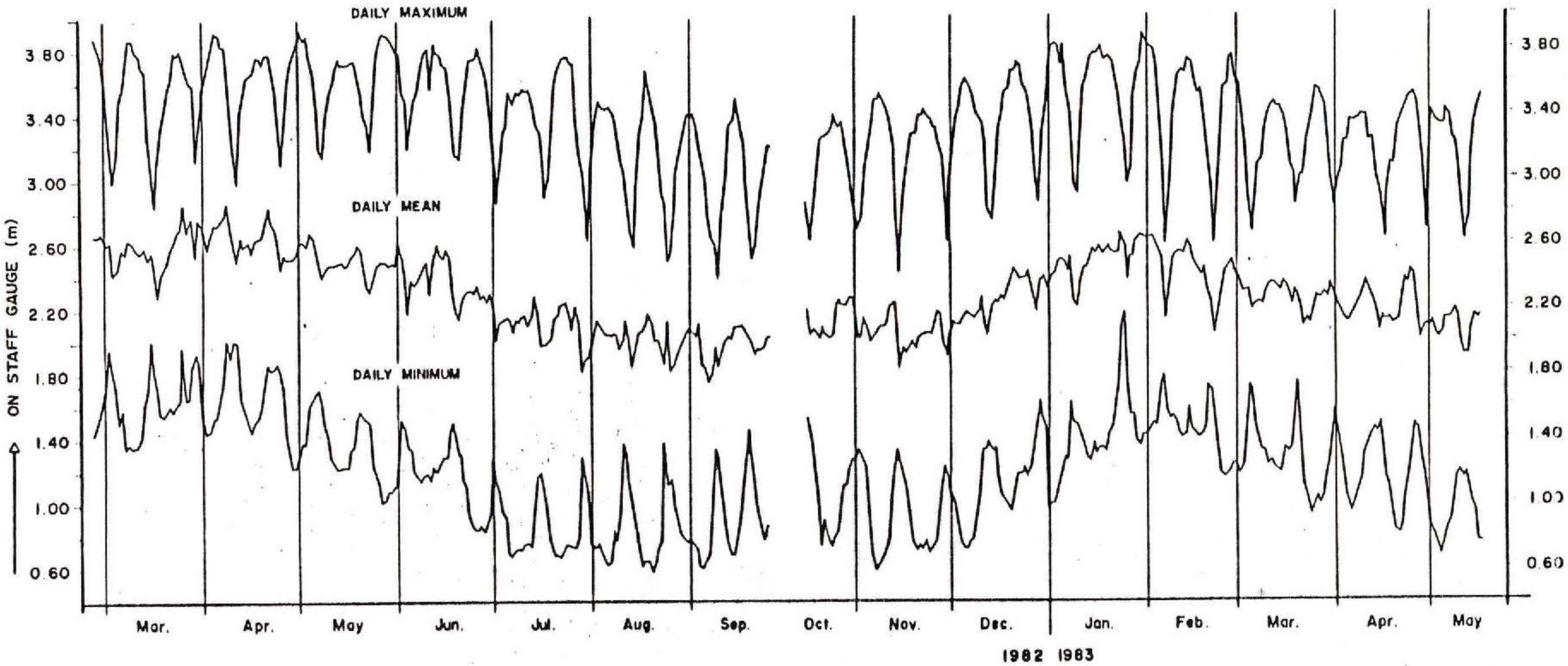


Figure 12

FIELD-LEVELS, TIDAL WATER SUPPLY, UPANG (SP)

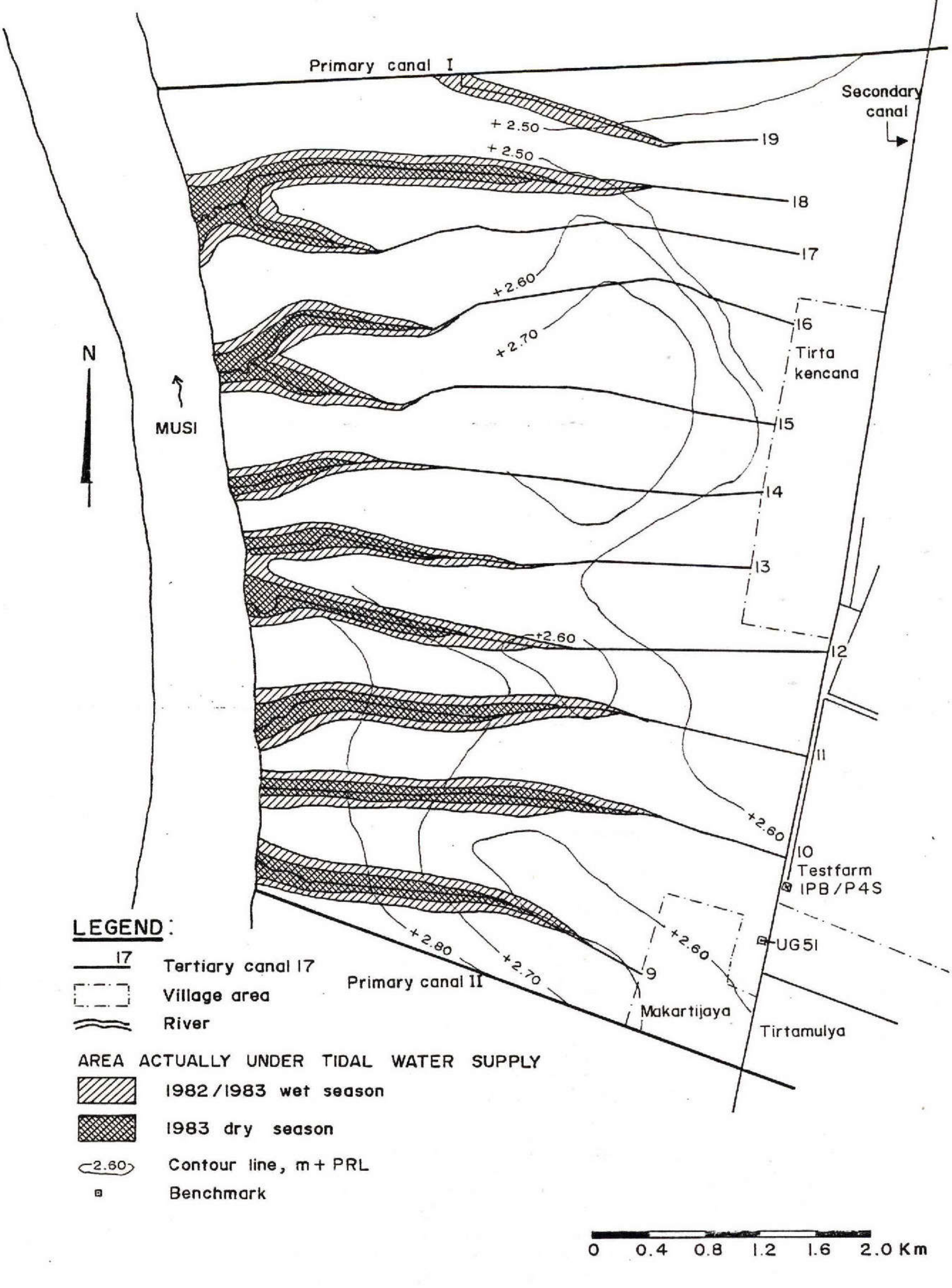


Figure 13

The tides more freely into the tertiary canals as there are no structures to regulate the flow. In some tertiary canals farmers build temporary dams for water retention at the end of the wet season. The flows from the river and the secondary canal meet each other half-way in the tertiary canals.

A topographical survey with survey lines 800 m apart was carried out for reconnaissance purposes. The result is shown in Figure 13. Field-levels are between 2.30 and 2.80 m + PRL. The level of bench-mark UG 51, being 3.182 m + PRL, was taken as reference. The results do not completely coincide with the topographical map prepared by PT. Mettana in 1977 which shows generally higher field-levels. Part of the differences can be explained by the subsidence (peat) which has taken place. Water-level records show that during wet-season spring-tides the river reaches levels which allow for some tidal water supply in a large part of the area.

In Figure 13 the area presently under wet-season tidal water supply is also indicated. The area consists of narrow strips which is probably caused by the small size of the canals. Tidal water supply takes place in most parts of Upang Island during the wet season. This is especially so in those areas where large canals provide a short connection with the river. The government-sponsored settlement area at the eastern side of Upang Island where canals were enlarged in 1983 is an example.

4.2.3.3 Drainage capacity

The drainage capacity of the tertiary canals is sufficient for present cropping. The exception may be about 100 ha in the northern section at the end of the tertiary canals 17, 18 and 19, where canals are poorly developed. Farmers do not mention excessive water as a constraint, and floods have not been noticed. Canals, however, will require deepening and cleaning if the more rigorous drainage criteria for HYV-rice are to be met. These criteria are some 4.0 - 4.5 l/s/ha.

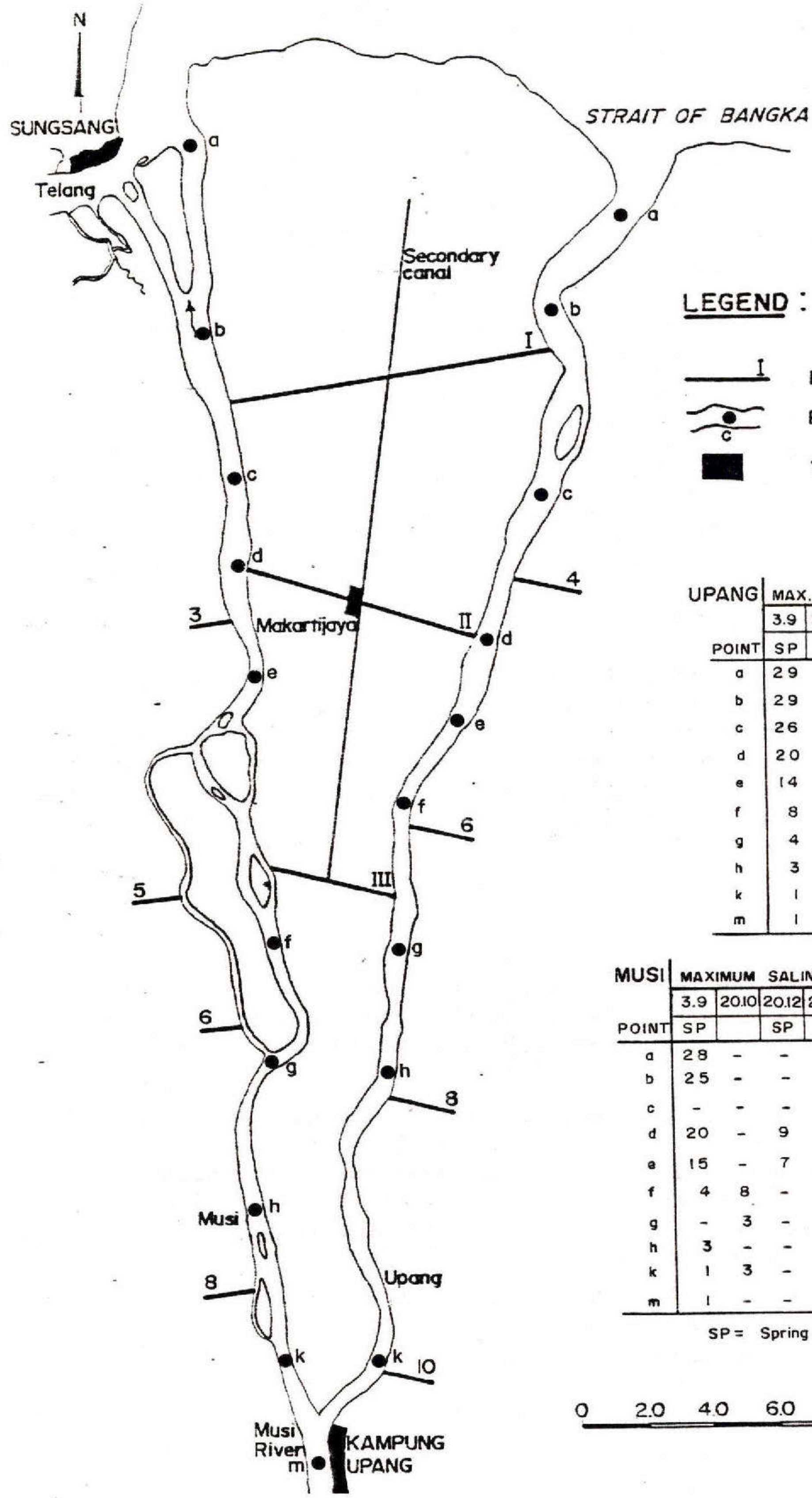
4.2.3.4 Quality surface water

Data on the salinity of river water are given in Figure 14, and Figure 15 contains data on the quality of canal water. Salt intrusion in the river is significant in the dry season when the salinity reaches up to 30 $^{o}/oo$ at the project site. The tertiary canals also have saline water for a large part of the year.

In the wet season the limit of the salt intrusion moves up and down the river close to the mouth of primary canal I, and hence it is difficult to predict when and how often the river will turn saline at the project site. As there still is fresh water in the canals and on the fields during the mentioned period, saline water does not normally reach the fields and hence does not endanger agricultural production.

Data on the acidity of surface water are given in Figure 15. The pH-values are always between 5 and 7, and we conclude that the acidity of surface water does not damage cropping.

SALINITY RIVER WATER, UPANG



LEGEND :

- I — Primary canal I
- c — River + survey point
- Village

UPANG	MAX. SALINITY (‰), 1982 – 1983						
	3.9	21.10	19.12	16.1	7.5	13.6	1.7
POINT	SP		SP	SP			
a	29	-	-	-	-	-	-
b	29	-	-	12	20	-	-
c	26	-	-	4	-	-	-
d	20	-	5	0	0	11	5
e	14	-	-	-	-	2	-
f	8	19	0	-	-	-	-
g	4	-	-	-	0	1	0
h	3	19	0	-	-	-	-
k	1	-	-	-	-	-	-
m	1	-	-	-	-	-	-

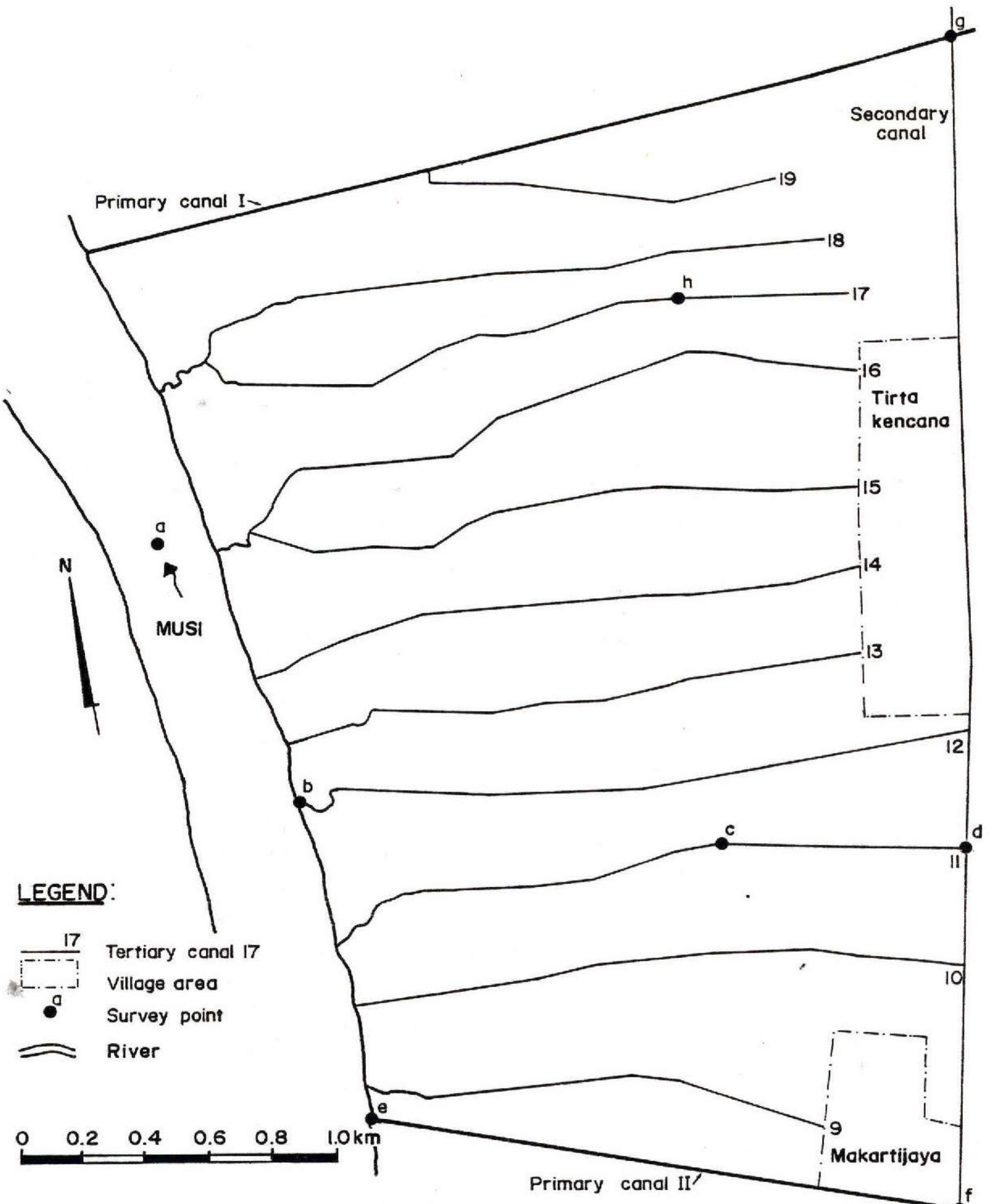
MUSI	MAXIMUM SALINITY (‰), 1982 – 1983								
	3.9	20.10	20.12	20.1	5.5	21.5	3.6	21.6	24.6
POINT	SP		SP		SP	SP	SP		SP
a	28	-	-	-	-	-	-	-	-
b	25	-	-	-	26	20	20	13	28
c	-	-	-	-	-	-	-	-	-
d	20	-	9	0	-	-	17	0	23
e	15	-	7	0	9	1	1	0	16
f	4	8	-	-	0	-	-	-	0
g	-	3	-	-	-	-	-	-	-
h	3	-	-	-	-	-	-	-	-
k	1	3	-	-	-	-	-	-	-
m	1	-	-	-	-	-	-	-	-

SP = Spring – tide

0 2.0 4.0 6.0 8.0 10 km

Figure 14

QUALITY CANAL WATER, UPANG (SP)



POINT	MAX. SALINITY (‰) 1982 / 1983						
	3.9	21.10	20.12	1.1	3.6	21.6	28.6
	SP		SP	SP	SP		SP
a	20	-	9	-	-	-	-
c	-	4	-	0.5	0.6	0.7	0.6
d	-	-	1	-	-	-	-
e	>6	>6	-	-	-	-	-
g	-	-	-	-	0.6	0.8	1.0
h	-	-	-	-	1.3	2.6	0.7

SP = SPRING-TIDE PERIOD

POINT	MAX. ACIDITY (pH) 1982 / 1983					
	29.9	14.12	22.12	3.6	22.6	27.6
b	-	6.5	-	-	-	-
c	7.5	-	-	6	6	6.5
f	-	-	6.5	-	-	-
g	-	-	-	6	5.5	5.5
h	-	-	-	6	6.5	5.5

Figure 15

4.2.3.5 Other aspects

The tertiary canals are cleaned and deepened by the population. For this reason, the reportedly small quantities of earth removed annually are not exactly known.

The canals are navigable by canoes during high tide.

4.2.4 Soil conditions

4.2.4.1 General description

Mineral soils, covering most of the area, are of heavy to medium texture with a low percentage of organic matter in the topsoil. The distribution of peat soils is presented in Figure 16. Further details are dealt with in the following Subsections.

The feasibility area is not yet completely cleared. Forest still occurs in the northern part of the area along the Musi River, and close to the secondary canal. Secondary bush is more widespread, and also occurs midway along the tertiary canals farther from the river. The size of forest and bush areas has been taken from September 1981 aerial photographs, see Figure 16.

4.2.4.2 Peat

The present peat consists of saprist with a very strong to complete humification. This is usually mixed with the upper layer of the mineral soil. It has frequently been found that rice straw is left to rot on the soil after harvest. The straw is burned before land cleaning and transplanting, and burned soil is found in the topsoil.

The areas which are covered by each class of peat thickness are given in Table 15.

Table 15. Peat thickness, Upang (SP)

Thickness of peat (cm)	0-25	26-50	51-100	101 and over	Total
Area covered, study area only (ha)	295	165	30	0	490
Area covered, study area only (% total)	60	34	6	0	100
Area covered, feasibility area (ha)	2,230	355	45	0	2,630*
Area covered, feasibility area (% total)	85	13	2	0	100*

* Excl. home yards, villages

In 1969 in half of the area, along the secondary canal, peat thickness was 0.3 to 0.8 m. In the other half, along the Musi River, peat was less than 0.3 m thick (IPB, 1969). A comparison of these data with our survey results showed that after the construction of drainage canals, the process of subsidence and oxidation had indeed reduced the size of deep peats in the eastern part.

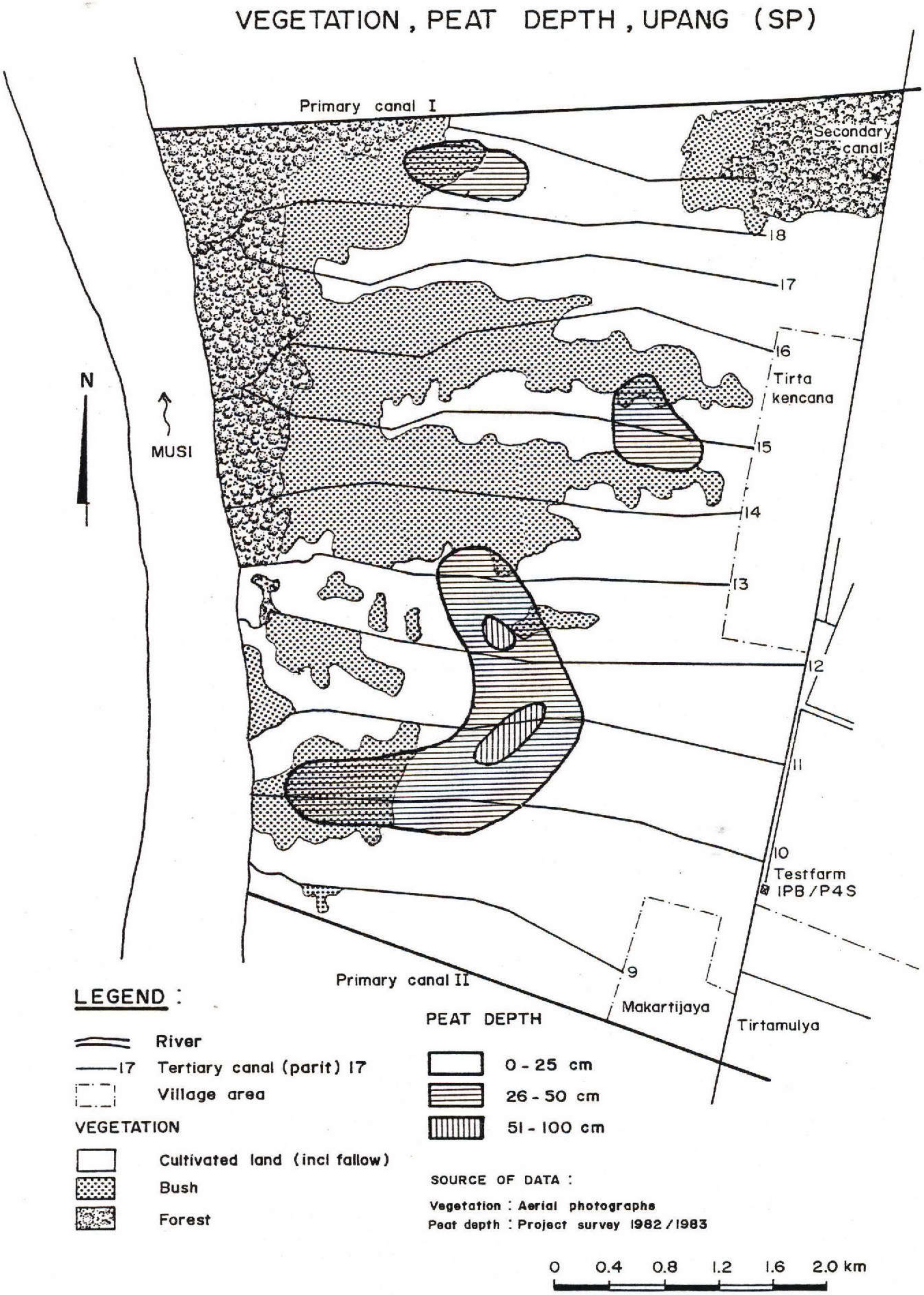

VEGETATION, PEAT DEPTH, UPANG (SP)
Primary canal I
Secondary canal
18
17
16
Tirta kencana
N
MUSI
15
14
13
12
11
10
Testfarm IPB/P4S
9
Primary canal II
Makartijaya
Tirtamulya
LEGEND:
River
17 Tertiary canal (parit) 17
Village area
VEGETATION
Cultivated land (incl fallow)
Bush
Forest
PEAT DEPTH
0 - 25 cm
26 - 50 cm
51 - 100 cm
SOURCE OF DATA:
Vegetation : Aerial photographs
Peat depth : Project survey 1982/1983
0 0.4 0.8 1.2 1.6 2.0 km

Figure 16

4.2.4.3 Soil acidity and salinity

The presence of potential acid sulphate soils (PASS) has been determined in 12 soil profiles (out of 37) in the study area and in 27 soil profiles (out of 130) in the feasibility area. In the study area these PASS are concentrated in the eastern part, and in the feasibility area they are found in the northern part along tertiary canals 13, 15 and 19. The potential acidity occurs especially at a depth of 0.25 to 0.75 m below surface or peat-layer. In the pronounced 1983 dry season these soils appear to have remained PASS without turning into actual acid sulphate soils (AASS).

In the period March to July 1983 hardly any salinity occurs in the top layer of 0.25 m in the study area. Soil salinity increases with depth. In the feasibility area the pattern of soil salinity is similar to the study area. Although the salinity is relatively high in the top 0.25 m along tertiary canals 9, 11 and 13 close to the Musi River, it still does not harm the crop.

4.2.5 Water conditions

4.2.5.1 Gley phenomena

From the depth of the permanently reduced layers in the soil profiles, usually between 0.6 and 0.8 m below surface, we conclude that groundwater drops too low to allow the cultivation of a dry-season crop dependant on groundwater only. The permanently reduced layer starts 0.4 to 0.5 m below the surface in only a few profiles found in the northern part of the feasibility area clase to the Musi and the secondary canal. Statistical data on the permanently reduced layer are given in Table 16.

Table 16. Permanently reduced layer, Upang (SP)

Depth top reduction layer (cm below surface)	0-25	26-50	51-75	76 and over	Total
Area covered, study area only (ha)	0	60	200	230	490
Area covered, study area only (% of total)	0	12	41	47	100
Area covered, feasibility area (ha)	0	455	1,340	835	2,630*
Area covered, feasibility area (% of total)	0	17	51	32	100*

* Excl. home yards, villages

4.2.5.2 Groundwater

At the end of the 1982 dry season, groundwater-levels in the study area were around 0.6 m below surface. In November they rose, and standing water appeared from December until the end of January. The depth of this water was up to 0.2 m. The groundwater-levels dropped in the period with low rainfall. The April and May 1983 levels were similar to the September 1982 ones. Levels rose again thereafter and were close to the surface, either below or above it, from June until the end of our monitoring program, medio August 1983.

Looking for geographical variations in this general picture, one finds two parts of the area where levels fell deeper than indicated above, to 1.0 m and more below surface. Such parts lay around the eastern section of tertiary canal 11 and between the eastern half of canals 15 and 17.

The quality of the groundwater, as far as acidity is concerned, is very good for tidal-land conditions. The pH-value is routinely above 5, and even reaches 7. In the exceptional case that it drops below 4 it rises to usual levels within some weeks.

The salinity of the 1982/83 wet-season groundwater was low. In April/May 1983 it passed the 4,000 micro S/cm level in a stretch along the Musi River and in the northern part of the feasibility area. In August the salinity level was once again acceptable. At the end of the dry season the groundwater is probably too saline. However, this is not hazardous because the crop rootzone is far above groundwater-level.

4.2.5.3 Farmers'efforts

In addition to the tertiary canals dug by the spontaneous settlers, quaternary canals were dug in the area cultivated by the Buginese. They have a regular distance of 80 m, are 0.75-1.00 m wide and 0.50-0.75 m deep. These quaternary canals are cleared annually after the rice transplantation.

In tertiary canals 13 and 18 simple earthern dams were built to retain incoming tidal water. A bypass canal enables farmers to regulate the water-level in the inland section of the canal.

Present land preparation, done by both Buginese and Javanese, consists largely of bush clearing. Levelling is mainly done by Javanese, usually in preparing sorjans.

4.2.6 Agriculture

4.2.6.1 Cropping systems

Rice is the dominant cropping system, particularly in areas where Javanese farmers cultivate the land. Although the Buginese also started rice cropping, they are gradually converting their ricefields into coconut groves. This is shown by the different ages of the coconut and the transition from pure rice, via intercropping of rice and coconut, to monoculture of coconut. Local rice varieties are cultivated, transplanted during November/December and harvested from April onwards. Some upland food crops are grown on the bunds.

Cultivation of palawija following rice hardly occurs.

The large areas under fallow or bush are particularly striking in the northern part of the project area. These areas are usually made up of land abandoned because of crop failures due to pests or because of security reasons. The low cropping intensity is probably responsible for the fact that substantial areas are still under forest.

The farm size in the northern region averages 3.2 ha with a cropping intensity of 60% of the cleared land. In the southern part the average farm size is 2.2 ha with a cropping intensity of 80% of the cleared land.

4.2.6.2 Yields and related inputs

The project has interviewed farmers to obtain information on rice yields. The results are given in Figure 17.

Rice

The average paddy yields in the southern part of the project area are in the order of 1.5 t/ha, and substantially higher in areas not attacked by rats. In areas with a low pest incidence, yields exceeding 2 t/ha are common, although paddy crops which are heavily attacked by rats yield only 0.8 t/ha. Both figures apply to years with favourable rainfall. Yields in the northern part of the area are lower than those given for the southern part. Rice input levels are low and consist of seed and rat-control measures.

Coconut

Present yields of mature coconut are difficult to assess because most of the trees are not yet in the bearing stage or have just reached it. Yield counts of immature trees amounted to 30 nuts/tree, equivalent to 0.9 t copra/ha/yr. Such yields indicate the high potential of the trees once they have survived the wild pig attacks during their initial growth.

4.2.6.3 Diagnosis of the present low yields

The major reason for the current low paddy yields is the damage caused by rats, which are able to reduce the yields by 50%. Two factors are responsible for this damage. Firstly, the high rat population is closely related to the substantial areas of non-cultivated land and forest. Secondly, in the spontaneously developed area farmers cultivate local varieties of rice with longer growing seasons than the HYV rice grown in the nearby government-sponsored areas. The result is that after the rice harvest in the latter area, the rats migrate to the Upang (SP) area where they concentrate on the fairly small areas under rice.

Farmers seldom mention water shortage as a constraint. Many areas can benefit either from tidal water supply during spring-tide of from high groundwater-tables preventing drainage losses. Farmers characterize the soils as fertile, meaning that there are no toxicity problems or prohibitive peat-layers. Salinity problems do not arise during the rice growing season. Sometimes labour shortage, resulting in poor weed control, is reported to be a constraint.

In coconut cultivation, the ultimate aim of Buginese settlers when conditions are favourable for it, problems arise in establishing the crop. Young trees are attacked by wild pigs to such an extent that replanting is often necessary. In the worst affected areas the cultivation of coconut is terminated because the pigs are uncontrollable. The performance of successfully established coconut is promising.

The water regime in the project area is very favourable for the production of coconut. The groundwater movements follow a strict pattern as a result of tidal movements. These conditions allow adequate oxygen supply and optimal root development which constitute the bases for high yield potential. Farmers report that areas on the fringe of fresh and saline water are very suitable for coconut production. These are the areas with the possibility of tidal water supply during the wet season and with marked differences between the high and low tides intruding into farm ditches.

REPORTED YIELDS, UPANG (SP)

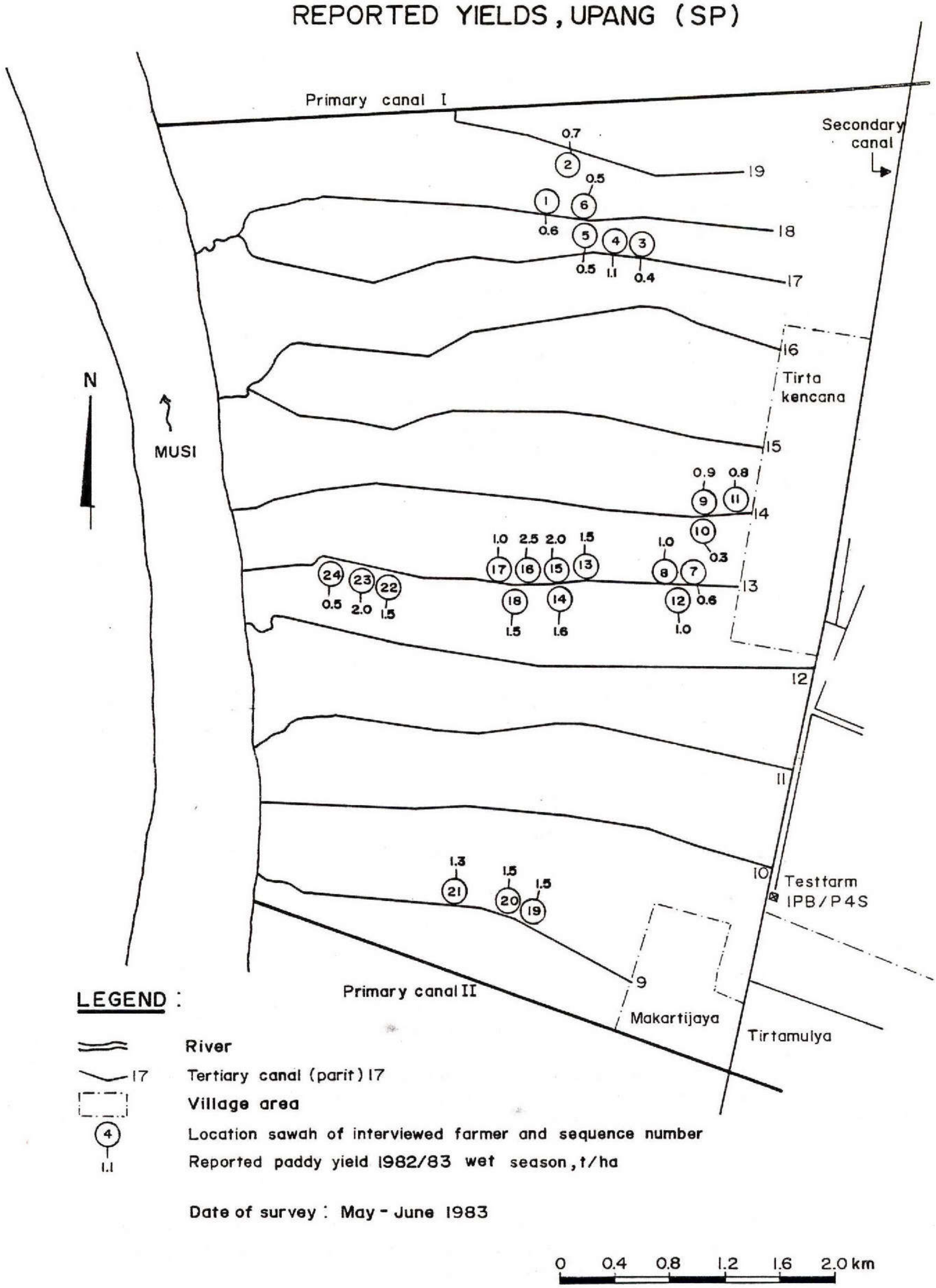


Figure 17

4.2.7 Socio-economy

4.2.7.1 History of the project

Most of the settlers, Buginese spontaneous migrants, came in the early 1960s.The pioneers obtained land from the Sungsang and Upang Margas* and either sold it to other settlers or entered into production sharing for 2-3 years.

The settlers cultivated rice initially. The population reached its peak at the end of the 1960s.Most of the Buginese settlers left the area in 1976/77 mainly because of the heavy rat challenge to their crops in the period 1972-1975. They moved to the Tirtakencana area close to the secondary canal. The remaining Buginese then started to plant coconut, and rice cultivation was taken over by non-Buginese spontaneous migrants coming mainly from the adjacent government-sponsored settlement. Other newcomers arrived from Palembang and Sungsang. A few Javanese families arrived as well and some of the original Buginese settlers returned.

At present the people build their houses in groups with the main concentration along the secondary canal. Other farmers live along the tertiary canals in groups of at least 5 families. This settlement pattern is preferred for security reasons.

4.2.7.2 Incomes

As the area under review was not included in the UNSRI socio-economic survey, we do not have data on incomes derived from on-farm and off-farm work to compare with similar data from Rantaurasau and Barambai.

4.2.7.3 Infrastructure

Both Tirtakencana and Makartijaya have schools. The settlers depend on the health centre (Puskesmas) in Makartijaya, some 5 to 10 km away, for health care. Makartijaya is a rather large trading centre with rice mill, marketing facilities, shops and repair services.

4.2.7.4 Drinking-water

Rainfall is the usual source of drinking water. The capacity of storage drums is often not sufficient to last the dry season. People living along the tertiary canals then resort to hand-dug wells. People living in the concentrated villages of Makartijaya and Tirtakencana often buy water at a rate of Rp 5,000 - Rp 7,500 per m^3. Trials to find a more dependable water source have failed so far. A number of deep borings have not been successful (DPMA, 1978).

4.3 Development prospects

Having described the present state of affairs in Upang (SP), we will now discuss whether upgrading is warranted, whether it is possible, and what its outline should be.

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* Traditional territorial unit in South Sumatra

4.3.1 The need for upgrading

The Upang (SP) project area deserves attention under the policy of distributing government assistence among the different sectors of the tidal-land population. The area has gone through a period of declining population and land use which was at least partly caused by insecurity. Land-title problems may also have been a factor here. Recently this trend has been reversed, and former occupants, as well as newcomers, are slowly re-occupying the deserted farm plots.

The situation on Upang Island is special because a spontaneously developed project area and a government-sponsored settlement are separated only by the secondary canal. This closeness has a negative effect on the Upang (SP) area as the different cropping calendars in the two areas result in heavy attacks by migrating rats. Moreover, road connections are poor, and there are few signs of a positive exchange of agronomic information.

The Upang (SP) warrants government intervention if the Government wishes to unify Upang Island in terms of agricultural production. Obviously such intervention has to be carefully prepared and guided to assure that upgrading is well received and reacted upon by the original settlers and developers of the area.

4.3.2 Agricultural prospects

Agricultural problems are limited to pests, predominantly rats attacking the rice crop and wild pigs damaging the coconut. Hydro-topographical conditions are favourable. There are no salinity or acidity problems.

Hence, if pest constraints are relieved the production of a good rice crop is assured. This will definitely be the case if HYV, short-duration varieties are used to make optimal use of the rainfall, and to prevent the invasion of the rats and insects (rice bugs) from the neighbouring government-sponsored area. Conditions can further be improved by providing water-retention facilities to cope with drought periods.

The cultivation of a second, dry-season rice crop is not possible. The insufficient rainfall cannot provide enough soil moisture and proper river water is not available in that season.

Palawija following rice can be cultivated as the residual soil moisture and additional dry-season rainfall are sufficient for such crops.

If the problem of wild pigs is solved, conditions will also be favourable for coconut. The area is located in the zone where tidal movements influence groundwater-levels and oxygen supply in such a way that coconut root development is optimal. A canal system should guarantee an undisturbed inflow and outflow of tidal water, and prevent stagnant water on the fields. The construction of raised beds may be necessary.

4.3.3 Prospects of water management

As the drainage base of the area is sufficiently low, it will be relatively easy to reduce the floods which only occur in some isolated spots. The present tertiary canals have sufficient drainage capacity for both rice and coconut.

River water presently supplies 20% of the area during wet-season spring-tides. This percentage can probably be increased to 75%, but water-levels will only be slightly higher than field-levels. Water-control structures and enlarged canals are required to improve the tidal water, supply. These structures would also be helpful in keeping the saline water, which occasionally emerges after January, out.

Dry-season water-levels in the river are such that canal water-levels will remain below field-levels. The river water turns saline during this period.

4.3.4 Soil potential

The area has good soil potential. Deep peats have nearly disappeared, there will be no acid sulphate soil hazard after further draining of the area, and soil salinity is confined to deeper layers. The salinity of the groundwater at the end of the wet season in areas where drainage will be deepened must be checked.

4.3.5 Scope for upgrading

The scope for upgrading lies first of all in completing the clearing of the area and in an improvement of the communication with surrounding areas.

The area benefitted by tidal water supply can be enlarged to enable the cultivation of HYV, short-duration rice. Growing conditions for coconut can also be improved.

The main question in assessing the upgrading potential of the area is which farming system will be preferred by the present population. Fortunately, hydro-topographical conditions are such that both crops can be grown along a tertiary canal, though in consolidated blocks with coconut close to the river and rice in the hinterland. It therefore seems advisable to consult the population, prior to upgrading, to find out where the coconut and rice will be grown.

4.4 The upgrading project

In this Section we describe the outlined upgrading project in detail, and analyse its economic effects.

4.4.1 Agriculture

4.4.1.1 Farming systems

The following farming systems are envisaged;

- HYV, short-duration rice (wet season) - palawija (dry season);
- coconut, monoculture.

The present low cropping intensities of 60% in the north and 80% in the south could increase to 100% in the wet-season once rats and pigs are under control. Clearing the remaining forest is a prerequisite, and abandoned land, at present under bush, has to be re-cleared.

The cropping intensity of wet-season rice could be 100% within three years of the start of the project. Thereafter palawija will gradually be introduced. In view of the experience in the adjacent government-sponsored area, it is not expected that more than 50% of the cultivated land will be under dry-season crops during the first 10 years.

In areas where the population prefer to grow coconut, its cropping intensity will be 100%. During the initial years there may be some intercropping with food crops thereby increasing the realised cropping intensity.

4.4.1.2 Yields

General

The anticipated yields for all crops have been based on present production and its constraint analysis, on the extent and time at which such constraints can be removed, and on results in other tidal land areas in Indonesia. Yield trends are related to fairly low levels of management during the initial stage of the project. The management level, however, will improve in time. Estimates of yields and related inputs are given in Table 17.

Table 17. Yield and related input projections*, Upang (SP)

Year	Rice, water supply yield water retention	Rice, water supply yield no water retention	Rice, water supply related inputs	Palawija yield water retention	Palawija yield no water retention	Palawija related inputs
1	2	3	4	5	6	7
1	2,100	2,000	20	500	450	15
2	2,200	2,050		500	450	
3	2,300	2,100		550	500	
4	2,400	2,150		550	500	
5	2,500	2,200		600	550	
6	2,600	2,300		600	550	
7	2,700	2,400		650	600	
8	2,800	2,500		700	650	
9	2,900	2,600		750	700	
10	3,000	2,700	20	800	700	20
Potentially	3,750	3,400	25	1,000	900	25

* yield of rice in kg paddy (14% moisture)/ha;
yield of palawija in kg soya bean equivalent/ha;
inputs as percentage of gross production value.

Rice

The yield projections for rice depend on the amount of available water. Rainfall and tidal water supply will be sufficient to meet the water requirements of HYV, short-duration rice in average years. To meet such requirements in years with low river water-levels, water-retention measures and tidal water supply are required.

The relatively low yields in the first years are related to the pest problem which needs time to be solved. It should be noted that the above mentioned yields are those obtained by an individual farmer who starts growing HYV rice. It will take about 4 years, after the completion of the upgrading measures, to introduce this variety over the whole area. During this introduction period the area under local varieties, yielding an average of 1.5 t/ha, will gradually decrease.

Palawija

The anticipated palawija yields are based on relatively high groundwater-levels to be maintained with the aid of water-retention facilities. This, together with residual moisture, supplemental dry-season rainfall and the prevailing good soils, will enable the cultivation of a relatively high-yielding palawija. It is important to grow the crop early in the dry season to avoid any chance of salinity. The introduction of HYV, short-duration rice will assist in achieving this goal, as its early harvest enables an early planting of palawija.

Coconut

Yields of 2.5 t copra/ha/yr can be expected when the crop establishment problems, mainly pests, have been overcome. Moreover, although hydro-topographical conditions are very favourable, some measures to control the inflow and outflow of tidal water should also be taken to induce optimal root development. Under such conditions the first year of copra production will be 6 years after the planting of trees, and full production will be obtained from year 12 onwards. The input costs during the immature period will be Rp 250,000/ha (pre-devaluation prices). Production costs for coconut in the bearing stage will amount to Rp 20,000/ha/yr.

During the initial three years coconut will be intercropped with rice, producing an estimated yield of 1.0 t/ha.

4.4.1.3 Inputs

For the quantities of seed, fertilizer and agro-chemicals required, reference has been made to earlier studies (Nedeco-Euroconsult, 1981). The inputs for rice and palawija are expressed as a percentage of the GPV. The percentages are based on long-term experience.

4.4.1.4 Farm size and labour

The average farm size in the northern part of the project area is 3.2 ha and in the southern part 2.2 ha.

The available family labour will be adequate if part of the farm is planted to coconut. This is likely to happen on Buginese farms. In areas where the rice - palawija cropping system is followed exclusively, hired labour may be needed during transplanting and harvest.

Labour requirements for individual crops in the anticipated cropping systems are given in Table 11, page 36.

4.4.1.5 Agricultural support

The points made in Subsection 3.4.1.5 (page 36) also apply to Upang (SP).

4.4.2 Hydraulic infrastructure

4.4.2.1 General

We refer to Figure 18 which depicts the layout of the hydraulic infrastructure in a 100% rice farming system, and to Volume IV, Designs, of this Report.

The farming system HYV, short-duration rice - palawija requires optimal conditions for tidal water supply as well as a proper farm infrastructure to enhance water retention.

The coconut monoculture farming system requires a groundwater-table which is at a constant level. Our survey data showed that the present dry-season groundwater-levels are lower than the wet-season ones. As the Musi River has low water-levels during the dry season, it is best to lower wet-season groundwater-levels. Such a lowering necessitates farm ditches to drain the water from the upper soil-layers into the tertiary canals.

Should both farming systems be applied along the same tertiary canal, the drained conditions in the coconut area must not be jeopardized by high water-levels in the canal supplying water to the rice area.

To protect the river-land interface and its fish, a 200 m wide greenbelt along the Musi River will be left untouched when clearing forest and bush, 260 ha and 685 ha respectively.

The road along the western side of the secondary canal will be improved to facilitate motorcycles and carts. This requires the removal of bush and the reshaping of the small embankment on which the road is built. Bridges over the tertiary canals also require improvements. Finally, it is proposed that two bridges across the secondary canal be rehabilitated to improve communication with the government-sponsored transmigration area.

4.4.2.2 Rice

The Musi spring-tide water-levels are high enough to supply water to fields in 75% of the area. The actual supply comes either directly from the Musi (2/3 of area) or via the secondary canal (1/3 of area). The two flows will meet in the canals. The present tertiary canals, which intersect the area at 300-800 m distances, are the logical choice for conveyance. These canals have only to be enlarged somewhat to allow the tidal influences to enter the area to a sufficient distance. A small area in the north-east does not yet have tertiary canals. They will be constructed in this area.

In order to maintain maximum water-levels in the tertiary canals water must be prevented from flowing out of these canals into the river or the secondary canal. This can be accomplished by using water-control structures, provided with a flap-gate, both at the side of the Musi River and at the secondary canal.

For a description of the on-farm works, reference should be made to Subsection 3.4.2.1. The on-farm works of the LM-area in Rantaurasau are similar to those in Upang (SP). To estimate the costs for Upang (SP) we used a farm size of 2 ha.

LAYOUT* HYDRAULIC INFRASTRUCTURE, UPANG (SP)

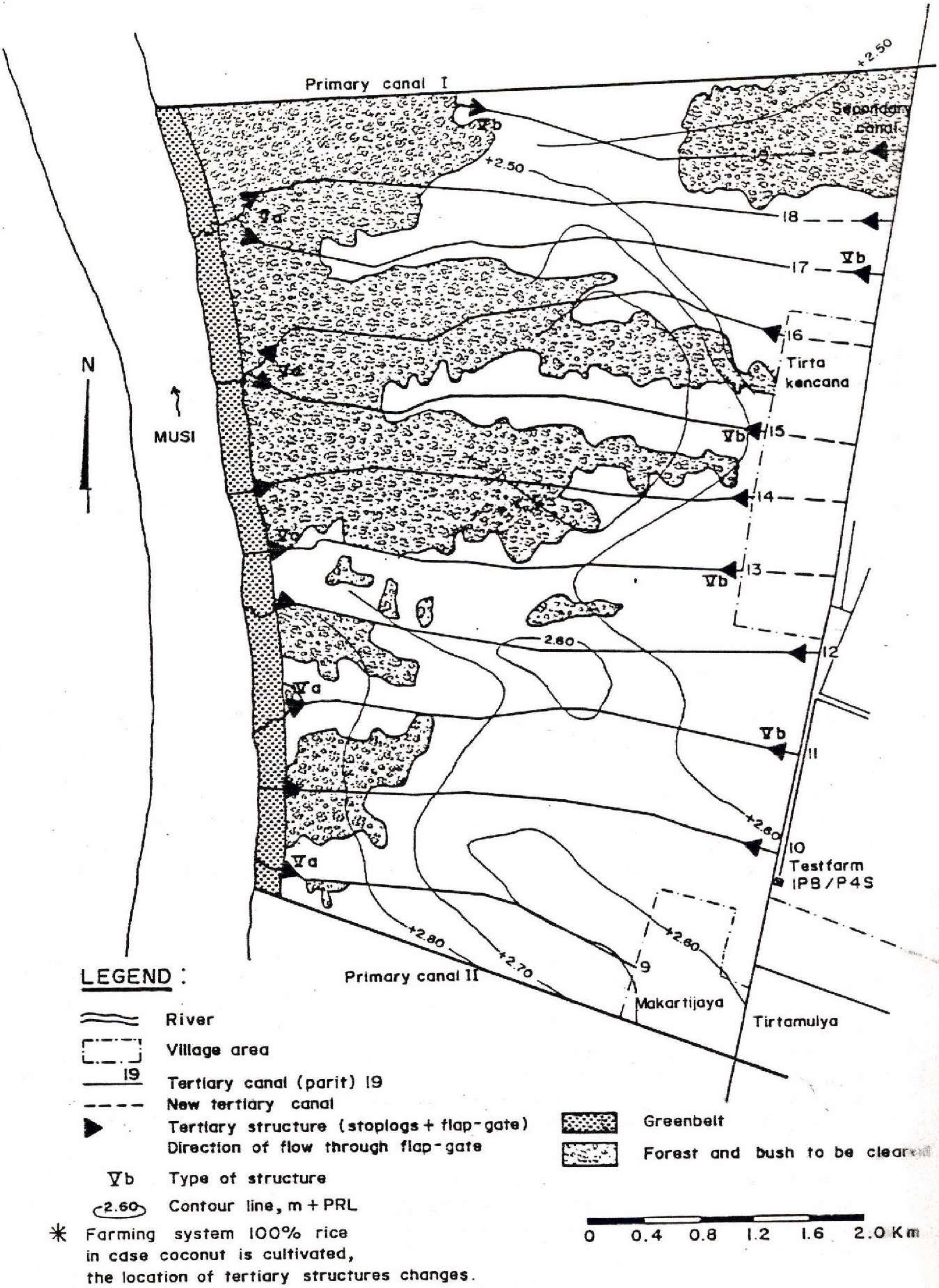

Figure 18

As presently designed, the tertiary canals become supply canals, with the outflow of water being prevented by flap-gates at both ends of the canals. Should the farmers have to drain their fields, which occurs rather frequently, they will have to counteract the automatic functioning of these flap-gates. Such procedures will lead to increased wear and tear and this is inadvisable. Instead, we have added a stoplog provision to the flap-gate structure. During supply periods the stoplogs will be put in place. For drainage they will be raised, water will drain out of the upper canal section, and the flap-gate will close itself automatically.

4.4.2.3 Coconut

We again refer to the similar works for Rantaurasau, see Subsection 3.4.2.3. For Upang (SP) we assessed the design groundwater-level at 0.5 m below surface as the soil has a higher water-holding capacity than in Rantaurasau.

4.4.2.4 Rice and coconut

When both rice and coconut are to be grown along one tertiary canal, the present planting system should be followed. In this system coconut is planted close to the river where tidal fluctuations provide the proper conditions, and rice is planted in the hinterland where high-water levels can be attained. The envisaged tertiary structure, enhancing maximum water-levels for rice, should be placed at the interface of the coconut and the rice area.

When the rice area has to be drained the coconut farmers should keep their outlet/inlet culverts closed to prevent intrusion of the rice-drainage water into their fields.

4.4.2.5 Operation of the system

The envisaged way to operate the upgraded infrastructure is similar to the one in Rantaurasau, see Subsection 3.4.2.4.

4.4.2.6 Land use

The improvements in infrastructure require land which could have been used for cropping. The size of the distinguished categories of land use before and after implementation of upgrading measures is given in Table 18.

Table 18. Size land categories, Upang (SP)

Land category	At present	After upgrading	
		Farming system 100% rice	Farming system 50% rice 50% coconut
Cropping	1,540	2,240	2,320
Home yards, villages	255	255	255
Infrastructure	50	275*	195*
Forest, bush	1,040	115**	115**
Total	2,885	2,885	2,885

* Incl. on-farm works

** green belt

4.4.2.7 Construction

Reference should be made to Subsection 3.4.2.6 for comments on construction methods. The time-schedule for contracted works is given in Figure 19.

Figure 19. Time-schedule contractor, farming system 100% rice, Upang (SP)

Description	labour force per month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mobilization and demobilization	-	—	—						—	
Bush clearing 685 ha; 175 ha/month/labourgang	100		—		—	—	—			
Forest clearing 260 ha; 65 ha/month/labourgang	200		—		—	—	—			
Excavation canal 91,500 m^3 18,300 m^3/month/5 hydr.excavators	15		—		—	—	—	—		
Structures, value Rp 71,000,000	60		—		—	—	—	—		

The costs of the envisaged works are given in Table 19. For details see Appendix III.

Table 19. Construction costs of project, Upang (SP, Rp '000,000)

Farming system	100% rice		50% rice 50% coconut	
Contractor, direct costs	293		291	
Contractor, indirect costs	90		90	
Contractor, total costs		383		381
Farmers, total costs		479		309
Construction costs of project		862		690

4.4.3 Economic analysis

4.4.3.1 The without-project case

In the consultants' view none of the constraints to improved agricultural production are insurmountable. A continuing influx of population will automatically lead to more intensive land use and eventually to the clearing and cultivation of the entire area. The clearing of land and the synchronizing of rice cropping over the entire width of the island will contribute to solving the rat problem and bush clearing will greatly reduce pig attacks. The labour constraint will gradually be lifted when more farmers settle in the area.

There are no specific technical constraints. The available resources can be tapped by the population itself and, without government intervention, the development of the area is only matter of time. The socio-political merits of a project aiming at assisting spontaneous settlers are not easily dealt with in an economic evaluation and will not be discussed here. The project may advance full development of the area.

4.4.3.2 The project

The project includes improvements to the agricultural services and the hydraulic infrastructure, and the improvement of communication between the various sub-areas on the island by upgrading roads and bridges. Implicitly, the project assumes that the public administration and agro-supporting services are aware that a number of technical improvements alone will not produce the foreseen project benefits. Concerted action of these agencies is required to attain an integration of the various migrants' groups and the exchange of know-how among those groups.

Government intervention will definitely speed up the development process, and lead to a quicker utilization of the available resources. From this point of view the project is consistent with the aim of the upgrading projects, to optimize resource utilization.

4.4.3.3 Project returns

The project returns have been calculated based on the yield projections given in Table 17. It is assumed that the project and its related operations will result in adequate water retention, in a departure from the present practice of growing long-duration, local rice varieties, and in a gradual introduction of the HYV, short-duration varieties. The introduction will take about 4 years and participating farmers will attain a cropping intensity of 100% of the new variety within three years. Yields will reach 3 t/ha after 10 years. Thereafter, yields may gradually increase to the potential of 3.75 t/ha, depending on the farmer and the refining of the development of his plot. The cropping intensity of palawija will reach its maximum of 50% after 10 years. Part of the area has to be cleared and brought into operation again. Palawija yields will develop somewhat slower initially.

A large part of the area also has good potential for coconut cultivation. Yields of 2.5 t copra/ha/yr, at full plantation maturity, appear possible. Investments in coconut can be covered to a large extent by intercropping with rice during the first three years after planting.

Taking the aforementioned conditions into consideration, average net returns have been estimated for the two envisaged farming systems, see Table 20.

Table 20. Net returns cropping, Upang (SP, Rp'000/ha/yr)

Year after completion of project	1	5	10	15
HYV, short-duration rice - palawija	192	387	451	565
Coconut monoculture	-	130	548	728*

* full maturity

In the cultivation pattern of spontaneous settlement areas the boundaries between the coconut and rice area gradually shift inland. The ultimate division of land used for coconut and rice cannot be estimated or prescribed. For calculation purposes only, a ratio of 50% rice, 50% coconut has been applied.

4.4.3.4 Project costs

The project costs involve improvements to the hydraulic infrastructure, roads, bridges, and water-management provisions at farm level. The contractor component of the project costs, hydraulic infrastructure, roads and bridges, amounts to Rp 178,000 - Rp 185,000 per hectare. The on-farm works, bunding, levelling and ditches, will be implemented by the farmers themselves with guidance from the Ministry of Public Works (P3S). Farmers may receive an incentive to implement these works. A guidance allocation of 6% has been included in the above costs of farm improvements. The total economic costs of on-farm works are Rp 40,000/ha. In order to operate and maintain the system, 4% of the total development costs, or Rp 9,000/ha/yr, have been set aside.

4.4.3.5 Evaluation

The anticipated benefits are based upon an intensive type of agriculture. In the government-sponsored areas adjacent to the project under review there are such signs of intensification, and advanced farmers attain high yield-levels. The present population and labour force cannot cope with the work load involved in intensive agriculture on large holdings (2.2-3.2 ha per holding). Intensifying land use implies additional spontaneous or stimulated settlement in the project area.

It is imperative that prior to developing the project, the proposals be discussed with the present tenants to assess the required extent of infrastructural works for growing coconut (required drainage) and rice (tidal water supply and water retention), and to assess the peoples'perception of the upgrading plan's implications.

Except for the timing of the land development, there is no fundamental difference between the with-project and the without-project case. The most crucial issue is whether the population will respond adequately to governmental intervention in the with-project case. The analyses therefore concentrate on what would happen if the farmers react slowly to the project.

Land development projects are often characterised by lengthy maturing periods. The analyses have been carried out assuming that once the project is implemented, development periods of 10, 15 and 20 years will be involved. Investing in the project now will yield returns 10,15 and 20 years later, reflecting an increasingly moderate development pace.

The analyses show an IRR of 20% when the project reduces the development period from 20 to 10 years. The IRR drops to 18% when the without-project lead period is 15 years. The project would reduce this lead period to 10 years. Shortening the process of developing or improving land use by 5-10 years is realistic, and therefore we conclude that, leaving socio-political considerations aside, the project investments are economically worthwhile.

5 BARAMBAI

5.1 Location of areas

The Barambai project is located in South Kalimantan Province, to the north of Banjarmasin town on the western shore of the Barito River, see Figure 20. It belongs to Subdistrict Rantaubadauh, capital in Gampa, of Baritokuala District. The area can be reached by water from Banjarmasin town, and by motorcycle from Marabahan, the centre of the District.

The testfarm formerly run by UGM*/P4S is located near the fork of the secondary canals Kiri and Kanan.

The UNLAM socio-economic survey covered the area of Kolamkanan, in the eastern half of the project between its tertiary canals 1 and 4. For general data collection purposes we extended this area to the corresponding area of Kolamkiri east, between tertiary canals 3 and 6, to arrive at our study area. The size of the study area is 415 ha.

The feasibility study deals with the area occupied by government-sponsored transmigrants, viz Kolamkiri west, over a distance of 2 km from the secondary canal, Kolamkiri east, Kolamkanan west and Muara. See Figure 20. It should be noted that the Kolamkanan east area was set aside for spontaneous/local settlers. The size of the feasibility area is 2,700 ha.

The present project carried out routine surveys in the study area from November 1982 to January 1983, and in the feasibility area from February to November 1983.

5.2 Present conditions

5.2.1 Population

We obtained accurate population figures for Kolamkanan village from its village head. The population grew quickly during the first years of the project, from 250 families (1971) to 410 families (1976). Thereafter, the growth was more gradual to 435 families in 1982. The latter figure was also given in the UNLAM report (UNLAM, 1983). During the last five years 20 families have left, but new spontaneous migrants more than compensate for the loss.

Data on the whole project scheme are found in the 1979 SAE** report. The scheme had 890 families in 1972 and 1,040 in 1978. This variation is the difference between the population growth, 90 families in the settled population and 130 families consisting of new spontaneous/local settlers, and the 70 families who left the scheme.

The family size decreased from 4.8 to 4.5 persons per family over the years. The UNLAM report mentions an average labour availability of 2.3 persons per family made up of 0.9 male and 1.4 female persons.

5.2.2 Climate

According to the Koppen's system, the climate of the area can be classified as Af; a tropical rainy climate as was the case in Rantaurasau.

Rainfall records from stations operated by the present project and the Barambai testfarm are given in Table 21.

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* Universitas Gajah Mada, Yogyakarta

** Survey Agro Ekonomi, Jakarta

LOCATION OF AREAS, BARAMBAI

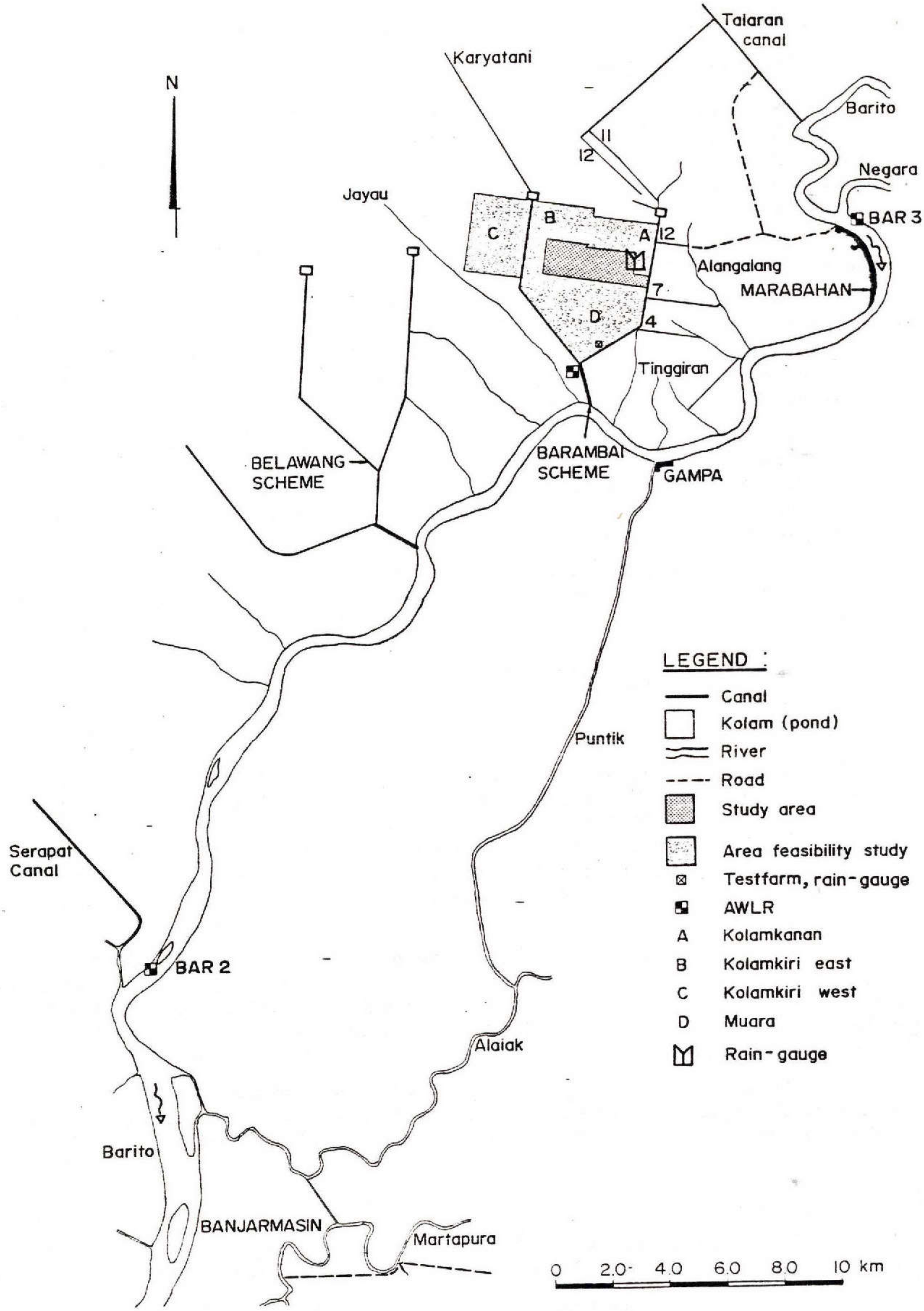


Figure 20

Table 21. Rainfall, Barambai

Month	S	O	N	D	J	F	M	A	M	J	J	A	Total
Project, 1982/83													
rainfall (mm)	-	-	-	392	450	213	103	149	302	116	105	38	1,868
rain-days	3	9	-	21	19	10	7	10	11	4	9	2	105
Testfarm, 1982/83													
rainfall (mm)	33	0	0	432	428	140	125	119	373	103	159	34	1,946
rain-days	3	0	0	20	21	10	12	6	14	7	11	5	109
Testfarm, 1978/83													
rainfall (mm)	50	116	163	329	304	263	346	219	180	96	90	75	2,231
rain-days	6	8	11	19	18	16	13	11	11	7	6	6	132

As was the case in Sumatra, the rainy season started late and was broken by a dry period in March and April 1983. However, this abnormal period was not as pronounced as in Sumatra.

5.2.3 Hydrology and hydraulic infrastructure

5.2.3.1 Description hydraulic system

The canal system is the so-called fork-system in which a short, wide primary canal is divided into two secondary canals each ending in a large pond, or kolam. Tertiary canals then serve the area and leave the secondary canals at regular distances. Some areas outside the project area, partly cropped or still under forest and bush, are also drained via these canals. All canals are in open connection with the Barito River. The project is located at 60 km from the sea.

The Barito River has a catchment area of 43,000 km^2 upstream from the project with an average annual rainfall of 3,450 mm. At Barambai the river width is 500 m. The river regime is tidal throughout the year.

The primary canal is 1,400 m long, 50 m wide and 4.5 m deep. The secondary canal Kiri serves 1,550 ha of the project area and 2,200 ha of ricefields outside the area. It is 6,800 m long. Its width decreases from 31 to 19 m, and its depth from 3 to 2 m. The secondary canal Kanan serves 1,150 ha of the project area and 1,100 ha of ricefields and forest outside the area. It is 6,600 m long. Its width decreases from 34 to 19 m, and its depth from 3 to 2.5 m. The secondary canals run parallel to each other at 4.6 km distance. The longitudinal profiles of the two secondary canals are given in Figure 21. It should be noticed that the bottom-level is too deep in places, hampering the complete replenishment of water in the canal. The kolams have a net storage area of 8.5 ha. The lowest level of the kolam Kiri is at 1.70 m - PRL, and that of the kolam Kanan is at 2.60 m - PRL.

The tertiary canals are 400 m apart. In Kolamkiri and Kolamkanan they serve 88 ha, while in Muara the service area varies from 120 to 60 ha. Cross-sections vary from 15 to 5 m^2. There are no structures to regulate the flow, but farmers close the tertiary canals during certain periods of the year to maintain proper water-levels.

LONGITUDINAL PROFILE CANALS, BARAMBAI

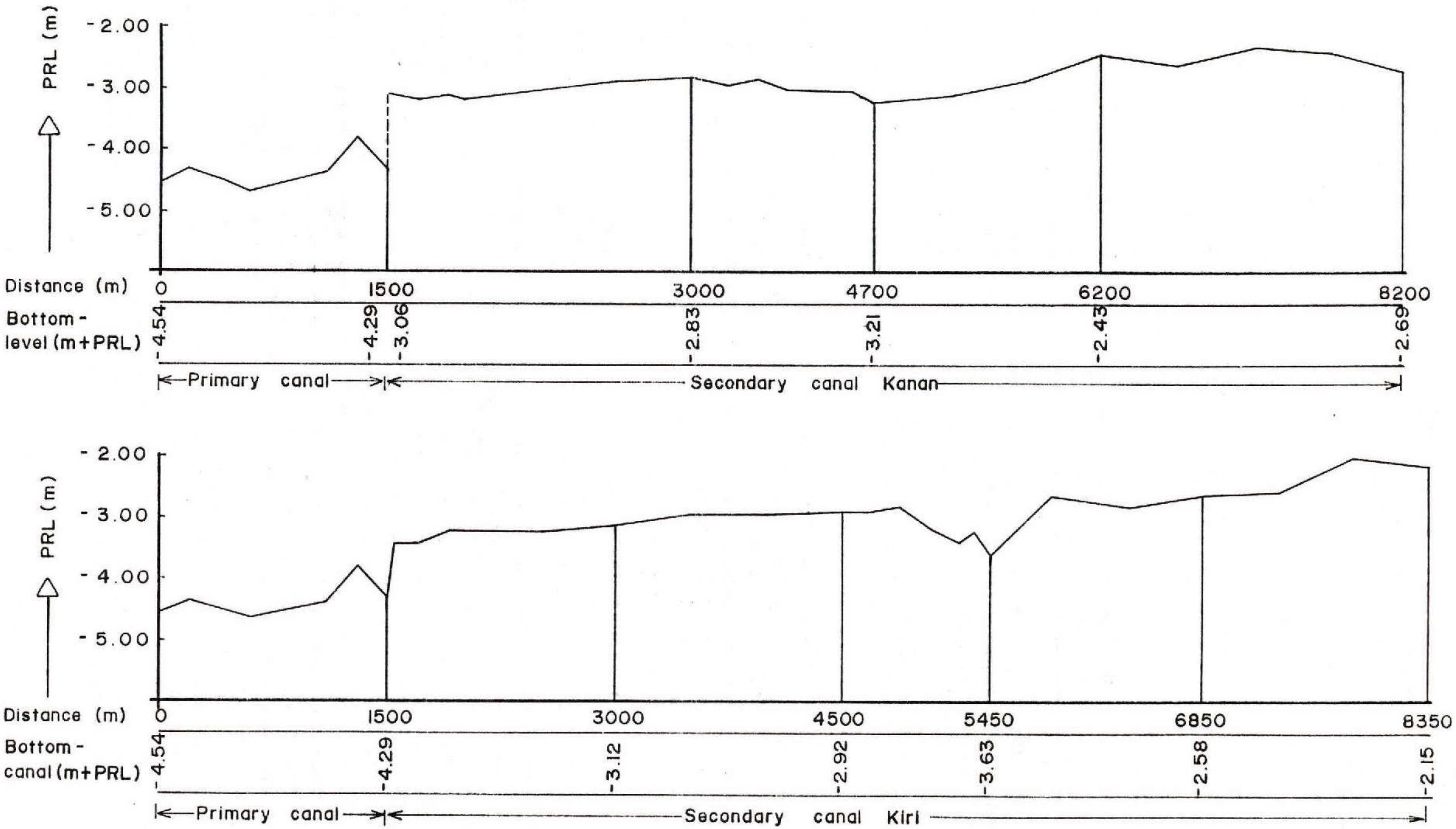


Figure 21

The condition of the primary and secondary canals is fair. The sideslopes are irregular but the canals are reasonably clean. Conditions of tertiary canals differ considerably. Close to the secondary canals they are generally good but at further distances they deteriorate.

5.2.3.2 Comparison water-levels and field-levels

River water-levels are governed throughout the year by the tidal movements at sea, although the wet-season (November-April) levels are also influenced by upland river discharges. The wet-season mean water-level at sea is 0.25 m higher than the dry-season level. This is caused by the north-eastern monsoon. The wet-season river water-levels have a tidal range of 1.5 to 0.6 m, and the dry-season tidal range is 1.8 to 0.9 m.

Daily water-levels in the Barito River are measured at Marabahan (BAR 3), see Figures 22a and 22b. This station is 12.5 km upstream from the primary canal. In the wet season maximum water-levels reach 0.10 m + PRL. In the dry season they are usually below 0.20 m - PRL. The tidal pattern is mixed - mainly diurnal.

The water movement in the primary and secondary canals is tidal and reaches the kolams at the end of the secondary canals. Here the tidal range is reduced by 0.30 m.

In the areas of Kolamkanan west and the eastern part of Muara, the water from the river enters the tertiary canals and, in parts of these areas, even the ricefields. In the other areas the river water hardly enters the tertiary canals.

For reconnaissance purposes a topographical survey has been carried out. The results are shown in Figure 23. One notices differences of 0.6 m in field-levels. The lower area of Muara and Kolamkanan have levels from 0.3 to 0.5 m - PRL, and the area of Kolamkiri 0.0 to 0.2 m + PRL. The size of the areas between contour lines is given in Table 22.

Table 22. Size of areas between contour lines, Barambai

Field-level (m + PRL)	- 0.8	- 0.6	- 0.4	- 0.2	0.0	+0.2	+0.4
Size of area, ha	10	540	420	550	1,070	110	
Ditto, cumulative, ha	10	550	970	1,520	2,590	2,700	
Ditto, cumulative, % of total	0	20	36	56	96	100	

5.2.3.3 Drainage capacity

The drainage capacity of the primary and secondary canals is sufficient as far as rainfall is concerned. However, some lower-lying areas in Kolamkanan and Muara have standing water for a longer period and the water quality is the main damaging factor here. The tertiary system is not adequate in these areas.

Water from uncleared areas and from ricefields opened by local transmigrants drain via the tertiary canals of Kolamkiri west towards the secondary canal Kiri. Similar areas north of Barambai drain directly into the kolams Kiri (1,800 ha) and Kanan (300 ha). Some natural streams along secondary canal Kanan also benefit from water supplied and drained via this canal but the quantities involved are small.

1980/81 WATER-LEVELS, BARITO RIVER

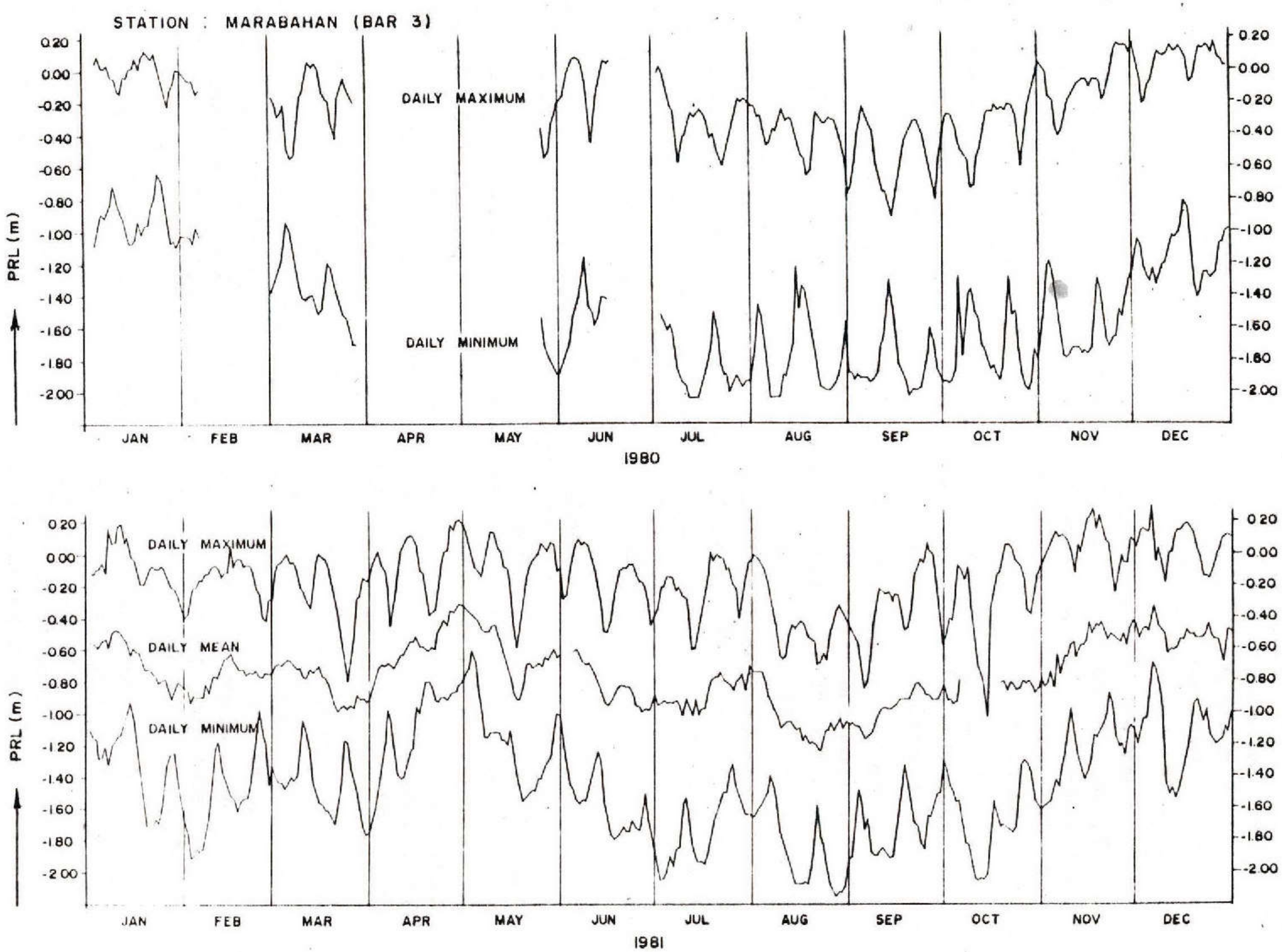


Figure 22a

1982/83 WATER-LEVELS, BARITO-RIVER

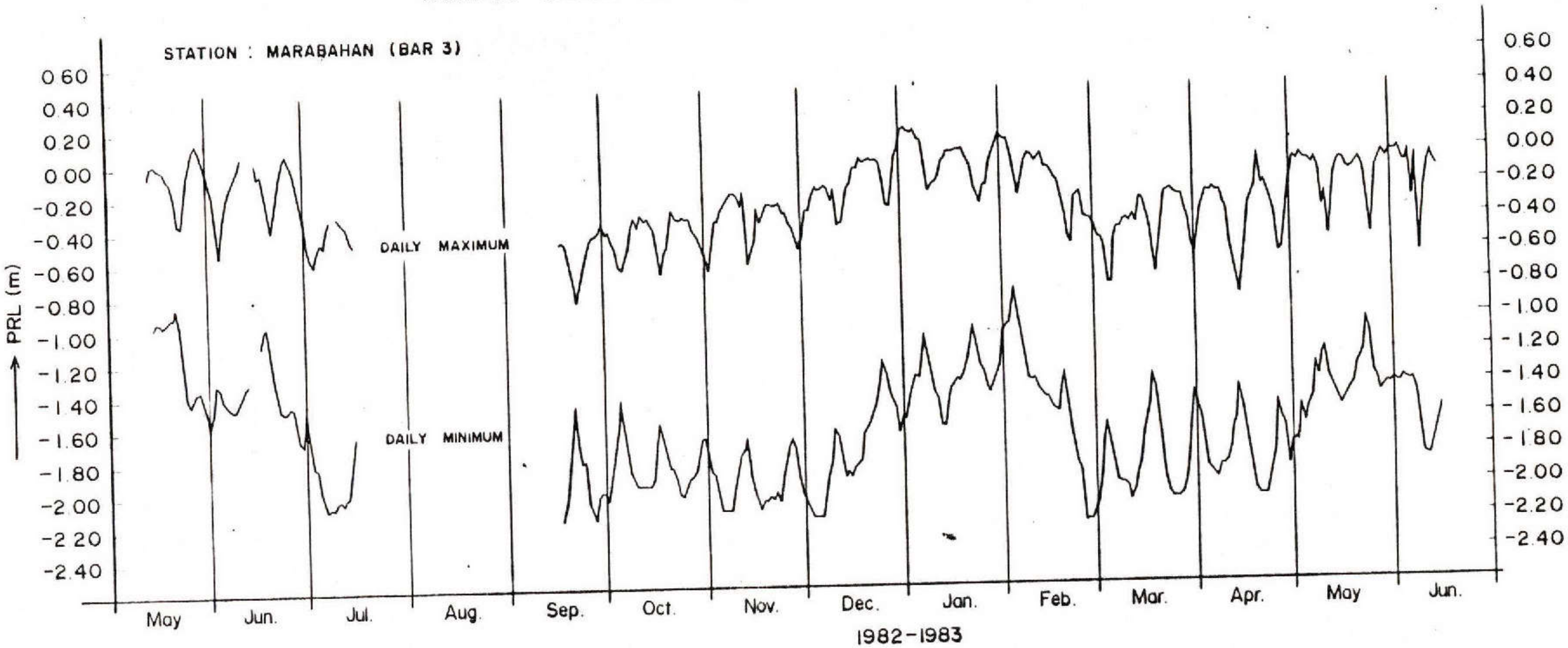


Figure 22b

FIELD-LEVELS, BARAMBAI

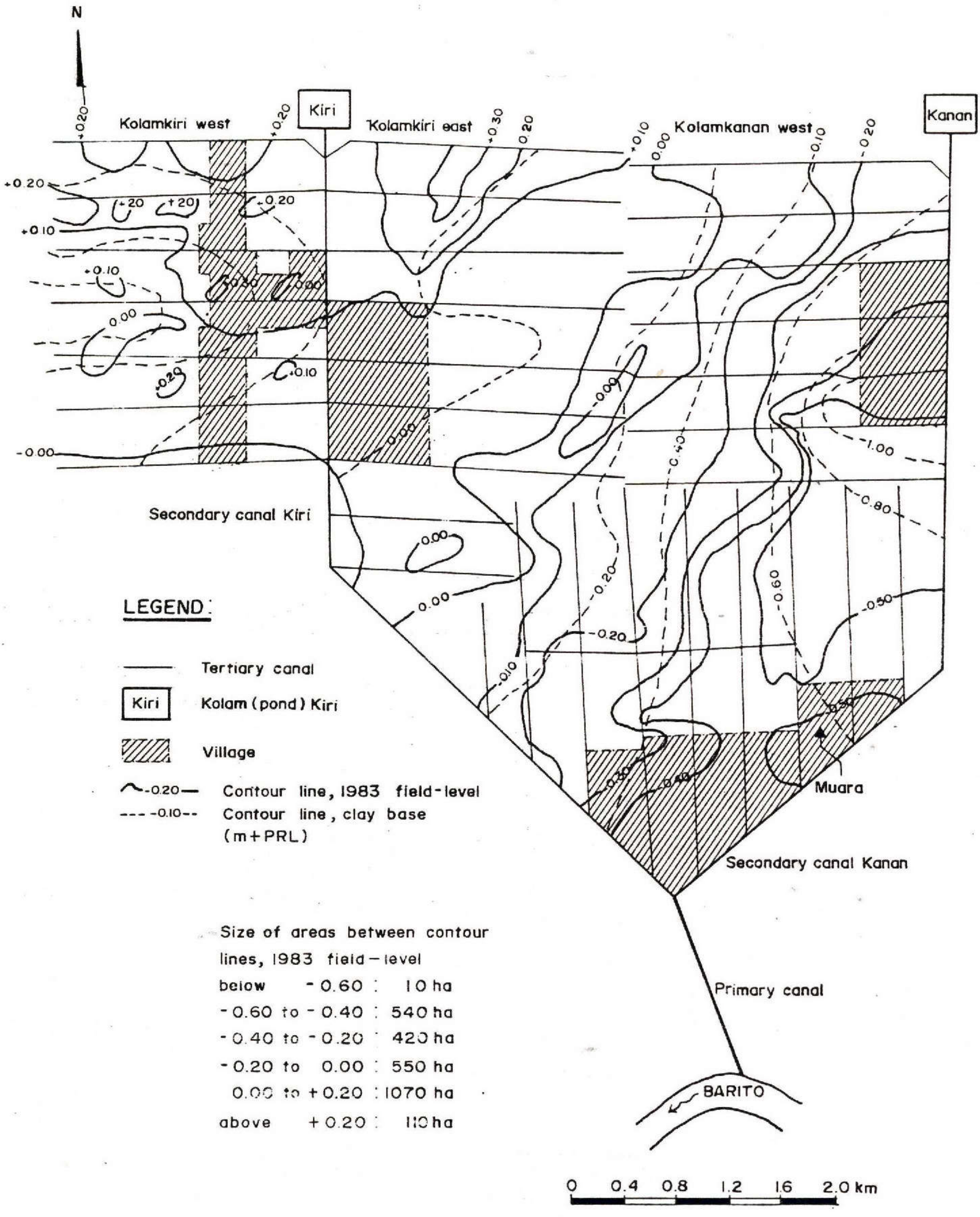


Figure 23

The drainage system also removes toxic elements and in this respect it performs rather poorly. There are two reasons for this situation. The surrounding forest at Kolamkanan discharges water with pH-values of 3 to 4, and the considerable volume of water which remains in the system at ebb is pushed back into the canals and kolams during flood. To indicate the magnitude of the latter phenomenon, the volumes have been calculated for two cases, viz a spring-tide with tidal range 1.76 m, and a neap-tide with tidal range 1.28 m.

At maximum water-level during the spring-tide, the system contains 1,015,000 m^3 water, 265,000 m^3 of which is still in the system at minimum water-level. The volumes during the neap-tide were assessed as 850,000 m^3 and 250,000 m^3. The pH-values of the remaining water are poor, 3 to 4. This low-quality water is pushed back into the kolams and tertiary canals when the high tide enters.

5.2.3.4 Quality surface water

The river turns saline only in an extended dry season. In such a period the limit of intruding saline water moves back and forth close to the entrance of the primary canal. It is hard to predict how often saline water will actually pass the mouth of the canal. Survey results are given in Table 23.

Table 23. Salinity Barito river (in $^o/oo$)

Date of survey	19.3.77	1.5.77	25.8.77	22.9.77	19.11.82	10.12 82	13.6.83
Salinity	0	0	1	3	1	1	0

As discussed in the previous Subsection, the water in tertiary, secondary and primary canals remains acid, see also Figure 24. The water is acid throughout year. This is confirmed by other surveys (DPMA 1979, UGM 1973, 1982).

5.2.3.5 Other aspects

Maintenance figures are not available. The primary and secondary canals, excavated in 1969, have reportedly been rehabilitated once, in 1978/1979. Another rehabilitation started at the end of 1983. The tertiary canals are maintained by the farmers on a more or less regular, yearly basis.

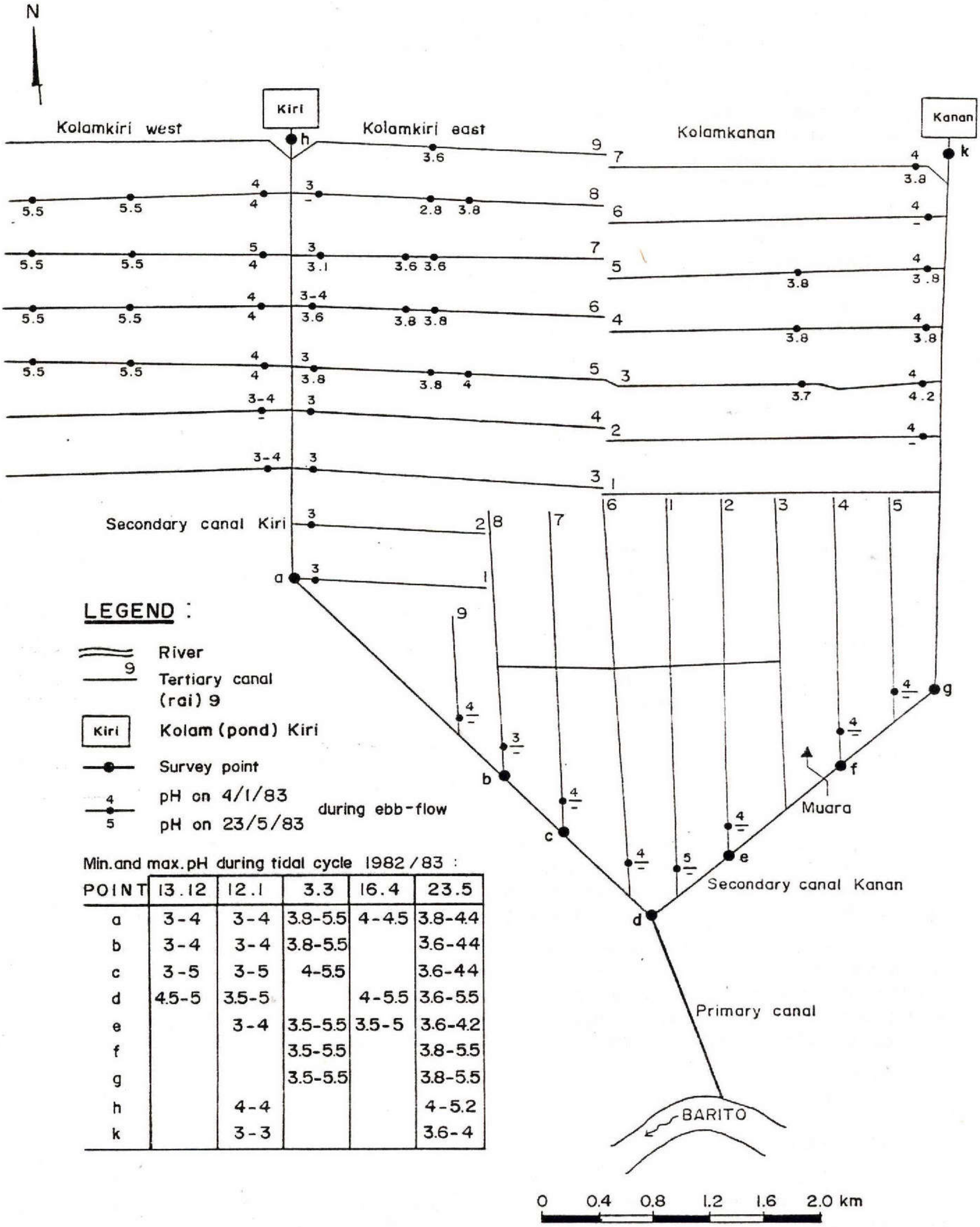
Primary and secondary canals give good access to the market at Muara and to the villages Kolamkanan and Kolamkiri. Roads along the major canals are used intensively by motorcycles and are in fair condition. Roads along tertiary canals differ and cannot always be used by bicycles. A road of fair quality connects Barambai with Marabahan, the Subdistrict capital.

5.2.4 Soil conditions

5.2.4.1 General description

The area has medium to heavy textured soils, mostly silty clays. Peat is still present in one third of the area, but is no longer a general problem. The clay is physically ripened to 0.5 - 0.7 m below surface as can be seen in the oxidation of the soil profile. Less ripened soils occur in pockets. Soils are potentially acid, and related problems are apparent in the crop productivity of the area.

ACIDITY CANAL WATER, BARAMBAI



Min.and max.pH during tidal cycle 1982 / 83 :

POINT	13.12	12.1	3.3	16.4	23.5
a	3-4	3-4	3.8-5.5	4-4.5	3.8-4.4
b	3-4	3-4	3.8-5.5		3.6-44
c	3-5	3-5	4-5.5		3.6-44
d	4.5-5	3.5-5		4-5.5	3.6-5.5
e		3-4	3.5-5.5	3.5-5	3.6-4.2
f			3.5-5.5		3.8-5.5
g			3.5-5.5		3.8-5.5
h		4-4			4-5.2
k		3-3			3.6-4

Figure 24

At present the area is not completely cleared. The Muara area has 225 ha land which has never been cleared and 75 ha land with regrowth of bush.

Information on vegetation and peat depth is given in Figure 25. Further details are dealt with in the following Subsections.

5.2.4.2 Peat

The common type of peat is saprist. The depth is usually less than 0.5 m and one finds peat-layers 0.6 to 0.8 m thick only to the south of Kolamkanan village. This area is poorly drained at present, and the peat should disappear when drainage conditions are improved. The size of the areas covered by each class of peat thickness is given in Table 24.

Table 24. Peat thickness, Barambai

Thickness peat (cm)	0-25	26-50	51 and over	Total
Area covered, study area only (ha)	350	20	45	415
Area covered, study area only (% of total)	84	5	11	100
Area covered, feasibility area (ha)	2,045	125	65	2,235*
Area covered, feasibility area (% of total)	91	6	3	100

* Excl. home yards, villages

We have compared the present peat thickness with the situation in 1973, as reported by UGM (UGM, 1973). In 1973 the larger part of Kolamkanan and Kolamkiri west was covered with more than 0.5 m peat. These peat-layers, with the exception of the poorly drained area mentioned above, have indeed disappeared as a consequence of the construction of drainage canals.

5.2.4.3 Soil acidity

Volume II, Surveys, of this Report describes the survey methods applied.

<u>Potential acidity</u>

The project has taken soil samples with a density of one profile per 50 ha to determine whether soil-layers have potential acid sulphate soil (PASS). A soil-layer contains PASS when its pH-value after maximum oxidation is 3.4 or lower. To enable comparison of data between sub-areas we have applied PASS-scores. A soil-layer with PASS has the value 1. At pH-values of 3.5 or higher, the soil-layer has the value 0. To obtain one PASS-score per profile of several layers, weighing factors have been applied; viz 0.5, 0,3 and 0.2 for layers of 0 - 25, 26 - 50 and 51 - 75 cm below surface. The results are given in Table 25 and Figure 26 (page 88).

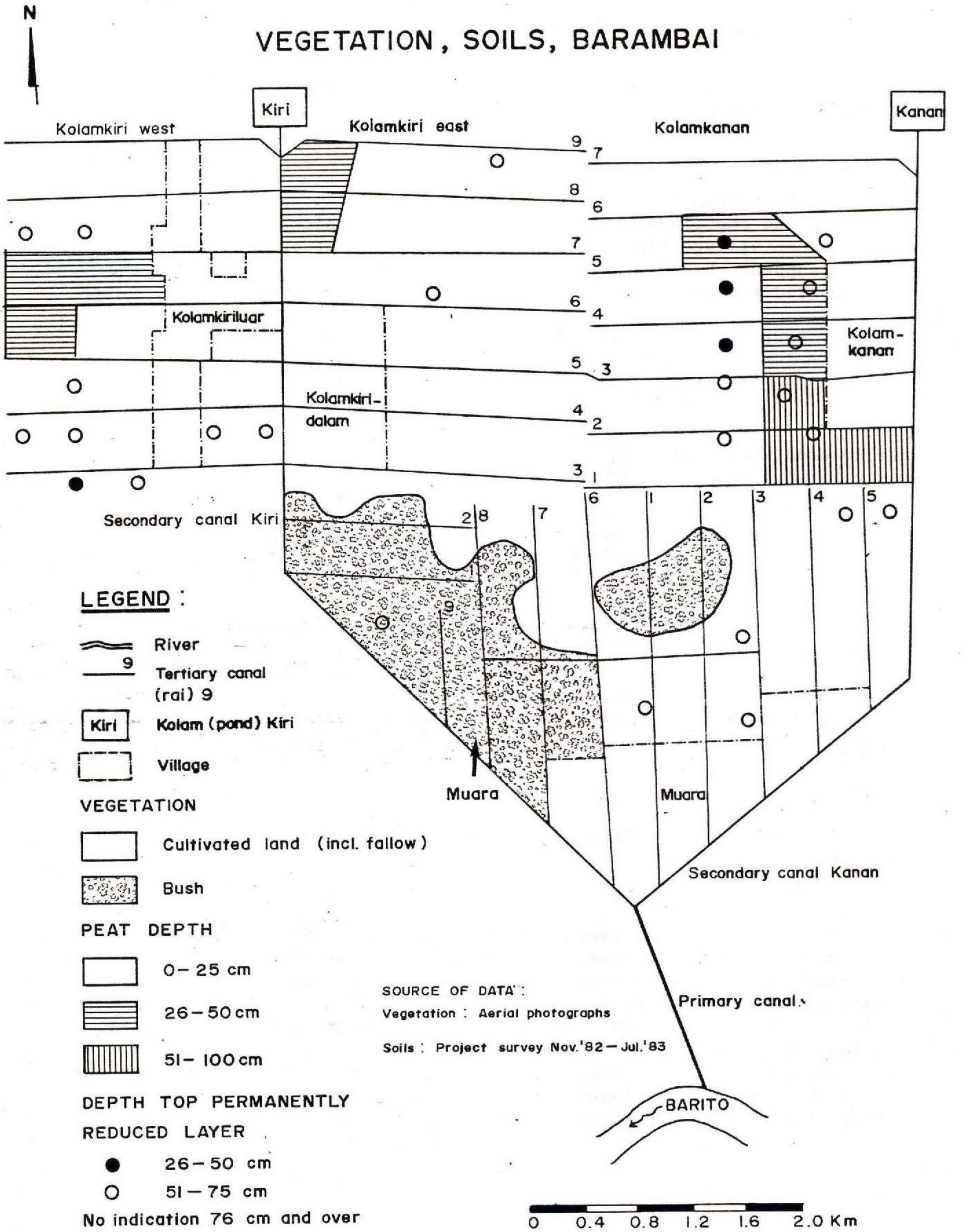

N
VEGETATION, SOILS, BARAMBAI
Kiri
Kanan
Kolamkiri west
Kolamkiri east
Kolamkanan
Kolamkiriluar
Kolamkiri-dalam
Kolam-kanan
Secondary canal Kiri
Muara
Muara
Secondary canal Kanan
Primary canal
BARITO
LEGEND:
River
Tertiary canal (rai) 9
Kolam (pond) Kiri
Village
VEGETATION
Cultivated land (incl. fallow)
Bush
PEAT DEPTH
0-25 cm
26-50 cm
51-100 cm
DEPTH TOP PERMANENTLY REDUCED LAYER
26-50 cm
51-75 cm
No indication 76 cm and over
SOURCE OF DATA:
Vegetation: Aerial photographs
Soils: Project survey Nov.'82-Jul.'83
0 0.4 0.8 1.2 1.6 2.0 Km

Figure 25

Table 25. Potential acid sulphate soil profiles, Barambai

Sub-area	Number of auger holes with PASS-score of				Number of analysed auger holes	Average PASS - score
	1.0	0.5	0.2	0.0		
Kolamkanan	5	0	7	4	16	0.40
Kolamkiri east	1	3	2	5	11	0.25
Kolamkiri west	3	6	5	2	16	0.45
Muara	10	3	1	2	16	0.75
Feasibility area	19	12	15	13	59	0.45

The Muara sub-area scores the highest. The Kolamkiri west and Kolamkanan sub-areas score around the average for the feasibility area, and Kolamkiri east has the lowest PASS-score. The northern part of the feasibility area is strikingly free of PASS. It should be noted that high PASS-scores occur without clear relation in the distance from major canals.

The given scores for PASS do not basically change when one alters the weighing factors. Another check on the stability of the PASS-score involves the possibility that soil-layers become dry and hence can indeed oxidize. Below the permanently reduced layer, see Subsection 5.2.5.1, soil-layers will normally remain wet and PASS will not oxidize and have harmful effects. Taking this into account, the average PASS-score of Kolamkanan improves from 0.40 to 0.35, and the score of Muara from 0.75 to 0.70.

Actual acidity

The project analysed soil samples to search for actual acid sulphate soils (AASS).

The first batch of samples was taken from 36 locations in the study area when we started the surveys in November/December 1982. At that time groundwater-levels were rising after the long dry season. We did not encounter AASS.

The 1983 dry-season sampling started at the end of June beginning of July when we sampled the top 0.3 m at 36 locations and the complete profile at another 16 locations. The pH-values ranged between 3.6 and 4.8 and AASS had not yet developed. Groundwater-levels were still rather high.

In the middle of August samples were again taken at 40 locations. The results of the analyses were difficult to interpret. At 75% of the locations we definitively did not find AASS. We found clear indications of AASS at only one location. In the remaining profiles soil-layers were too wet to account for the low pH-values measured. The moisture conditions were judged using our groundwater monitoring data, see Subsection 5.2.5.2. The phenomenon might be explained, apart from systematic analysis errors, by the quick oxidation of PASS, possibly within one month after lowering of the groundwater.

SOIL ACIDITY, BARAMBAI

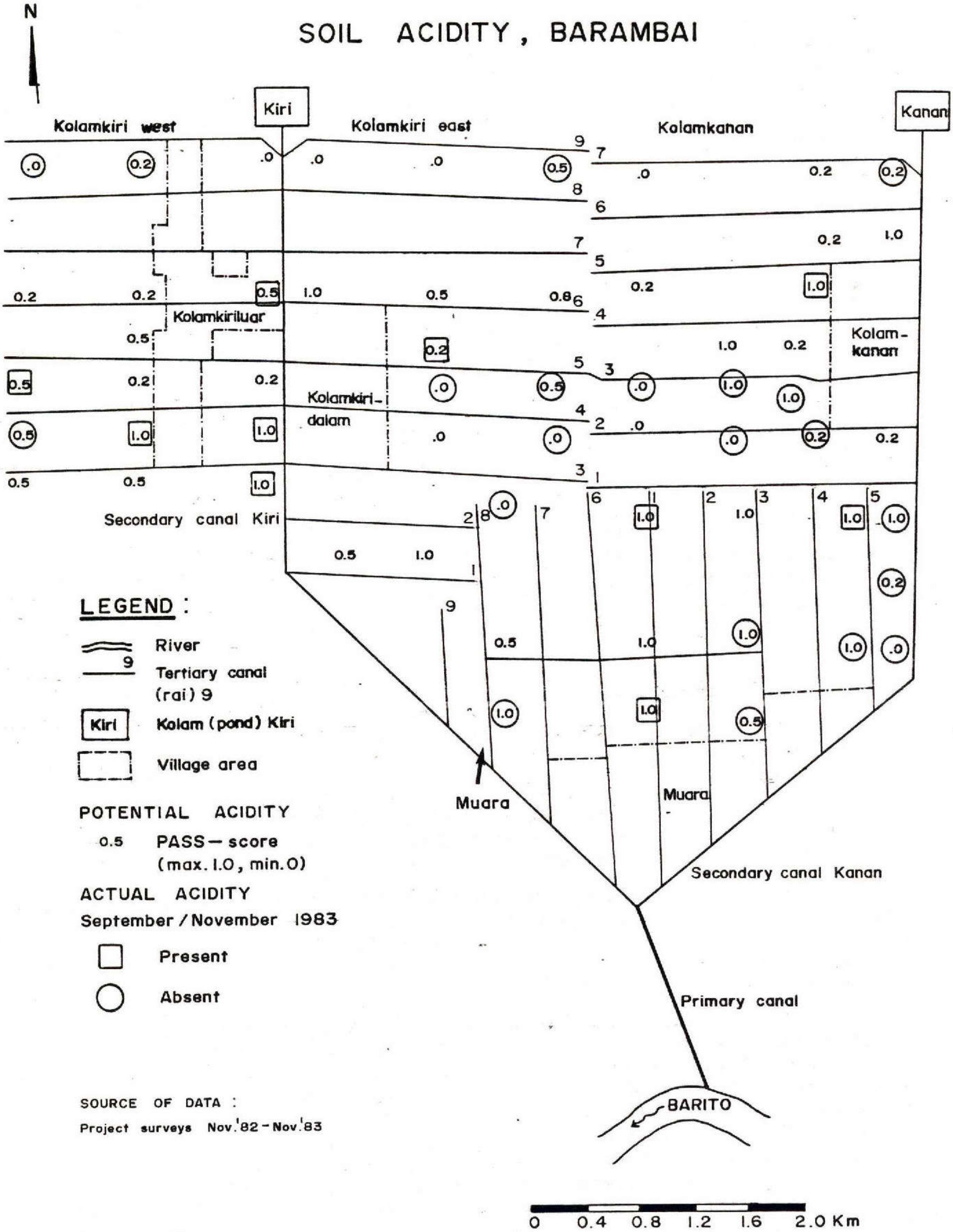


Figure 26

Sampling rounds were continued at 26 locations at the end of September 1983, and at 38 locations at the beginning of November 1983. Part of the samples were analysed by Analabs, a commercial laboratory in Jakarta. By taking all available data into account, viz availability of PASS, groundwater-levels, pH and SO_4 content and their relationship, we were able to judge the position of AASS with fair reliability at 31 locations. The results are given in Table 26 and have been added to Figure 26. It should be noted that the locations were not spread systematically over the area as was the case with PASS analyses.

Table 26 Actual acid sulphate soil profiles, Barambai

Sub-area	Number of profiles in which			Number of analysed profiles
	AASS present	interpretation data doubtful	AASS absent	
Kolamkanan	1	4	6	11
Kolamkiri east	1	3	4	8
Kolamkiri west	5	3	3	11
Muara	3	0	8	11
Feasibility area	10	10	21	41

The data in Table 26 show the same pattern as the PASS-scores. The areas most seriously effected by AASS are Kolamkiri west and Muara.

Effects

The PASS contains pyrite which oxidizes when groundwater-levels drop sufficiently, as is the case during the dry season. The pH-value decreases and dissolved toxic aluminium and easily reducible iron are formed. By submerging the land to prepare for the transplanting of local-variety rice, anaerobic conditions are created inducing the reduction of the iron to dissolved Fe^{++}ions. Especially if organic matter is present in the soil the quantities of dissolved iron will easily exceed toxicity levels although the soil-pH will increase as result of the reduction process. At the same time the concentration of toxic aluminium will decrease with higher pH-values. Stagnant surface water will also become very acid (pH 3.0-3.5) because the dissolved Fe^{++}ions oxidize in the surface water.

5.2.5 Water conditions

5.2.5.1 Gley phenomena

The permanently reduced soil-layers usually start more than 0.7 m below surface. This makes such areas unsuitable for the cultivation of a dry-season crop dependant on groundwater only. A rather large area behind Kolamkanan village has these layers at depths of 0.4 to 0.6 m indicating that dry-season groundwater-levels remain high here. Kolamkiri west has the deepest occurrence and hence the deepest dry-season groundwater-levels. Statistical data on the layer are given in Table 27. The profiles with the reduced layer at shallow depth are indicated on Figure 25.

Table 27. Permanently reduced layer, Barambai

Sub-area	Area (% of total) with reduced layer starting at (cm - surface)				Size area* (ha)
	26-50	51-75	76-100	101 or more	
Kolamkanan	14	29	43	14	505
Kolamkiri East	0	8	67	25	500
Kolamkiri West	3	25	56	16	450
Muara	0	24	55	21	825
Feasibility area	4	22	55	19	2,235

* Excl. home yards, villages

5.2.5.2 Groundwater

In this Subsection we have described the situation found by our survey. In the study area this survey started medio November 1982, and in the remaining parts of the feasibility area in March 1983. It should be pointed out that the 1982/1983 period was relatively dry. In the average rainfall year conditions will undoubtedly be wetter than indicated below.

Kolamkanan

The groundwater-levels rose and standing water appeared during December. The acidity of the groundwater and of the initial surface water was reasonable, pH 4. However, during January the pH-value dropped to 3.5 and during February to 3. Water-levels in the area behind the village were more than 0.2 m above the surface in January/February, the transplanting period for the local rice variety.

The area remained inundated for long periods.In June the standing water disappeared in part of the area, but behind the village it disappeared in August. In the standing water, pH-values remained low, 3.5 to 3. When surface water disappeared the pH-value of groundwater was often, but not always, higher than that of the standing water.

Kolamkiri east

Kolamkiri east is higher-lying than the Kolamkanan sub-area. It was inundated in January, and the acidity of the standing water deteriorated to pH 3.5 during February and in March it often fell to pH 3. By April the standing water had disappeared.

Kolamkiri west

During the survey period the sub-area was mainly characterised by its low groundwater-levels, 0.3 to 0.6 m below surface, in the wide strip along secondary canal Kiri.This occurred from March onwards. Only the most western parts of the sub-area had higher groundwater-levels, although there were hardly any long periods of standing water.

The pH-values of the groundwater in the southern part of the sub-area were 3.5 to 3 up to August. The north-westernpart had pH-values of 4 to even 5.

Muara

The western part of the sub-area had deeper groundwater than the eastern part. In the latter, standing water of up to 0.2 m occurred throughout the survey period, March to August. Here, we found the most consistently high pH-values in the feasibility area. Such values were lower, 3.5 to 3, in the western, less cultivated part.

5.2.5.3 Farmers' efforts

Canals

Some farmers, especially those at the former tertiary demonstration plots, have dug quaternary canals along the boundary of their fields. Such canals are 0.3 to 0.4 m wide and 0.4 to 0.6 m deep. Many farmers prepare ringtrenches around their paddy fields to function as collector drains.

Maintenance of tertiary canals depends on the activity of the farm leader in the canal area. The canals of Kolamkiri west are still clean after the rice harvest. Those of the Muara and Kolamkanan area are less maintained in the rice area and consequently their drainage function becomes inefficient.

Structures

The Government has installed many tertiary structures. Some have been transferred to the boundaries between ricefields and home yards thereby preventing excessive water-levels in the home yards.

Occasionally earthen dams are built halfway along the tertiary canals apparently to adapt canal water-levels to field-levels.

Land preparation

Part of the land, especially that for HYV rice cultivation, is levelled. Peat fires destroy the effect of levelling though, and necessitate extensive re-levelling. Such fires also destroy any bunds.

Some farmers change their ricefields into sorjans to cope with soil acidity. They plant cassava and string beans on the higher parts, but the lower parts remain too acid for cropping.

Water management

The most interesting type of soil and water management is applied by HYV farmers in Kolamkiri west. They transplant the rice into moist soil in the middle of November. In that period the dams in the canals are kept at 0.5 m below surface and rain-water is used to flush toxic elements out of the topsoil. The level of the dams is gradually raised to obtain a groundwater-level 0.15 m below surface. Surface water is drained off via ringtrenches into a quaternary or tertiary canal.

When cultivating local varieties of rice, farmers used to retain water on the fields after slashing the weeds in order to promote rotting. This method is declining, probably because of its toxic effects. Farmers open the dams in April to remove the standing water even when they expect drought stress to the rice.

5.2.6 Agriculture

5.2.6.1 Cropping systems

Field crops are rice, cultivated on 70% of the cleared area, and cassava on 5%. Home yards cover 15% of the cleared area and fallow lands 10%. About ten percent of the total area of the government-sponsored development scheme has not yet been cleared, or has reverted to permanent bush. Local varieties of rice are cultivated according to the multiple transplanting system with seedbeds in November and final transplanting in February/April. In limited areas HYV rice has been introduced. This type of rice is also planted in November/December but is harvested in March. In most cases HYV rice is followed by a local variety of rice thereby attaining double cropping.

Cassava, the only other field crop, has replaced rice in places where the paddy crop suffered from toxicity or drought and hence produced marginal yields. Cassava is cultivated on raised beds and also on sawah bunds. Palawija, an upland crop cultivated after a rice crop is harvested, does not exist.

Fallow lands are directly related to poor soil and groundwater conditions. These have forced farmers to abandon the land. The percentage of fallow land varies between the various sub-areas and is highest in Kolamkanan where 30% of land was out of cultivation in 1983.

The main home-yard crop is cassava which is grown to supplement the rice food supply. The second important crop is coconut. Bananas and pineapple are fairly common, but vegetables and protein-food crops are almost absent. Jackfruit is the dominant fruit tree.

5.2.6.2 Yields and related inputs

The project has interviewed farmers to obtain data on rice yields. The results are given in Figure 27.

Paddy

Since the start of the project, paddy yields have been declining, from an initial 1.5 t/ha to a present low average of 0.7 t/ha. There are wide variations over the sub-areas. Kolamkanan has the lowest yields at 0.3 t/ha, Kolamkiri east somewhat higher at 0.4-0.5 t/ha, and both Kolamkiri west and Muara have the highest yields of 0.7-1.0 t/ha. These yield figures relate to local varieties. Input levels are low and are usually limited to seed and rodenticides. Some progressive farmers apply fertilizers in the form of urea and triple-super-phosphate. The input cost is about 15% of the gross production value.

The yields of the recently introduced short-duration, HYV rice are substantially higher than the local varieties and reach levels around 2.5 t/ha. These yields are, however, obtained by a limited number of progressive farmers growing their crop on levelled fields with fairly high input levels. The costs of inputs amount to 20-25% of the gross production value.

Cassava

The cassava crop is still doing reasonably well on fields where rice failed. When grown on raised beds, the cassava is able to deal with the soil toxicity problems and produces yields up to 10 tonnes of wet tubers/ha. Inputs are low and are mainly confined to planting material.

REPORTED YIELDS, BARAMBAI

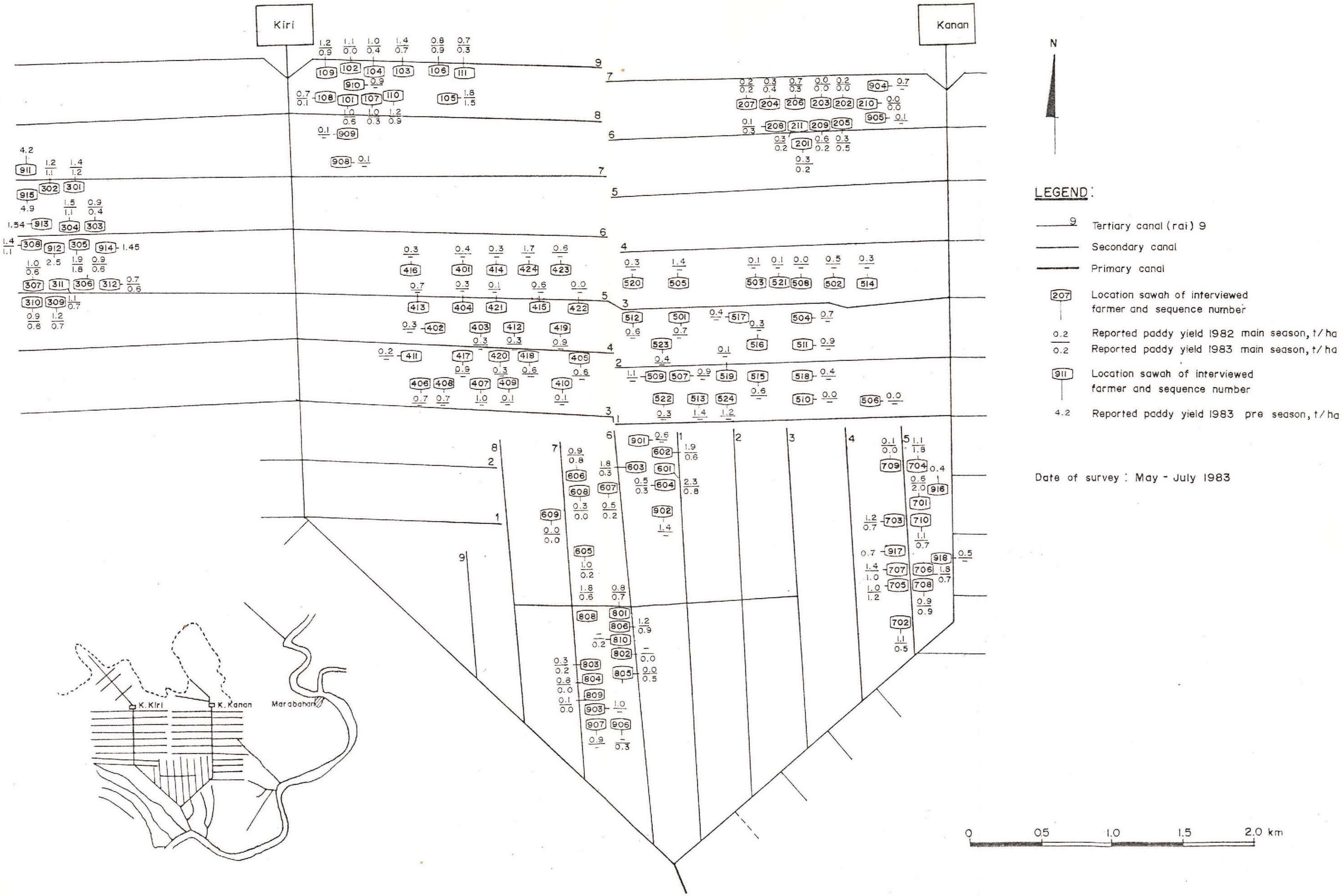


Figure 27

Home-yard crops

The performance of home-yard crops is disappointing. Cassava yields less than when cultivated as field crop. Coconut, the other important crop, shows healthy growth, but produces hardly any nuts although trees are between 7 and 10 years old. Pineapple shows some promise.

5.2.6.3 Diagnosis of present yields

Low yields of local-variety rice

In soils with potential acid sulphate material (PASS), the processes discussed in Subsection 5.2.4.3 may initially lead to low values of soil-pH and to aluminium toxicity, followed by higher pH-values with toxic quantities of dissolved iron. The excessive amount of dissolved iron will ultimately have an adverse effect on the paddy yields. Leaves will discolor and empty panicles will be formed. In addition, the stagnant surface water will become very acid, pH 3.0-3.5, aggravating the detrimental effect on the yield.

Farmers drain water from the fields in April. During dry spells a substantial drop in the water-table occurs, the pH decreases again, and the return of toxic aluminium levels may result. This, together with inadequate rainfall and the former harmful effect of dissolved iron, causes extremely low yields. These processes are most severe when the oxidation during the dry season is followed by stagnant water during the paddy growing season. It appears than this is happening in Kolamkanan, the area with the lowest yield levels. Where stagnant surface water is absent and additional water, either from the forests or via tidal influence, is available for flushing, the harmful effects are reduced and higher yields are obtained. This is presently the case in Kolamkiri west and the Muara area. The absence of stagnant water, and of additional flushing water, makes the Kolamkiri east area an intermediate one with regard to crop production.

It is worth noting that we have observed originally well-developed, but ultimately dead, rice plants in the finally transplanted ricefields. As the final transplanting takes place in February/March, this could mean that the actual toxic effects start rather late, in February.

Yields are not only reduced by the described adverse chemical effects. Water shortages are also responsible for lower yields. The growing season of local varieties extends far into the dry season. Yield reductions of up to 50% are common in years of low rainfall. Nevertheless, farmers give priority to flushing toxic elements out of their fields instead of retaining water on their fields. They apparently fear acidity more than water stress.

Progressive farmers are convinced that local varieties grown under the present cultivation methods are not suited to the Barambai conditions. These do not fully utilise the rainfall for plant development or for optimal flushing. These varieties are grown for traditional reasons and probably originate in flooded areas. A change from local varieties to the more adapted HYV rice will therefore be welcomed by the farmers' community.

High yields of HYV rice

The short-duration, HYV rice is transplanted at the beginning of the rainy season and makes optimal use of the rainfall for flushing and plant development purposes. Water is not retained on the well-levelled fields. Earthen dams are used to try and keep the groundwater-level at 0.15 m below soil surface to avoid the standing water conditions of wetland cropping. Excess rain-water is drained via ringtrenches into the tertiary canals.

In this cultivation/water-management system the toxicity problems related to acid sulphate soils are removed or made inconsequential. The dry-cropping method limits submergence and hence the production of dissolved iron ions which are, moreover, largely removed by flushing the top soil. Although the pH-value does not increase substantially, its increase will probably be just sufficient to prevent aluminium toxicity. Aluminium toxicity is further counteracted by phosphate fertilizer applications. Since most of the dissolved iron in the topsoil has been flushed there will be little lowering of the pH when the soil becomes drier,and no aluminium toxicity.

Time-related aspects

The general decline in yields of local varieties of rice over the last ten years is attributed to toxicity and water deficits. Factors which have influenced these two components are pronounced dry years, disappearance of the protective peat-layer, decreased supplies of forest water and a delay in maintaining canals.

As was described in Subsection 5.2.4.2,the project area was covered by peat-layers of more than 0.5 m before clearing. Due to gradual subsidence and peat fires, the peat disappeared, especially in years with a prolonged dry season. The subsoil, containing PASS, became more and more exposed to the air and the pyrite of the PASS oxidized more and more easily, thereby starting the whole process of subsequent noxious element formation. It could even be that the concentration of such elements increased through the years thereby surpassing critical limits only after a number of years of reasonable yields.

The process is aggrevated by the gradually diminishing amount of forest water flowing into the area. This water contributes to the flushing process. The conversion of part of the forest area into cropping land both diminishes the outflow from the forest area and increases the area of land needing forest water.

Poor maintenance of canals in the tidal supply areas has a similar effect. In lower-lying areas it leads to poor drainage and hence to stagnant water.

5.2.7 Socio-economy

5.2.7.1 History of the project

The first government-sponsored transmigrants arrived in 1969 and settled the Muara area between 1969 and 1971. The Kolamkanan area was settled in 1971 - 1972 and the Kolamkiri area in 1972 - 1973.

The project was transferred to the Ministry of Home Affairs in 1977 and an auxiliary Subdistrict office is being established for its administration.

Prior to the transfer, land titles were granted to the transmigrants.

5.2.7.2 Incomes*

Animal husbandry and off-farm activities contribute nearly half of the modest family resources. Off-farm activities mainly consist of labour and carpentry. The household size is 4.5 persons. Income figures are given in Table 28.

Table 28. Incomes, Kolamkanan Barambai (Rp'000/household/year)

Cropping	Animal husbandry	On-farm income	Off-farm income	Total
112	34	146	63	209

Farmers carry their produce, either on foot or by bicycles, to the secondary canals. Boats then carry the produce to the larger centres.

5.2.7.3 Infrastructure

Education is well looked after. All three villages have primary schools and Muara, the central village at the bifurcation of the primary canal, also has a secondary school.

Both Kolamkiri and Muara have a market place and a rice mill. The Muara village, being the administrative centre of the area, has an office of the credit bank, the BRI, and the co-operative, the KUD. It also has a fertilizer store house and a rice seed centre, presently part of the testfarm managed by the Ministry of Agriculture.

Health-care facilities are provided in a health centre (Puskesmas) close to the Barito River, and in a semi-hospital at Marabahan, 7 km away. The area has a mother-and-child health-care unit.

The cemetries of Kolamkiri and Kolamkanan village are located within the right of way of the secondary canals.

5.2.7.4 Drinking-water

Stored rain-water is the main source of drinking-water. The villages have been supplied with 60 ferrocement water tanks, capacity 3.5 and 10 m^3. The storage capacity is not sufficient to last through the dry season and in this period people resort to the tertiary canals in Kolamkiri and to water from the forest and hand-dug wells in Kolamkanan. If the quality of this water deteriorates (acidity), people carry water from the Barito River.

* Source: UNLAM (1983)

5.3 Development prospects

Having described the present state of affairs in Barambai, we will now discuss whether upgrading is warranted, whether it is possible, and what its outline should be.

5.3.1 The need for upgrading

The feasibility area suits the selection criteria set in Subsection 2.2.1. The cropping intensity is high and inputs are low where local varieties of rice are concerned. However, the successful introduction of HYV, which requires considerable outlay for proper seed and fertilizer, is a clear indication that farmers are prepared to use the land even more intensively than is presently the case.

The yields of local rice varieties have progressively declined since the beginning of the development of the area and in one part of the scheme a considerable percentage of plots are no longer cultivated. In the other parts, yields have not yet reached this bottom level. From both a social and economic point of view, this situation warrants government assistance to prevent the departure of government-sponsored transmigrants and to ensure proper returns for the investments made in the area.

5.3.2 Agricultural prospects

Two types of rice are presently grown; local varieties during the main season, February to September, and HYV during the pre-season, September to March. A constraint analysis of the yields gives clear indications that future development should focus on HYV rice. The growing-season rainfall pattern is favourable to HYV rice and any toxins can be controlled so the crop can survive. Yields of 2.5 t/ha can be attained when short-duration, HYV rice is planted early in the wet season, and proper flushing is attained, followed by water retention. This water should not be allowed to stagnate.

Rehabilitation of the local rice varieties'yields is less promising. The development pattern of toxins is not favourable, and the crop also has to cope with low rainfall during the later part of the growing season. The anticipated structures to facilitate flushing and water retention will not be able to reduce the toxicity level or the water shortage to such an extent that yields surpass the 1.5 t/ha level.

The introduction of palawija in a cropping system involving rainfed rice should not be considered in areas with potential acid sulphate soils. Soil conditions are so delicate that any lowering of the groundwater-table may have an adverse effect on the subsequent paddy crop. The expected low palawija yields, at subsistence levels because of unreliable rainfall, will not stimulate farmers to risk planting a dry-season crop.

Irrigation will stimulate further agricultural development. It will guarantee the complete removal of toxins from the upper soil-layers within a reasonable time through increased leaching, and will prevent the re-introduction of the toxicity problem by maintaining high groundwater-levels. It will provide full water supply to the main crop, and allow the growing of a second rice crop. Paddy yields in both the wet season and the dry season could surpass 3.0 t/ha. The potential of HYV rice under good water management is seen in the results from the Barambai testfarm. Yield estimates are supported by results obtained in Vietnam where enforced drainage of actual acid sulphate soils increased the yields from 0.5 t/ha to an ultimate level of 3.5 t/ha over a period of 4 years.

Upland cropping is also possible but will only be applied by the majority of farmers when improved rainfed cropping does not provide the expected results, and the investments required for irrigated cropping are not made. The soil has to be leached to a minimum of 0.6 m to enable ample storage of soil moisture in non-toxic soil. This can be achieved by a drainage system or by the construction of raised beds. In these conditions, even with a pH-value of 4, economic yields of oil-palm, coconut and rubber can be attained.

5.3.3 Prospects of water management

Tidal water supply to ricefields is possible, but will be confined to a certain area and a certain period. The area with field-levels below 0.20 m - PRL, some 1,000 ha gross, can be supplied with water during December and January. The quantities of water are in the order of 0.05 to 0.10 m per spring-tide period, or 0.25 to 0.50 m per year. Even if all present peat would disappear, the area with tidal water supply to ricefields would nearly be the same although the supplied quantities would be larger and more secure. Dry-season water supply is not possible as river water-levels are too low, see Subsection 5.2.3.2.

The dry-season tidal water supply will not be affected if water is withdrawn further upstream in the Barito River because the river remains tidal until 30 km upstream of the Barambai canal. In the wet season the effect will not be substantial as water-slopes in tidal rivers are very small.

In Barambai the water supply can be improved by pumping. The danger of saline water is remote, especially if one does not pump during spring-tide. However, if more areas along the Barito River are to be provided with pumped water, the water availability and the extent of saline-water intrusion should be accurately assessed.

Water-level records indicate that maintaining high water-levels in the canals will not influence groundwater-levels in the dry season. Making optimum use of high water-levels in the river by properly operating structures would bring the water-levels in tertiary canals to 0.40 m - PRL. With present field-levels, only about 500 ha will profit.

River water-levels are such that the whole area can be properly drained.

5.3.4 Soil potential

The soils in the project area require careful attention from their users, and soil-development processes must be understood by the agencies responsible for developing the area.

The farmers of Kolamkiri west, though faced with many difficulties in dealing with the specific properties of their soil have demonstrated that it is possible to cultivate the soils in a profitable way.

The poor-yield area of Kolamkanan west has similar soil types but the potential hazard of the prevailing soil type materializes because of adverse water-management conditions. Experience in other countries has shown that it is possible to reclaim areas with problems related to actual soil acidity development. The reclamation consists of flushing noxious elements out of the soil. The flushed layer has to be deeper than the future root zone. Unfortunately, the exact quantification of such reclamation methods is not yet available so it is hard to accurately predict how much water is needed or how long it will take to bring conditions back to normal. One should, however, think in terms of years, rather than months.

In a long-term view, the soil potential of the area is promising. Once the potential acid sulphate aspects are overcome the clayey soils will be highly productive because of their excellent structure-stability.

5.3.5 Scope for upgrading

The purpose of the upgrading project is the rehabilitation and improvement of the rice production which has declined to submarginal levels during the past 10 years. Self-sufficiency in rice should get priority. Measures have to be taken to eliminate or reduce toxicity and water shortage, the main constraints.

As software measure, the replacement of the local, late-maturing varieties by early-maturing, short-duration cultivars could result in substantial production improvements as the risk of drought, leading either to water shortage or acidity, can be reduced. This may require more intensive land-preparation methods which increase acidity hazards, and hence should be carefully implemented.

All hardware measures have to take into account the shortage of water required for the evapotranspiration demands of cultivated crops and to control soil acidity. We again propose a step-by-step approach. As the first step in reclaiming the presently impoverished area, one should increase the area's capacity to flush acids. Shallow drains at relatively short distances would be instrumental. Further steps would be the installation of water-management structures to improve water retention in the area and to increase water supply to ricefields. If these measures are well accepted by the farmers and lead to increased agricultural production, one could install low-lift pumps in the area. Farmers could then pump water to leach the soil when acidity arises, or to replace water lost to evapotranspiration. A second crop could also be cultivated in most years. Dry-season rice cropping will not succeed in years when too saline river water reaches the project.

More modest improvements can be achieved by improving the capacity of drainage canals in the areas with impeded drainage. Such improvements are technically feasible.

The main reason for clearing bush is to obtain more cropping land. Bush areas between cultivated fields should be cleared to consolidate rice-growing areas.

We do not believe that the Government can utilise forest water to reclaim lands in Barambai because this water source was developed by local farmers who have obtained, legally or illegally, a sense of ownership of the water. Moreover it is difficult to predict when the source of the water will be converted into cropping land.

In defining the optimal hydraulic infrastructure, it appeared that the possibilities of improving the above features in the feasibility area were rather homogeneous, with the exception of water supply. Consequently, defining conditions for water supply led to the distinguishing of the following zones:

Kolamkanan (supply)	- the area of Kolamkanan with field-levels below 0.20 m - PRL. Supply of river water possible. Covers 230 ha of the feasibility area;
Muara (supply)	- the corresponding area of Muara. Covers 460 ha of the feasibility area;
Kolamkiri (supply)	- the area of Kolamkiri which presently receives forest water. However, it is difficult to judge how long such water will remain available to the farmers. Covers 270 of the feasibility area;
Remaining area (no supply)	- the area between the above-mentioned areas where water can only be supplied to canals and not to ricefields. Covers 1,130 ha of the feasibility area.

Apart from these areas which are all suitable for rice cultivation, there are 120 ha presently cropped to cassava and 490 ha covering village areas, including home yards. These areas will not be dealt with.

5.4 The upgrading project

In this Section we describe the upgrading project in detail and analyse its economic effects.

5.4.1 Agriculture

5.4.1.1 Farming systems

Development prospects suggest the possibility of three farming systems:

- single cropping of HYV, rainfed rice;
- double cropping of HYV, irrigated rice;
- upland cropping of perennial tree crops.

Combinations may be possible but will require separate water-management systems for the individual components of the farming system. In selecting the appropriate system it should be kept in mind that it is much easier, and less expensive, to change from wetland cropping to dryland cropping rather than the other way around. If there is potential for irrigated rice, upland cropping becomes a suboptimal use of the tidal-land resource.

Cropping intensities for single-cropping of HYV rice will ultimately be 100%. However, the initially limited supply of HYV seed and farmers' inexperience will only result in a gradual replacement of local varieties by HYV. It is assumed that the intensity of HYV rice cultivation will increase from 10% in the first year to 30%, 80%, and 100% in the fourth year.

Should irrigation facilities be added after a certain period of time, double cropping of HYV rice will be possible. The intensity will start at 150% and gradually increase to 200%.

Double-cropping consisting of a HYV rice followed by a local variety grown under rainfed conditions is not envisaged. Under usual cultivation methods one third of the farm area, which is also a potential HYV area, is used as intermediate, multiple transplanting area for the local variety of rice. In this way a cropping intensity of 67% HYV and 100% local rice, in total 167%, is obtained. The loss of 33% HYV production has to be more than compensated by a 100% production of a local variety. The extra production so obtained will hardly pay for the labour involved.

Perennial tree crops grown under upland conditions will cover 100% of the land. During the first 2-3 years intercropping with food crops is possible.

5.4.1.2 Yields

Rice, general

The anticipated yields of rice have been based on present production and its constraint analysis, on the assumption that constraints can be removed, and on results obtained in other countries where cropping in tidal lands is common. Yield trends are related to fairly low levels of management during the initial stages of the project. The management level, however, will improve over time. Estimates of yields and related inputs are given in Table 29.

Table 29. Yield and related input projections*, Barambai

Year	Local variety, rainfed rice in main season		HYV, rainfed rice in pre-season		Year	HYV, irrigated rice in pre-season and dry season	
	yield	related inputs	yield	related inputs		yield	related inputs
1	2	3	4	5	6	7	8
1	800	15	1,600	15	11	2,600	20
2	900		1,600		12	2,700	
3	1,000		1,600		13	2,800	
4	1,100		1,600		14	2,900	
5	1,200		1,800		15	2,950	
6	1,250		2,000		16	3,000	25
7	1,300		2,200				
8	1,350		2,300				
9	1,400		2,400				
10	1,400	15	2,400	20			
Potentially	1,400	15	3,000	25	Potentially	3,750	30

* yield of rice in kg paddy (14% moisture)/ha; inputs as percentage of gross production value.

Local variety, rainfed rice

Drainage and water-retention facilities can not solve the toxicity and water stress problems prevailing during the main growing season, although the problems will be reduced. Conditions for flushing, water supply and toxicity development are less favourable during the growth period of the local varieties than during the cultivation period of the HYV rice. For this reason it is expected that the yields of local varieties will not surpass the 1.4 t/ha level.

HYV, rainfed rice

Water-balance calculations have been used to assess water deficits to crop production and their impact on yields. The average yield reduction is in the order of 10% of a yield under optimal water-supply conditions. Rainfall quantities and distribution are such that a complete elimination of the acidity problem during pre-season cropping will take years, although a reasonable production can be obtained from the beginning.

During the initial years yields will be constant because farmers will be changing from local varieties to HYV paddy during this period. The yield level of 2.4 t/ha in year 10 refers to a medium level of management. It will be further determined by the still prevailing adverse soil and water constraints which will, however, be strongly reduced when compared to the present conditions. The potential yield of 3.0 t/ha refers to a high level of management.

HYV, irrigated rice

The projected yields of HYV, irrigated rice are ultimately 25% higher than the HYV rainfed yields because of the total elimination of the toxicity problem, the adequacy of the water supply to meet crop water requirements and the related crop response to increased levels of fertilizer.

The yield projections given in Table 29 refer to an introduction of irrigation when the rainfed rice has reached optimum yield levels.

Perennial tree crops

Oil-palm, coconut and rubber are the most economic tree crops which can be grown on drained, potential acid sulphate soils when the upper 0.6 m has been leached. Our yield estimates are based on experience gained with estate crops in Malaysia, and are adjusted for smallholders' cultivation. Estated production is up to 50% higher than smallholders production. The estimated yields are averages over the productive period from 10 to 20 years after planting in the field. The yield projections are given in Appendix IV.

5.4.1.3 Inputs

In determining the quantities of seed, fertilizer and agro-chemicals needed, reference has been made to earlier studies (Nedeco-Euroconsult, 1981). Quantities of phosphate fertilizer may have to be higher than indicated there. The use of rock phosphate instead of triple-super-phosphate may be considered as long as the acidity problem has not been totally solved. In exceptional cases, liming may be another solution to acidity.

The inputs are expressed as a percentage of the GPV. The inputs of the three most important tree crops, oil-palm, coconut and rubber, are expressed in actual costs, see Appendix IV. The percentages are based on long-term experience.

5.4.1.4 Farm size and labour

The average size of a holding within the feasibility area is still around 2 ha. The home yard including the house lot covers 0.25 ha of the holding, and 1.75 ha is allocated for field crops.

The available labour per family is adequate to deal with the proposed farming systems. In rice cultivation, hired labour will still be common although not actually required. Mechanized land preparation or ox-ploughing must be introduced as soon as double-cropping of HYV rice starts.

When cropping is confined to tree crops only, family labour can cope with 3 ha rubber or oil-palm, or 6 ha coconut.

5.4.1.5 Agricultural support

Reference should be made to Subsection 3.4.1.5 which also applies to Barambai.

5.4.2 Hydraulic infrastructure

5.4.2.1 General

We refer to Figure 28 which depicts the layout of the hydraulic infrastructure, and to Volume IV, Designs, of this Report.

Single-cropping of HYV, rainfed rice requires the following functions of the hydraulic infrastructure in the area:

- prevention of undesirable standing water;
- facilitation of the flushing of toxic elements from the topsoil;
- evacuation of toxic elements from canals;
- maximization of wet-season water supply to fields and canals;
- facilitation of water retention on the fields when desired;
- reduction of the drop in groundwater-levels.

The farming system double-cropping of HYV, irrigated rice sets two additional demands:

- provision of water in the dry season;
- maintenance of groundwater-levels above PASS-layers.

The upland cropping of perennial tree crops poses contrary demands:

- drainage of the upper 0.6 to 1.0 m of the soil irrespective of whether such layers contain PASS or not.

In the present short feasibility study, we concentrated on the single-rice cropping farming system and designed the appropriate hydraulic infrastructure for it. This infrastructure is discussed in the following Subsections. For the time being we assumed that adding pumps to the designed infrastructure, without refining that design however, would be adequate for double-cropping of rice. Some aspects of pumping are discussed in Subsection 5.4.2.10. The upland farming system requirements could probably be met in most of the area. In terms of design, this system does not require more components in the infrastructure than the single-cropping of rice, although canals should be deeper. As this system is meant as a last resort, we have not elaborated on its hydraulic infrastructure.

5.4.2.2 On-farm works

On-farm works are required to enhance prevention of stagnant water, to flush toxic elements from the topsoil, to maximize water supply to fields, to facilitate water retention and to reduce the drop in groundwater-levels.

LAYOUT HYDRAULIC INFRASTRUCTURE, BARAMBAI

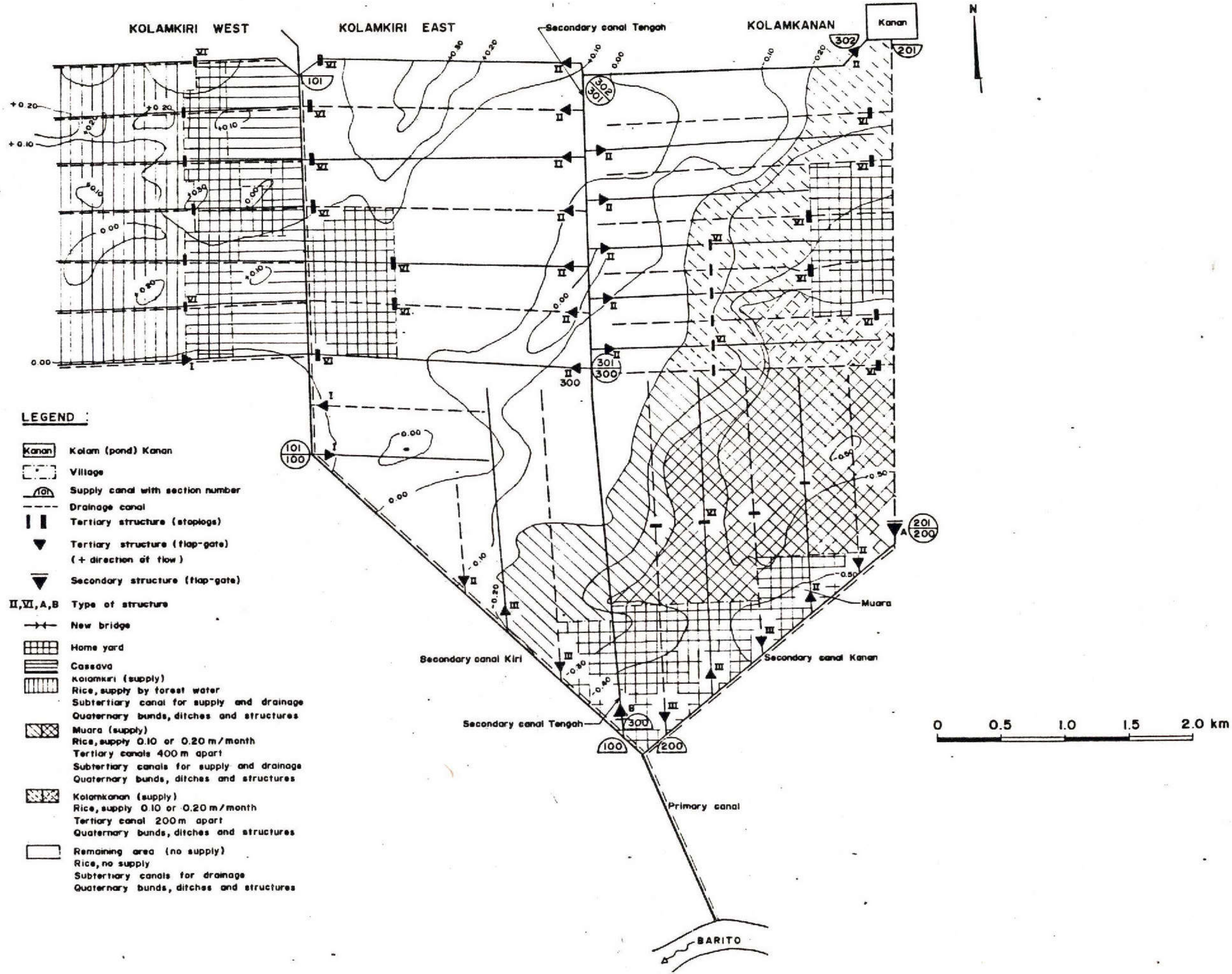


Figure 28

The envisaged on-farm works consist of bunds, ditches, culverts and land levelling. Subtertiary canals are also dealt with. Figure 29 shows typical layouts and cross-sections of the envisaged on-farm works. An explanation of the works has already been given in Subsection 3.4.2.1. Bunds are all the more important in Barambai because they force the water to infiltrate into the soil, thereby enhancing the flushing of toxic elements from the topsoil.

The flushing water has to be removed from the soil through quaternary ditches. The required drainage capacity of the flushing ditches has been set equal to the amount of water which can be supplied to the ricefields, viz 0.10 m per 15-day period, see Subsection 5.4.2.4. Drain spacing should be in the order of 25 to 30 m, or two extra ditches within the average farm plot.

Levelling requirements have been estimated at 250 m^3/ha.

In the areas where tertiary canals are 400 m apart and water supply to ricefields is envisaged, subtertiaries are required to serve the farm plots which are farthest away from the canals. A similar type of canal is suitable for drainage. Subtertiary drainage canals are envisaged in all areas except Kolamkanan (supply).

5.4.2.3 Alternative layouts secondary system

Toxic elements have to be removed from ricefields and tertiary canals. Good quality water has to be supplied to tertiary canals and where possible to ricefields. To prevent mixing of both types of water we should try to differentiate between supply and drainage canals in the secondary and primary system. In searching for a proper layout for such a canal system, we assessed three alternative approaches, see Figure 30. In Volume IV these alternatives are extensively discussed. We have summarized the effects of the three alternatives in Table 30.

Table 30. Effects of alternatives, Barambai

Item	Crop water supply						Drainage			Domestic water supply		
	Quantity			Quality								
Alternative	I	II	III	I	II	III	I	II	III	I	II	III
Kolamkanan (supply)	0	++	++	0	++	++	+	+	++	-	--	-
Muara (supply)	+	+	+	0	+	++	+	+	+	0	0	+
Kolamkiri (supply)	0	0	0	0	0	+	0	0	0	0	0	0
Remaining area (no supply)	0	0	0	0	0	+	+	+	+	0	0	+
Kolamkanan east*	0	-	--	0	-	-	+	+	+			

* outside project area

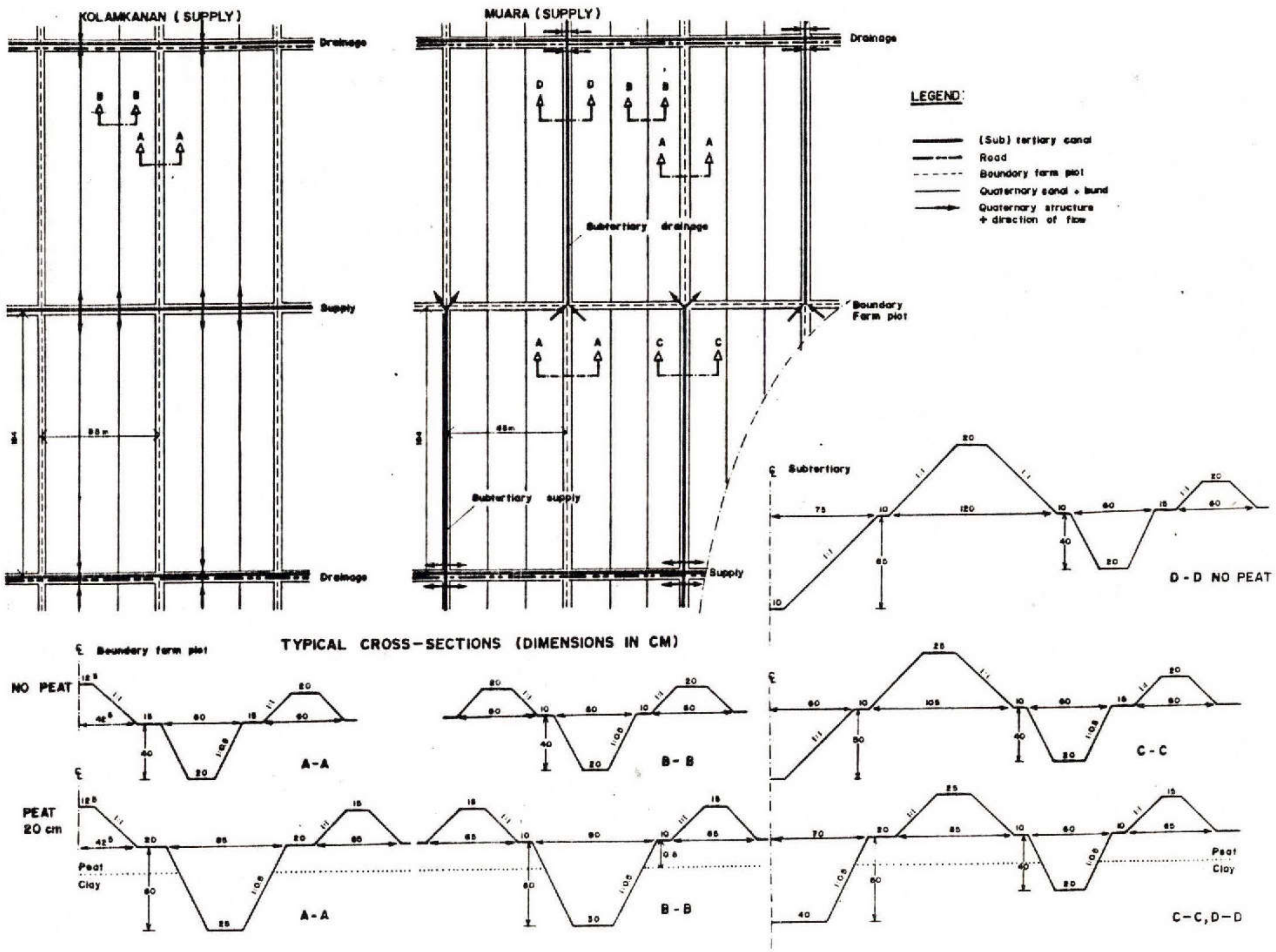
Signs are explained as follows:

-- effects are negative, compared with present conditions;
- effects are slightly negative, compared with present conditions;
0 no effects;
+ effects are slightly positive, compared with present conditions;
++ effects are positive, compared with present conditions.

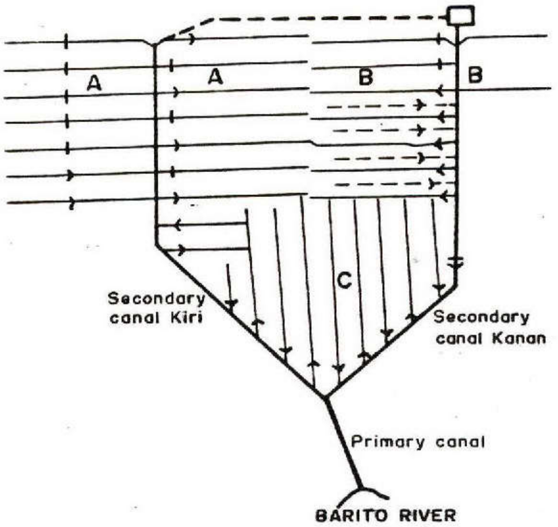
The costs of the three alternatives, including works which are similar in all cases, are 816, 910 and 889 million Rupiah respectively.

Figure 29

FARM LAYOUTS, BARAMBAI

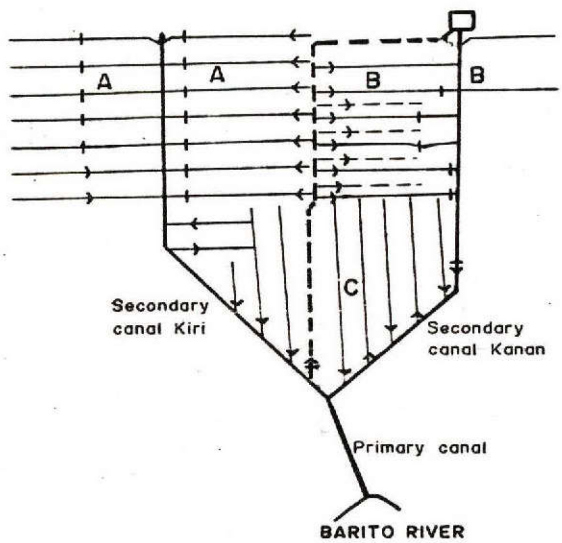


ALTERNATIVE LAYOUTS SECONDARY SYSTEM, BARAMBAI



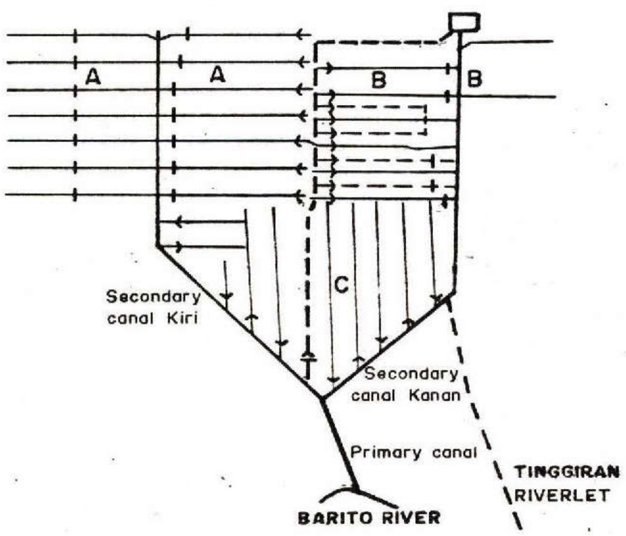
ALTERNATIVE I

. New canal between kolams
. Secondary structure
. Tertiary structures
. Quaternary bunds, ditches
. Quaternary structures



ALTERNATIVE II

. New canal through centre
. Secondary structures
. Tertiary structures
. Quaternary bunds, ditches
. Quaternary structures
. Close kolam kiri



ALTERNATIVE III

. New canal through centre
. New canal from kolam kanan
. Secondary structure
. Tertiary structure
. Quaternary bunds, ditches
. Quaternary structures

LEGEND:

–	Tertiary stoplogs
〉	Tertiary flap-gate
I〉	Secondary flap-gate
———	Existing canals
-----	Envisaged canals
A	Kolamkiri area
B	Kolamkanan area
C	Muara area

Figure 30

Studying these effects leads to a preference for alternative II. Alternative I does not improve the conditions significantly. Alternative III is a very drastic step and the extent of its effects on other areas is difficult to assess. Alternative II is a fair compromise with good prospects. The design is based on alternative II and the remaining part of this Volume refers to this alternative only.

5.4.2.4 Secondary canals

As explained in Volume IV, Subsection 5.3.1, the amount of water which can be supplied to ricefields without requiring excessively large canals, equals

- 0.10 m per spring-tide period (0.20 m per month) to areas with field-levels below 0.40 m - PRL;
- 0.05 m per spring-tide period (0.10 m per month) to areas with field-levels between 0.20 and 0.40 m - PRL;
- fields higher than 0.20 m - PRL cannot be supplied. Here water supply will be confined to canals only.

The rainfall-drainage criterion has been taken from previous studies (Nedeco-Euroconsult, 1981) and, where applicable, reduced to account for the storage capacity of ricefields without water supply. The area with field-levels below 0.2 m - PRL discharges 4.0 l/s/ha. The area above this level discharges 3.0 l/s/ha. This criterion is far higher than the flushing-drainage criterion taken as equal to the water supplied to the field, 0.10 m per 15-day period, and equivalent to 0.8 l/s/ha.

5.4.2.5 Tertiary system

The type of water management influences the design of tertiary canals. The location of areas with different water management is indicated in Figure 28, Page 105.

Kolamkanan (supply)

The existing tertiary canals are 400 m apart. To improve water supply and flushing it is proposed that this distance be reduced to 200 m, and canals be alternately supply and drainage canals. Existing canals are designated as drainage canals and for this purpose they should be deepened and widened.

The drainage canals have stoplog structures at their downstream end, close to the village or close to the secondary canal, to facilitate water retention. Stoplog structures, to adjust water-levels to field-levels, are envisaged at the halfway point of all canals.

New supply canals are envisaged between existing canals. The supply canals have inlet structures with a flap-gate to prevent water flowing back into the secondary supply canal.

Muara (supply)

The existing canals in the Muara sub-area are also 400 m apart. This is left unchanged but canals are alternately designated to be supply and drainage canals.

Ricefields along a supply canal are connected with the drainage canal via a subtertiary drainage canal. Subtertiary supply canals are also foreseen.

All tertiary canals have a structure with flap-gates at their entrance to direct the flow. Halfway along the canals, stoplog structures may be required to adjust water-levels to field-levels.

Kolamkiri (supply)

The existing canals have the dual function of supply and drainage. The supply water (forest water) enters the canals from the west, while drainage goes east towards the secondary canal Kiri. To improve drainage and the removal of toxics from the ricefields, it is proposed that the canals be cleaned.

The installation of stoplog structures at the borders of home yards and ricefields is proposed in order to facilitate water retention.

Remaining area (no supply)

Existing canals are alternately assigned to serve as drainage and water supply. It should be realised that the water supply here is to tertiary canals to enhance water-retention measures and not to the ricefields. Drainage canals require deepening and widening and supply canals require cleaning.

Tertiary structures allow water to enter the canals from the secondary canal Tengah. Water can be retained by closing the stoplogs of the structures at the canal junctions with secondary canal Kiri. Drainage canals are connected to the secondary canal Tengah via a tertiary structure to prevent damage to the secondary-canal embankments. Preferably, these structures should not be used.

5.4.2.6 Structures

It is proposed that all structures, with the exception of the structure in secondary canal Kanan, be built of tropical hardwood. To achieve the required stability of wingwalls and of the structure as a whole, the structure in the secondary canal Kanan should be built of concrete. Soil mechanic investigations should determine foundation requirements.

The discharge capacity of the structure takes into account the possibility of future installation of pumps.

5.4.2.7 Operation of the system

Kolamkanan (supply)

The water management should be fully geared to flushing for quite some time to come. Once the flushing process is finished the system can also be efficiently operated as a normal supply system meeting crop water requirements.

It is important to keep high water-levels in tertiary and quaternary supply canals. Each high tide will then start discharging water to ricefields immediately, instead of just filling empty canals.

At the beginning of each dry season the operation of the system should be geared to maintaining as much water in the system as possible.

Muara (supply)

The operation of this system is very similar to that of the Kolamkanan (supply) area.

Kolamkiri (supply)

It is recommended that the new layout be initially explained to the farmers closest to the secondary canal in, for example, the northern-most area. Once the system proves its practical merits to the farmers, they may apply it further.

Remaining area (no supply)

The Remaining area has no supply of water to the ricefields. Water supply is to the tertiary canals only. The prevention of waterlogged areas, where water from higher spots collects, is all the more important in this area. Bunding should be emphasized as a means of retaining rainfall, the only water supplied to the fields.

5.4.2.8 Land use

The improvements in infrastructure require land which could have been used for cropping. The size of the distinguished categories of land use before and after implementation of upgrading measures is given in Table 31.

Table 31. Size land categories, Barambai (ha)

Land category	At present	After upgrading
Rice	1,710	1,760
Upland crops	110	110
Home yards, villages	465	465
Infrastructure	115	365*
Bush	300	-
Total	2,700	2,700

* incl. on-farm works

5.4.2.9 Construction

The envisaged construction methods are similar to those in Rantaurasau, see Subsection 3.4.2.6. The time-schedule for construction is given in Figure 31. The costs of the envisaged works are given in Table 32. For details see Appendix V.

Figure 31. TIME-SCHEDULE CONTRACTOR, BARAMBAI

Description	Labour force per month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mobilization and demobilization	-	—							—	
Clearing light and dense bush 300 ha; 75 ha/month/labourgang	365		—		—	—	—			
Excavation canals 219,000 m^3 43,800 m^3/month/12 hydraulic excavators	24		—		—	—	—	—		
Structures, value Rp 117,000,000	107		—		—	—	—	—		

Table 32. Construction costs of project, Barambai (Rp'000,000)

Contractor, direct costs	383	
Contractor, indirect costs	119	
Contractor, total costs		502
Farmers, total costs		408
Construction costs of project		910

5.4.2.10 Additional pumps

The costs of pumping water into the tertiary canals have been assessed to check whether such a system would be economically feasible. The assessment was made using data from the Karang Agung feasibility study (40,000 ha, Nedeco-Euroconsult, 1981). Costs have been upgraded to reflect price increases.

The number of 300 l/s pumps, taken proportionally to the area to be supplied, amounts to 30. This roughly equals the number of present tertiary canals so, on average,each canal area would be supplied by one pump. Pumps will be grouped and installed in pumping stations at every second tertiary canal to ease operation of the system.

The total capacity of all pumps will be sufficient to supply the above-mentioned amount of 0.2 m per 15-day period over the whole rice area when pumps operate for 7.2 hours a day. With a high-water period of about 10 hours a day, this requirement still allows the repair and maintenance of some of the pumps. The number of pumping hours per year has again been set at 670 allowing for about 200 days evapotranspiration of 6 mm/day. Alternatively, it would allow for 2 months leaching supply of 0.2 m per 15-day period in the wet season, and a total supply of 0.8 m at the end of the dry season to keep groundwater-levels above PASS.

The investment and the annual costs of pumps are discussed in Appendix VI.

5.4.3 Economic analysis

As stated earlier, the short feasibility study concentrates on the single-cropping farming system. The economic aspects of a project aiming at this system are discussed in the following Subsections, and those of a pumped water supply in Subsection 5.4.3.6.

5.4.3.1 The without-project case

Land allocated to rice presently covers 1,710 ha and the average yields are around 0.7 t paddy (14% moisture) per hectare. At an economic farm-gate price of Rp 196/kg paddy (see Appendix VII),the total net economic returns of the area are Rp 199 million per year.

Considering the history of declining yields in Barambai, it can be safely assumed that without upgrading average yields will not increase. By keeping the total net economic returns at Rp 199 million per year the without-project case will not be over-estimated. The small area cropped to cassava, which does not yield higher than the rice area on a Rp/ha basis, has been valued as if a production of 0.7 t/ha paddy could be harvested.

5.4.3.2 The project

The project aims at creating conditions for single-cropping of HYV, rainfed rice. The cultivation of such a crop would imply a great improvement when compared with the continued cultivation of the late-maturing, local rice varieties. The present infrastructure, both of canals and at farm level, will be adapted and improved to this end.

The envisaged measures and related water-management practices could lead to considerable improvements in farm income which renders further upgrading measures unnecessary for the time being.

Measures are envisaged in a gross area of 2,010 ha. After bringing 300 ha of bush into (re)cultivation and after deducting the land required for additional infrastructure, a net cultivable area of 1,760 ha will be available for HYV, rainfed rice cultivation.

5.4.3.3 Project returns

Yield projections were given in Table 29, page 102. Increases in yield go parallel with increases in applied inputs. It is assumed that it will take some years before farmers cultivate the HYV, short-duration rice and improve their cropping practices accordingly.

After the lead period, yields increase relatively quickly to an average of 2.4 t/ha paddy. The potential yield, attainable under ideal conditions, is estimated to be 3.0 t/ha. This implies that, after the initial quick growth in production, the growth continues by 1-1.5% per year for a further ten years.

The project returns were calculated using these data, see Table 33. The returns are assumed to first materialize in the year immediately after completion of the infrastructure.

Table 33. Project returns gravity supply, Barambai (Rp'000,000)

Year	1	2	3	4	5	6
Returns with the project	232	302	499	622	642	662
Returns without the project	199	199	199	199	199	199
Project returns	33	103	300	423	443	463

5.4.3.4 Project costs

The project costs comprise Rp 502 million, investments in infrastructural works, and Rp 408 million for improvements at farm level including supervision of implementation by the staff of the Ministry of Public Works (P3S). It is anticipated that the major infrastructural works will be carried out by contractors supervised by P3S. The on-farm improvements will be carried out by the farmers themselves, again under supervision of P3S staff. The major infrastructural works will be implemented in one year. However, the on-farm improvements will be gradually developed by the farmers. It is assumed that this process of improvements will take five years. At this pace of implementation the farmers will be engaged in improving their land for a period of 1.5 to 2 months per year. Instead of paying the farmers for their labour, it seems more realistic to give them an incentive in order to promote appropriate farmer follow-up of the infrastructural measures. A sum of Rp 20 million per year is meant for upkeep and operation of the project. This fund comprises an allocation for P3S staff (2) for guiding farmers during implementation and management of the water-control system.

5.4.3.5 Evaluation

Project benefits and costs have been evaluated over 25 years, the lifetime of the project. It should be noted that the project returns comprise the effects of two distinct measures; the creation of an infrastructure and its related on-farm improvements, and the introduction of a rice variety more suited to the area. However, as the introduction of the superior rice variety will not be possible without the projected technical measures, and these technical measures will not have any significant impact on the present yield levels of traditional varieties, the joint project benefits are assumed to be accured from the proposed technical measures. The IRR of the project is 28%, and the discounted value of future benefits is Rp 2,000 million (discount rate 10%).

A crucial factor is the need for farmers to follow-up the major infrastructural works provided by improving their fields and by planting the appropriate rice variety. If such action is delayed or if only 50% of the farmers respond, the IRR will drop to 17% and the present value to Rp 600 million (discount rate 10%).

The project appears to provide a safe investment and demonstrates that relatively minor improvements to the existing infrastructure, in conjunction with appropriate farming practices, can produce attractive results.

5.4.3.6 Additional pumps

A brief assessment of the benefits of irrigation, a pumped water supply to the project, has been carried out.

Project returns

Irrigation will lead to a gradual increase of paddy yields obtained under rainfed conditions in the wet season, and a productive dry-season rice crop, grown instead of a marginal palawija. Full water management will control the acid conditions met in the area.

The wet-season paddy yields will increase from 1.6 t/ha to 3.0 t/ha ten years after project implementation. The dry-season crop will have similar yields. Potential yields of 3.75 t/ha could eventually be reached under ideal conditions.

It is assumed that it will take four years for the farmers to absorb the new technology. However, it is unrealistic to assume that the complete area will immediately be double-cropped. The project returns have therefore been further reduced, by 50% initially and then gradually diminished until full production is reached in year 10. The underlying reason is that, even when the technical constraints for irrigation are solved, it will take some time to build up an optimally effective organization for agricultural extension, pest and rat control, water management and so on.

The returns of the pumped supply project are given in Table 34.

Table 34. Project returns pumped supply, Barambai (Rp'000,000)

Year	1	2	3	4	5	6	7	8	9	10	11
Gravity supply	232	302	499	622	642	662	662	622	662	662	662
Pumped supply	886	986	1,121	1,274	1,325	1,358	1,391	1,422	1,427	1,433	1,433
Ditto, corrected for acceptance farmers	514	662	930	1,274	325	1,358	1,391	1,422	1,427	1,433	1,433
Ditto, corrected for build-up organisation	257	364	558	828	928	1,019	1,113	1,209	1,284	1,361	1,433

Project costs

Water will be supplied by low-lift diesel pumps, and an organization will be provided for operating and maintaining the system. The total investment in 30 pumps and 15 pumping stations is Rp 809 millions. The initial cost of an envisaged organization is Rp 140 million. The yearly costs for pumping (670 hours) are Rp 101 million. The equipment will be renewed after 15 years. The yearly costs of the organization are Rp 33 million.

It is assumed that the pumps will be installed over a period of two years. In year 1 the entire organization will be created and 50% of the pumps will be installed. In year 2 the remaining pumps will be installed. Total investment in year 1 is Rp 544 million, and Rp 404 million in year 2. Yearly operation and maintenance costs in year 1 are Rp 88 million, and in year 2 and onwards Rp 133 million.

Evaluation

The IRR is 18% and the discounted value of future benefits is Rp 764 million (discount rate 10%). The evaluation period is 15 years, up to the first replacement of the pumps. Reasonable safety margins have been built in to allow farmers to gradually adapt themselves to the new situation and to allow the Government to develop and refine its organization.

One additional factor has to be considered before embarking on the irrigation of the Barambai area. The area is situated at the interface between fresh and brackish water at the end of the dry season. It is probable that slightly brackish water will be supplied in some years, leading to yield reductions. The project, however, is economically strong enough to absorb small losses.

Nevertheless, developing Barambai for irrigation may completely block irrigation development further upstream. When more water is tapped upstream, salt will intrude deeper into the basin and the supply of irrigation water of sufficient quality and on a reliable basis will be jeopardized. In this situation the farmers will not be willing to invest heavily in inputs required to obtain the projected yields, and the project may eventually become a bad investment.

It is recommended that the irrigation project be postponed for two reasons:

- External effects could make the project risky because no clear insight into the development of the river basin exists.
- The farmers may make sufficient improvements with the envisioned upgrading project. They will probably absorb the additional potential of irrigation rather slowly. Hence, if the irrigation project is postponed until the farmers are ready for the second step, the newly created potential will be more quickly absorbed and the investment in pumped irrigation will produce rapid results.

6 PROGRAMMES

6.1 Hydrology

It is anticipated that within 10 to 20 years the tidal-land development projects will have reached the stage in which the supply of irrigation water is an economically viable improvement. It is, likewise, to be anticipated that the availability of fresh river water for irrigation will be limited. This calls for a careful allocation of the scarce commodity. The required hydrological information to do so centres on upland flow, salinity intrusion and rainfall. As these phenomena show large variations from year to year, they should be recorded over a considerable period, say ten years, before a reliable prediction can be made for the period over which a project is usually evaluated.

6.1.1 Upland flow

The volume of upland river flow entering the tidal lands has to be known. The obvious way to measure the flow is by operating AWLR's and establishing the relation between water-level and discharge of inflowing and outflowing water. Ideally, the AWLR's should be placed in major rivers just upstream of the tidal stretch, but in practice a compromise has to be found using existing stations. The DPMA* is to be the coordinating agency. It could well be, that this part of the programme does involve only the continuation of operating already available AWLR's. It has to be explained to the observers that the data will become relevant only after quite some time.

6.1.2 Salt intrusion

The distance over which saline water can intrude into the rivers during the dry season, depends on the amount of upland river flow which counteracts the tidal intrusion. When river water is used for irrigation, saline water will intrude further into the river . The relation between upland flow and salt intrusion has to be known to predict possibly negative effects of dry-season irrigation in downstream project schemes.

It is proposed to measure the intrusion of saline water at the beginning and end of each dry season, say in June and September during the years to come. Results can be tied to the upland-flow data. Again DPMA is to be the coordinating agency.

6.1.3 Rainfall

Long-term rainfall records are important to determine exact irrigation-water requirements. It is proposed to intensify the existing network of LMG-controlled rainfall stations. Each island between major rivers could have two stations, one in the seaward stretch and one at the upstream part of the tidal lands. The present coverage falls somewhat short in the Musi River area and surroundings.

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* Direktorat Penyelidikan Masalah Air; Directorate of Hydraulic Research

Observers should preferably be sought under indigenious people, who are not inclined to travel to their island of origin regularly, thereby leaving the station suboptimally manned. In line with present practice, the observers can be employees of the Dinas Pertanian.

6.2 Upgrading

The activities under this heading belong to the responsibility of P3S.

6.2.1 Determining the need for upgrading

The present project determined the need for upgrading in a selected number of project schemes. The procedure should be repeated basicly in all existing project schemes, especially in the government-sponsored ones. This applies also to the project scheme Tambanluar, surveyed by the present project. As explained in Volume II, Subsection 9.4.6, some questions remain to be answered here. Based on the results a proper priority for upgrading project schemes could be established.

The investigations per project scheme should be focussed on the land-use intensity, the use of crop inputs, yield-levels of rice, population dynamics since the start of the settlement and off-farm labour opportunities. The collection of information via key persons is to be supplemented by extensive visits to all parts of a project scheme, including at least one visit during harvest time of the main rice crop.

6.2.2 Configuration of upgrading projects

Tidal lands have been developed by different parties in isolated units. Usually, government-sponsored and spontaneous/local project schemes are separate hydraulic entities. Especially in Kalimantan, the same applies to different government-sponsored project schemes.

When considering upgrading of those schemes in need for it, it stands to reason to combine several entities if this would lead to a concise hydrological unit covering, for instance, one half of an island. It has to be investigated in the field, whether the different communities presently living within such a unit, would appreciate the envisaged approach. In this respect it is also important to trace the reasons why forest and bush stretches, if any, are not cultivated and what the situation as to land titles of the settlers and of non-inhabitants are.

The constraints to an increased agricultural productivity have to be assessed, both agronomic ones (possibly input supply, rats), soil features (deep peat, acid sulphate soils) and those related to the hydraulic infrastructure (water shortage, floods).

This type of investigations is difficult to carry out succesfully. It requires quite some experience and exposure to tidal-land conditions to prevent a survey team drawing the wrong conclusions. One has to avoid being induced by often conflicting interests and fixed opinions. In the process of data collection, a regular feed-back with earlier investigations can be helpful in arriving at a consistent picture throughout the already developed tidal lands.

6.2.3 Technical feasibility of upgrading

In the consolidated blocks of tidal lands selected for upgrading the hydraulic infrastructure the possibilities of improvements usually depend on the relation between levels of river water and of crop-fields. A topographic survey has to define and detail such relations. Another paramount feature is the movement of acid water in the canal system during low and high tides. In the third place, the salinity of river water has to be assessed.

The stretches of land with more than 0.5 m peat and with apparent soil-acidity problems have to be mapped, as here a different farming system will apply. The relevant information could best be gathered by interviewing farmers, followed by quick field checks.

In this stage, soil-mechanic data have to be collected when the type of envisaged works so warrants (larger structures, high embankments).

Finally, an outline of the improved hydraulic infrastructure at all levels, from primary to field level, has to be made and thoroughly checked against the conditions in the field.

The described surveys require a continuous presence of a multi-discplinary team for periods of up to some months. The coordination of the several components of such a survey is of paramount importance.

6.2.4 Preparation of implementation

Once the basic approach to improve the hydraulic infrastructure has been agreed upon, the implementation of upgrading can be further prepared. Detailed designs, technical specifications and a bill of quantities have to be prepared.

Arrangements have to be made for the right of way to construction, compensation of damages to crops, and land titles may have to be checked.

Not least importantly, the farmers have to be informed about the coming project and their assumed co-operation in it, viz the execution of the on-farm works as far as earthwork is concerned. The P3S advisors who are to assist the farmers in the implementation stage, have to become involved from this stage onwards.

6.3 Agriculture

As the tidal lands economic activities will be agricultural in outlook for a long time to come, major responsibilities fall to the Ministry of Agriculture.

6.3.1 Crop research

It is imperative to activate research in export-oriented crops under tidal-lands conditions in Indonesia. Here, a similar reasoning as under hydrology applies, once the farmers are ready to cultivate such crops on a large scale, the agronomic information should be readily available. Obviously, it may take more than 5 to 10 years to collect such information on rubber and oil-palm.

6.3.2 Operation and maintenance tertiary works

The proper organization for operating and maintaining the hydraulic infrastructure at tertiary and farm level has to be set up at the time of outlining such an infrastructure. The interface with the similar organization of the Ministry of Public Works concerning the secondary level upwards has to be well-defined and effective day-to-day communications have to be maintained.

APPENDIX I AVAILABLE DATA

METEOROLOGICAL DATA

- Rainfall

Source: Lembaga Meteorologi dan Geophysika (LMG)

Station name and number		Period
Muarasabak	173	: 1914 - 1941 (monthly)
		: 1974 - 1976 (daily)
Jambi	175[b]	: 1953 - 1982 (daily)
Jambi	175	: 1904 - 1941 (monthly)
Kualatungkal	173[b]	: 1973 - 1976 (daily)
Sungsang	190	: 1913 - 1941 (monthly)
Marabahan	306[a]	: 1917 - 1949 (daily)
Kualakapuas	306[b]	: 1918 - 1933 (daily)

Source: testfarm, IPB/P4S or UGM/P4S

Berbak	: 1976 - 1983 (monthly)
Upang	: 1975 - 1983 (daily)
Barambai	: 1972 - 1983 (daily)

- Climatic data

Jambi, Palmerah 175	: 1954 - 1979
Talangbetutu	: 1961 - 1971
Testfarm, Upang	: 1975 - 1983
Testfarm, Barambai	: 1972 - 1983
Banjarmasin	: 1954 - 1964

HYDROLOGICAL DATA

- Automatic water-level recorder (DPMA/P4S)

Batanghari River	: BAT 4	1979, 1980, 1981
	: BAT 3	1982/1983
Berbak River	: BER 1	1983 (January - April)
Banyuasin River	: BAN 1	1979 , 1980
Kampung Upang	:	1979, 1980, 1981, 1982, 1983
Barito River	: BAR 3	1979, 1980, 1981

APPENDIX II. BILL OF QUANTITIES, CONSTRUCTION COSTS, RANTAURASAU

Bill of Quantities and costs, LM-area, Rantaurasau

Code	Description	Unit	Unit costs (Rp)	Quantity	Total costs (Rp'000,000)	
	Direct costs, contractor					
A.1	Mobilization and demobilization	pc	3,000,000	1	3	
A.2	Forest clearing	ha	250,000	200	50	
A.3	Canals, 1.2 m^3/m'	m^3	1,150	52,600	60.49	
A.4	Flood protection dikes	m^3	860	5,500	4.73	
A.5	Tertiary structure, type I	pc	600,000	22	13.2	
	Tertiary structure, type VI	pc	550,000	20	11.0	
A.6	Secondary structure, type C-2	pc	1,033,000	1	1.033	
	Secondary structure, type C-3	pc	715,000	1	0.715	
	Secondary structure, type C-1	pc	7,770,000	1	7.770	
	Secondary structure, type F	pc	715,000	1	0.715	
A.7	Quaternary structure, type 1	pc	9,000	930	8.370	
	Quaternary structure, type 2	pc	16,000	930	14.880	
A.8	Small bridge	pc	15,700	465	7.301	
	Subtotal, direct costs contractor					183.204
	Indirect costs, contractor					
A.9	Contractor	% of A1-A8		27	49.465	
A.9	Ministry of Public Works	% of A1-A9		3	6.980	
	Subtotal, indirect costs contractor					56.445
	Costs, farmers					
B.1	Levelling	m^3	600	428,700	257.22	
B.2	Bunds, ditches	m^3	450	222,100	99.945	
B.3	Technical assistance	% of B1-B2		6	21.432	
	Subtotal, costs farmers					378.597
Total costs, LM-area						618.246

Bill of Quantities, construction costs, HP-area, Rantaurasau

Code	Description	Unit	Unit costs (Rp)	Quan-tity	Total costs (Rp '000,000)	
	Direct costs, contractor					
A.1	Mobilization and demobilization	pc	4,000,000	1	4.00	
A.2	Primary canal	m^3	1,100	26,400	29.04	
A.3	Tertiary canal	m^3	860	30,900	26.574	
A.4	Tertiary structure, type X	pc	440,000	15	6.6	
A.5	Secondary structure, type E	pc	9,490,000	1	9.49	
	Secondary structure, type D	pc	5,610,000	1	5.61	
A.6	Quaternary structure, type 1	pc	14,000	690	9.66	
	Quaternary structure, type 2	pc	26,000	690	17.94	
	Quaternary structure, type 3	pc	18,500	15	0.278	
	Quaternary structure, type 4	pc	31,500	15	0.472	
A.7	Small bridge	pc	21,500	350	7.525	
	Subtotal, direct costs contractor					117.189
	Indirect costs, contractor					
A.8	Contractor	% of A1-A7		27	31.641	
A.9	Ministry of Public Works	% of A1-A8		3	4.465	
	Subtotal, indirect costs contractor					36.106
	Costs, farmers					
B.1	Bunds, ditches	m^3	450	295,700	133.065	
B.2	Technical assistance	% of B1		6	5.604	
	Subtotal, costs farmers					138.669
Total costs, HP-area						291.964

APPENDIX III. BILL OF QUANTITIES, CONSTRUCTION COSTS, UPANG (SP)

Bill of Quantities and costs, farming system 100% rice, Upang (SP)

Code	Description	Unit	Unit costs (Rp)	Quantity	Total costs (Rp'000,000)	
	Direct costs, contractor					
A.1	Mobilization and demobilization	pc	5,000,000	1	5	
A.2a	Bush clearing	ha	61,000	685	41.785	
A.2b	Forest clearing	ha	350,000	260	91	
A.3	Tertiary canal	m^3	860	91,500	78.69	
A.4	Tertiary structure, type Va	pc	1,100,000	10	11	
	Tertiary structure, type Vb	pc	730,000	10	7.3	
A.5	Quaternary structure, type 1	pc	9,000	1,240	11.16	
	Quaternary structure, type 2	pc	16,000	1,240	19.84	
A.6	Small bridge	pc	21,500	310	6.665	
A.7	Secondary canal + road	m	530	3,500	1.855	
A.8	Primary canal	m	430	5,400	2.322	
A.9	Bridge secondary canal	pc	3,700,000	1	3.7	
A.10	Bridge tertiary canal	pc	1,550,000	8	12.4	
	Subtotal, direct costs contractor					292.717
	Indirect costs, contractor					
A.11	Contractor	% of A1-A10		27	79.034	
A.12	Ministry of Public Works	% of A1-A11		3	11.153	
	Subtotal, indirect costs contractor					90.187
	Costs, farmers					
B.1	Levelling	m^3	600	555,000	333	
B.2	Bunds, ditches	m^3	450	264,500	119.025	
B.3	Technical assistance	% of B1-B2		6	27.122	
	Subtotal, costs farmers					479.147
Total costs, Alternative I						862.051

Bill of Quantities, construction costs, farming system 50% rice, 50% coconut Upang(SP)

Code	Description	Unit	Unit costs (Rp)	Quantity	Total costs (Rp'000,000)	
	Direct costs, contractor					
A.1	Mobilization and demobilization	pc	5,000,000	1	5	
A.2a	Bush clearing	ha	61,000	685	41.785	
A.2b	Forest clearing	ha	350,000	260	91	
A.3	Tertiary canal	m^3	860	91,500	78.69	
A.4	Tertiary structure, type VB	pc	730,000	20	14.6	
A.5	Quaternary structure, type 1	pc	14,000	285	3.99	
	Quaternary structure, type 2	pc	26,000	285	7.41	
	Quaternary structure, type 3	pc	18,500	125	2.313	
	Quaternary structure, type 4	pc	21,500	125	2.688	
	Quaternary structure, type 5	pc	9,000	620	5.58	
	Quaternary structure, type 6	pc	16,000	620	9.92	
A.6	Small bridge	pc	21,500	360	7.74	
A.7	Secondary canal + road	m	530	3,500	1.855	
A.8	Primary canal	m	430	5,400	2.322	
A.9	Bridge secondary canal	pc	3,700,000	1	3.7	
A.10	Bridge tertiary canal	pc	1,550,000	8	12.4	
	Subtotal, direct costs contractor					290.993
	Indirect costs, contractor					
A.11	Contractor	% of A1-A10		27	78.568	
A.12	Ministry of Public Works	% of A1-A11		3	11.087	
	Subtotal, indirect costs contractor					89.655
	Costs, farmers					
B.1	Levelling	m^3	600	277,500	166.500	
B.2	Bunds, ditches	m^3	450	277,750	124.988	
B.3	Technical assistance	% of B1-B2		6	17.489	
	Subtotal, costs farmers					308.977
Total costs, Alternative II						689.625

APPENDIX IV. SMALLHOLDERS TREE CROPS, BARAMBAI

Crop	Oil palm	Coconut*	Rubber
yield/ha, averaged over year 10-20	11 ton bunches (2,200 kg oil)	1,200 kg copra (600 kg oil)	900 kg rubber
quality	reasonable	good	poor
first year production	4	7	6
top production year	10	12	15
inputs** during improductive years	Rp 350,000	Rp 200,000	Rp 300,000
annual inputs** productive years	Rp 80,000	Rp 20,000	Rp 40,000
annual labour	120 mandays	60 mandays	150 mandays

* Coconut : potential dwarf varieties (hybrids) higher: up to 2,000 kg copra/ha with increased input levels
2,000 kg copra = 1,000 kg coconut oil

** Pre-devaluation, Rupiah

APPENDIX V. BILL OF QUANTITIES, CONSTRUCTION COSTS, BARAMBAI

Bill of Quantities and costs, alternative II, Barambai

Code	Description	Unit	Unit costs (Rp)	Quan-tity	Total costs (Rp'000,000)	
	Direct costs, contractor					
A.1	Mobilization and demobilization	pc	12,000,000	1	12	
A.2	Light bush clearing	ha	61,000	75	4.575	
A.3	Dense bush clearing	ha	350,000	225	78.75	
A.4	Canals 10 m^3/m'	m^3	590	68,000	40.12	
A.5	Canals 3 m^3/m'	m^3	860	151,000	129.86	
A.6	Tertiary structure, type I	pc	550,000	2	1.1	
	Tertiary structure, type II	pc	790,000	16	12.64	
	Tertiary structure, type III	pc	760,000	6	4.56	
	Tertiary structure, type IV	pc	550,000	29	15.95	
A.7	Secondary structure, type A	pc	32,000,000	1	32	
	Secondary structure, type B	pc	3,800,000	1	3.8	
A.8	Bridge secondary canal, type 1	pc	2,300,000	5	11.5	
	Bridge secondary canal, type 2	pc	4,600,000	1	4.6	
A.9	Quaternary structure, type 1	pc	9,000	1,480	13.32	
	Quaternary structure, type 2	pc	16,000	220	3.52	
	Quaternary structure, type 3	pc	18,500	260	4.81	
A.10	Small bridge, type 1	pc	20,300	225	4.568	
	Small bridge, type 2	pc	15,700	300	4.710	
	Subtotal, direct costs contractor					382.383
	Indirect costs, contractor					
A.11	Base camp				11.3	
A.12	Engineering				35.5	
A.13	Transport				13.5	
A.14	Overhead	% of A1-A13		10	44.268	
A.15	Ministry of Public Works	% of A1-A14		3	14.609	
	Subtotal, indirect costs contractor					119.177
	Costs, farmers					
B.1	Levelling	m^3	600	443,250	265.95	
B.2	Bunds, ditches	m^3	450	265,000	119.25	
B.3	Technical assistance	% of B1-B2		6	23.112	
	Subtotal, costs farmers					408.312
Total costs, alternative II						909.872

APPENDIX VI. COSTS ADDITIONAL PUMPS*

Investment costs, pumps (Rp'000,000)

Unit costs	
price pump on site	16.9
installation, ancillary works	1.6
total initial investment	18.5
rest value (10% price pump)**	1.7
total reinvestment**	16.8
Number of pumps	30
Total costs	
initial investment	555
reinvestment**	504

** after 10,000 operating hours.

Investments in pumping stations, viz foundations, stilling basin, and other auxiliary provisions are Rp 12 million per station, hence a total Rp 180 million is required. The total initial investments of Rp 735 million are augmented by 10% contingencies, bringing the initial outlay for the technical infrastructure for irrigation to Rp 809 million.

Hourly operation costs, pumps

Unit costs, (Rp/hour/pump)	
fuel, Rp 250/litre	3,000
lubricants, 40% fuel costs	1,200
maintenance and repairs, 50% of reinvestment	840
total hourly operation costs	5,040
Number of pumps	30
Total hourly operation costs, Rp/hour	151,200

The annual costs of the 30 pumps, operating an average of 670 hours, are Rp 101 million.

The costs of organization comprise an element of investment for a workshop, buildings for staff and transport equipment. These costs include the indivisible elements of direction and management, and hence are not entirely proportional to the area irrigated. A small area like Barambai will require higher investments than a much larger area like Karang Agung. Therefore, organizational costs are estimated at 20% of those incurred in Karang Agung. They have been corrected for inflation from end-1981 and are rounded to Rp 140 million. Operational costs are Rp 33 million per year, and comprise salaries for staff, upkeep of buildings and operation and maintenance for transport.

* see Nedeco-Euroconsult, 1981

APPENDIX VII. ECONOMIC PRICES

The economic prices are expressed in US $ per tonne, in constant 1983-prices. They are quoted from World Bank, Commodities & Export Projections Div. revision, July 1983.

commodity	Rp, year		
	1985	1990	1995
rice	329	429	422
palm oil	547	588	586
coconut oil	624	703	694
soya beans	292	343	340
copra	451	511	500
phosphate rock	45	51	51
urea	193	268	278
TSP	158	197	197

Economic farm-gate prices of the main inputs and outputs, relating to year 1990 but expressed in constant 1983-prices, were assessed using these prices.

Item	Rp
Rice (tonnes)	
Export price, Thai 5% broken f.o.b. Bangkok	429
Quality adjustment a)	343
Freight and insurance	25
Economic price (import parity)	368
Conversion to Rp b)	360,800
Transport costs from project to harbour	15,000
Value at mill after milling	345,800
Processing, handling and marketing charges (14%)	42,500
Value at mill before milling	303,300
Conversion to paddy (65%)	197,200
Transport from farm to mill	1,500
Economic farm-gate per tonne paddy	195,700
Economic farm-gate price Rp/kg	196
Financial farm-gate price Rp/kg f)	145

Item		Rp
Soybean (tonnes)		
Export price, c.i.f. Rotterdam		343
Freight and insurance	c)	24
Economic price (import parity)		367
Conversion to Rp	b)	359,700
Transport costs from project to harbour		15,000
Marketing charges, storage etc. (10%)		31,300
Transport costs within project area		1,500
Economic farm-gate price per tonne soybean		311,900
Economic farm-gate price, Rp/kg		312
Financial farm-gate price Rp/kg	f)	280
Coconut		
Export price copra-oil European market		703
Freight and insurance	d)	66
Economic price (import parity)		769
Conversion to Rp	b)	753,600
Transport costs to harbour		10,000
Value at oil factory after extraction		743,700
Processing, handling and marketing charges (24%)		144,000
Conversion rate (54%)		599,700
Value at oil factory before extraction		323,800
Transport to processing unit		25,000
Economic farm-gate price per tonne copra		298,800
Economic farm-gate price, Rp/kg		299
Economic farm-gate price per nut	e)	60
Financial farm-gate price per nut		50

Source: World Bank Commodity Price Forecasts.

Note : a) Assumed output quality is 80% of high quality.
b) Price are converted at the official exchange rate of Rp 980 = US$ 1.00 (September 1983).
c) Freight and insurance US Gulf port to Jakarta (US $ 50/tonne cif) minus freight and insurance US Gulf to Europe (US $ 27/tonne cif) plus US $ 1/tonne for unloading and handling.
d) Freight and insurance Philippines to Europe (US $ 95/tonne) minus freight and insurance Philippines to Indonesia (US $ 29/tonne).
e) Conversion of nuts per kg copra.
Coconuts are presently sold at a premium as fresh fruit. As more and more coconut groves come on stream the price will lower and settle on the price of coconuts sold as copra.
f) Source: instruksi presiden RI 14/1982.

Item	Rp
Urea - 46% N (tonnes)	
World export price f.o.b Europe, US $	268
Palembang - US $ 22 a)	246
Handling, distribution and storage charges	25
Economic farm-gate price per tonne	271
Economic farm-gate price, Rp/kg c)	266
Financial farm-gate price	90
TSP - 46% P_2O_5 (tonnes)	197
World export price f.o.b. Florida	233
Handling, distribution and storage charges	25
Economic farm-gate price per tonne	258
Economic farm-gate price, Rp/kg c)	253
Financial farm-gate price	90
Insecticides (litres)	
Economic farm-gate price US $	13
Economic farm-gate price c) Rp	7,200
Financial farm-gate prices	1,500
Rodenticides - (kg) Klerat RMB	
Economic farm-gate price US $	8
Economic farm-gate price Rp	2,400
Financial farm-gate price	500

Source: World Bank Commodity Price Forecasts

Notes :
a) Indonesia is assumed to be a net exporter of urea. Transport cost to the point of price quotation (Europe) have been deducted (US $ 22/ton).
b) Indonesia will remain an importer of TSP. (A transport premium of US $ 36/tonne has been added).
c) Official exchange rate of 1 US $ = Rp 980. (September 1983).