THE REPUBLIC OF SIERRA LEONE

THE FEASIBILITY STUDY REPORT ON THE RHOMBE SWAMP AGRICULTURAL DEVELOPMENT PROJECT

MAIN REPORT

SEPTEMBER, 1983

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

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PREFACE

In responce to a request of the Government of the Republic of Sierra Leone, the Government of Japan agreed to conduct a feasibility study on the Rhombe Swamp Agricultural Development Project, and entrusted the study to the Japan International Cooperation Agency (JICA).

The JICA sent to Sierra Leone a survey team, headed by Prof. S. Kanatsu, which had discussions with the officials concerned of the Government of Sierra Leone and conducted a rainy-season survey from August to October 1982 and a dry-season survey from November 1982 to January 1983.

After the team returned to Japan, further studies were made and the present report has been prepared.

I hope this report will be useful for the development of the Project and contribute to the promotion of friendly relationship between our two countries.

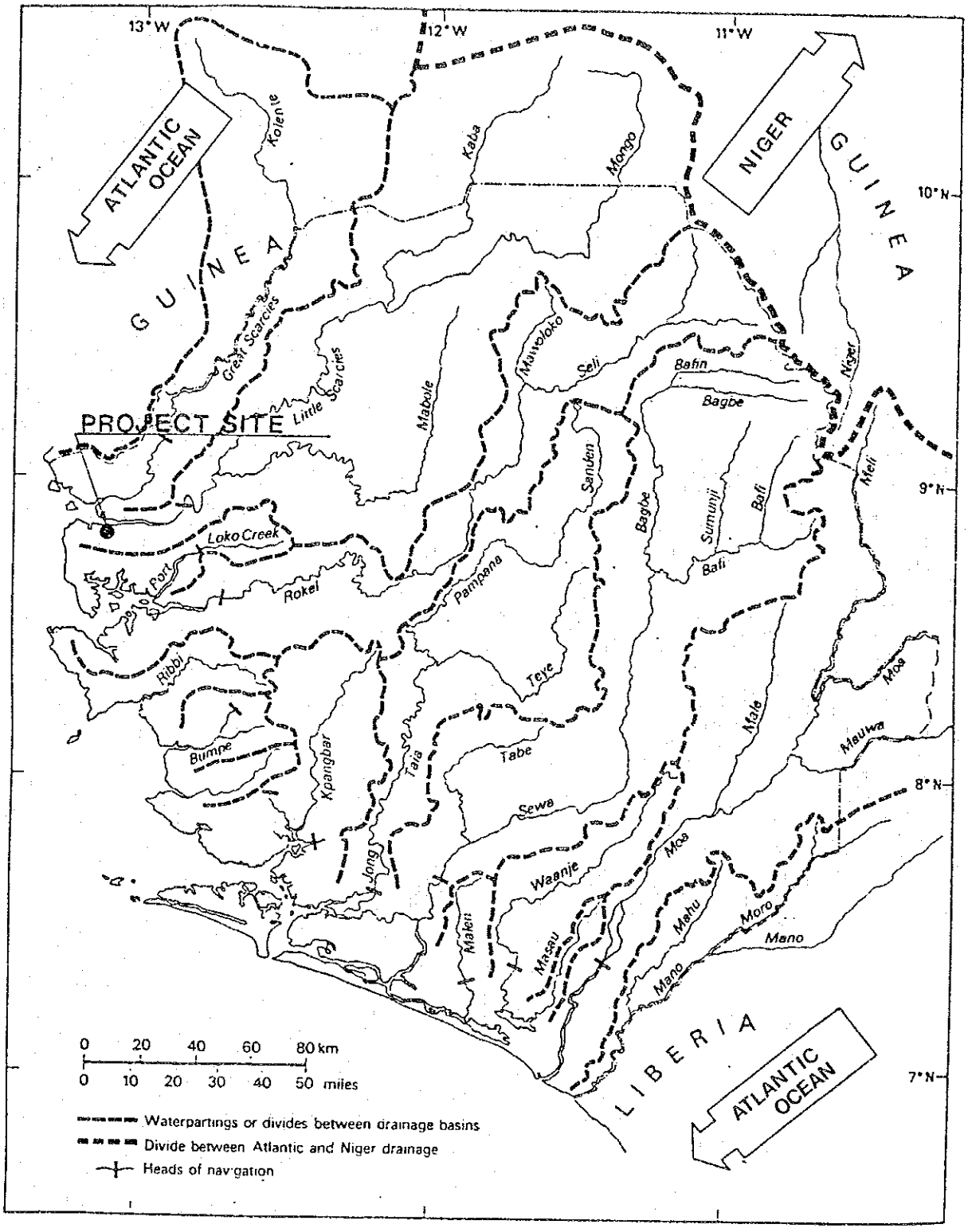
I wish to express my deep appreciation to the officials concerned of the Government of the Republic of Sierra Leone for their close cooperation extended to the Japanese team.

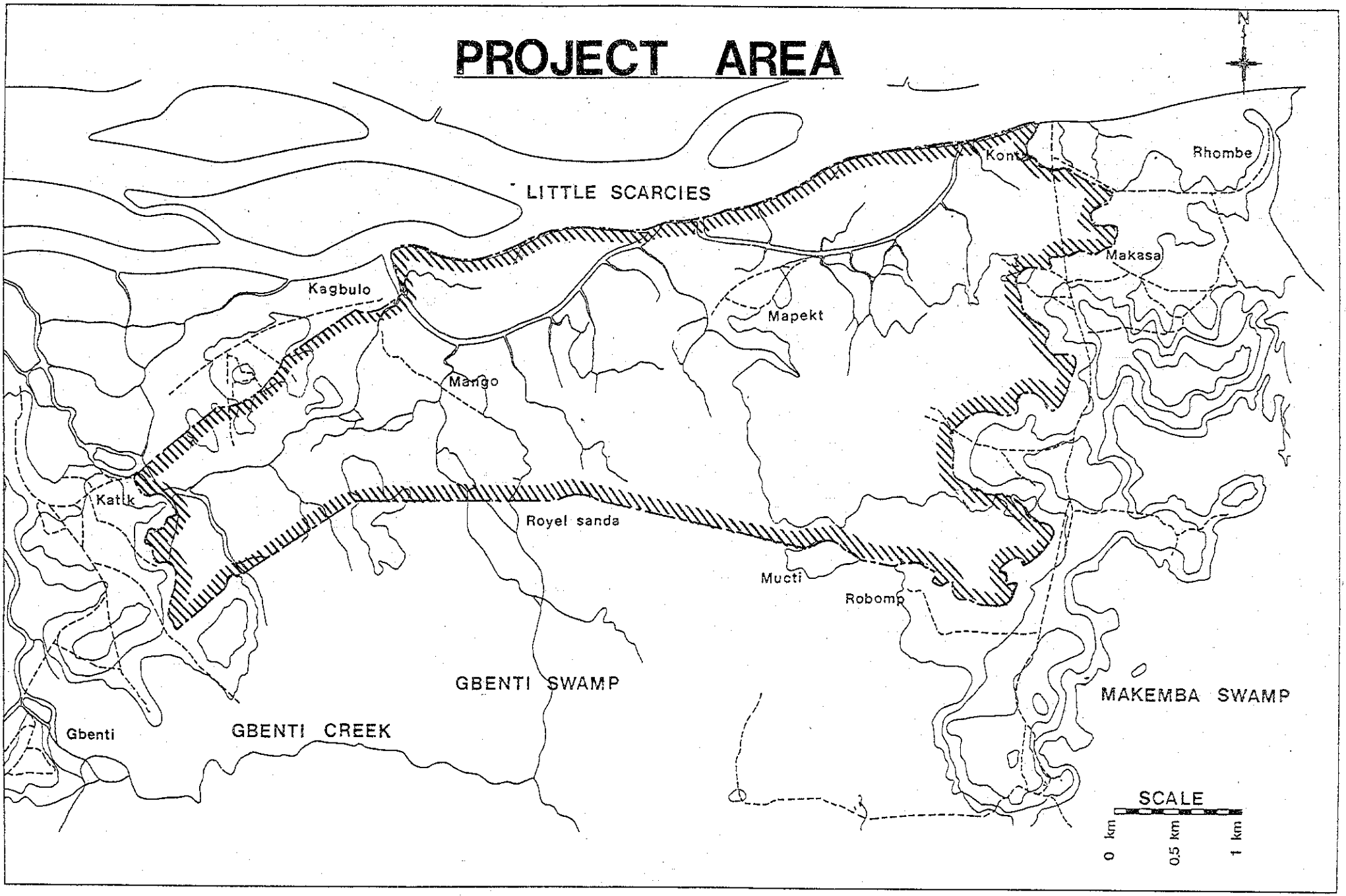
September 1983

Keisuke Arita

Keisuke ARITA
President
Japan International Cooperation Agency

LOCATION MAP




PROJECT AREA
N
LITTLE SCARCIES
Kontk
Rhombe
Makasa
Kagbulo
Mapekt
Mango
Katik
Royel sanda
Mucti
Robomp
GBENTI SWAMP
MAKEMBA SWAMP
Gbenti
GBENTI CREEK
SCALE
0 km
0.5 km
1 km

SUMMARY and RECOMMENDATION

SUMMARY AND RECOMMENDATION

Introduction

1. This draft final report embodies the result of survey conducted during the wet season from August 1982 to October 1982 and the dry season from November 1982 to January 1983 on Rhombe Swamp Agricultural Development Project, followed by office studies in Tokyo.

2. The object of the feasibility study is to formulate the agricultural development plan in Gbenti North (approx. 1600 ha) as the first phase project in the overall Rhombe Swamp Agricultural Development.

Agriculture

3. With the traditional farming method, cropping, sowing, nursery, and transplanting stages take 4 months with the help of the tidal water. The present yield, approximately 1.9 t/ha , is admirably achieved under natural conditions and without using fertilizer.

4. The paddy field area is projected to be enlarged to 1.5 times and double cropping will then increase this figure to 3 times. It is also planned to increase the yield per ha to 3.5 t in each season (7 t a year), by correctly carrying out the planned water management, fertilizer application, introduction of new varieties of seed, etc.

5. When the project's basic infrastructure has been completed, then attention must be given to ensuring that the administrative programmes, i.e. extension and mechanizing offices, seed centre and farmers organization etc., are successfully carried out.

6. The extension services include an indispensable credit system for rice production, as is extended to other National Projects, which will naturally have a highly encouraging effect on the farmers.

Soil

7. The classified Thionic Fluvisols and other soil groups, on drying out, may become acidic and infertile. So, enough irrigation water is required to ensure the soil is maintained in a good condition.

Water Quality

8. Salt water intrudes into the Little Scarcies river as the dry season progresses. The type of salt water intrusion is a "strong mixed type". The salt water intrusion reaches maximum at high tide and minimum at low tide. During the study, the limit of salt water intrusion which had a high concentration grade above 2,000 micro.mho/cm was not reached in the project area. It is estimated that this limit will not be reached upstream at Konta until the end of February.

9. Water quality of Makemba swamp is highly acidic due to humic acid. The electric conductivity is very low and the swamp water is almost pure.

10. The project area consists of swamp deposits and Bullom series. The hydrogeologically important formation is sandy layers. Due to the almost total absence of sandy layers in the project area, it is therefore concluded that the groundwater development is not recommended.

Climate and Hydrology

11. The hydrology of the project area is complex, being dominated by distinct wet and dry seasons, typical of this coast, and the interaction between the flow in the Little Scarcies, the tides, and the flooded rainfall water. The hydrological studies carried out during the investigation were aimed at determining the effect and magnitude of these factors.

12. Basically, one half of the year is very wet and the other half very dry, with a mean annual precipitation of about 3,000 mm. More than 95% of the annual rainfall in the project area is concentrated in an average wet season, extending from about May to November, and about 60% in the three months July, August and September.

13. The river flow varies in the extreme, from a low of about 6 m^3/sec in April to a high of about 2,400 m^3/sec in September. During high river flows and at times of spring tides, flooding of the riverine lands and the swamps occurs. Tidal effect is greater during the dry season, coinciding with the low river flows. The effect of a spring tide can be felt as far upstream as Mange except for the period of high flows.

Road

14. All existing roads in the site are footpaths which are flooded during the wet season. They are not motorable even in the dry season, so that this area is almost totally isolated with respect to transportation by land. Therefore all agricultural products are transported by boat in and around the project area, due to the present inaccesibility of the main road from the site.

Taking into consideration that development will involve the increasing transportation of products which will

require the use of trucks, it is proposed to construct a trunk road connecting Gbenti and Konta.

15. After development of the overall project, this road will be connected to the national Port Loko - Lungi road via Robis, thereby ideally accomplishing the total road network. The proposed polder bunds will also serve perfectly as branch roads.

Engineering Rerquiements

16. For the improvement of existing critical conditions affecting the agricultural production, several alternatives have been studied in detail.

I. Fundamentals of the development plan from the engineering point of view are as follows:

(1) Flood protection

(2) Drainage of excess rainfall

(3) Prevention of salt water intrusion during the dry season

(4) Security of steady water resources

Two crops of rice can be raised in the area when these conditions are fulfilled.

Fundamentals for the fulfillment of these conditions are respectively, as follows:

(1) Construction of polder

(2) and (3)
Miter gates and irrigation pumps, the latter possibly serving as drainage aids in the event of an emergency

(4) Construction of water supply channel and intake facilities

II. Drainage

Full drainage control is essential to any development, and will necessitate a network of drainage channels to all parts of the project area. But in this development plan, no main drain channels are proposed, due to the existing creek network. It is advantageous to utilize existing creeks as main drain channels.

Drain from polders is conducted through proposed miter gates during the low tide level.

Flooding or salt water is prevented from entering into the polders by same miter gates.

III. Irrigation

Irrigation is required for about six months of the year for double-cropping system and, although not essential during the wet season, would give full water control and therefore greater crop yields. Three basic sources of supply have been considered; the Little Scarcies river, Makemba North Swamp and groundwater.

Alternatives Considered

17. Several development alternatives were considered to meet the engineering requirements. They can be classified into how and where to get water, how to distribute it and how to consolidate this site.

They are classified as follows:

(1) Site Development Plan

I. Small scale polder plan

II. Large scale polder plan

(2) Method of Intake and Supply Water

I. Intake and distribution without pumping

- ° Intake at Sirian
- ° Intake at Mange
- ° Intake at Makane

II. Pumping at Sirian and supply without pumping

III. Pumping at Rhombe and supply without pumping

IV. Diversion at Rhombe and distribution by small pump at each polder

V. Water of Makemba Swamp

VI. Groundwater

18. Regarding the method of development of the area, polder construction seems indispensable. After consideration of economical and technical factors, the small scale polder plan was chosen as best suited to the local conditions.

As for water resources, method of intake and supply, Plan III and IV were discovered as feasible in technical and approximate economical aspects; these two plans involve, respectively, pumping up at Rhombe and supply by gravity and diverting at Rhombe and supply by pumping at each polder. Necessary facilities for both plans are listed as follows.

Necessary Facilities for Plan III and IV

	Plan III	Plan IV
Irrigation area	1,300 ha	1,300 ha
Water resource & location of intake	The Little Scarcies river at Rhombe	The Little Scarcies river at Rhombe
Method of intake	Pumping	Diverting
Method of supply	Conventional canalisation	Pumping at each polder
Necessary Facilities	Irrigation pump station 1 Q=1.2m^3/sx3H=5.6m Drainage pump station, Q=7m^3/minx3H=3.5m 16 Convey channel (banking) 8,200 m Convey channel (cut) 2,000 m Siphon Dimension 2mx1.5m 4 Siphon Dimension ϕ800 4 Bund W=3.0m 38.9km Land consolidation 1,300 ha Trunk road W=6.0m 12.9km	Miter gate (Rhombe, Makasa) 2 Pump station for irrigation & drainage 16 each 7m^3/minx2H=3.5m 16 Water supply channel (cut) 13,250 m Siphon Dimension 2mx1.5m 4 Siphon Dimension ϕ800 4 Bund W=3.0m 38.9km Land consolidation 1,300 ha Trunk road W=6.0m 12.9km

Investment cost and M/O cost for these two plans are as follows:

Comparison of Investment Cost and M/O Cost

Unit: Le.1,000

Item	Plan III	Plan IV
1. Pump Station	3,257	1,659
2. Water Supply Channel	5,982	1,849
3. Road and Bridges	4,386	4,386
4. Bund and Land Consolidation	7,092	7,029
5. Miter Gate	-	62
6. Others	13,171	13,325
Total	33,888	28,310
M/O Cost for Project Life	1,957	1,789

Recommended Plan

19. From the above, it can be seen that the Plan IV of diverting from the Little Scarcies river at Rhombe entails the lowest capital and operating cost.

Project Cost

20. Investment cost of the plan IV is estimated as follows.

Investment Cost of Project

Work Item	F/C	L/C	Total
1. Preparatory Work	-	20,000	20,000
2. Water Supply Channel	Le. 731,000	Le. 465,000	Le. 1,196,000
3. Bund	Le. 2,278,000	Le. 978,000	Le. 3,256,000
4. Siphon	Le. 443,000	Le. 210,000	Le. 653,000
5. Miter Gate	Le. 54,000	Le. 8,000	Le. 62,000
6. Land Consolidation	Le. 3,393,000	Le. 194,000	Le. 3,587,000
7. Pump Station	Le. 1,577,000	Le. 82,000	Le. 1,659,000
8. Creek Improvement	Le. 181,000	Le. 5,000	Le. 186,000
9. Trunk Road and Bridges	Le. 2,451,000	Le. 329,000	Le. 2,780,000
10. Farm Road Bridges	Le. 1,538,000	Le. 68,000	Le. 1,606,000
Sub-Total	Le.12,646,000 (US$5,269,166)	Le, 2,359,000 (US$982,916)	Le.15,005,000 (US$6,252,082)
11. Project Facilities	-	Le. 197,000	Le. 197,000
12. Administration Cost	-	Le. 277,000	Le. 277,000
13. Consulting Services	Le. 3,641,000	Le. 117,000	Le. 3,758,000
14. Overseas Training	Le. 106,000	-	Le. 106,000
Sub-Total	Le.16,393,000 (US$6,830,415)	Le. 2,950,000 (US$1,229,165)	Le.19,343,000 (US$8,059,580)
15. Physical Contingency	Le. 1,639,000	Le. 295,000	Le. 1,934,000
Total	Le.18,032,000 (US$7,513,332)	Le. 3,245,000 (US$1,352,081)	Le.21,277,000 (US$8,865,413)
16. Price Escalation	Le. 5,483,000	Le. 1,550,000	Le. 7,033,000
Grand Total	Le.23,515,000 (US$9,798,000)	Le. 4,795,000 (US$1,998,000)	Le.28,310,000 (US$11,796,000)

The project Executing Agency

21. The Ministry of Agriculture and Forestry (MAF) should be the executing agency for project implementation. The organizational arrangement should be designed to integrate with the existing administrative structures of the MAF and to further strengthen it.

Overall coordination and management of project implementation will rest with the project manager who is directly responsible to the permanent secretary of the MAF. A project coordinating committee should be formed if there is a consensus that such a committee will serve to facilitate coordination at the inter-ministerial level.

Project Appraisal

22. Present and after-project land use plan and production of rice are shown below.

Land Use and Rice Cropping

(ha) Classification	A at present(%)	B with Project(%)	B/A Index
Paddy Field	1,208 (76)	1,287 (81)	107
Cropping Ratio	70%	200%	250
Rice Crop Area	846	2,574	304
Others	377 (24)	298 (19)	79
Total	1,585 (100)	1,585 (100)	100

Annual Paddy Rice Production

	A at present(%)	B with Project(%)	B/A Index
Yield per ha (t)	1.9	3.5	184
Total Production (t)	1,607	9,009	561
*Unit Price (Le./t)	368	368	0
Total (Le.1,000)	591	3,315	561

* 1 bu. (27.2 kg) = Le.10 in local price

23. The Economic Internal Rate of Return is 11.4%. About 640 small farmers of 2.0 ha holding with about 7,000 members of household would get benefit directly and indirectly from the project in terms of welfare as well as income.

Relations to the Overall Plan

24. The development schemes used for this site can be applied to the overall project. The Gbenti North Development should form a good example for the development of the entire area.

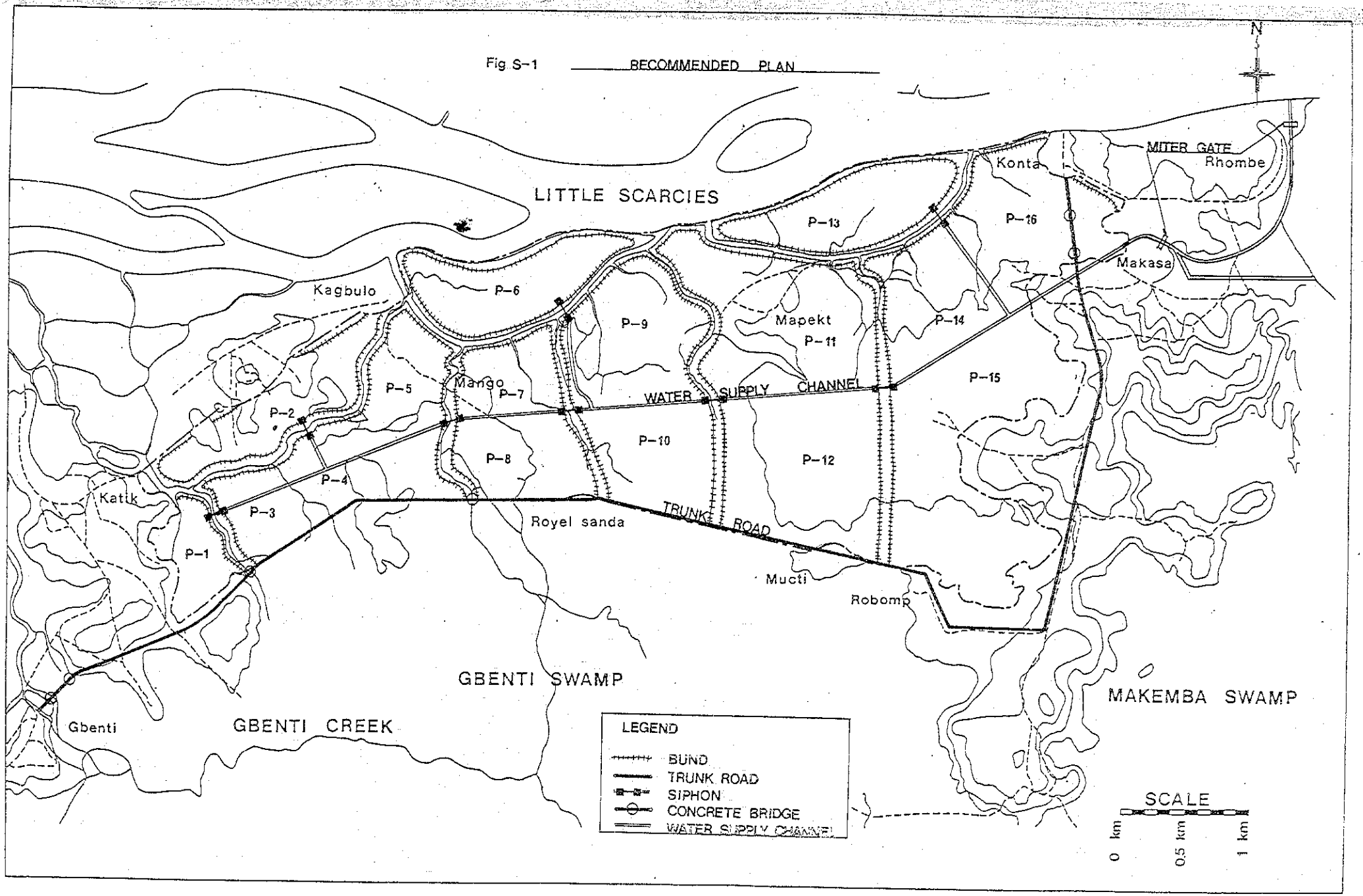
25. In the Gbenti North Development, which can be said to be a scaled-down development of the overall project, not one facility shall be constructed that will prove useless for adoption in later plans.

26. It can also be said that the traffic network system in the region will be ideally completed when the roads planned in the Gbenti North Development are connected with the roads to be planned in the overall project so that Konta, Mane and Robis are connected with the national highway of Port Loko - Lungi Line.

Conclusion

27. As a result of the feasibility study, it can be concluded that this development Plan IV is feasible from both the economical and technical point of view and also suitably appropriate from the point of view of local conditions.

Fig. S-1 RECOMMENDED PLAN



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DRAWING

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ABBREVIATION

(Length)

mm	Millimetre
cm	Centimetre
m	Metre
km	Kilometre

(Area)

m^2	Square Metre
km^2	Square Kilometre
ha	Hectare

(Weight)

mg	Milligram
kg	Kilogram
t	Metric Ton

(Volume)

m^3	Cubic Metre
1; lit.	Liter

(Currency)

Le.	Leone
US$	US Dollar
¥	Yen

(Derived)

m/s, m/sec.	Metre per second
m^3/s, $m^3/sec.$	Cubic metre per second
$m^3/min.$	Cubic metre per minute
t/ha	Metric ton per hectare

(Other Measurement)

hr	Hours
%	Percentage
ϕ	Diameter
°C	Centigrade temperature
HP	Horse Power
m.eq.	Milligram equivalent
N	Nitrogene
P	Phosphorus
K	Potassium
pF	Log H_2O cm
ppm	Parts per million = mg/lit.
pH	Potential hydrogen
μS/cm	Micro semence per centimetre
μ.mho/cm	Micro.mho per centimetre
M.D.	Man days
EIRR	Economic Internal Rate of Return

FAO	Food and Agriculture Organization
AFDB	African Development Bank
IBRD	International Bank for Reconstruction and Development
IMF	International Monetary Fund
MAF	Ministry of Agriculture and Forestry
WARDA	West Africa Rice Development Association
IDA	International Development Association
Rokupur R.R.S.	Rice Research Station
IADP	Integrated Agricultural Development Project
A.O.	Agriculture Office
SLPMB	Sierra Leone Produce Marketing Board

CONVERSION

1 mile	= 1.61 km
1 ft	= 30.48 cm
1 inch	= 2.54 cm
1 acre	= 0.40 ha
1 galon	= 4.55 l
1 ounce	= 28.35 g
1 pound	= 0.45 kg
1 bushel	= 36.37 l = 27.2 kg
1 cwt (bag)	= 50.80 kg
1 US$	= Le. 2.40 = ¥235
1 cusec	= 0.028 m^3/sec
1 °C	= 5/9 (°F-32)
1 knot	= 0.515 m/sec = 1.85 km/hr
	= 44.5 km/day

MEMBER LIST OF SIERRA LEONE TEAM

Assignment	Name	Position
Leader	Mr. J.D. SANDY	Permanent Secretary of M.A.F.
Chief Coordinator	Mr. C.B. SESAY	Chief Agriculturist of M.A.F.
Project Coordinator	Mr. A.A.W. JALLOH	Director of Land and Water Development DIV. M.A.F.
Cooperation Policy	Dr. L. KUMALA	Assistant Secretary, Technical Cooperation Div., M.A.F.
Chief Counterpart/ Irrigation and Drainage	Mr. J.C. HAMELBERG	Head of Water Resources Section, M.A.F.
Counterpart/ Geology and Hydrology	Mr. A. WILLIAMS	Staff of Water Resources Section LWDD, M.A.F.
Counterpart/ Meteorology	Mr. H. TARAWALEY	-ditto-
Counterpart/Water Chemistry	Miss CONTEH	-ditto-
Counterpart/Soil Science	Mr. M. SESAY	Staff of Soil Section LWDD, M.A.F.
Counterpart/ Agro-economics	Mr. DAN KOROMA	Staff of Agro-economic Section LWDD, M.A.F.
Counterpart/ Agronomy	Mrs. HAWA WURIE	Staff of Agronomy Section, LWDD, M.A.F.
Counterpart/ Operations Coordinator	Mr. A.S. BUNDU	Administrative Officer LWDD, M.A.F.

MEMBER LIST OF SUPERVISORY COMMITTEE

Assignment	Name	Position
Chairman	Mr. K. MIYAMOTO	Head, Design Div., Chugoku-Shikoku Regional Administration Office, Ministry of Agriculture, Forestry & Fisheries. (MAFF)
Irrigation & Drainage	Mr. Y. KITAMURA	Chief, System Development Div., Land Improvement Engineering Service Centre, Tohoku Regional Agricultural Administration Office, MAFF.
Swamp Development	Mr. H. SHIMONOMURA	Assistant Director, Project Planning Div. Agricultural Structure Improvement Bureau, MAFF.
Agronomist	Mr. Y. SUZUKI	Land Improvement Environment Officer, Resources Div., Tokai Regional Agricultural Administration Office, MAFF.
Agro Economist	Mr. I. HIRAYAMA	Assistant Head, Regional Planning Div., Hokuriku Regional Agricultural Administration Office, MAFF.

FEASIBILITY STUDY TEAM MEMBER LIST

Speciality	Name	In charge of
Team Leader	Prof. S. KANATSU	Planning, Coordination and Management.
Economics (Deputy leader)	Mr. F. ONODA	Economic and Financial Evaluation
Irrigation and Drainage	Mr. Y. YAMADA	Planning of Irrigation and Drainage System, Land Consolidation.
Hydro-geology	Mr. Y. UNE	Water Quality Survey, Geological Survey and Ground Water.
Hydrology	Mr. I. MAKUTA	Hydrology and Meteorology.
Soil Science	Mr. H. KUSANO	Soil Survey and Soil Improvement.
Agronomy	Mr. M. SHIBATA	Farm Management and Cultivation.
Irrigation Drainage	Mr. T. KURAUCHI	Design of Structure, Top-survey and Cost Estimation.

CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

This final report embodies the result of surveys conducted during the wet season from August 1982 to October 1982 and the dry season from November 1982 to January 1983 on Rhombe Swamp Agricultural Development Project, followed by office studies in Tokyo. As a result of consultation on the draft final report with Government Agencies and authorities concerned of Sierra Leone and Japan, the final report was completed in September, 1983.

1-1 The Background

In Sierra Leone, the national economy has mainly depended upon export of mineral resources such as diamonds, iron ore and bauxite and of agricultural products such as coffee and cacao after independence from Great Britain.

Agricultural products, especially rice production have recently played an increasingly important role in the national economy with the decrease of income from mineral resources.

Current development plans in the country are directed towards improving agriculture and raising farmers' income. Improved methods of farming would result in a surplus of food for sale, especially of rice, thus ending any need to import rice.

Sierra Leone is a major rice producing country in West Africa, rice being one of the staple foods, with an annual consumption of about 100 kilograms per capita. The country is nearly self-sufficient, importing only about 10% of the present domestic consumption which exceeds 300,000 metric tons.

The agriculture of the country is highly diversified, but rice accounts for about half of all agricultural product in value. It plays a major role both in subsistence agriculture and in commercial agriculture.

Swamp rice accounts for just over half of the total rice production, the remainder coming from upland areas. Of the swamp rice, about one quarter comes from inland swamps and the rest from tidal and riverine areas.

One hundred years ago, little swamp rice was grown in Sierra Leone, except in the area along the Great and Little Scarcies rivers, where some Temne cultivators had already been clearing mangrove for paddy cultivation.

Rhombe Swamp has attracted attention as a potential area for agricultural development, particularly for the growing of rice. The study on Agricultural Development of Rhombe Swamp was made several times, i.e., British West African Rice Mission between 1947 and 1948, and MRT consulting Engineers Ltd. between 1970 and 1972.

However, implementation of the project has not been carried out because of high construction costs.

In 1980, the government of Sierra Leone requested the technical cooperation of the Government of Japan for a feasibility study on the Rhombe Swamp Agricultural Development Project. The government of Japan has decided to undertake a feasibility study on the Rhombe Swamp Agricultural Development Project as part of the technical cooperation programme of the government of Japan in 1982. In August and November, 1982, the Feasibility Study Team was dispatched by Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of the technical cooperation programme of the government of Japan in collaboration

with the Ministry of Agriculture and Forestry and other authorities concerned of Sierra Leone.

1-2 Scope of Study and Its Content

The object of the feasibility study is to formulate the agricultural development plan in Gbenti North (Approx. 1,600 ha) as the first phase project in the overall Rhombe Swamp Agricultural Development Project.

This feasibility study has to be conducted on the basis of the scope of works for the Feasibility Study on Rhombe Swamp Agricultural Development Project signed between the Leader of Sierra Leone's Team for Feasibility Study on Rhombe Swamp Agricultural Development Project and the Leader of the Scope of Works Team for Feasibility Study on Rhombe Swamp Agricultural Developmetn Project dispatched by JICA on July 13, 1982.

A scope of works for the feasibility study is prepared on the basis of the results obtained from the preliminary survey (February 2 to 10, 1981) for the project, describing the items to be studied, implementation schedule, and services and facilities to be provided by the government for the smooth execution of the study.

The study is carried out in two stages.

(1) Field work in Sierra Leone
(2) Home office work in Japan

Each work consists of the following items.

Field Work

(1) Collection of existing data

(2) Field survey and analysis

(3) Complementary survey for the review of the Rhombe Swamp Engineering Feasibility Study (MRT Consulting Engineers Ltd. 1972)

Home Office Work

(1) Formulation of the overall agricultural development project for the project area Gbenti North.

(2) Pre-design of the major structures in the project.

(3) Preparation of implementation schedule of the project.

(4) Estimation of the cost and benefit of the project.

(5) Formulation of maintenance and operation plan for the main structures in the project.

(6) Economic evaluation

(7) Review of the MRT Consulting Engineers Ltd. report.

CHAPTER 2 THE GENERAL BACKGROUND

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2-1 Geographical Description

The Republic of Sierra Leone, with an area of about 73,326 km^2, is one of some 15 countries of which West Africa is made up. The area is within a circle of 177 km radius, with the township of Yele (approx. 8°25'N, 11°51'W) being its centre. Its southwestern boundary forms the coast line of 340 km in length, which faces the Atlantic; the southeastern part forms an international boundary with the Republic of Liberia, and the rest with the Republic of Guinea.

Internally, the country is divided into 3 provinces, namely East, South, North and Western Area; the provinces are further sub-divided into 12 districts for administrative convenience. Each district consists of many chiefdoms, which have traditional backgrounds, and which are divided into sections and further into towns and villages.

Physically, there are five regions in Sierra Leone, namely Coastal Plain, Freetown Peninsula, Interior Lowlands, Interior Plateau and the small part of Futa-Jalon Plateau. There are Escarpment Zones in transitional areas between lowlands and plateau; Boli-lands in the Interior Lowlands and two basins, Kono & Moa, in the interior plateau (see Appendix Chapter 1, Fig. 1-1-1).

Sierra Leone has a monsoonal climate with two distinctly divided seasons; wet season (usually May to October) and the dry season (November to April). The wet season continues for nine months in the extreme east and six in the north.

The mean annual rainfall is over 3,000 mm in most of the places along the coast line. Freetown peninsula

and the central part of the escarpment zone gets more than 5,000 mm. Generally the further away from the coast, the less the rainfall, and in the utmost north, the mean annual rainfall becomes under 2,000 mm. The mean relative humidity at 3:00 p.m. in the wet season is over 80% from the coast to the escarpment and under 70% in the north; whereas in the dry season, the relative humidity is over 60% along the coast and below 30% in the north. The annual mean temperature is around 27°C, and the monthly means do not vary much. But the days are generally cool in August when the wet season is at its height and the nights are generally cool in January when the harmattan wind gains ground.

There are seven major river systems in Sierra Leone, i.e., Great Scarcies, Little Scarcies, Rokel, Jong, Sewa, Moa and Mano, and all of them flow into the Atlantic with the general direction of North east-south west at their lower reaches, but the direction tends to be north-south in their upper reaches.

One of the main characteristics of the rivers of Sierra Leone is the big difference of their discharge in dry and wet seasons. The catchment areas of the two rivers in the west, the Great Scarcies and the Little Scarcies and of two rivers in the east, the Moa and the Mano extend themselves beyond the international boundaries between Guinea and Liberia.

A part of the Mangrove swamps along the coast and the lower reaches of the rivers, and a part of the grass-lands in the Boli-lands, are now used for rice cultivation.

Most of the interior lowlands and plateau which once were covered by the tropical rain forest have been replaced by the "farming bushes" where oil-palms are grown and by the "derived savannas" where the elephant grasses are predominantly grown. Along the north to

north-east border, the woodland savanna is spreading where herdsmen are raising their cattle.

In most of the inland area, soils are developed on the Pre-Cambrian Rocks except some alluvial soils in Boliland and on the river terrace. The soils found in the coastal region mainly consist of four categories, i.e., Mangrove swamp soils, recent alluvial soils, soils developed on sedimentary rocks and the sandy soils.

2-2 National Economy

2-2-1 Population

The total population shown in the previous census year of 1974 is 2,729,479. The annual population growth rate between 1963 and 1974 was around 2.1%. If this trend has continued, the present population is around 3.2 million with the average population density around 45 per km^2 (See Appendix Chapter 2 for the different estimates of the population).

Around 80% of the people are still living in rural areas and the primary sector offers about 70% of the total employment opportunity, yet the rural exodus is noticeable.

The growth rate of the employment increase was three-fifth of the labour force increase, so the unemployment rate has increased, especially in the case of women, and the unemployment rate is now alarmingly high.

As more than 40% of the total population were under 14 years of age in 1974, the more years that pass, the more difficult it becomes to find a job.

The background breakdown figures are shown in the Appendix Chapter 1, Table 1-1-1 to 1-1-4.

2-2-2 Production

In 1979/1980 the GDP at factor cost by kind of economic activity at current prices was 1,054.3 million Leone, with an average annual growth rate of 17.2% since 1975/1976 (2.6% in real terms).

Production from the primary industries contributes the most to the GDP. Then, transport, storage and communication sectors come second and wholesales, retail trade, hotels and restaurants third. At constant prices of 1972/1973, the primary industries account for just below 40% of the GNP in 1970/1980; the secondary sector about 11%, the tertiary about 40%.

With the decline in diamond production, even after an upward adjustment by including an estimated amount of smuggled diamonds in the figure, the mining & quarrying sector comes behind the government services sector and the financial sector. Its share of the GDP decreased to about 8% in 1979/1980 compared to about 60% of 1975/1976's share. As Maranpa Iron Ore Mine has resumed its operation from December 1982, annual export of more than a million tons of concentrated ore will soon contribute both to the GDP and to the balance of payment.

Per capita National Income in 1979/1980 was 295.9 Leones. Some detailed figures are shown in Appendix Chapter 1, Table 1-1-5 and 1-1-6.

2-2-3 Balance of Payment

A summary of the balance of payment in the calendar year of 1980 is shown in Table 2-2-1.

Table 2-2-1 Balance of Payment (Summary)

(Unit: 10^6 Leones)

Merchandise	-181.0	
Freight + Insurance	- 42.0	
Transport + Travel	+ 21.0	
Investment	- 23.0	
Other Services - Private	- 14.0	
Government	- 8.0	
Goods and Services		-247.0
Transfer	+ 55.0	
Current A/C		-192.0
Private Long Term	- 6.6	
Private Short Term	+ 29.4	
Government	+106.0	
Current and Capital A/C		- 63.2
Arrears + Refinancing	+ 51.2	
S.D.R.	+ 4.4	
Monetary Institutions	+ 18.0	
Net Unrecorded Item	- 10.9	

(Source: The Bank of Sierra Leone: Economic Review Vol. 15)

The balance of trade has been chronically on the debit side, as has the balance of current accounts.

Diamond (54.1%)*1, Bauxite (7.7%) and Rutile (9.6%) are the major mineral exports and Coffee (14.4%), Cocoa (10.1%) and Palm kernels and its products (2.4%) are the major exports of agricultural products. Most of the prices for these commodities are highly susceptible to changes in the international markets.

In 1981, 83% of total export went to EEC, 15% to USA.

Regarding imports, Machinery and Transport Equipment (25.9%)*2, Manufactured goods (18.6%), Food (17.4%)

*1. Average share in domestic export in 1980 and 1981.

*2. Average share in imports from Jan. 1979 to Sept. 1981.

and Fuels (16.5%) are four main commodity categories. In 1978, 28% of total import came from EEC, 10% from Japan, 7% from U.S.A. and 3% from China. The position of external reserves of the central bank has been deteriorating, reaching the stage where it scarcely covers the value of one month's imports.

Detailed table of Balance of Payment between 1977 and 1980 is given in Appendix Chapter 1, Table 1-1-7.

2-2-4 Government's Revenue and Expenditure

Table 2-2-2 shows the government's revenue and expenditure since 1975/1976.

Table 2-2-2 Government's Revenue and Expenditure

(in million Leone)

	75/76**	76/77	77/78	78/79	70/80	80/81	81/82	82/83
Current Revenue	92.4	112.4	153.8	173.9	195.9	216.7	241.5	248.6
Current Expenditure	101.4	128.8	148.8	168.2	205.9	236.0	272.8	393.4
Balance	-9.0	-16.4	+5.0	+5.7	-10.0	-19.3	-31.3	-144.8

* Extra budgetary expenditure is not included, which reached as much as 84.8 million in 1980/1981.

** A Fiscal Year starts from June.

Source (1975/1976 - 1980/1981): Bank of Sierra Leone, Economic Review Vol. 15

1981/1982 Revised Estimate

1982/1983 (Revised Projection) "West Africa 15 Nov."

There were times when at least some efforts were exerted to keep a surplus in the budget as are shown in the years 1977/1978, 1978/1979, but as a whole, a deficit in current revenue has become institutional.

The government has been, is, and will be taking every step to expand the base of the current revenue. To review the tax and account systems are one thing, for which IBRD, IDA and IMF have been giving assistance, but it is another thing to maintain discipline on daily fiscal procedures, and further it is quite another thing to restructure the national economy.

The development expenditure by sector and by ministry is shown in Table 2-2-3.

The low rate of actual implementation in relation to the fund allocated suggests some operational faults in the administration framework. Especially in the agricultural sector, the rate in 1977/1978 is 18.8% and in 1978/1979 is 19.7%. But since 1979/1980, the rate has been remarkably improved.

The summary of development estimates in the year 1982/1983 is shown in Appendix Chapter 1, Table 1-1-8 and 1-1-9.

The total current deficit and the development expenditure has been filled with borrowing, domestic and external, and grant and commodity aids such as PL 480. Domestic borrowing covers about two-thirds, and external borrowing and grants less than a quarter.

Table 2-2-3 Development Expenditure

(in million Leone)

	75/76	76/77	77/78	78/79	79/80	80/81*1	81/82*2
1. Economic Service	25.85	26.14	8.63	19.06	26.76	55.80	77.32
1.1 Agriculture, Forestry & other natural resources	6.19	7.80	2.82	2.96	8.76	20.81	21.73
1.2 Mining	0.08	0.49	0.41	0.49	0.31	7.79	20.77
1.3 Electricity*3	4.15	9.29	0.09	3.49	2.26	1.28	7.83
1.4 Water	1.57	0.55	0.94	0.96	2.42	5.54	5.41
1.5 Transport & Communication	8.84	4.86	2.11	7.12	5.33	8.74	0.86
1.6 Trade & Industry	-	-	0.02	0.02	-	0.11	0.15
1.7 Others	5.02	3.15	2.24	4.02	7.68	11.53	20.57
2. Social Service	4.32	3.08	3.56	4.89	6.96	9.43	n.a.
3. General Service	8.71	5.22	8.53	11.49*5	66.72*6	7.26	n.a.
Total	38.88	34.44	20.72	35.44	100.44	72.49	94.93
Implementation Rate (%)	55	55	55	55	77	79	75

*1 Preliminary Actual

*2 Revised Estimate

*3 Cooperation Investment of Sierra Leone Electricity Cooperation til 1979/1980 was included in "Electricity".

*4 Expenditure in "Ministry of Development & Economic Planning" had been included in "General Service" till 1979/1980, then in "Others".

*5 Leones 3.3 million for OAU related expenditure is included in this figure.

*6 Leones 64.0 million for OAU related expenditure is included in this figure.

2-2-5 Price Indices

Most of the manufactured goods and some foodstuffs are imported. Even rice and material for locally brewed beer are imported. They are the main factors causing inflationary tendencies.

Table 2-2-4 shows the consumer indices of Freetown and mining area, and the wholesale price index.

The government of Sierra Leone introduced a two-tier exchange system in December 1982 to combat the unofficial exchange market. The real impact on the dominating system in the existing market is, as yet, unknown. As early as Jan. 1983, the government spokesman warned the members of the business communities almost everyday to refrain from taking advantage of the situation either to raise the commodity prices or to hoard.

2-3 Agriculture

2-3-1 Farming in General

Rice is a staple food in Sierra Leone, so wherever natural conditions permit, farmers prefer to grow rice and have developed a variety of paddies to suit the different conditions of nature. Upland rice cultivation and swampland paddy cultivation are the two major different farming systems of Oriza Sativa, a rice which was brought to Sierra Leone several hundred years ago via Guinea.

Indigenous African Rice (Oriza Grabema) has almost disappeared from the cultivation scene because its grains shed easily. Cultivated Area and total production of major crops in 1979/1980 are shown in Table 2-3-1 and farming systems in Sierra Leone are shown in Appendix Chapter 1, Fig. 2-1-1.

(i) Consumer Price Index (1961 = 100)

		All Items		Housing		Food x Drinks	
		Index	Average Annual Increase	Index	Average Annual Increase	Index	Average Annual Increase
Freetown	81	476.2	15.2%	358.9	11.0%	508.5	15.8%
	72	133.4		140.2		135.3	
Mining Area	81	377.4	11.7%	360.8	11.4%	448.1	12.9%
	71	125.1		122.7		133.2	

(ii) Wholesale Price Index (75 = 100)

	All Items		Manufactured Goods		Food x Drinks	
81	327.2	21.7%	391.6	24.3%	215.0	14.1%
76	122.5		132.2		111.3	

Souce: Bank of Sierra Leone, "Economic Review Vol. 15."

Table 2-3-1 Cultivated Area and Production of Major Crops in 1979/1980

	Area in thousand ha	Production in thousand tons
Rice	404.7	547
Cassava	19.0	95
Maize	12.1	12
Ground nuts	15.8	15
Soyhum	6.5	7
Sweet Potato	8.1	21
Cocoa	51.4	14
Coffee	78.5	22
Sugar cane	0.6	27
Others		
Total	647	-
Palm Kernel	-	80

Cattle are reared by the Fulas, who migrated from Fouta Djallon Plateau area of Guinea to Koinadugu and Bombali, Districts of the Northern Province of Sierra Leone, where they do pastoral farming.

There were about 333 thousand cattle in Sierra Leone in 1980 and 90% of them were found in the Northern Province. Most of the farmers of other communities, such as Temnes and Mendes, have no custom of keeping cattle at home. (Mendes in grassland areas keep them, but they hire Fulas to look after them.)

Cattle are of N'dama type; small in size, but resistant to trypanosomiasis. They are mainly kept for meat, but efforts have been made for more than 50 years to use them for crop cultivation and farm transport.

2-3-2 Land Tenure

Tribal authorities still have a say in reallocating land in all the provinces of the country. Chiefdom hierarchies, from the paramount chief down to the section or village head, the district officer and the representative from the land-holding joint families are the parties concerned at the negotiation table for leasing of land. But, it is more common practice in swamplands that migrant farmers deal directly with the village heads.

The government has been expressing its concern about the system, which does not allow for the change in land-use and development. The previous national development plan says that "the replacement of communal tenure by individual tenure may be an essential pre-requisite if the standard of living of the community is to be improved", and it further states that "it could be highly desirable to formulate a functional, long-term land use policy which would concentrate future permanent rice production in the more suitable irrigated areas ... ."

Another aspect of the communal land tenure is the joint ownership and use of land by extended family. This rejects the individual claims on land, and unites the extended family in a farmer bond. Likewise, the right to use a village common by the members of the village is another factor to bind the members together.

2-3-3 Agricultural Labour Force and Farm Size

As is shown in Appendix Chapter 1, Table 1-1-3, the increase rate of employment in the agricultural sector is much slower than in the non-agricultural sector, and an overall increase of the nemployment rate is apparent. Still, labour shortage is felt by most of the small

scale paddy growers, especially at the time of harvesting, partly because they are not able to provide the seasonal labour force with an appropriate wage.

So, the area to be utilized for cultivation is mainly determined by the number of family and clan hands. According to the agricultural statistical survey carried out in 1970/1971, a total area of 528 thousand hectares used for growing crops, equivalent to 7.4% of total land area, was cultivated by 286 thousand holders (1.85 ha on average).

Each holder has an average of nine members in its household, of which three are adult. Percentage distribution of farm size is shown in Table 2-3-2.

Table 2-3-2 Farm Size

Farm Size (ha)	-0.5	0.5-1	1 - 2	2 - 3	3 - 4	4 - 6	6 -	Not reported
% to total household	13.7	25.1	22.2	14.4	11.1	6.7	6.7	3.9

Source: Agricultural Statistical Survey of Sierra Leone 1970/1971.

2-3-4 Agricultural Institutions

At present, the Ministry of Agriculture and Forestry is the main institution to provide administrative services to the affairs concerning the field of agriculture and forestry, and the Ministry of Natural Resources provides services for livestocks and fisheries.

In 1981, a proposal for restructuring both ministries was made by a world bank mission with the intention of streamlining the administrative structure. According to the mission, the Ministries should be united. The

new proposed ministry has four departments, namely, the department of agriculture, of livestock, of fisheries and of forestries. The administration are stratified into four levels, namely, Ministry Headquarters, Department Headquarters, Regional Headquarters and Field.

The diagram is shown in Appendix Chapter 1, Fig. 1-1-2.

Within the present ministry's frame work, the principal agriculture officer is stationed in district headquarters, assisted by a senior agriculture officer and several agriculture officers.

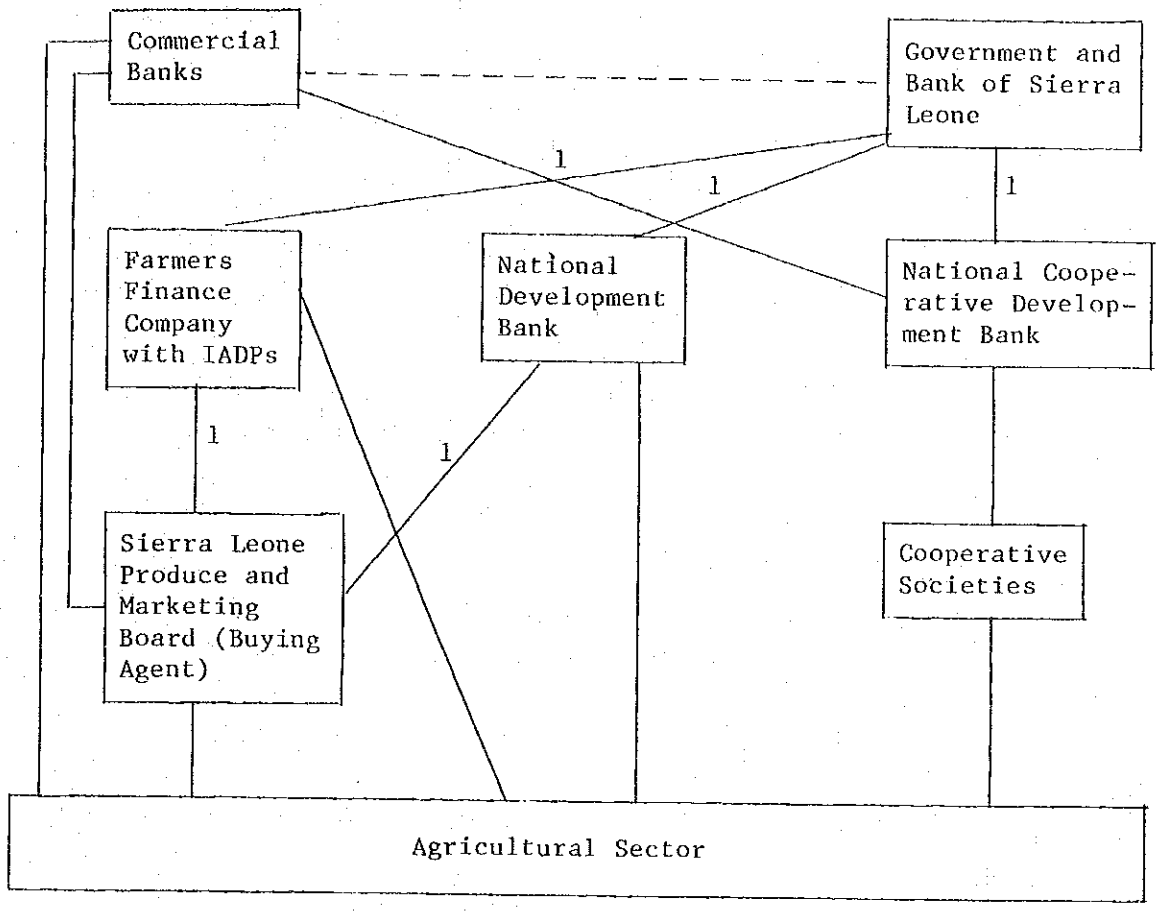
The extention staffs of the office consist of agricultural instructors, mechanical superintendents, Agrotechnicians, phyto & pest control specialists, tractor and lorry drivers, and various kinds of artisans such as fitters, masons, carpenters, ironsmiths etc. Regional training centres are operated, and regional seed farms with contract growers are maintained.

The ratio between extention workers and farmers is 1:1,200 in the case of Port Loko district. Research efforts have been made for the mangrove swamp rice development in Rokupr Research Station, which accomodates the WARDA research facilities.

There are two basic flows of agricultural credit, namely institutional and non-institutional ones. The non-institutional money lenders in the rural financial markets mostly deal with short-term credit for seasonal agricultural inputs, and effective interest rates, though the rates are usually so high that the lender deserve to be called usurers.

The flow of institutional finance to the agricultural sector is summarized in Fig. 2-3-1.

Fig. 2-3-1 Flow of Institutional Agricultural Finance



Source: F.E.S. Jones, 1982

\- - - - - Corporate taxes, financial transactions and direct loan

1 ——— Share capital

——— Flow of credit

In 1978, a national workshop on agricultural credit and banking in Sierra Leone was held. The establishment of the agricultural credit bank, in addition to the array of existing banking institutions, was recommended to increase the accessibility of credit to the farmers. The Bank of Sierra Leone was asked to form the agricultural credit advisory committee at board level and the rural credit section in the development finance department. It was also asked to promote the credit guarantee system for small borrowers. (In the case of rice growers, farmers holding less than 40 ha are eligible.) The scheme is to guarantee two thirds of the amount of a loan approved by the bank.

The number of projects and the amount of loan guarantteed is summarized in Appendix Chapter 1, Table 1-1-10.

During 1970/1971 to 1975/1976, commercial banks gave loans of 264 thousands Leones per year to the agricultural sector. This is 0.85% of the total loans made.

The National Development Bank was established in 1968 for providing medium and long term loans to the development schemes. Since its inception, to the end of 1977, it had given loans to 94 projects amounting to 6.5 million Leones. The Agricultural sector received 24% of the total amount for 36 projects, an average of 43,700 Leones per project.

The bank, with the cooperation of Netherland's FMO and HVA, began the development of an agro-related processing industry.

The National Cooperative Development Bank is giving credit to the various types of cooperatives in the country. Two terms of loans, i.e., short-term production loan and long term loan are provided to the

cooperative societies. There were 215 cooperatives, with about 250 members on average in the country, as of June 1977.

The Farmers' Finance Company has been operating in the intensive agricultural development project area in the Eastern and Southern provinces. For the swamp rice development project, for example, two different types of loan are credited to the farmers holding at least 3 acres of paddy field. 150 Leones (in 1977) were lent as the development fund to each farmer. The interest rate was 8% and it was repayable over 5 years.

Then 60 Leones were given as a seasonal loan. The interest rate was 10% deducted in advance and the loan was repayable over 12 months. The breakdown of the loan is shown in Appendix Chapter 1, Table 1-1-11.

In strengthening the linkage of credit with marketing, Sierra Leone Produce Marketing Board extended its activites. It created the National Produce Company, which established the Sierra Leone Agricultural Production Company, and started its own agricultural extension service.

2-4 Rice; its Production, Marketing, Consumption and Importation

The basic relationship between production, consumption and importation of rice, is expressed in the following simplified equation.

Area under Rice Cultivation x Unit Yield

($^{+}$ Import (Shortage of domestic production)
($^{-}$ Export (Surplus of domestic production)

= Loss (Post-harvest Damage) + Population

x Unit Consumption + Stock ($^{\text{for seed}}_{\text{for emergency}}$

If we now disregard the amount of stock for emergency, and estimate the post-harvest damage at 10 % of total production and storage for seed at 5%, the equation is rewritten as:

$$0.85 \times \begin{matrix}\text{Area under}\\ \text{Rice Cul-}\\ \text{tivation}\end{matrix} \times \begin{matrix}\text{Unit}\\ \text{Yield}\end{matrix} \begin{pmatrix}+\text{Import}\\ -\text{Export}\end{pmatrix} \begin{matrix}(\text{shortage})\\ (\text{surplus})\end{matrix}$$

$$= \text{Population} \times \text{Unit Consumption}$$

The area under rice cultivation in 1978/1980 was 405 thousand ha and unit yield was 1.35 ton per ha (see Table 2-3-1). According to the WARDA statistics, average area under rice cultivation during 1975/1979 was 425 thousand ha, and unit yield 1.4 ton per ha. So, total rice production (milled) ranges from between:

405×10^3 ha x 1.35 ton/ha x 0.85 x 0.66*

$\doteq 307 \times 10^3$ ton ..... (1) During 1979/1980,

to 425×10^3 ha x 1.4 ton/ha x 0.85 x 0.66*

$= 334 \times 10^3$ ton ..... (1) During 1975/1979

* milling rate

Whereas, for consumption, population in 1982 was estimated around 3.2 million (see 2-2-1) and average unit consumption during 1975/1979 was 130 kg per capita per annum according to the WARDA statistics.

$3.2 \times 10^6 \times 0.13$ ton/capita annum

$= 416 \times 10^3$ ton ..... (2)

So, shortage ((1) - (2)) ranges between

$(82 \text{ to } 109) \times 10^3$ tons ... (3)

Rice import has been necessary since 1976 and the quantity of yearly importation of rice is shown in Table 2-4-1.

Table 2-4-1 Rice Import

1976	1977	1978	1979	1980	1981	1981/1982
3.5	16.5	29.5	90.7	54.1	53.1	73.2

Source: (1976 - 1979) WARDA Statistics
(1980 - 1981) Spencer: 1982
1981/1982 SLPMB

The difference between (3) and actual import can be explained in many ways. For example, for supply, a 10% increase either in the area of productivity; or for consumption, a 10% forced decrease of unit consumption due to the price hike, of which the latter case is most likely to have taken place.

If unit consumption is 120 kg per capita per annum, the total consumption becomes:

$$3.2 \times 10^6 \times 0.12 = 384 \times 10^3 \text{ ton}$$

and the shortage ranges between

$$(50 \text{ to } 77) \times 10^3 \text{ ton}$$

The figure more or less tallies with the actual tonnages of import.

Argument on the policies of rice production, marketing, consumption and importation revolves around the above mentioned basic equation and the figures.

Presently 80% of the farmers grow rice. It is grown in the upland areas and in swampland. In the upland areas, the farmers practice the rotational bush fallow system. With the population increase, the fallow periods tend to be reduced from the ideal ten years

to a critical four years. The swampland can be subdivided into four distinctly different types of physical regions, namely, the tidal mangrove swamps, the Boli-lands, and the riverine grasslands, all of which are flooded during the wet season.

The rice growing practice used in these areas is called the floodland farming system. Roughly speaking, swampland consists of a quarter of the rice growing area at present.

A field survey on consumption conducted during March 1974 and May 1975 revealed that the average family budget share for rice was 39.4% (for total food commodities 70.0%).

Income classes and their household economy and demography are shown in Appendix Chapter 1, Table 1-1-12.

2-5 Agricultural Development Plan, Past and Present

The sectoral policy for agriculture in the previous national development plan (1976/1977 - 1980/1981) identified eleven constraints which would influence the pace and pattern of future development. They are:

(i) Inadequacy of government funds for the agricultural sector

(ii) Inadequacy of up-to-date basic data on agriculture

(iii) Inadequacy of a developed agricultural research programme & coordinating institution

(iv) Lack of skilled personnel for effective administration and implementation of development programmes at all levels.

(v) Inadequate marketing and transport facilities.

(vi) Problem of agricultural credit facilties

(vii) Local availability of farm supplies & materials

(viii) Lack of supply of high-yielding rice varieties

(ix) Inefficient rice-milling facilities

(x) Lack of workshop and maintenance facilities

(xi) Inadequacy of the present land tenure system for efficiency in land-use and development.

These constraints were found in almost all aspects of agricultural activities, such that an inexperienced administrator may feel at a loss as to where to take steps.

The five years of the 1976/1977 - 1980/1981 National Development Plan have now passed and we are still told that the theme of the National Development Plan (1981/1982 - 1985/1986) is the resuscitation of the drowning national economy. (The plan is yet to be published.) And we can infer from the inaugural address of The Ministry of Agriculture of Sierra Leone at the 15th session of the International Rice Commission held in Freetown that in the agricultural sector an integrated and consistent approach is the only method to combat the seemingly invincible army of constraints so far identified in the previous national plan.

As the success of the agriculture development programme depends chiefly on the positive participation

of the smallholders, organizing farmers into cooperatives or introducing the master farmers scheme is among the strategies incorporated in the various integrated agriculture development projects (IADP).

Domestic rice is the first chosen commodity to substitute the imported rice, and the emphasis has been put on rice growing in the swampland. Though the outcome of the attempt was not favourable, a crash rice programme has been initiated every year to raise the productivity, as well as volume, by introducing mechanization and applying fertilizers.

So far, most of the IADPs in which rice growing areas are included are concentrated in the Southern and Eastern Provinces. Port Loko IADP will soon be initiated along with Kambia IADP, in the district where the project area is located. The breakdown of the agricultural development budget for the Ministry of Agriculture and Forestry is shown in Appendix 2, Table 1-1-13.

For Rhombe Swamp Development for the year of 1982/198, 129,000 Leones is allocated, 75,000 Leones of which are taken from foreign funds.

CHAPTER 3 PRESENT SITUATION OF PROJECT AREA

CHAPTER 3 PRESENT SITUATION OF PROJECT AREA

3-1 Natural Conditions and Infrastructure of the Area

The project area is a part of Rhombe Swamp*, which is the collective name given to the swamps lying on the left bank of the lower reach of the Little Scarcies between the settlement of Katoma and the mouth of Gbenti Creek.

As is shown in the location map, the Rhombe Swamp area, which lies about 50 km northeast of Freetown, is approachable both via Lungi and via Port Loko.

The Rhombe Swamp area is bounded by the Lungi - Port Loko Main Road on the south, and by two feeder roads, Man Bundulai - Katonga and Petifu Junction - Barbara, on the east and on the west.

The project area (about 1,600 ha), which is conventionally called Gbenti North in the MRT Report, is a riverine land and not the swamp proper, and is bounded by Malai - Konta ridge on the east by a chain of low mounds on which several settlements are found: i.e., Masama - Katik - Kagbulo on the west, and by the line drawn between Masama and Malai via Yalesanda on the south, which separates the Gbenti North from the Gbenti South.

The project area belongs to two sections of Loko Masama Chiefdome; i.e., the Konta Section and Gbenti Section. A part of the area is used for swamp rice farming by the people of Konta village and of some hamlets of

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* The Rhombe Swamp is supposed to have been named by a topographic survey team sent by the British firm of J.A. Storey and Partner, which was stationed at a small settlement of Rhombe on the Little Scarcies and made a survey of an area of about 6,800 ha.

Konta Section and of Kagbulo and Katik villages (daughter villages of Gbenti village) and of some hamlets of Gbenti Section. Most of these villages are not accessible from the main road network. The village people depend mainly on water transport. Farmers use canoes to reach the farmland.

Recently, with the introduction of mechanized cultivation, many feeder roads have been extended inward from three sides because of the frequent traffic of tractors from Katonga agricultural extention centre. Along the left bank of river, Konta can be connected with Katonga by road during the dry season if several wooden bridges are rehabilitated. (Katoma - Konta Section is assessible by jeep all year round.)

Makombow, Benbia and Robis are also connected by roads which can be traveled by jeep throughout the year. Even Yalesanda on the southern boundary of the project area can be reached by jeep during the dry season via Mala on the Konta - Mane ridge.

The population of the project area is shown in Table 3-1-1. The total number amounts to about seven thousands. A half of the population consists of children and about 12% of absentees from the villages.

Houses are actually counted, and the number of tax payers are from the registry of the tax office. Whereas number of total population, of children and of the absentees are estimated from the figures given by the village chiefs in charge whom we got a hearing.

Enquiries were made in ten settlements in and around the project area. Some of the farmers have their paddy fields outside the project area.

The distribution of the population is shown in Fig. 3-1-1. About 40% of the total population live in

Konta section which consists of four settlements, and the rest in Gbenti section, of six settlements.

According to the record of censuses, the population of the main settlements in this swamp area had shown a slight decrease in number between the two consecutive census periods (1963 to 1974), though the annual growth rate of the country is over 2%. This fact may reflect the natural constraints which have prevented villagers from receiving large scale development assistance and being near to the capital city, several hours' trip by bus, villagers, especially the younger people have been apt to be attracted by the capital, even though they do not actually find jobs there.

The discrepancy between the figures given by the census (see App. Table 1-1-1) and by our hearing may be explained by some facts that the official count is liable to leave out some segments of population due to certain technical difficulties. So the FAO statistics always give bigger figures for the population and for the growth rate (see App. Ch. 1-1).

The meaning of population count for the project formation chiefly lies in estimating the availability of agricultural labour force. In this sense, the difference of the figures is not big enough to cause the change of programme. As is explained in Ch. 2-3-3, the constraint felt at the time of harvesting of paddy is not the number of the seasonal labour force but the luck of input capital for the payment of wage. And there are also positive indications that many families will be willing to migrate in the project area, once the stable irrigation and drainage facilities are provided.

Human settlements are found on the areas which are relatively higher than the neighboring swamps and low plain.

The settlements are surrounded by the oil palm plantation, wild growth, and cultivated lands on which mostly cassava and sweet potatoes are grown. Sometimes woodland or fallow-land with bush growth are found. Actual swamps are classified morphologically and vegetationwise as mangrove swamps where several Rhizaphora and Avicennia species are growing, Riverine and Aquatic grassland, the swamp area perennially under water where floating vegetation is sometimes found, and the area where rice is cultivated in the rainy season.

At Magbundus near Mabundulai, there is a small water reservoir with a pumping station for the water supply to Pepel, a township of several thousand inhabitants, 25 km south of the site. The small catchment area utilized by the dam shows there is an ample inflow of groundwater.

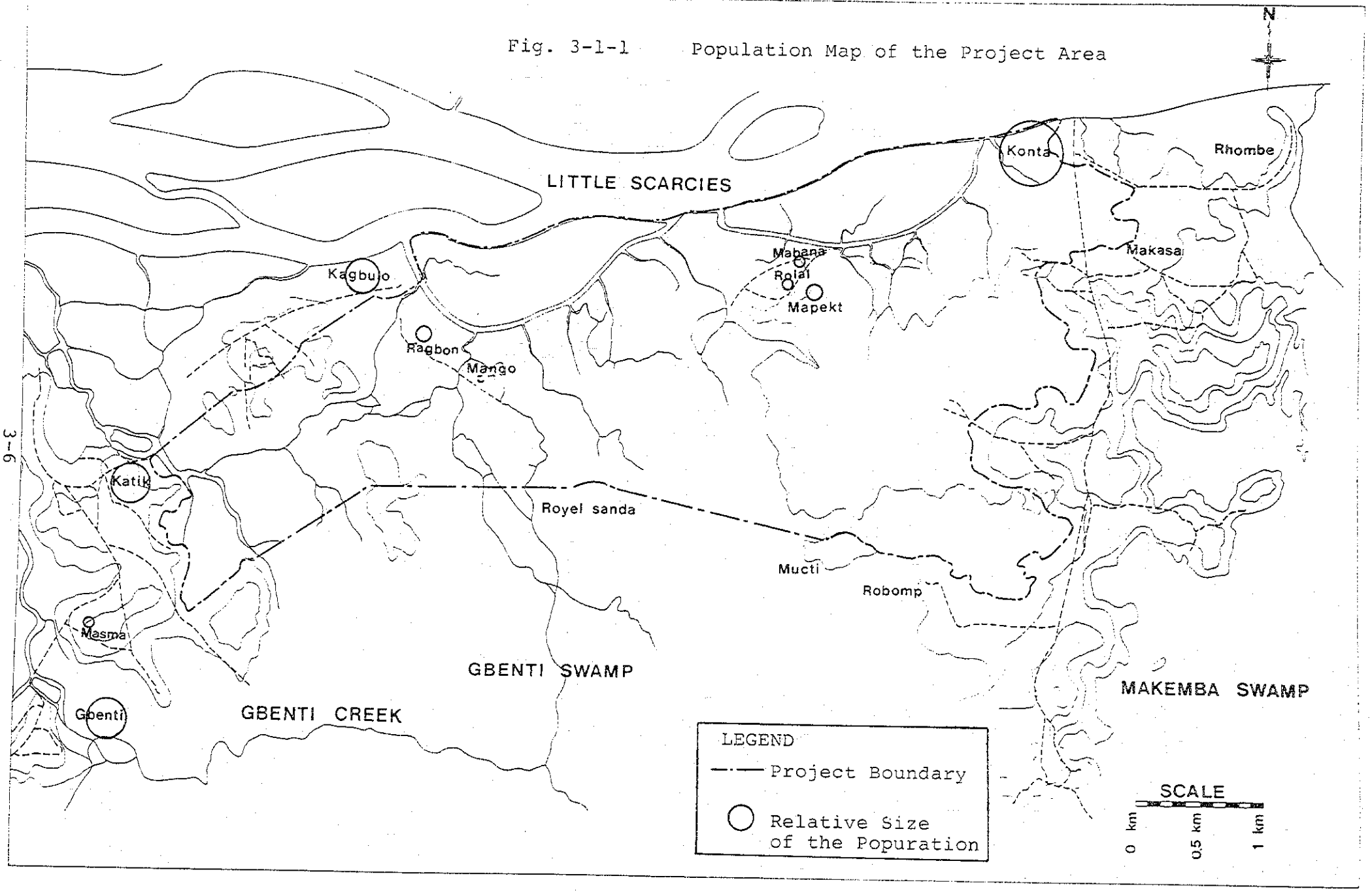
Table 3-1-1 Population of Project Area

No.	Number of Village	Houses	Tax-Payers	People	Chil-dren	Absent Family Members
1	Konta (K)*1	200	248	2,400	1,000	160
2	Mabana (K)	18	26	108	72	40
3	Rolal (K)	12	26	108	60	20
4	Mapekr (K)	15	26	195	75	14
5	Kagbulo (G)*2	105	242	1,155	630	100
6	Rogbom (G)	26	39	208	78	70
7	Mango (G)	7	18	70	35	-
8	Katik (G)	94	182	1,410	940	200
9	Masama (G)	10	19	120	40	70
10	Gbenti (G)	142	243	1,420	568	200
	Total	629	1,069	7,194	3,498	874

*1 Konta Section

*2 Gbenti Section

Fig. 3-1-1 Population Map of the Project Area



3-2 Meteorology and Hydrology

3-2-1 Meteorology

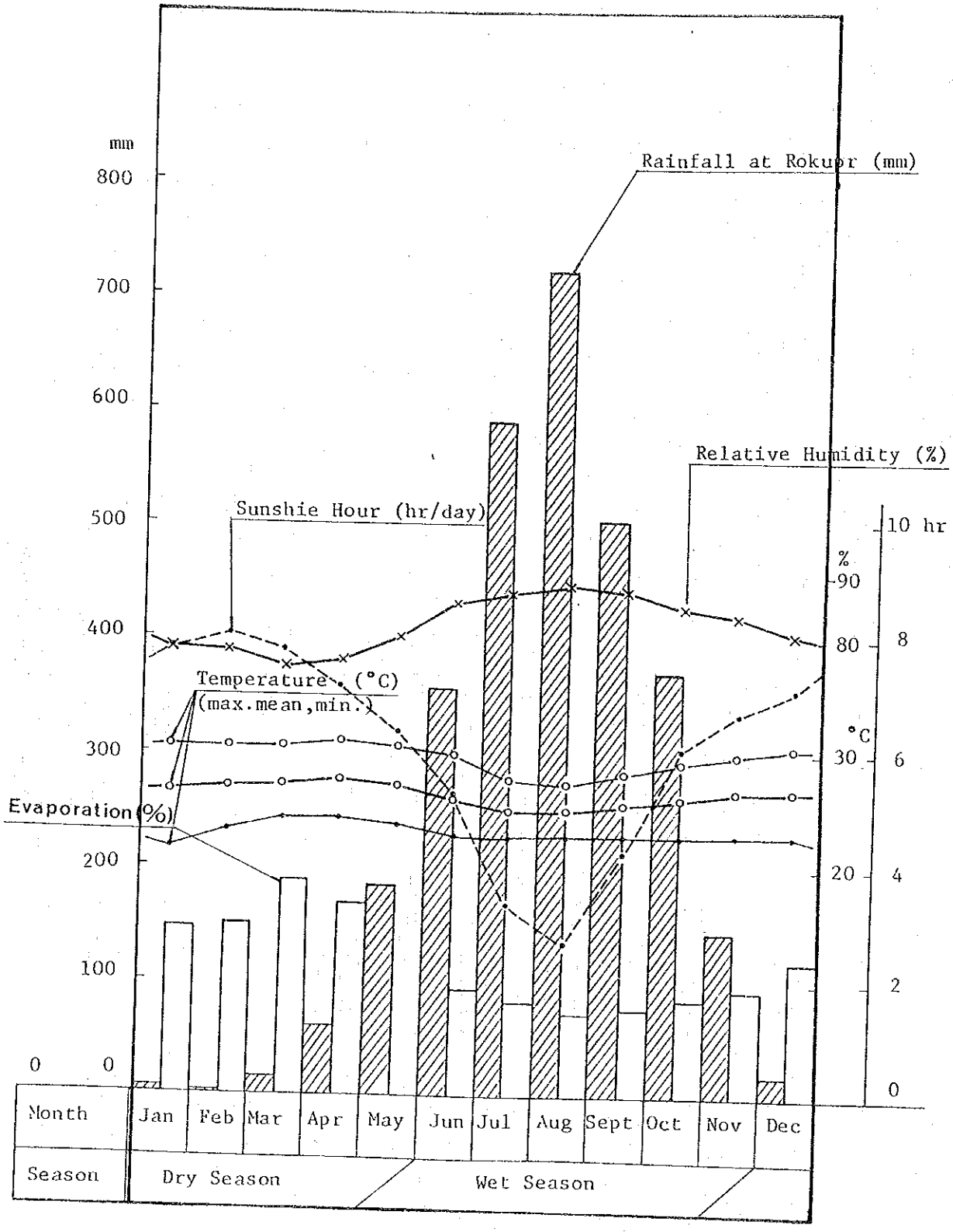
Sierra Leone is characterized by a humid tropical climate. The regional climate of west Africa is in fluenced by two air masses, namely dry "Harmattan" air of the Sahara desert origin and humid "Monsoon" air from the Equatorial and South Atlantic. The warm Guinea current flows eastwards along the coast thus engendering a wet climate. The study area, located in the coastal region of Sierra Leone, has a relatively mild climate due to maritime influence, but experiences clearly distinct dry and wet seasons.

According to the meteorological records at Lungi, the annual mean air temperature is about 26.5°C. The monthly mean temperature show very little seasonal fluctuation or within a maximum of 3°C. The annual mean relative humidity is 82%, with seasonal fluctuation ranging from 75% in March to 89% in August. The monthly mean wind speed ranges from 2.1 to 3.2 metres per second and the annual evaporation averages about 1,400 millimeters. The average monthly sunshine hours in the dry and wet seasons are 230 and 140 hours respectively, with the annual mean sunshine hours totalling about 2,200 hours (Refer to Fig. 3-2-1 and Appendix Chapter 4).

Rainfall varies substantially according to region and from year to year in the upper part of the Little Scarcies Catchment area. The annual precipitation ranges from less than 2,000 millimeters in the northern watershed to more than 3,000 millimeters in the south-western coastal region. The overall average annual precipitation in the Little Scarcies river basin is about 2,400 millimeters. According to the rainfall record at Rokupr, the annual mean precipitation is about 3,000 millimeters in the study area.

Fig. 3-2-1 CLIMATOLOGICAL CHARACTERISTICS

Meteorological data is from Lungi



More than 95% of the annual rainfall in the area is concentrated in the wet season from May to November (Refer to Fig. 3-2-1).

The consecutive 3-day probable precipitation is estimated at 252 millimeters for the return period of 5 years (Refer to Appendix Chapter 4-1).

3-2-2 Hydrology

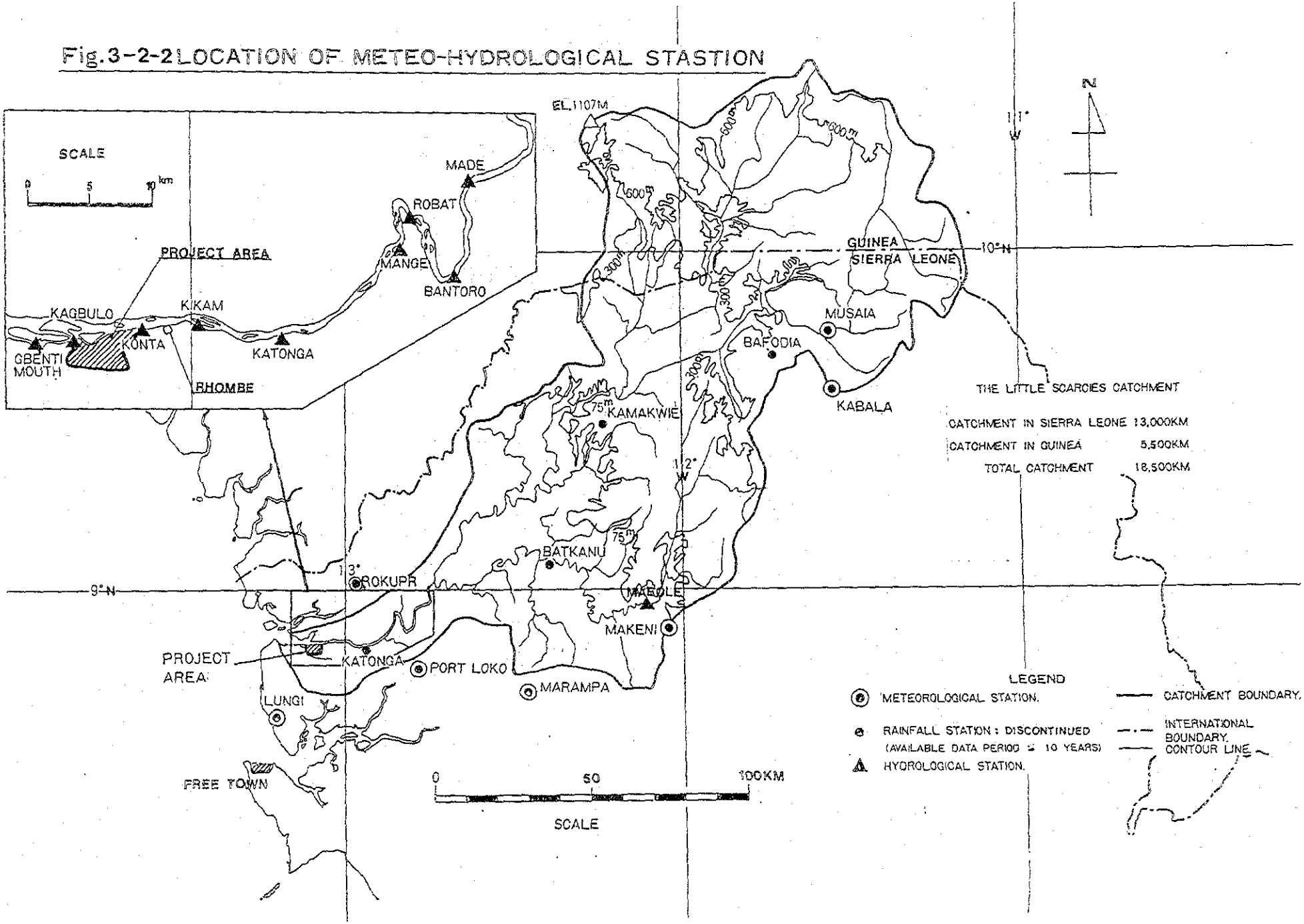
(1) The Little Scarcies Basin

The Little Scarcies river, which is one of the major rivers in Sierra Leone, originates in the Fouta Djallon Plateau in Guinea. It flows down from northeast to southwest as shown in Fig. 3-2-2. The total length of the river is about 430 km and the average gradient of the upper portion is about 1/240 and lower portion 1/3,000. The catchment area of the Little Scarcies river is about 18,500 km^2, of which 5,500 km^2 lie in the Republic of Guinea. The catchment can be divided into three physiographic regions, namely the coastal plain, interior lowlands and interior plateau regions. Area height relationship and area of each region of the Little Scarcies catchment are summarized in Table 3-2-1 and 3-2-2.

Tabel 3-2-1 Area Height Relationship

Contour Interval (m)	Area (km)	Percentage (%)
Over 600	1,500	8
300 - 600	6,100	33
75 - 300	5,100	28
0 - 75	5,800	31
Total	18,500	100

Fig.3-2-2 LOCATION OF METEO-HYDROLOGICAL STASTION



Tabel 3-2-2 Areal Region Relationship

Region	Area (km)	Percentage (%)
Coastal Plain	1,000	5
Interior Lowlands	4,800	26
Interior Plateau	12,700	69
Total	18,500	100

(2) The study area

An approximate correlation was prepared by the MRT consultants between predicted tide levels from the tide tables and Storey datum. The datum of the tide tables or that of the admiralty charts, (hereafter called the chart datum), are 25.76 meter to Storey datum. Tidal information in the tide tables (1982) for the Freetown port is summarized in Table 3-2-3. Mean sea-level is estimated at 27.43 m in Storey datum or at 1.68 m in the chart datum.

The estuary of the Little Scarcies is tidal and the effect is felt as far upstream as Mange, expect at high flow when it is drowned out, often as far downstream as Konta. Water level records exist for five stations along the Little Scarcies for the years 1960 to 1963. Of the five stations, Kagbulo and Konta are located along the river at the western and eastern ends respectively. Based on those records and additional data obtained during 1982 for the Project at Kagbulo and Konta, general fluctuation of water level is estimated as shwon in Fig. 3-2-3 and 3-2-4.

Lowest water level at Rhombe, which is located about 2 Km upstream from Konta, is estimated at around 27.1 m in Storey datum, while water level for the minimum high water neaps is about 28.1 m.

Table 3-2-3 Tidal Information

Location: Port of Freetown
Source : "Tide Tables 1982"

(m)

Item	The charts datum	Storey datum	Above estimated M.S.L.
Max. High Water Springs	3.3	29.06	1.62
Mean High Water Springs	3.03	28.77	1.35
Mean High Water Neaps	2.28	28.04	0.60
Min. High Water Neaps	2.0	27.76	0.32
Estimated M.S.L.	1.68	27.43	0
Max. Low Water Neaps	1.3	27.06	-0.38
Mean Low Water Neaps	1.0	26.76	-0.68
Means Low Water Springs	0.4	26.16	-1.28
Max. Low Water Springs	0.1	25.86	-1.58
The Charts Datum Level	0	25.76	-1.68

Fig 3-2-3 MONTHLY WATER LEVEL AT KONTA

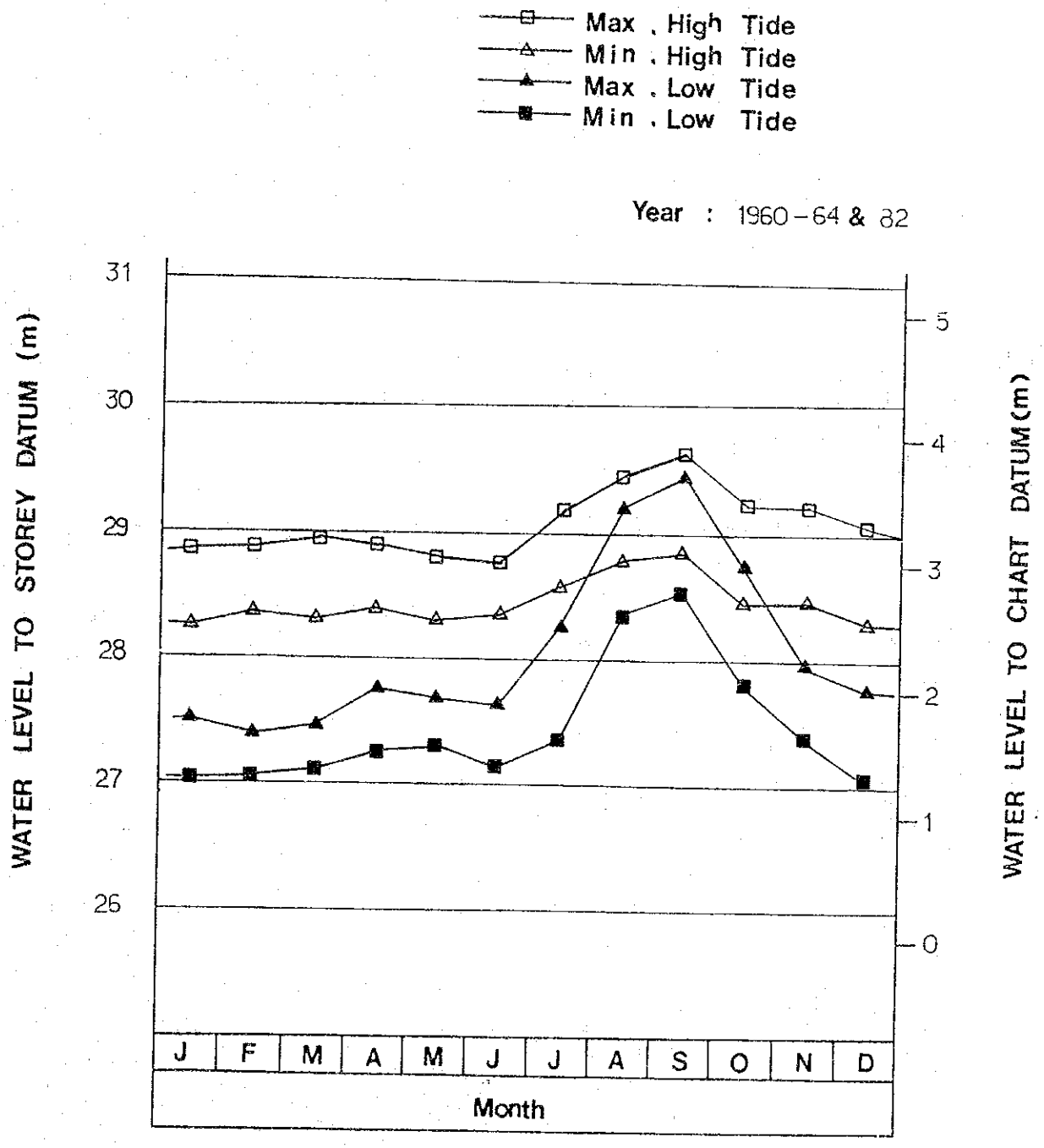
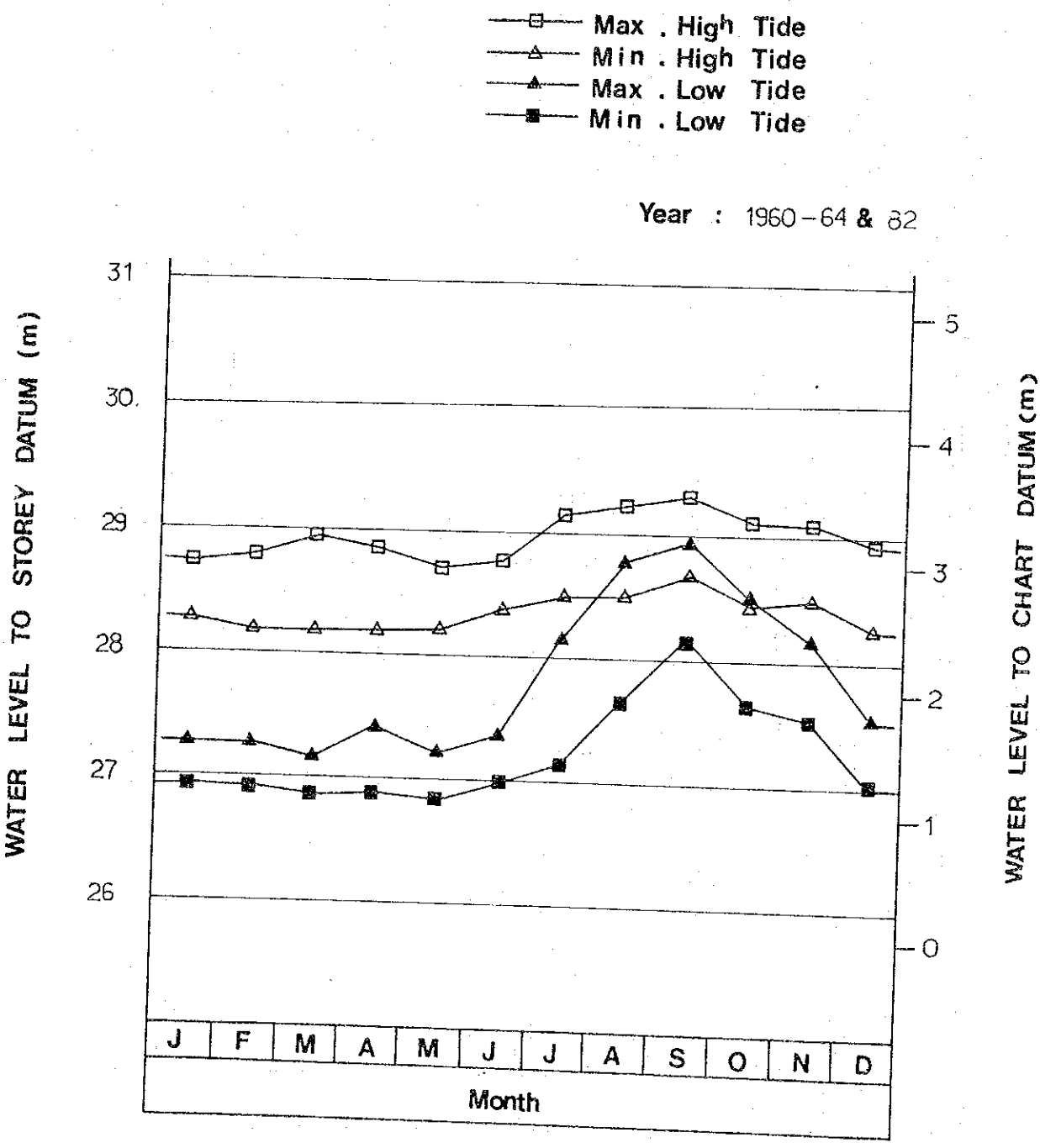


Fig 3-2-4 MONTHLY WATER LEVEL AT KAGBULO



Peak water level at Kagbulo and Konta is estimated at more than 29.4 m and 29.6 m respectively. Flood discharge fluctuation seems to be relatively small ranging from about 1,800 m^3/sec to 2,400 m^3/sec for the period of records. Monthly drought discharge in April was estimated between 7 m^3/sec to 14 m^3/sec and spot drought discharge of 5.7 m^3/sec was measured in April, 1971.

Swamp water of the Makemba North is considered to be dried up during April, May and June in general. Northern part of the Makemba North swamp was observed to be dried earlier.

3-3 Water Quality

3-3-1 The Little Scarcies

(1) Water temperature and pH

The water temperature in the Little Scarcies ranges from 26.9°C to 27.8°C in the wet season and varies from 29.2°C to 29.5°C in the dry season.

The pH value ranges from 7.3 to 7.6 in the wet season and varies from 7.0 to 7.7 in the dry season. Thus, the pH value indicates a weak alkaline content in both seasons.

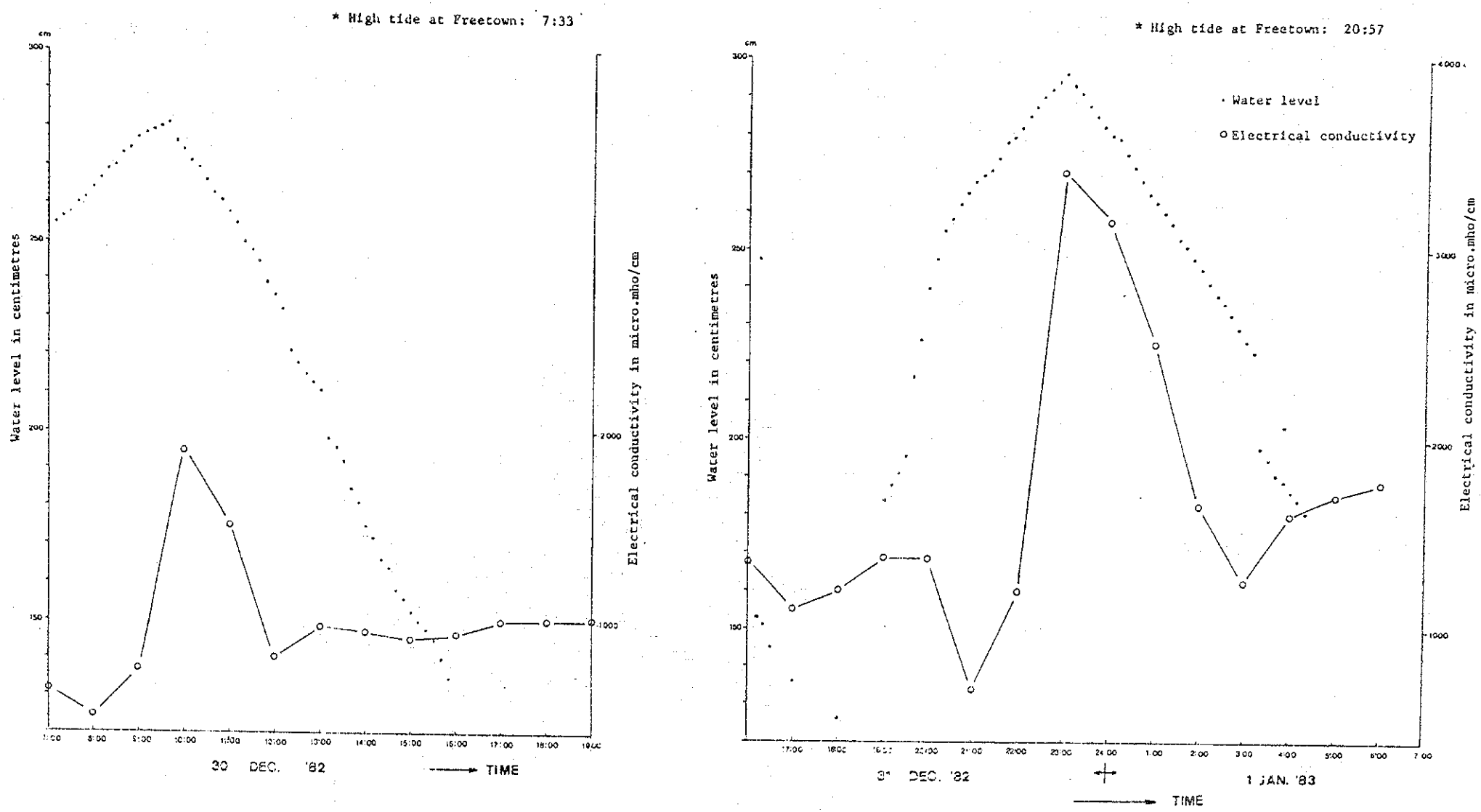
(2) Salinity variation with tidal change

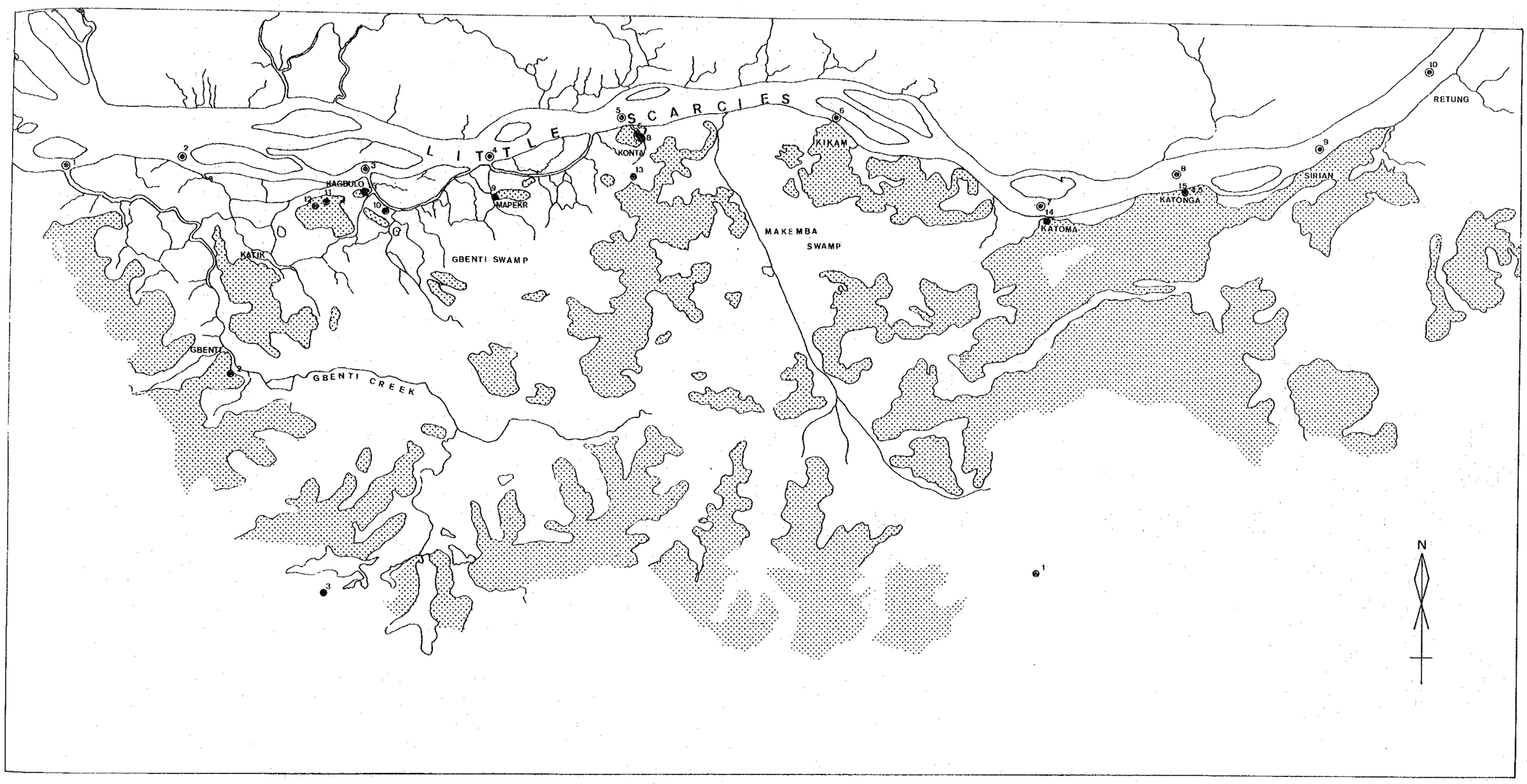
The Little Scarcies, which is a tidal river, is affected by tidal change throughout the year and the water level varies. The salinity also varies with the water level fluctuation. As shown in Fig. 3-3-1, electrical conductivity increased with increasing water level and a peak was found at almost the same time as the water level reached a maximum. The high electrical conductivity was limited to a period of between one and two hours before and after the peak of the water level.

(3) Seawater intrusion

Seawater intrusion into the Little Scarcies is maximum at high tide. This seawater intrusion was observed at 10 points along a reach as shown in Fig. 3-3-2. Water samples were taken and measured at varying depths at each point. The measurements showed that there was little difference in water quality according to depth and

Fig. 3-3-1 FLUCTUATION OF ELECTRICAL CONDUCTIVITY WITH TIDAL CHANGE AT WGS-9





LEGEND

- ● Existing well
- o Water quality investigation in the Little Scarcies
- Area above approx. 95 ft. contour to Storey datum

Fig. 3-3-2 LOCATION MAP OF FIELD SURVEY

0 1 2 3 4 5KM

that the type of seawater intrusion was a strong mixed type.

As shown in Fig. 3-3-3, the seawater intrusion did not occur in the wet season due to abundant flow. However, in November influence from seawater intrusion appeared as drier weather approached and an increase in the electrical conductivity was observed at each point. This influence of seawater intrusion was strongest near the rivermouth and diminished with distance from the rivermouth. From these observations it was found that the limit of the seawater intrusion was between Kikam and Katoma.
The limit of high concentration which had a negative effect on crops was between TAS BM-1 and Kagbulo. The project area had not been affected at that time. However, it is estimated that the limit of high concentration will reach further upstream as the dry season progresses by May. So, a salinity variation in the future at WGS-3 and Konta was estimated as shown in Fig. 3-3-4.

While electrical conductivity at WGS-3 will exceed 2,000 uS/cm at the end of February, the electrical conductivity at Konta will still be below 1,000 uS/cm. It is therefore estimated that the limit of high concentration which has a negative effect on crops will occur between WGS-3 and Konta at the end of February.

3-3-2 Swamps

(1) Gbenti swamp

In the Gbenti swamp, there is little change in water temperature and pH between the wet season

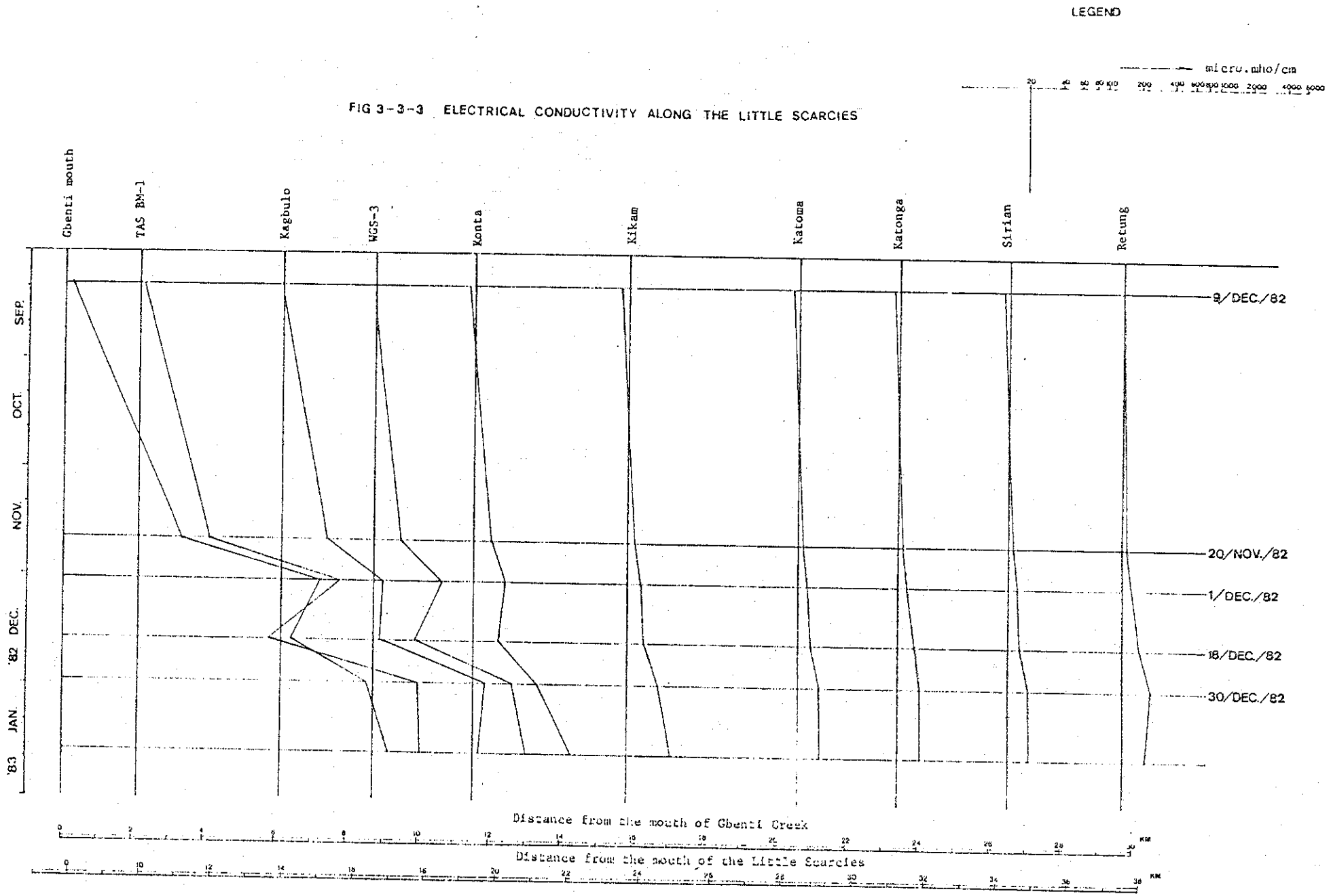
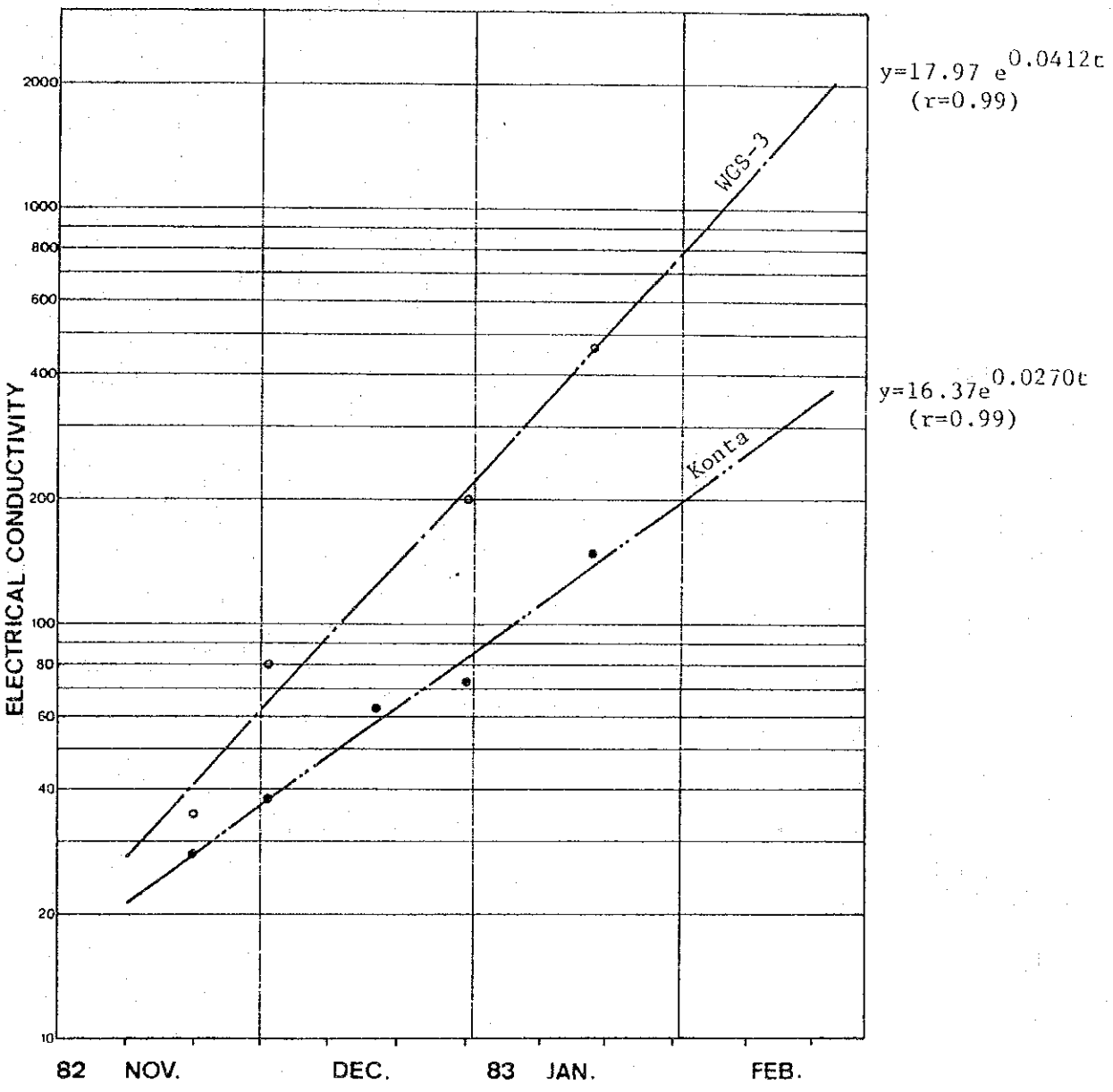


FIG 3-3-3 ELECTRICAL CONDUCTIVITY ALONG THE LITTLE SCARCIES

Fig. 3-3-4 ELECTRICAL CONDUCTIVITY AT SPRING HIGH TIDE



and the dry season. The pH value is slightly acidic, different from the Little Scarcies.

The electrical conductivity ranged from 190 to 1,350 μS/cm in the dry season and the water quality of the Gbenti swamp was also affected through creeks when the Little Scarcies was influenced by seawater intrusion.

(2) Makemba swamp

Makemba swamp is situated east of the project area and is a possible water reservoir for the project area.

Water temperature ranged from 25.2 to 29.8°C. The pH value varied from 5.5 to 5.8 high acidity. It is assumed that this high acidity is due to humic acid and/or soil characteristics. Electrical conductivity ranged from 7.0 to 31.0 μS/cm. The swamp water was almost pure.

3-4 Hydrogeology and Groundwater

3-4-1 Hydrogeology

The geology of Sierra Leone corresponds roughly with its topographical features. The coastal area is underlain by Bullom series which consists of Tertiary to Recent formations. The interior region consists of Cambrian to Pre-Cambrian formations (Fig. 3-4-1).

The project area consists mainly of Bullom series, swamp deposits and lateritic deposits. A hydrogeologically important formation in and around the project area is Bullom series which consists of unconsolidated sediments, i.e., sand, gravel, silt and clay. Metamorphic rock of Cambrian to Pre-Cambrian is distributed below the Bullom series and is considered to be an impermeable basement. To determine the distribution of sandy layers of Bullom series, electrical soundings were carried out. It was found that the depth of the impermeable basement was relatively shallow and that a major part of the project area consisted of clayey layers with a lack of sandy layers as shown in Fig. 3-4-2.

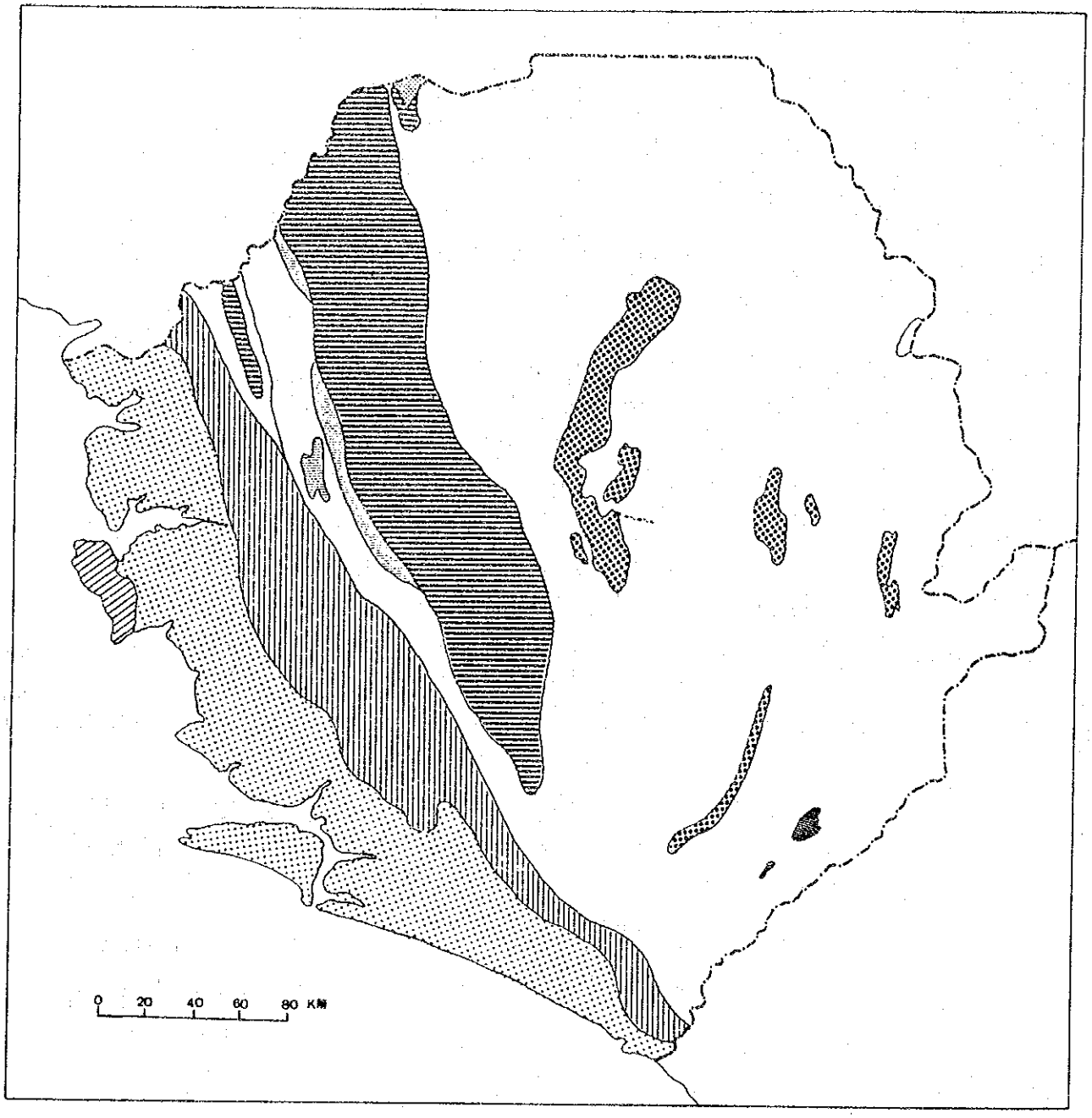
It is therefore considered that groundwater exploitation for irrigation requirement is not appropriate.

3-4-2 Groundwater

Existing wells, which are located in and around the project area (Fig. 3-3-2), are hand-dug type wells with a depth of 1.5 m to 5.4 m. These wells are utilized for domestic purposes, mostly during the dry season.

The water temperature of these wells ranged from 26.0°C to 28.5°C and the pH value varied from 4.4 to

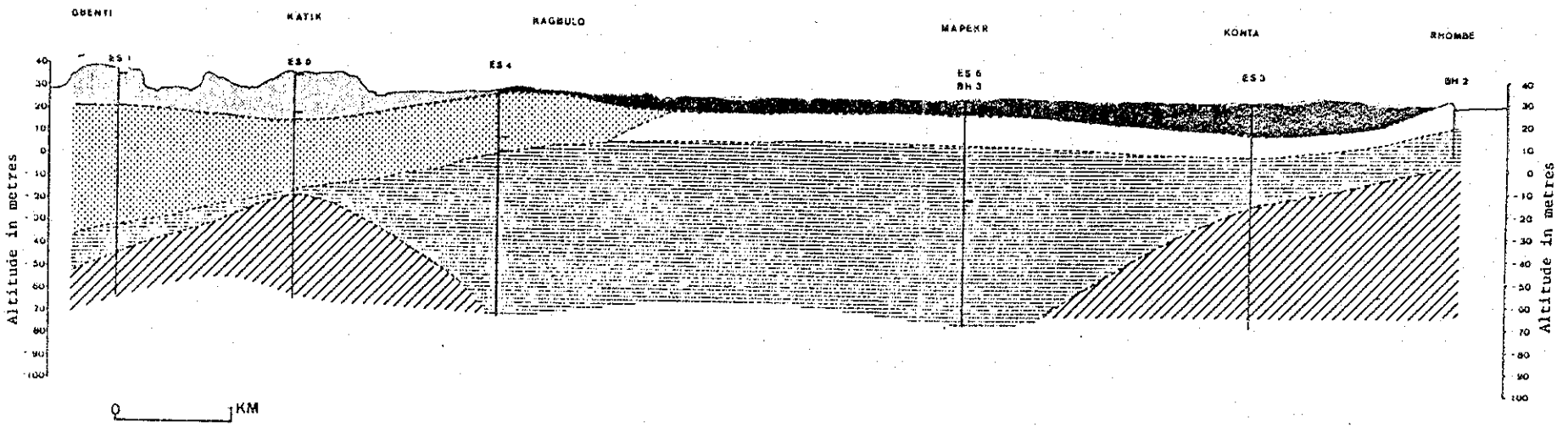
Fig. 3-4-1 GEOLOGICAL MAP



LEGEND

- Bullom series
- Sainya scarp series
- Rokel river series
- Marampa shists
- Kambui schists
- Mano-Moa granulites
- Kasila series (Crystalline schists & gneiss)
- Gabbro
- Granite and acid gneisses

Fig. 3-4-2 ESTIMATED HYDROGEOLOGICAL CROSS SECTION



LEGEND

- Swamp deposits — Recent
- Lateritic deposits — Recent
- Clayey layer — Bullom series
- Sandy layer — Bullom series
- Weathered basement — Cambrian to Pre-Cambrian
- Fresh basement — Cambrian to Pre-Cambrian

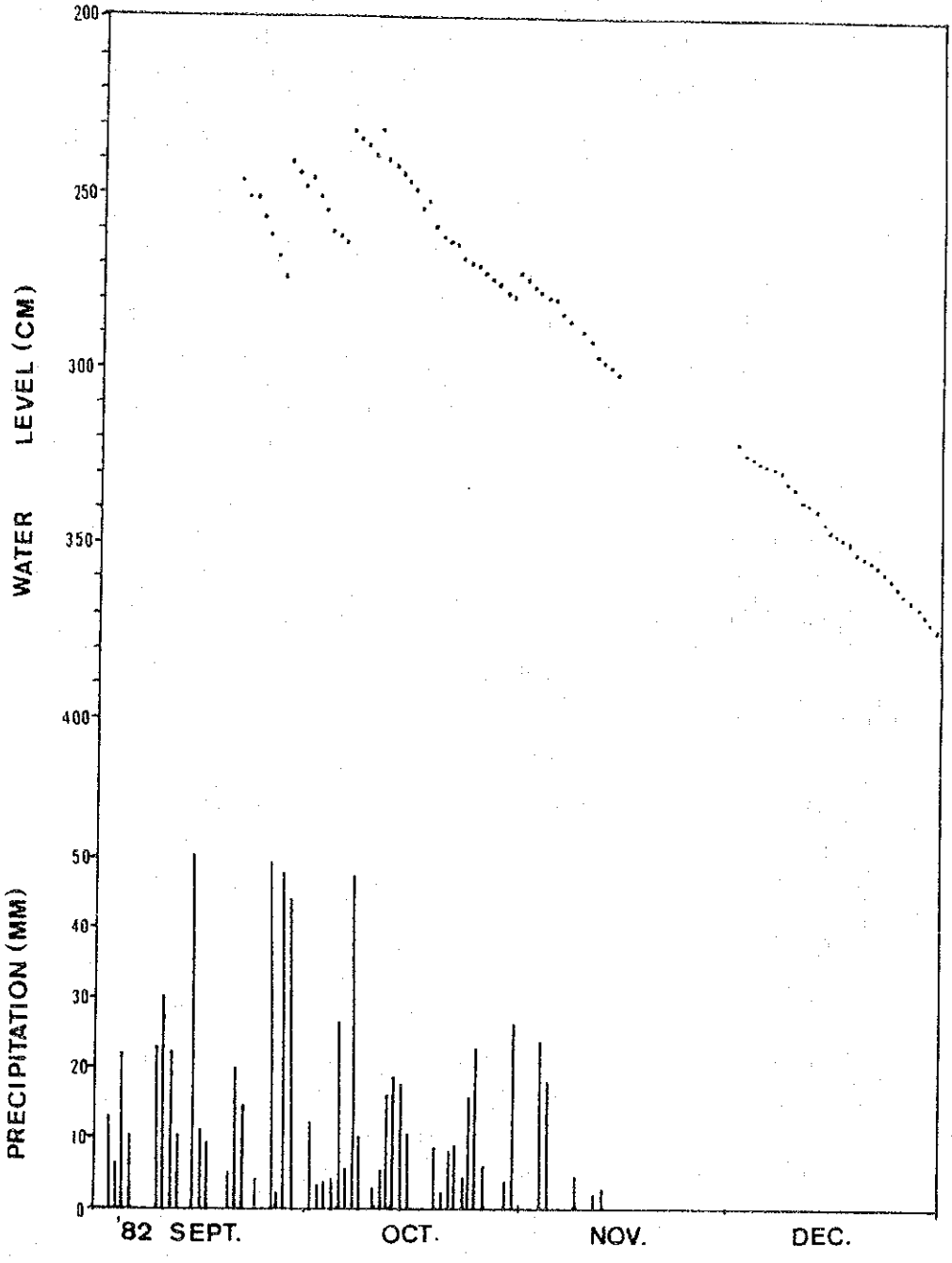
6.4, indicating strong acidity. Electrical conductivity ranged from 13.0 to 340 μS/cm. Some wells which exceeded 200 μS/cm were probably contaminated by domestic sewage.

Water quality of the groundwater is considered to be stable, as it was not affected by seawater intrusion.

In the wet season, groundwater level was usually shallow and varied from 0.2 to 2.3 m below the ground surface. In the dry season, groundwater level ranged from 0.9 to 3.2 m - a drop ranging from 0.5 to 1.2 m. As shown in Fig. 3-4-3, the groundwater level was affected by precipitation and started to decrease at a linear rate after the wet season.

Thus, it is estimated that the groundwater of the project area is mainly recharged from the precipitation.

Fig. 3-4-3 WATER LEVEL FLUCTUATION AT KAGBULO WELL



3-5 Soil Survey

3-5-1 Soil Distribution

Three major soil types occur in the survey area: Thionic Fluvisols (Ft), Plinthic Gleysols (Gp) and Gleyic Cambisols (Gg). (FAO/UNESCO, 1974)

Thionic Fluvisols occurs mainly in the western part of the project area along the Little Scarcies River. Plinthic Gleysols is dominant near Konta Village.

Thionic Fluvisols is mostly cultivated in paddy rice; Plinthic Gleysols is partly not cultivated in the Gbenti swamp (See Figs. 3-5-1 and 3-5-2).

3-5-2 Soil Characteristics

Soil characteristics can be summarized as follows:

(1) Thionic Fluvisols (Ft)

Thionic Fluvisols is a fertile soil in that it is supplied with muds by daily flooding. During the wet season, the heavy discharge of fresh runoff water reduces the effects of brackish water incursions.

It is commonly fine textured soil; i.e. clay to clay loam with depth. The water table is 40 to 60 cms below the soil surface.

The Thionic Fluvisols is the most common soil type in the survey area.

Yield differences between western and eastern parts of the survey area is thought to be a result of greater mud accumulation and hence finer textures.

Fig. 3-5-1 LOCATION MAP OF SOIL SURVEY

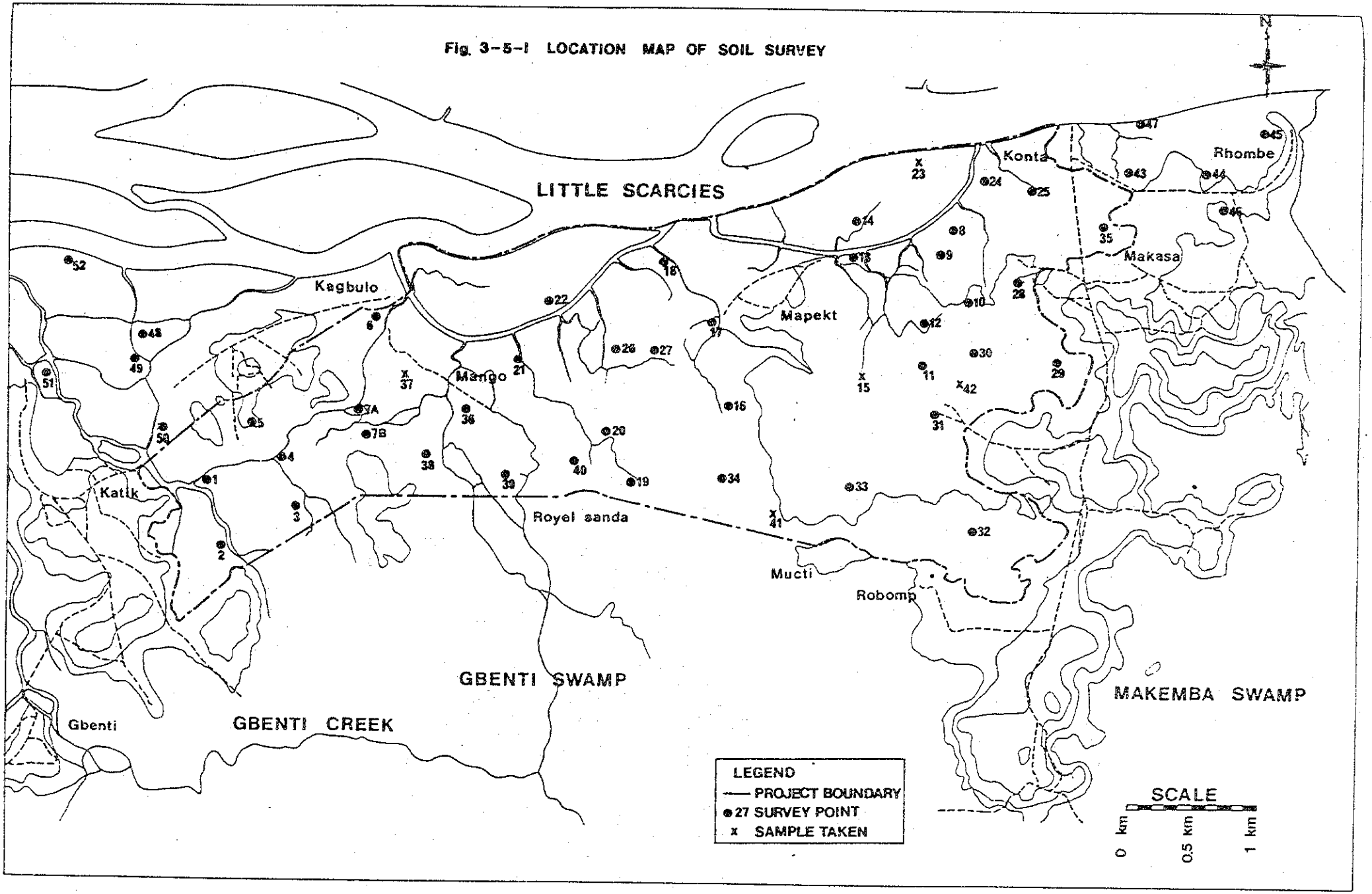
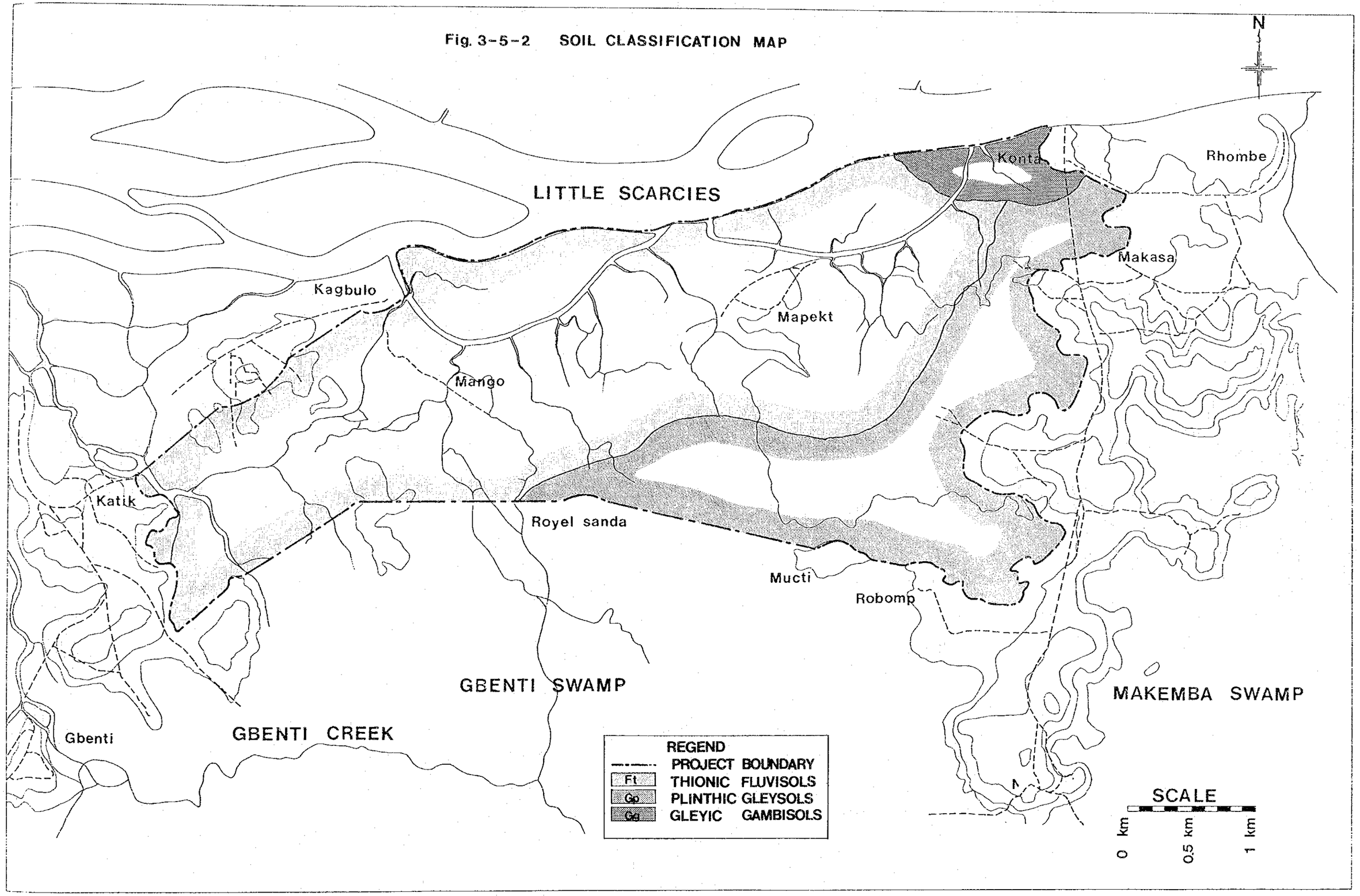


Fig. 3-5-2 SOIL CLASSIFICATION MAP



Soil with a sandy horizon in the deeper subsoil have been found (see Profile 37) but they are of very little extent. Analytical data from a simple soil detector are as follows:

pH (H_2O) 5.0 - 5.5;

pH (Kcl) 4.5 - 6.0; salt (NaCl) 0.01 - 0.05%

(2) Plinthic Gleysols (Gp)

Plinthic Gleysols is the second most common soil type in the survey area and occurs in the western swamp near Konta; and in the south in the Gbenti swamp.

The water table is higher than in Thionic Fluvisols and peat is common.

Plinthic Gleysols is found under uncultivated grassland and in paddy fields recently prepared for transplanting rice (5th Dec. 1982).

Soil profiles show a peaty surface horizon and a poorly drained grey clay with depth.

Yield in this soil is less than in Thionic Fluvisols.

Analytical data are as follows:

pH (H_2O) 4.5 - 5.0: pH (KCl) 4.0 - 5.0

(3) Gleyic Cambisols (Gg)

Gleyic Cambisols is of very little extent in the project area. The soil is brown and comparable in colour to the upland soils.

Gleyic Cambisols occurs near Konta along the Little Scarcies river. Flooding occurs for 1 to

3 months with a water depth of about 50 cm. The soil is mainly used for rice nurseries.

Analytical data are as follows:

pH (H_2O) 5.0 - 5.5; pH (KCl) 9.5 - 5.5

3-5-3 Conclusion

The result of soil classification obtained are as follows (only paddy field).

Project area	1,208 (ha)	100 (%)
Thionic Fluvisols	824	68.2
Plinthic Gleysols	347	28.7
Gleyic Cambisols	37	3.1

3-6 Land Use

The project area is estimated to be about 1,585 ha. Out of this, about 1,208 ha appears to be suitable for paddy rice cultivation. Due to a shortage of labour and available irrigation water, however, the actual paddy rice cultivation is estimated at about 850 ha, 70% of the potential.

The land in the project area is classified into three categories based on the height of the ground surface level which coincides with the land use pattern.

The high lands, 29.5 m above sea level (to Storey Datum), has the resident areas, grass lands and coconut palm tree zone.

The intermediate area, elevation between 28.5 m and 29.5 m, is mainly utilized for paddy rice fields. Almost 90% of the paddy fields in the project area are in this category.

The ground surface level of the third category, where paddy rice cultivation is limited because of seasonal flooding, lies below 28.5 m asl. The land used for paddy fields is estimated at 50% of the low lying area.

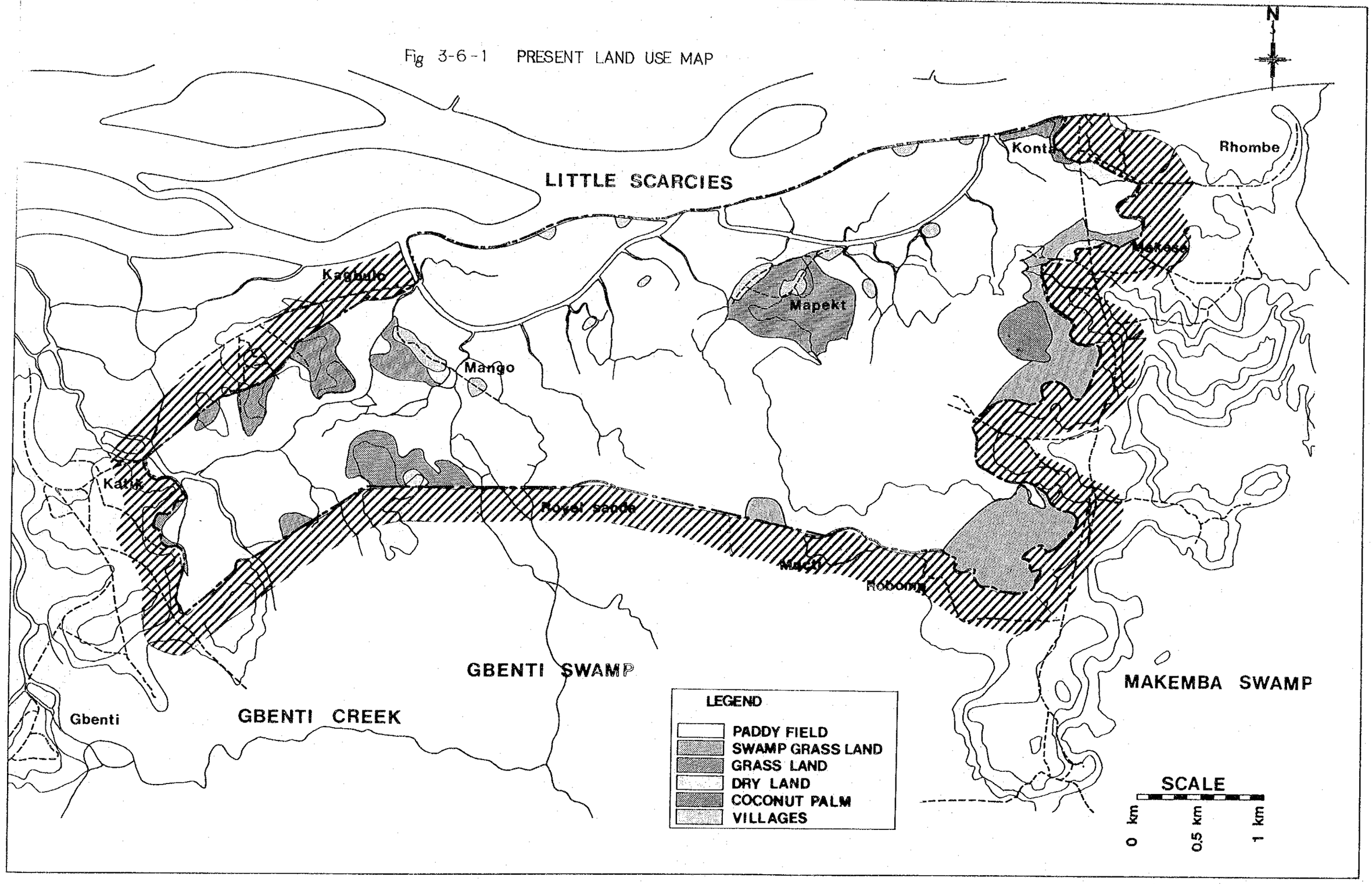
The present state of land use in the project area is summarized as shown in Table 3-6-1 and Fig. 3-6-1.

Table 3-6-1 Land Use Classification

Classification	Area (ha)	Ratio (%)
Paddy Field	1,208	76
Swamp Grass Land	119	7
Coconut Palm	38	3
Grass Land	76	5
Dry Field	10	0.6
Villages	17	1
Others	117	7.4
Total	1,585	100

Note: Others including creek and channel.

Fig 3-6-1 PRESENT LAND USE MAP



3-7 Agriculture Production

3-7-1 Rice Farming Practice

(1) Varieties

Over 90% of cropped varieties in the project area are long culm, medium term, local varieties. Most varieties are panicle weight types which lodge easily, so it takes more time to harvest. Grain form is mostly round and big with no beard. The paddy husk of some varieties is coloured black, brown or dapple brown. The rice grain also varies in colours, white, brown, red, etc.

There were some cases when farmers or even agricultural officers could not clearly identify rice type because of varietal crossing in the course of nature and mixed seeding on purpose. The most favoured local varieties grown are Fatuyando, Sanphary, Samayoka, Pa Black, Pa Lead, Thorkoll, etc. Among the improved varieties, Rok 3, Rok 5, Nachin 11, CP4, and CCA, are known to farmers. (See Table 3-7-1)

Experimental seed selection for salty water proved that amongst varieties like Rok 5 a lot of unripened seed was found. This tendency was particularly marked in the village where Rok 5 received no manure. (See Table 3-7-2)

(2) Nursery

Most of the seedling beds in which seeds are sown in May or June are flat rainfed ones. Some beds are prepared for seeding in August, September or October as in upland nurseries.

Table 3-7-1 Rice Varieties known to Farmers

Local Varieties

Pa Black, Pa Lead, Pa Thorkoll, Pa Fatuyando,
Pa Sanphary, Pa Samayoka, Pa Marh, Pa Tiaim,
Pa Abibatu, Pa Weenut, Pa Yeinkayanga, Pa China,
Pa Alpha, Pa Amara, Pa Yeino, Pa Kollma, Pa Guinee,
Pa Reyanah, Pa Koobar, Pa Dembarya, Pa Indian Bathurst,
Pa Koroma, Pa Mansaray, Pa Win The War, Pa Kimore,
Pa Kamara, Pa Boloo, Pa Thewuri

Improved Varieties

ROK 3, ROK 4, ROK 5, CCA, Chinan 5, CP 4, BD 2, ROK 5,
ROK 12, ROK 11, ROK 14, ROK 10, TOS 78, ROK 7, Andy 26,
72-1, 72-230, 73-49, Nanchin 11

Table 3-7-2 Seed Selection by Salty Water

Specific gravity / Variety	floating seed percentage 1.00	1.12	1.15	1.20	1000 grain weight	moisture contents
SEED Provided by Govt.						
ROK 3	4%	8%	11%	30%	29g	14%
ROK 5	18	34	41	55	28	13
ROK 6	8	21	23	57	22	13
CCA	15	35	48	82	18	15
73-230	19	35	51	69	22	14
SEED From Farmers						
SANFARAY	1.6	2	2.4	7.2	24	15
PA LEAD	2	4	6	14	30	13.5
PA BLACK	4	7	12	27	29	20
PA MARH	3	5	8	25	30	13.5
PA TOKOL	7	13	22	42	18	14
ROK 5	12	33	41	73	22	15

Though the seed quantity for the unit area of nursery is rather low (400 - 600 kg/ha), the nursery area ratio to paddy field averages about 10% which is bigger than in some high yield producing areas.

The rice seedling grows in the nurseries for about40 days or so and reaches a height of over 40 cm, being trimmed on top when transplanted. Even without watering for 2 months, short seedlings of about 25 cm have also been seen in upland nurseries in November.

(3) Transplanting

The land preparation is completed before transplanting commences. Plowing and levelling is not so hard when the land has been softened by the tide water. Labour expended in this land preparation is only 15% or less of the total rice cropping labour effort.

The number of seedlings per hill is about eight. The planting distances are about 20 x 25 (cm) with random planting - about 15 to 20 hills per square meter. All the farmers use a planting tool called DIBRA, made of bamboo or iron. Planting depth is 2 or 3 cm. Planting time is spread out over 4 months, from July to November. The large scale farmers (over 4 ha) divide their farm into 2 or 3 sections, and depending on conditions of water or labour force, harvest twice.

(4) Management of paddy fields

Weeding, manuring, and water management are not done in the project area. Wooden fences are often seen in the fields along the river or the creeks. These fences prevent fish from entering

the fields and act as a defence against land erosion.

The biggest damage to paddyfields is caused by wild birds, so some farmers make scarecrows. Nurseries near the river sometimes suffer great harm from crawling grubs, but partially.

Submergence of the field after transplanting causes the seedlings to wither and so decrease the yield.

(5) Harvesting

Harvesting is done with a straight 20 or 30 cm knife, but as the local varieties are weak in the stem and apt to fall down, farmers have to cut the paddy ears one by one. The ears are cut 50 to 60 cm long and about 70 cm remain after harvesting. The depth of mud in the field at harvest time is usually 20 to 30 cm.

Harvest time starts at the end of November and ends in the middle of March.

Average yield per unit area cannot be learned from farmers, who have no measure of weight an acreage. Their measure of paddy rice is the volume, but 1 bushel of paddy in all villages was found to be about 44 litres, which is over 20%.

A yield survey in the field shows various data, depending on crop varieties and/or crop conditions. Minimum yield is 60 gr/m^2 and maximum 600 gr/m^2.

(6) Cropping pattern

The actual cropping pattern in the Project area varies from farmer to farmer. Most farmers among the 41 surveyed grow rice two times a year but in

different fields. The Surveyed rice cropping season is as follows (Fig. 3-7-1).

Two cropping patterns have been observed because of the conditions of water and labour force, particularly among the larger scale farmers (over 4 or 5 ha).

In the latter pattern (Aug. to Feb.), the following special technics are employed by most farmers.

1) Use of upland nursery
2) Seed soaking and sprouting before sowing
3) Trimming seedlings (25 cm)
4) Use of few seedlings per hill (3 or 4 seedlings)

(7) Drying, storage and rice mill

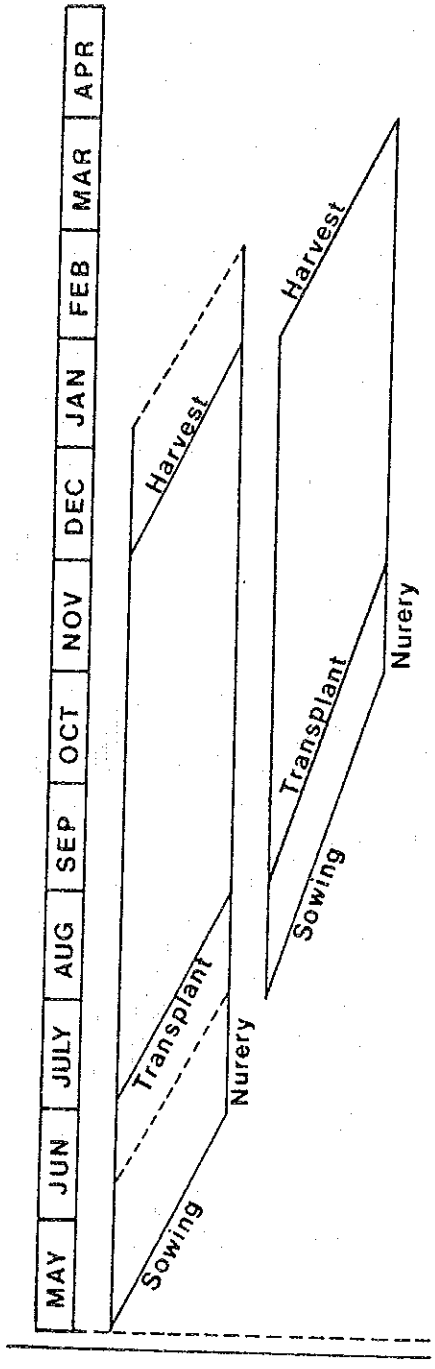
A good moisture content for harvested paddy is about 16% or so. There are two drying processes, both in panicles after harvest and in paddy grains after threshing.

Panicle drying is seen in the field with round shaped heaps or around the house eaves. Paddy grain drying is done on the road in front of the house or on a special cement yard for drying.

Wet panicles which have fallen down into water are sometimes dried after threshing and par-boiling. Threshing by mechanical means is seen only on the governmental farms. Farmers in the villages thresh the panicles with long sticks or by crushing underfoot.

Rice grains are usually stored in a wooden storage box in the house. Warehouses for paddy are not seen in villages.

Fig. 3-7-1 RICE CROPPING PATTERN AT PRESENT



Rice for sale is milled in the small factories, but rice for self-consumption is usually hulled and cleaned by pounding with big sticks.

3-7-2 Farm Household Economy

(1) Farming labour force

The data obtained by interviewing the farmers show that the total labour force expended for production of one ha of yield, is 136 Man-Days (MD). This breaks down into 2.2 MD for nurseries, 46.5 MD for transplanting, 72.0 MD for harvesting, and 15.0 MD for land preparation.

Harvesting accounts for 53% of the rice cropping labour. Labourers are easily hired by paying through a paddy sharing system, not with money. Farmers make it a custom to the give labourers 10% of the harvested paddy yield, and also to exchange and rotate labourers amongst themselves, especially family labourers, who work for free to help each other out.

Thirty six M.D., 26.5% of the labour efforts, is done by labourers outside the family. Average wage for this labour is Le. 2.6 per 1 M.D. which translates into a production cost per ha of Le. 94.

(2) Farm household income

Paddy Gross Income of farm households is Le. 698 per ha, based on the average ha yield (1.9 t) and farming scale (1.35 ha). These average values have been drawn from an investigation of farm households.

Paddy Net Income is determined by subtracting production cost from Paddy Gross Income. As the production cost per ha is Le. 126, Net Income becomes Le. 572. For the tenant farmer, the land rental should also be included as part of production cost. One ha of paddy field in the project area rents for Le. 46 a year on average.

Other agricultural income is derived from Palm oil, bananas, cassavas, yams, livestocks and so on. These are mainly for self-sufficiency and do not add to farm operation costs. For supplementary income, farmers do quite well by fishing and selling their catch.

Farm Household Net Income is calculated as Le.874 on the average. The Paddy Income share is about 90% of the total and the share of other agriculture and non-agriculture incomes is 5 to 7% each (See Table 3-7-3).

Table 3-7-3 Farm Household Income and Cost

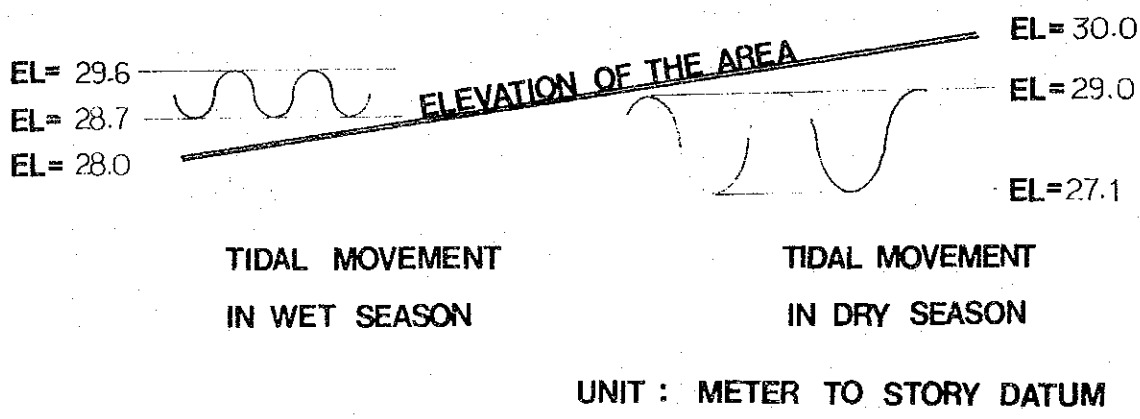
[Rice Production Income]	[Le. 773]
Rice Cropping area	1.35 ha
Yield per ha	1.9 t
Production	2.568 t
Gross Income	Le. 943
Production Cost	Le. 170
Net Income	Le. 773
[Other Agriculture Income]	[Le. 48]
[Non Agriculture Income]	[Le. 52]
Gross Income	Le. 69
Production Cost	Le. 17
Net Income	Le. 52
[[Total Farm Household Income]]	[[Le. 873]]

3-8 Present Condition of the Paddy Field

There are currently neither irrigation nor drainage facilities in the area. Rice cultivation is performed once a year allowing river water to enter the field, utilizing tidal movement and rainfall.

The relations between the elevation of the area and tidal movement are illustrated in Fig. 3-8-1.

Fig 3-8-1 ILLUSTRATING TIDAL MOVEMENT AND ELEVATION OF THE AREA



UNIT : METER TO STORY DATUM

There are no small bunds around the field, which means that the river water is allowed to pass in and out unimpeded.

At present, flooding in the wet season and intrusion of salty water in the dry season are significant features of this area. Rice is cultivated only in the wet season. Nowhere does double rice cropping take place, due to the intrusion of salty water.

he flood level, however, is very high; for example, it has been observed at Konta that the lowest water level figures for the month of September in 1961 and 1962 are 28.41 m and 28.68 m respectively. The drainage conditions are not satisfactory mainly where the elevation is lower than EL 28.5 m, which is almost 13% of the southern side of the total area. Since, from observation, the highest water level at high tide in September 1961 and 1962 reached 29.57 m and 29.38 m respectively, it can be said that irrigation and drainage conditions are far from satisfactory over almost the entire area of Gbenti North.

CHAPTER 4 DEVELOPMENT PLAN

CHAPTER 4 DEVELOPMENT PLAN

4-1 Objective of the Project

This is a major rice producing area which the government of Sierra Leone very much wishes to develop, but due to the prevailing conditions, which are very poor, low production and standard of living, it has been impossible to carry out development.

The major factors contributing to the present lack of development are flooding, salt water intrusion, and poor drainage over a large swamp area.

This area has a very low level of agricultural infrastructure, the improvement of which will require a very high initial investment cost, the introduction of high technology and long-term construction.

As a first stage plan it is proposed to install irrigation and drainage facilities, at present totally lacking in this area, as a main infrastructure.

As a result, the implementation of this plan will serve as a model for future plans projected for the entire area.

The project's objective is to introduce an infrastructure which will replace the area's unstable agriculture, which is at present entirely subject to natural conditions. The construction of artificial facilities means that the overall potential for production will be increased, double cropping per year will be employed and high productivity realized. At the same time self-sufficiency in staple foods will also be achieved.

The above factors are basically governed by the need for a secure supply of water in the dry season, employing drain channels and gates to prevent the intrusion of salty water.

The improvement of the infrastructure will enable new techniques to be introduced, which will raise the farmers standard of living and cause employment opportunities to increase. So it can be seen that this development plan will therefore have a direct positive influence on both social and economic development.

The standard for the irrigation and drainage design, under the agreement reached with the concerned parties of Sierra Leone, will adopt a once in five years probability for such a technical design.

4-2 Fundamental Plan of Development

Fundamentals of the development plan from the engineering point of view are as follows:

(1) Flood protection

(2) Drainage of excess rainfall

(3) Prevention of salt-water intrusion during dry season

(4) Security of steady water resources

Two crops of rice can be raised in the area when these conditions are fulfilled.

Fundamentals for the fulfillment of these conditions are respectively, as follows.

(1) Construction of polder

(2) and (3) Miter gates and irrigation pumps, the latter possibly serving as drainage aids in the event of an emergency

(4) Construction of water supply channel

4-2-1 Site Development Plan

As mentioned in 3-8, as there are no artificial dikes or bunds, this area is influenced directly by the water level of the Little Scarcies. It is observed that the river water floods the paddy field in wet season and sea water intrudes into the field in dry season.

It is proposed to avoid the river's above-mentioned negative influence by the construction of polders in the site.

In this case, there are two methods of polder construction. One is to enclose the total area by a bund and make one large polder, and the other is to divide the area into small sections and make small scale polders in the site.

A comparison of these two development alternatives is listed below in Table 4-2-1.

Table 4-2-1 Comparison of the Polder Plan

Items	large scale polder plan	small scale polder plan
Closing method	One large polder is constructed	Total area is divided into 16 small polders.
existing creeks	Poor drainage will be caused at adjacent swamps as the bund will effectively isolate the project area. Transportation by boat will become impossible.	Creeks will serve as drain channels and transportation by boat can continue uninterrupted.
Drainage facilities	Large scale drain pump station and a tide gate about 60 m wide are necessary.	Existing creeks can be used as drain channels utilizing difference of tide level. 32 miter gates for water control, of a width of 1.5m, are necessary.
Farm road	It is necessary to construct farm roads within the polder.	Bunds for polder can be used as farm roads.

It can be said that construction of a large scale polder will, in fact, involve almost the same amount of earthwork as the small scale polder plan, taking into consideration farm road construction.

From the point of view of drainage, transportation and the scale of the construction, the small scale polder plan is accordingly recommended.

4-2-2 Water Resources

A steady supply of irrigation water throughout the year is vital for the double cropping a year plan to be realised.

The three resources under consideration are;

(1) The Little Scarcies

(2) Water of Makemba North Swamp

(3) Groundwater

4-2-3 Method of Intake

Regarding intake of water, three alternatives are considered. They are intake without pumping, head works and intake by pumping. As there is no appropriate site for head works, this possibility was deleted.

(1) Intake without pumping

This is a plan to take water from the Little Scarcies at Sirian, Mange or Makane.

(2) Intake by pumping

1) Pumping up from the Little Scarcies directly at Sirian or Rhombe.

2) Water to be diverted at Rhombe, conveyed to the site and pumped up at each polder.

(3) Utilization of water in Makemba Swamp

(4) Utilization of ground water

The above mentioned alternatives are explained briefly in Table 4-2-2. (Refer to Chapter 8 of Appendix for further details)

4-2-4 Cost Comparison

As a result of investigation, the small scale polder plan is recommended as the most appropriate one for the site development. With regard to water resources, the final competitive alternatives proved to be III and IV. Therefore the construction and operation cost of each plan was compared, as listed in Table 4-2-3.

Table 4-2-3 Comparison of Investment Cost and M/O Cost

(Unit: 1,000)

Item	Plan III	Plan IV
1. Pump Station	3,257	1,659
2. Water Supply Channel	5,982	1,849
3. Road and Bridges	4,386	4,386
4. Bund and Land Consolidation	7,092	7,029
5. Miter Gate	-	62
6. Others	13,171	13,325
Total	33,888	28,310
M/O Cost for Project Life	1,957	1,769

Table 4-2-2 List of Alternatives

	Big Scale Polder Plan	Small Scale Polder Plan
Site Development Plan	Poor drainage in adjacent swamp area, as the bund will effectively isolate the project area. Necessity of installing a large scale drain pump and gate. Impossibility of transportation by boat at present. It is necessary to construct farm roads within the polder. This plan is not recommended.	Creeks will serve as drain channels and transportation by boat can continue uninterrupted. Bunds for polder can be used as farm roads. This plan is recommended.

Development plan	Small Scale Polder Plan							
Water resources	The Little Scarcies						Makemba Swamp	Groundwater
Method of intake	No Pumping I			Pumping II	Pumping III	No pumping IV	No pumping V	Pumping VI
Method of supply	No pumping			No pumping	No pumping	Pumping	Pumping	No pumping
Place of Intake	Sirian	Mange	Makane	Sirian	Rhombe	Rhombe	Makasa	Project area
Features	Necessary water level at this point is EL.35.24m to storey datum, whereas the mean low tide level in February is in fact EL.27.3m to story datum. This plan is impossible.	The necessary water level at Mange is El.36.7m, whereas the low water level is in fact EL.29.5m. Therefore this plan is impossible to intake water without pumping.	Construction of tunnel (L = 2.8km, ϕ2,500) and 23.9km long convey channel are necessary. Construction cost is estimated about Le. 30 million. This plan is not recommended.	Water quality is good for rice throughout the year. Construction cost is higher than Rhombe intake plan.	Operation of pumping is over by the middle of February. Water quality of this period is good for rice. Pump station for drainage is necessary at each polder. Necessary facilities: Irrigation pump station, Q = 1.2 m3/s x 3 H = 5.6m — 1 Drainage pump station, Q = 7 m3/min. x 2 H = 3.5m — 16 Convey channel (banking) — 8,200 m Convey channel (cut) — 2,000 m Siphon Dimension 2m x 1.5m — 4 Siphon Dimension ϕ800 — 4 Bund W = 3.0m — 38.9 km Land consolidation — 1,300 ha	Supply of irrigation water is pumped up by the small pump made at each polder. Drainage is performed by the same pump. Water control is performed by miter gates. Necessary facilities: Miter gate (Rhombe, Makasa) — 2 Pump station for irrigation and drainage 16 each 7 m3/min. x 2 H=3.5m — 16 Water supply channel (cut) — 13,250 m Siphon Dimension 2m x 1.5m — 4 Siphon Dimension ϕ800 — 4 Bund W=3.0m — 38.9 km Land consolidation — 1,300 ha	Little water in the dry season. When this swamp is used as a new reservoir, existing cultivating land, about 240 ha, will not be available. The Construction of dikes will be necessary to store water. Therefore this method is not so good as the direct intake at Rhombe on The Little Scarcies because of the high construction cost for reservoir.	A groundwater development is not recommended because a major part of the project area consists of impermeable layer such as swamp deposits and weathered basement with lack of sandy layers.

4-2-5 The Recommended Plan

The comparison of cost having been made it has been concluded that the scheme IV is the best selection.

The scheme IV is outlined as follows:

- The area is divided into 16 small scale polders without any modification of the existing big creeks.
- Irrigation water is diverted through a miter gate to be installed at Rhombe, and is lead to rice fields by a water supply channel which is to be installed through the hills at Makasa by an open-cut method.
- During the dry season the irrigation will be done by pumping at pump stations to be built at each polder.
- During the wet season the drainage from each polder will be done at low tide through a miter gate to be installed at each polder, but if the external water level is higher than the internal water level the water will be drained to the water supply channel. Accordingly, a miter gate is required at Makasa in order to prevent the intrusion of flooding water into the water supply channel.
  The drain from the water supply channel will be led to creeks, utilizing irrigation pumps.

4-3 Farming

4-3-1 Land Use and Cropping Scheme

(1) Land use

The planned paddy field area will occupy 1,287 out of 1,585 ha of the total Project area. The land to be reclaimed for paddy fields is 195 ha of grass land.

The planned rice crop area will be 2,574 ha, with double rice cropping by good water management. This means an increase in area size of about 2.7 times, compared with the actual rice crop area of 846 ha, estimated to be 70 per cent of the total swamp cultivation area at present.

Land use classification and rice crop area are shown by Table 4-3-1.

Table 4-3-1 Land Use Classification and Paddy Rice Area

h.a. Classification	A at present	(%)	B with project	(%)	B/A INDEX (%)
Paddy Field	1,208	(76.2)	1,287	(81.2)	106.5
Cropping Ratio	70		200		285.7
Paddy Crop Area	846		2,574		304.3
Grass Land	76	(5.0)	0	(0)	-
Swamp Grass Land	119	(8.0)	0	(0)	-
Coconut Palm	38	(2.0)	38	(2.0)	100.0
Dry Field	10	(0.5)	10	(0.5)	100.0
Village	17	(1.0)	17	(1.0)	100.0
Creeks, Canals Roads	117	(7.4)	233	(14.7)	199.1
Total	1,585	(100%)	1,585	(100%)	100.0

(2) Double cropping pattern for rice cultivation

The cropping pattern in wet season is planned to be similar to the present pattern, with sowing in May or June, and transplanting in June or July.

The transplanting duration in the project area will hopefully be shortened to the month of June only, due to the scheduled water and seedlings supply, although it is presently taking two months because of rainfall and labour management conditions. Mechanization of plowing and sowing will help to shorten the field preparation.

Medium term varieties, the growing period of which is 130 - 140 days, are chosen for wet season cropping. They are planned for the nursery in May, transplanting in June, and harvesting in October.

Of the total farming labour workforce, over half are presently involved in harvesting, so the project's resulting increase in acreage and yield will mean a labour force shortage at harvest time. It is proposed to solve this problem by the introduction of seasonal labour hired from outside the area.

Dry season cropping will start in November using the direct sowing method, with only one month's interval after the wet season harvesting. Direct sowing is presently employed by some farmers whose farms are located where the water conditions permit this method. Seed soaking and sprouting techniques are generally known to the farmers.