THE REPUBLIC OF SIERRA LEONE

THE FEASIBILITY STUDY REPORT ON THE RHOMBE SWAMP AGRICULTURAL DEVELOPMENT PROJECT

APPENDIX

SEPTEMBER, 1983

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

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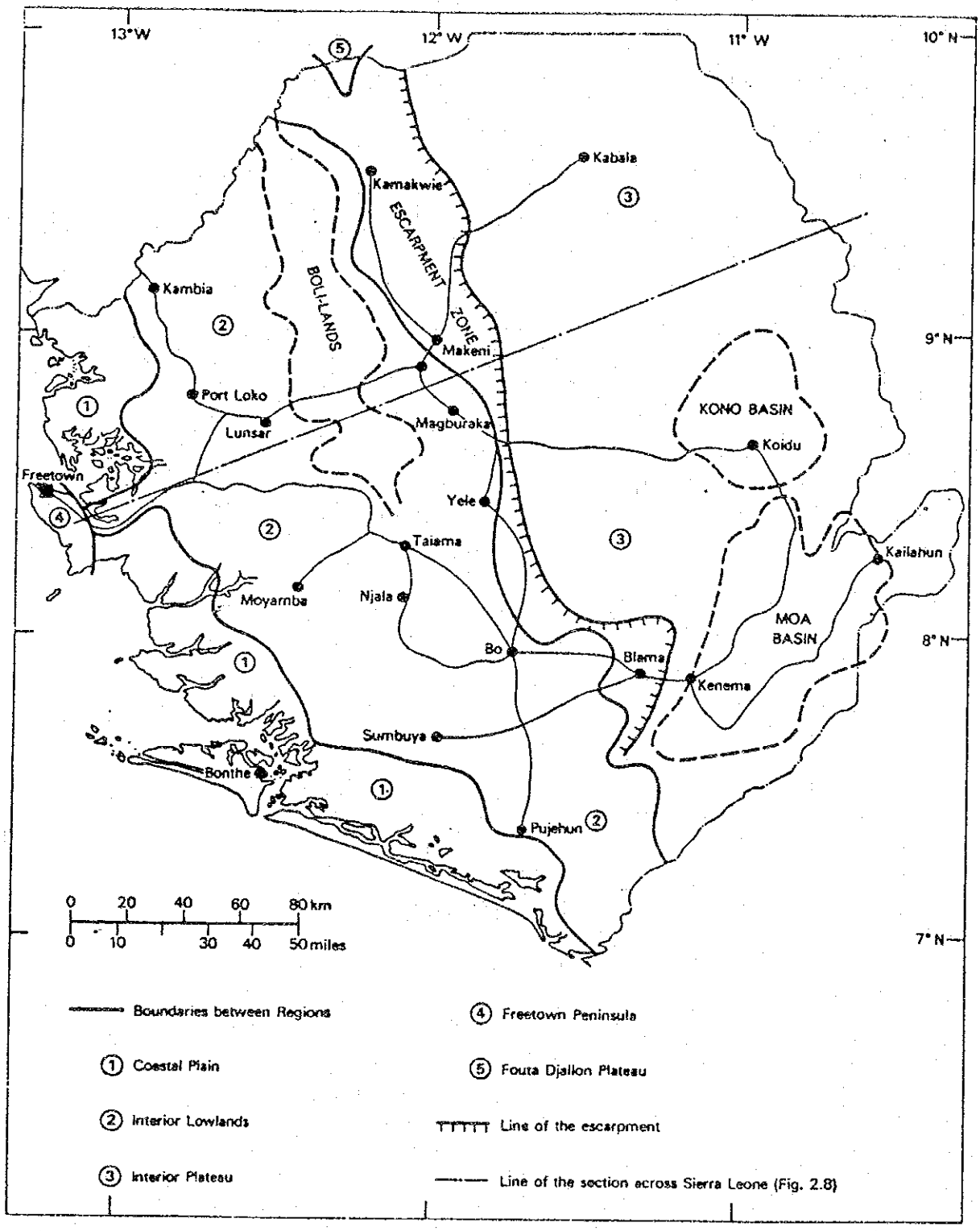
1-1 General

Fig. 1-1-1 PHYSICAL REGIONS OF SIERRA LEONE



* Tabken from "A New Geography of Sierra Leone", DRG Gwynne-Jones (1978)

Population

The FAO statistics of 1977 gave slightly bigger figures. The estimate in 1975 was 2,983 x 10^3. The annual growth rates estimated for the other periods are bigger, too. i.e, 2.41 for '70 - '75; 2.57 for '75 - '80; 2.64 for '80 - '85.

In the economic review of the Bank of Sierra Leone, the growth rates it uses are ca. 2.2% from 1974/75 to 1976/77, 2.1% for 1977/78 and 2.7% for 1978/79.

Table 1-1-1 TOTAL POPULATION AND ANNUAL GROWTH RATE

	1963	1974	Annual growth rate %	Density 1974 (/km^2)	Sex Ratio in 1974 M/F X 100
Sierra Leone	2,180,355	2,729,479	2.06	38	98.8
Port Loko (dist.)	247,463	292,853	1.54	52	93.2
Loko Masama (chiefdom)	47,853	47,826	-0.01	65	95.6
Gfenti	1,320	1,165	-1.13	-	96.5
Kontha	1,161	853	-2.76	-	97.5
Katik	984	583	-4.65	-	93.7
Kagbulo	900	736	-1.81	-	87.8

Source: Census 1963 & 1974

Table 1-1-2 PRINCIPAL POPULATION INDICATORS IN 1975

Age Distribution	0 - 14 y	15 - 64 y	65 -
	42.7 %	54.2%	3.1%
	Rural	Urban	
Area Distribution	85 %	15 %	
Annual Growth Rate (1970 - 1975)	2.1 %	4.2%	
	Agri.	Non Agri.	
Labour Force	68.4 %	31.6 %	
Annual Growth Rate (1970 - 1975)	0.9 %	3.7 %	

Source: "F A O (1977)" : Population 1975

Table 1-1-3 POPULATION OF 10 YEARS OF AGE (*) AND DITTO LABOUR FORCE, ITS EMPLOYMENT TREND AND GROWTH RATE

			1963 ($X10^3$)	1974	Growth rate (%)
1	Population ≧10 years old	Male	748	866	1.3
		Female	774	885	1.2
		Total	1,522	1,751	1.3
2	Labour Force (2=3+4) (**)	Male	604	772	2.3
		Female	334	336	0.0
		Total	938	1,108	1.5
3	Employment (3=5+6)	Male	577	727	2.1
		Female	331	283	-1.4
		Total	908	1,010	0.9
4	Unemployment	Male	27	66	8.5
		Female	3	73	33.7
		Total	30	139	15.0
5	Employment (Agricultural Sector)	Male	405	515	2.2
		Female	297	221	-2.7
		Total	702	736	0.4
6	Employment (Non-Agricultural Sector)	Male	172	212	1.9
		Female	34	62	5.6
		Total	206	274	2.7
7	Salary and Wage Earner	Male	96	132	2.9
		Female	6	15	8.7
		Total	102	147	3.4
8	Participation R a t e 1/2 X 100	Male	80.7	89.1	0.9
		Female	43.2	38.0	-1.2
		Total	61.6	63.3	0.2
9	Unemployment R a t e 4/3 X 100	Male	4.7	9.1	6.2
		Female	0.9	25.8	35.7
		Total	3.3	13.8	13.9

Source : G.M.K. Kpedekpo, 1981 :
"Some Aspects of the Sierra Leone Labour Force as revealed by the 1974 Census"

(*) 10 years and above (1963)
12 years - " - (1974)

(**) The figure does not tally in the case of 1974. Though all figures have detailed breakdown

Table 1-1-4 TRENDS IN THE SECTORAL DISTRIBUTION OF THE EMPLOYED LABOUR FORCE

	1963 ($X 10^3$)	%	1974 ($X 10^3$)	%	change %
1. Agri.,Forest,Fish	703	77.4	735	72.7	4.6
2. Mine & Quarry	48	5.3	21	2.1	-56.3
3. Manufacture	41	4.5	48	4.8	17.1
4. Elect.,Gas & Water	2	0.2	2	0.2	0.0
5. Construction	16	1.8	18	1.8	12.5
6. Commerce	53	5.8	98	9.7	84.9
7. Transport, Storage & Communicator	16	1.8	27	2.7	68.8
8. Services	29	3.2	61	6.0	110.3
T o t a l	908	100.0	1010	100.0	-

Source : G. M. K. Kpedekpo ;
1981, ibid.

Table 1-1-5 GROSS DOMESTIC PRODUCTS AT FACTOR COST BY KIND OF ECONOMIC ACTIVITY, NATIONAL INCOME AND PAR CAPITA INCOME AT CURRENT PRICES

	CLASSIFICATION	(In Million of Leones)					(Percentage Distribution)				
		1975/76	1976/77	1977/78	1978/79	1979/80	1975/76	1976/77	1977/78	1978/79	1979/80
1.	Industries										
1.1	Agriculture Forestry Hunting and Fishing	213.0	263.9	281.7	321.5	331.5	38.1	39.6	37.5	35.2	31.4
1.2.	Mining and Quarring	60.4	67.9	72.1	115.9	125.8	10.8	10.2	9.6	12.7	11.9
1.3	Manufacturing and Handicraft	31.2	34.0	40.2	54.5	58.5	5.6	5.1	5.4	6.0	5.5
1.4	Electricity and Water Supply	4.7	5.7	5.1	4.7	3.5	0.8	0.9	0.7	0.5	0.3
1.5	Construction	17.4	22.1	24.3	28.5	45.0	3.1	3.3	3.2	3.1	4.3
1.6	Wholesale, Rental, Trade, Hotel and Restaurants	68.4	91.6	116.5	140.3	153.3	12.3	13.7	15.5	15.4	14.5
1.7	Transports Storage and Communication	65.5	70.7	83.9	107.2	182.9	11.7	10.6	11.2	11.8	17.3
1.8	Finance, Insurance, Real Estate Other Business Industries	47.3	51.8	59.7	67.5	82.0	8.5	7.8	8.0	7.4	7.8
1.9	Other Services	17.2	15.0	20.6	24.6	24.8	3.1	2.2	2.7	2.7	2.4
1.10	Less Imputed Services Charges of Financial Intermediaries	(8.3)	(6.6)	(7.3)	(17.3)	(22.5)	(1.5)	(1.0)	(1.0)	(1.9)	(2.1)
1.11	Total Industries	516.8	616.1	696.8	847.4	984.8	92.5	92.4	92.9	92.9	93.4
2.	Producers of Government Services	39.8	48.9	51.3	62.2	67.0	7.1	7.3	6.8	6.8	6.4
3.	Producers of Private Non-profit Services to Households	2.0	2.2	2.2	2.5	2.5	0.4	0.3	0.3	0.3	0.2
Gross Domestic Product at Factor Cost		558.6	667.2	750.3	912.1	1,054.3	100.0	100.0	100.0	100.0	100.0
								+ 19.4	+ 12.5	+ 21.6	+ 15.6
Net Factor Income From Abroad		- 9.8	-11.2	-17.0	-40.7	-44.5	percentage change over previous year	+ 14.3	+ 51.8	+139.4	+ 9.3
Gross National Product at Factor Cost		548.8	656.0	733.3	871.4	1,009.8		+ 19.5	+ 11.8	+ 18.8	+ 15.9
Less : Fixed Capital Consumption		-49.3	-58.5	-69.1	-79.0	-107.4		+ 18.7	+ 18.1	+ 14.3	+ 35.9
National Income		499.5	597.5	664.2	792.4	902.4		+ 19.6	+ 11.2	+ 19.3	+ 13.9
Total Population		2.79	2.85	2.91	2.97	3.05		+ 2.15	+ 2.11	+ 2.06	+ 2.69
Per Capita National Income (Leones)		179.03	209.65	228.25	266.8	295.9		+ 17.10	+ 8.87	+ 16.89	+ 10.91

NOTE : - Estimates relate to the period July-June
Source:- Bank of Sierra Leone : Economic Review, Vol 15

Table 1-1-6 GROSS DOMESTIC PRODUCT AT FACTORY COST BY KIND OF ECONOMIC ACTIVITY AT 1972 - 73 PRICES

	CLASSIFICATION	(In Million of Leones)					(Percentage Distribution)				
		1975/76	1976/77	1977/78	1978/79	1979/80	1975/76	1976/77	1977/78	1978/79	1979/80
1.	Industries										
1.1.	Agriculture, Forestry, Hunting and Fishing	117.4	123.5	126.0	135.5	128.3	31.9	32.6	33.2	34.2	31.4
1.2	Mining and Quarring	50.1	42.4	26.3	28.2	31.7	13.6	11.2	6.9	8.4	7.7
1.3	Manufacturing and Handicrafts	26.0	25.3	26.7	27.6	25.9	7.1	6.7	7.0	6.8	6.3
1.4	Electricity and Water Supply	1.6	1.6	1.7	1.8	1.9	0.3	0.4	0.5	0.5	0.5
1.5	Construction	12.5	13.2	13.9	14.4	18.3	3.4	3.5	3.7	3.7	4.5
1.6	Wholesale, Retail Trade, Hotels & Restaurents	45.0	46.8	53.7	51.2	49.6	12.2	12.4	14.2	13.0	12.1
1.7	Transport Storage and Communications	40.7	40.3	42.4	46.6	58.5	11.0	10.7	11.2	12.2	14.3
1.8	Finance, Insurance, Real Estate and Other Business Services	33.2	33.1	35.3	35.6	40.1	9.0	8.7	9.3	8.8	9.8
1.9	Other Services	12.7	13.5	12.3	12.6	13.1	3.4	3.6	3.2	3.2	3.2
1.10	Less Imputed Service Charges of Financial Intermediaries	- 5.4	- 3.7	-3.8	- 8.0	- 8.7	- 1.5	- 1.0	- 1.0	- 1.3	- 2.1
1.11	Total Industries	333.8	336.0	334.5	345.5	358.7	90.4	88.8	88.2	89.5	87.7
2.	Producers of Government Services	33.1	40.7	42.8	47.1	48.6	9.0	10.8	11.3	10.0	11.9
3.	Producers of Private Non-profit Services to Households	1.7	1.6	1.8	1.8	1.8	0.5	0.4	0.5	0.5	0.4
	G.D.P. at 1972 - 73 Prices (at F.C.)	368.6	378.3	379.1	394.4	409.1	100.0	100.0	100.0	100.0	100.0

Source : - Bank of Sierra Leone : Economic Review Vol. 15

Table 1-1-7 BALANCE OF PAYMENTS

(In Thousands of Leones)

CLASSIFICATION	1977			1978			1979			1980		
	Credit	Debit	Net Inflow (+)	Credit	Debit	Net Inflow (+)	Credit	Debit	Net Inflow (+)	Credit	Debit	Net Inflow (+)
GOODS AND SERVICES	189,455	269,009	-79,554	221,180	368,240	-147,060	256,635	486,538	-229,903	290,128	537,136	-247,008
1. Merchandise	163,542	189,253	-25,711	193,764	264,918	-71,154	208,365	355,475	-147,110	224,082	405,073	-180,991
2. Freight and Insurance	1,229	18,790	-17,561	3,182	29,924	-26,742	3,267	40,244	-36,977	6,080	48,111	-42,031
2-1 Freight	-	16,678	-16,678	-	23,268	-23,268	-	31,087	-31,087	-	35,798	-35,798
2-2 Insurance	1,229	2,112	- 883	3,182	6,656	- 3,474	3,267	9,157	-5,890	6,080	12,313	-6,233
3. Other Transportation	13,328	6,752	6,576	12,818	6,543	6,275	30,254	9,263	20,991	29,933	13,298	16,635
4. Travel	3,397	4,367	- 970	3,907	5,022	- 1,115	4,885	6,278	- 1,393	13,128	8,784	4,344
5. Investment Income	2,191	19,212	-17,021	452	35,562	-35,110	424	44,942	-44,518	793	23,711	-22,918
6.1 Direct Investment Income	64	6,091	- 6,027	86	18,649	-18,563	170	21,778	-21,608	192	5,878	-5,686
6.2 Other dividend	-	901	901	-	1,068	1,068	-	959	959	-	5,459	5,459
6.3 Other Interests	2,127	12,220	-10,093	366	15,845	-15,479	254	22,205	-21,951	601	12,374	-11,773
6. Private other serveces	3,132	25,876	-22,744	4,301	17,136	-12,835	6,384	23,245	-16,861	12,542	26,122	-13,580
7. Government not included elsewhere												
(Non-Military Transactions)	2,636	4,759	- 2,123	2,756	9,135	- 6,379	3,056	7,091	- 4,035	3,570	12,037	- 8,467
Transfer Payments (9 plus 10)	25,589	2,301	23,288	23,152	2,498	20,654	37,262	2,941	34,321	59,852	4,341	55,511
8. Private Transfer Payments	7,207	1,823	5,384	9,512	1,445	8,067	8,623	1,962	6,661	10,758	2,054	8,704
9.1 To and From Foreign	915	672	243	1,034	27	1,007	1,100	29	1,071	72	-	72
9.2 Other	6,292	1,151	5,141	8,478	1,418	7,060	7,523	1,933	5,590	10,686	2,054	8,632
9. Central Government Transfer	18,382	478	17,904	13,640	1,053	12,587	28,639	979	27,660	49,094	2,287	46,807
9-1 Inter-governmental	17,056	470	16,586	11,627	581	11,046	26,403	512	25,891	45,680	1,549	44,131
9-2 Other	1,326	8	1,318	2,013	472	1,541	2,236	467	1,769	3,414	738	2,676
NET SURPLUS / DEFICIT ON CURRENT ACOUNT	215,044	271,310	-56,266	244,332	370,738	-126,406	293,897	489,479	-195,582	349,980	541,477	-191,497
CAPITAL AND MONETARY GOLD												
10 Private Long-term (including direct investment)	8,254	19	8,235	29,481	396	29,085	26,040	2,426	23,614	24,021	30,606	-6,585
10.1 Direct investment	5,769	19	5,750	25,553	174	25,379	19,354	2,409	16,945	7,827	27,474	-19,647
10.2 Other Liabilities	2,475	-	2,475	807	222	585	181	17	164	13,689	3,131	10,558
10.3 Other Assets	10	-	10	3,121	-	3,121	6,505	-	6,505	2,505	1	2,504
11 Private short-term (other than direct investment)	5,329	-1,414	6,743	9,516	- 113	9,626	36,033	3,850	32,183	29,462	104	29,358
TOTAL PRIVATE CAPITAL	13,583	1,395	14,998	38,997	823	38,714	62,073	6,276	55,797	53,483	30,710	22,773
12 Central Government												
12.1 Long-term issues abroad	-	-	-	-	-	-	-	-	-	-	-	-
12.2 Foreign long-term secu-	-	-	-	-	-	-	-	-	-	-	-	-
12.3 Short-term /rities securities Issued by	-	-	-	-	-	-	-	-	-	-	-	-
12.4 Long-term loans /Government												
12.4.1 Drawings	18,394	-	18,394	11,855	-	11,855	26,699	-	26,699	58,224	-	58,224
12.4.2 Repayments	-	3,260	-3,260	-	10,876	-10,876	-	18,655	-18,655	-	15,055	-15,055
12.5 Other long-term asset & liab.	11,630	19,745	-8,115	29,496	-	29,496	-	-	-	6,574	-	6,574
12.6 Other short-term asset & liab.	17,601	4,811	12,790	65,405	44,726	20,679	79,467	33,244	46,223	119,026	62,790	56,236
Total Government	47,625	27,816	19,809	106,756	55,602	51,154	106,166	51,899	54,267	183,824	77,845	105,979
Surplus (*) / Deficit (-) of current & capital items as recorded	-	-	-21,479	-	-	-36,538	-	-	-85,220			-62,745
13. Arrears & Refinancing	15,884	-	15,884	24,697	-	24,697	49,911	51,230	49,911 1/	51.230	-	51,230
14. Allocation of S.D.R.	-	-		-	-	-	-	-	4,404	-	-	4,404
15. Monetary Institutions												
15.1 Central Monetary	9,607	17,232	-7,625	19,707	9,177	10,530	13,391	12,072	1,319	27,735	1,028	21,707
15.1.1. Account with IMF	6,796	-	6,796	1,585	2,986	-1,401	1,046	-	1,046	-	911	- 911
15.1.2. Marketable assets	1,038	-	1,038	2,990	-	2,990	-	1,654	-1,654	2,702	-	2,702
15.1.3. Deposits	1,773	17,232	-15,459	15,132	6,191	8,941	12,345	10,418	1,927	20,033	117	19,916
15.2 Other Monetary Institutions	370	3,880	-3,510	-	4,754	-4,754	761	40	721	-	3,680	-3,680
15.2.1. Marketable assets	-	-	-	-	-	-	-	-	-	-	-	-
15.2.2. Deposits	370	3,880	-3,510	-	4,754	-4,754	761	40	721	-	3,680	-3,680
Total Monetary Institutions (17.1 + 17.2)	9,977	21,112	-11,135	19,707	13,931	5,776	14,152	12,112	2,040	22,735	4,708	18,027
NET UNRECORDED ITEM			+16,730			+6,065			-28,865			-10,919

Source : Bank of Sierra Leone : Economic Review Vol. 15

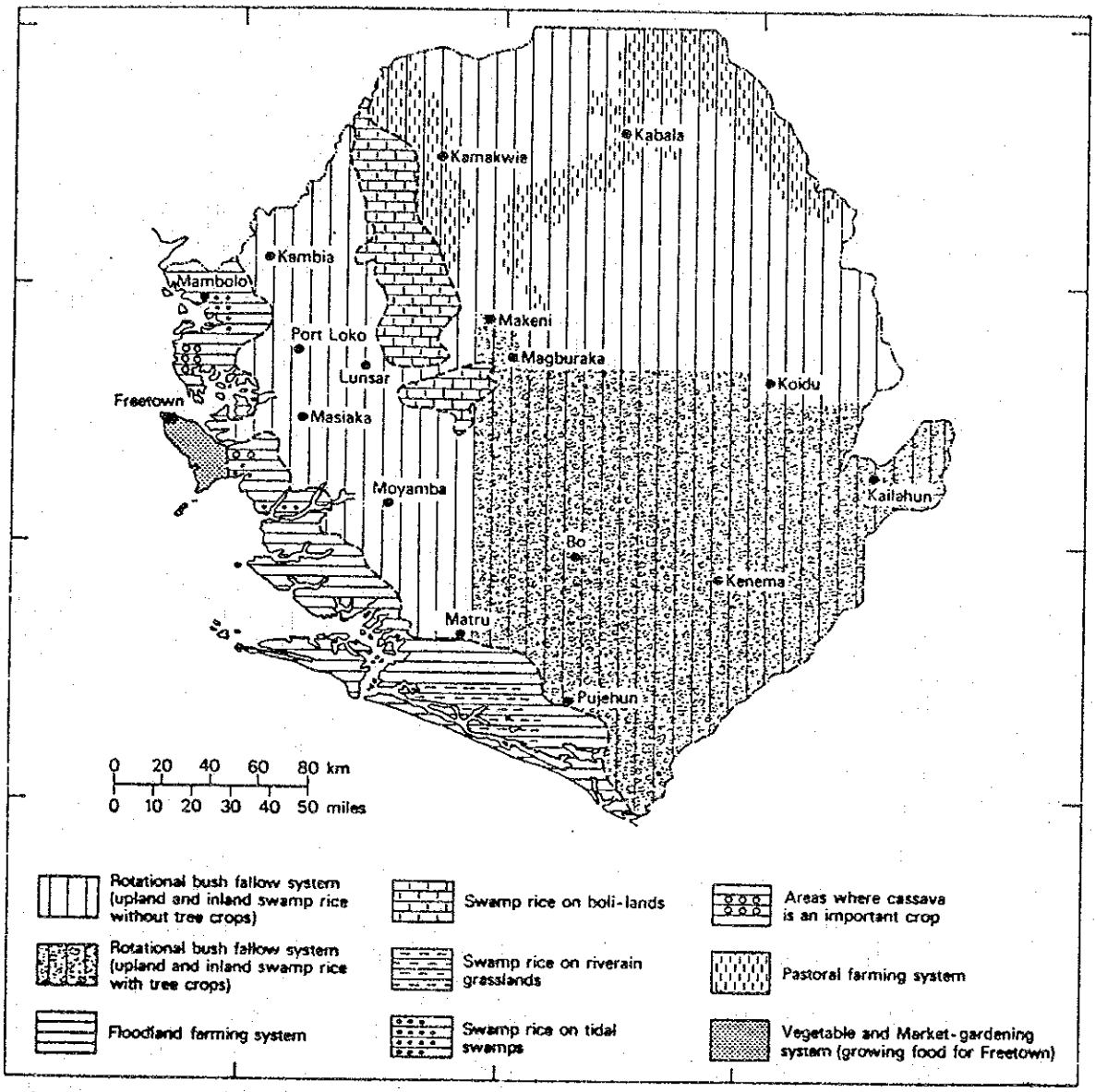
Table 1-1-8 SUMMARY OF DEVELOPMENT FINANCIAL RESOURCES AND EXPENDITURE 1982/83

TITLE OF HEAD	DOMESTIC	FOREIGN	TOTAL
	Le	Le	Le
I DEVELOPMENT EXPENDITURES	32,730,000	85,671,000	118,401,000
1.Economic Services	26,522,000	73,318,000	99,840,000
2.Social Services	3,385,000	8,853,000	12,238,000
3.General Services	2,823,000	3,500,000	6,323,000
II DEVELOPMENT RESOURCES	32,730,000	85,671,000	118,401,000
1.Agricultural Development Fund	1,540,000	-	1,540,000
2.OPEC Special Fund	1,260,000	-	1,260,000
3.Proceeds from PL 480 Sales	6,690,000	-	6,690,000
4.Proceeds from Commodity Sales (Rice and Sugar)	2,673,000	-	2,673,000
5.Internal Borrowings	20,567,000	-	20,567,000
6.External Resources (Bilateral and Multilateral Loans and Grants and other External Borrowings)	-	85,671,000	85,671,000

Table 1-1-9 SUMMARY OF DEVELOPMENT ESTIMATES BY SECTOR AND BY MINISTRY 1982/83

TITLE OF HEAD	DOMESTIC	FOREIGN	TOTAL
	Le	Le	Le
GRAND TOTAL	32,730,000	85,671,000	118,401,000
1. ECONOMIC SERVICES	26,522,000	73,318,000	99,840,000
A Ministry of Works	...4,300,000	11,278,000	15,578,000
B Ministry of Agriculture and Forestry	...5,543,000	20,871,000	26,414,000
1.Agriculture	5,407,000	19,371,000	24,778,000
2.Forestry	136,000	1,500,000	1,635,000
C Ministry of Natural Resources	...732,000	1,853,000	2,585,000
1.Veterinary	412,000	1,260,000	1,672,000
2.Fisheries	320,000	593,000	913,000
D Ministry of Transport and Communications	...405,000	100,000	505,000
1.Posts and Telecommunications	265,000	-	265,000
2.Civil Aviation	100,000	-	100,000
3.Meteorological Department	24,000	100,000	124,000
4.Road Transport Department	16,000	-	16,000
E Ministry of Energy and Power	...7,113,000	10,050,000	17,163,000
1.Water Supply	3,683,000	3,050,000	6,733,000
2.Electricity	3,430,000	7,000,000	10,430,000
F Ministry of Trade and Industry	...132,000	94,000	1,072,000
G Ministry of Tourism and Cultural Affairs	...10,000	-	10,000
H Ministry of Mines	...480,000	3,000,000	3,480,000
I Ministry of Development and Economic Planning	...7,807,000	25,226,000	33,033,000
II. SOCIAL SERVICES	3,385,000	8,853,000	12,238,000
J Ministry of Education	2,563,000	5,578,000	8,141,000
K Ministry of Social Welfare and	131,000	-	131,000
L Ministry of Health	641,000	3,275,000	3,916,000
M Ministry of Lands,	50,000	-	50,000
N Ministry of Labour	2h	-	2h
Housing and Country Planning			
III. GENERAL SERVICES	2,823,000	3,500,000	6,323,000
O Ministry of Defence	480,000	-	480,000
P Office of the President	2,050,000	3,500,000	5,550,000
Q Ministry of Information and Broadcasting	108,000	-	108,000
R Ministry of Finance	85,000	-	85,000
S Ministry of Foreign Affairs	100,000	-	100,000
T Ministry of the Interior	2h	-	2h

Fig. 1-1-2 FARMING SYSTEMS IN SIERRA LEONE



* Taken from "A New Geography of Sierra Leone", DRG Gwynne-Jones (1978)

Fig. 1-1-3 PROPOSED MINISTRY OF AGRICULTURE AND NATURAL RESOURCES

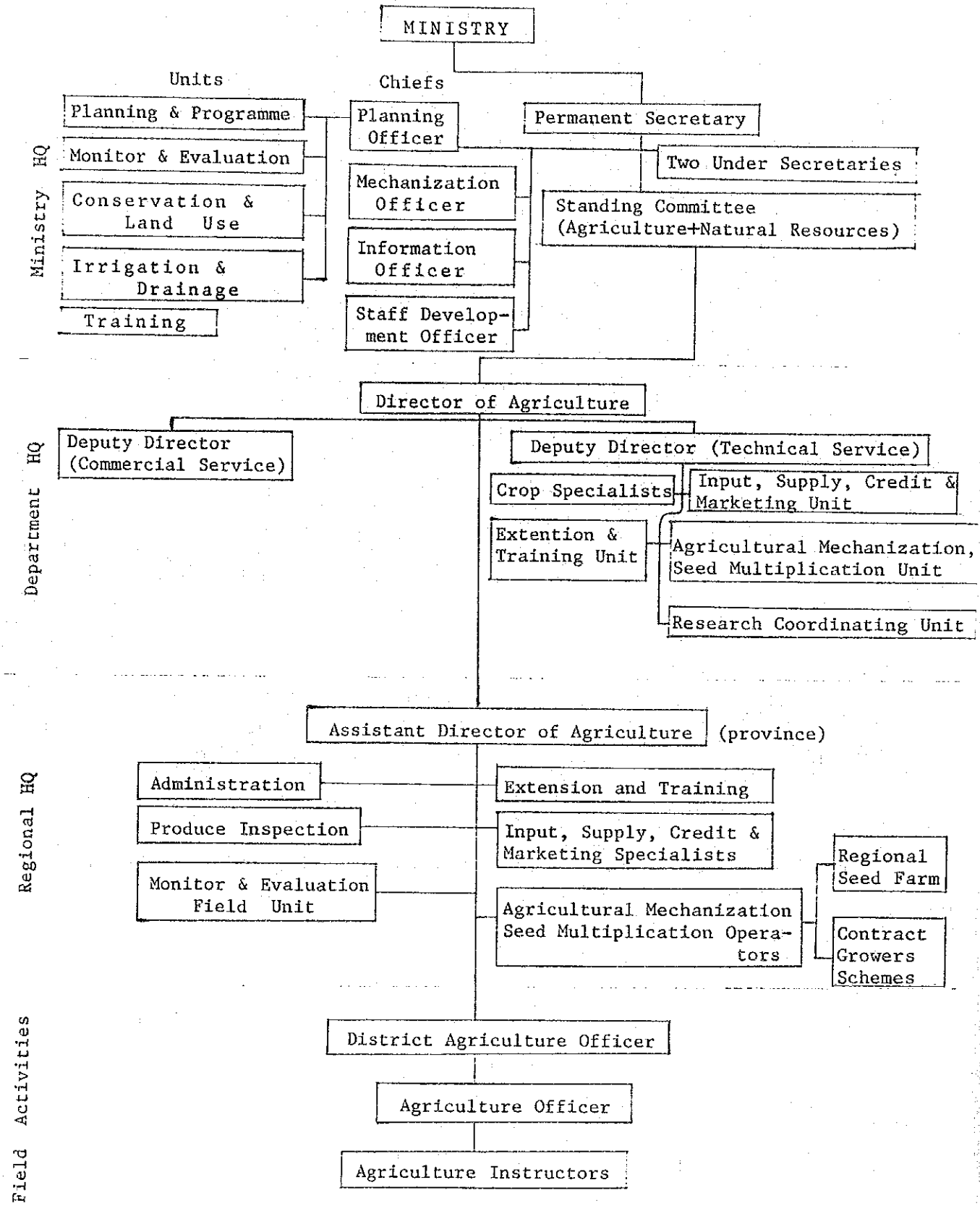


Table 1-1-10 CREDIT GUARANTEED SCHEME

(In thousand Leones)

	1974/75		1975/76		1976/77		1977/78		1978/79	
Agri. Sector	12	67.4	21	100.9	7	31.9	11	93.7	1	4.0
Total	203	807.1	106	519.9	61	232.2	39	233.5	26	116.0

Source: Bank of Sierra Leone

Table 1-1-11 IADP LOAN (SWAMP RICE DEVELOPMENT)

Development Loan			Seasonal Loan		
		@		@	
Shovel	1	8.00	Seed 2 bushels	8.5	17.00
Hoe	3	7.00	Fertilizer		
Mattock	1	6.50	Super phosphate 3 bags	4.0	12.00
Axe	1	6.50	Sulphate of Ammonia 3	5.0	15.00
Balance on tools		3.00	Muriate of Potash 1	6.5	6.50
		45.00			50.50
Cash for hired labor for reclamation		105.00	10 % interest		5.05
			Pest insurance premium		4.50
		150.00			60.05

Source: Bank of Sierra Leone

Table 1-1-12 INCOME CLASSES AND THEIR ECONOMIC AND DEMOGRAPHIC CHARACTERISTICS

Income class (decimals)	No. of samples	Mean Annual Capital Expen-diture (Le)	Expenditures	Average house hold size	% of children	Subsis-tence ratio
1	20	33.62	20.46 - 42.99	10.4	0.50	0.51
2, 3	42	55.61	43.00 - 68.99	9.7	0.44	0.49
4, 5	41	88.89	69.00—103.99	7.5	0.37	0.52
6, 7	40	122.02	104.00—142.99	5.3	0.29	0.47
8, 9	41	171.69	143.00—269.99	5.2	0.28	0.48
10	19	264.88	210.00—432.31	3.2	0.11	0.38
Average	203	116.28	20.46—432.31	6.9	0.34	0.48

Source : R.P. King & D. Byerlee 1977

Table 1-1-13 DEVELOPMENT BUDGET

PROJECT / SERVICE	Estimated Total Cost (Revised)	Actual Expendure, 1st July 1980 to 30th June 1981	Estimates 1981/82		Estimates 1982/83		
			Approved	Revised	Domestic	Foreign	Total
MINISTRY OF AGRICULTURE AND FORESTRY	274,478,000	22,238,410	32,693,000	21,131,672	5,543,000	20,871,000	26,414,000
1. AGRICULTURE	241,739,000	22,165,250	30,293,000	21,051,500	5,407,000	19,371,000	24,778,000
Intensive Rice and Vegetable Production	5,648,000	30,000	20,000	20,000	20,000	-	20,000
Onion Growing Scheme	345,000	3,000	5,000	35,000	10,000	-	10,000
Gambia-Mattru Oil Palm Project	3,200,000	350,000	1,400,000	100,000	50,000	-	50,000
WFP Storage and Distribution	345,000	10,000	10,000	10,000	5,000	-	5,000
Extension Service Mobilization	442,000	30,000	50,000	278,000	20,000	-	20,000
Coconut Development Project	20,400,000	100,000	5,000	2h	2h	-	2h
Rokupr Rice Research Project	6,098,000	80,000	-	-	30,000	-	30,000
(a) Station Development	-	-	50,000	50,000	2h	-	2h
(b) UNDP Counterpart Fund	-	-	-	-	2h	-	2h
Fibre Project	1,987,000	-	2h	2h	2h	-	2h
Integrated Agriculture Project (Eastern Area) Extension Phase III	26,000,000	690,000	3,046,000	2,875,000	525,000	2,325,000	2,850,000
Integrated Agriculture Development Project (nothern Area) Phase II	29,000,000	1,980,000	1,879,000	1,805,000	600,000	3,900,000	4,500,000
Land Resources Survey	2,450,000	785,000	950,000	1,050,000	100,000	479,000	579,000
Sugar Cane Project (Magbas)	13,800,000	2,562,000	900,000	2,000,000	200,000	2,000,000	2,200,000
WFP Inland Swamp Project	1,106,000	15,000	15,000	2h	10,000	-	10,000
FFHC Village Agriculture Stores	151,000	-	2h	-	2h	-	2h
Mechanical Cultivation (Spare Parts)	693,000	7,000	10,000	10,000	2h	-	2h
Mechanical Cultivation (Workshop)	2,708,000	131,250	600,000	244,000	100,000	122,000	222,000
Seed Multiplication Project Farm (Mag-	10,900,000	1,720,000	1,300,000	1,300,000	400,000	450,000	850,000
Fertilizer Distribution /bang)		125,000	153,000	187,000	20,000	100,000	120,000
Low Cost Oil Palm Mills	25,000	-	2h	2h	2h	-	2h
Extension Training Programme	3,236,000	900,000	500,000	328,000	80,000	250,000	330,000
Extension Staff Housing Offices and Store	1,414,000	-	30,000	30,000	10,000	-	10,000
Agriculture Machinery and Equipment Evaluation and Development Centre	229,000	-	2h	-	2h	-	2h
Project Evaluation and Service Unit	2,673,000	172,000	-	317,000	170,000	300,000	470,000
(a) Headquarters	-	-	80,000	-	80,000	-	80,000
(b) UNDP	-	-	40,000	-	40,000	150,000	100,000
(c) Evaluation Section	-	-	20,000	-	20,000	-	20,000
(d) IDA Technical Assistance	-	-	848,000	-	30,000	150,000	180,000
Bo/Pujehun I D A P	2,752,000	80,000	1,300,000	1,126,000	150,000	450,000	600,000
Boliland Irrigation Study	172,000	-	2h	2h	2h	-	2h
Rhombe Swamp Development	690,000	-	50,000	50,000	54,000	75,000	129,000
Agriculture Research Institute	66,000	-	-	-	2h	-	2h
Rice Crash Programme	8,723,000	420,000	350,000	610,000	700,000	-	700,000
Koinadugu Intergrated Agriculture Development Project	9,912,000	2,170,000	3,146,000	3,100,000	218,000	1,200,000	1,418,000
Kambia Integrated Agriculture Development Project	8,000,000	40,000	220,000	20,000	100,000	150,000	250,000
Magbosi Area Integrated Development Project	16,500,000	1,450,000	4,320,000	1,943,000	500,000	2,400,000	2,900,000
Rice Marketing,Milling and Storage Project	5,328,000	2h	2h	2h	2h	-	2h
Torma Bum Project	10,408,000	2,500,000	2,349,000	610,000	200,000	1,200,000	1,418,000
Sugar Cane Feasibility Study Project II	506,000	2h	2h	2h	2h	-	2h
ACRE Project	11,953,000	3,600,000	1,800,000	2,250,000	600,000	900,000	1,500,000
Oxen Cultivation Training Project	2,000,000	10,000	295,000	127,500	90,000	220,000	310,000
Moyamba IDAP - I	13,000,000	180,000	3,227,000	300,000	300,000	1,725,000	2,065,000
Agricultural Machinery	2,760,000	-	10,000	10,000	2h	-	2h
EEC Special Action Credit	2,500,000	2,025,000	2h	-	-	-	-
Upland Crops Storage Project	1,500,000	-	5,000	5,000	15,000	75,000	90,000
FAO Agricultural Co-operative Banking and Credit Personnel Training Centre	220,000	-	210,000	100,000	2h	75,000	75,000
Farmers Finance Project	4,800,000	-	550,000	111,000	30,000	450,000	480,000
Daru Oil Palm Project	5,000,000	-	550,000	50,000	50,000	525,000	575,000
Feasibility Studies	1,000,000	-	2h	-	2h	-	2h
Port Loko JADP	N A	-	-	-	50,000	-	50,000

CHAPTER 2 AGRICULTURE AND FARMING

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CHAPTER 2 AGRICULTURE AND FARMING

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CHAPTER 2 AGRICULTURE AND FARMING

2-1 General Affairs in the Project Area

Farm Household

The number of Farm Householders differs a little from the number of farm houses in the villages. The same differences are also occasionally seen in their land tenure. Such being the case, the farm householder or the farms cannot be exactly divided because large families are the custom.

So we have decided to regard the number of houses as equivalent to the number of Farm Households, which amounted to about 630. One Farm Household is a family of 11.4 and has 5.6 children on average in the project area.

Farming

The rice cropping accounts for about 90% of all produce in the villages. Generally speaking, the low stream part (the west area) yields better looking rice than the upstream part (the east area). Fishing is pursued as a side line in the villages, particularly in Katik.

Palm oil production is seen in every village, but not to such a degree that it can be sold in any amount to outside villages. Beside this, there are some tree-crops and some upland crops; Coconuts, Oranges, Mangoes, Cola-nuts, Bananas, Cassava, Yam. Beans, etc. which are mostly produced for self-sufficiency.

Rice Mills

There are 9 Rice Mills, the scale of which is almost the same as one or two mill machines.

The capacity of one machine is about 100 bushels of paddy rice a day.

The village memoranda are as follows (Table 2-1-1).

Vegetation

On the basis of vegetation, the swamp can be divided into mangrove swamps, sedge swamps and grass swamps. Most of the project area is located in the mangrove swamps, which are presently used for rice cultivation. Also some parts of the area are covered by a mixture of grass, reeds and rushes which form a typical swamp flora.

Regarding weeds, generally speaking, this area is remarkably free from weeds. Most weeds are killed off by the salty conditions in dry season.

The only durable weed is the creeper grass, "Kire-kire", which is pulled up while preparing the paddy fields. "Kire-kire" does not do much damage to the paddy field, providing the farmers weed it out annually.

2-2 Farming and Farm Household Economy Survey

2-2-1 The survey method

(1) Sampling method

The sample farmers were selected by village heads from amongst the willing farmers who attended the farmers' meeting held in three big villages Gbenti, Konta and Kagbulo. We also interviewed

Table 2-1-1 VILLAGE MEMO

No.	Number of Village	Houses	Tax-Payers	People	Children	Rice Mills	Boats	Wells	Absent Family Members	Health Centers	Schools	Shops
1	Konta	200	248	2,400	1,000	3	16	20	160	1	2	6
2	Mabona	18	26	108	72	1	5	2	40	-	-	-
3	Rolal	12	26	108	60	-	2	1	20	-	-	-
4	Mapekr	15	26	195	75	-	6	1	14	-	-	-
5	Kagbulo	105	242	1,155	630	1	50	40	100	-	1	4
6	Rogbom	26	39	208	78	-	10	2	70	-	-	-
7	Mango	7	18	70	35	-	-	-	-	-	-	-
8	Katik	94	182	1,410	940	2	60	38	200	-	-	2
9	Masama	10	19	120	40	-	3	3	70	-	-	-
10	Gbenti	142	243	1,420	568	2	80	8	200	1	2	5
	Total	629	1,069	7,194	3,498	9	232	115	874	2	5	17

all the householders in Mango Village.

The 41 selected householders are mostly the higher class farmers whose paddy field amount to 250 ha covering 30% of the rice crop area in the Project area.

The locations' map of the sample farmers is shown in Fig. 2-2-1.

(2) Questionnaires

Questionnaires (Table 2-2-1) were drawn up taking the farmers' rather limited abilities into account, for they have very little knowledge of weight and acreage.

Table 2-2-1 THE ITEMS OF QUESTIONNAIRES

I. Farming Practice

- A. Seed
- B. Sowing
- C. Seedling
- D. Transplanting
- E. Harvesting

II. Farm Household Economy

- A. Farm Family
- B. Property
- C. Labour
- D. Income and Expenditure for Production
- E. Cost of Living

(3) Duration of Inquiry

The 4 interviewers interviewed the farmers from Dec. 8, 1982 to Jan. 7, 1983 limiting the inquiries to the year of 1982. Every farmer was very friendly and co-operative, in spite of

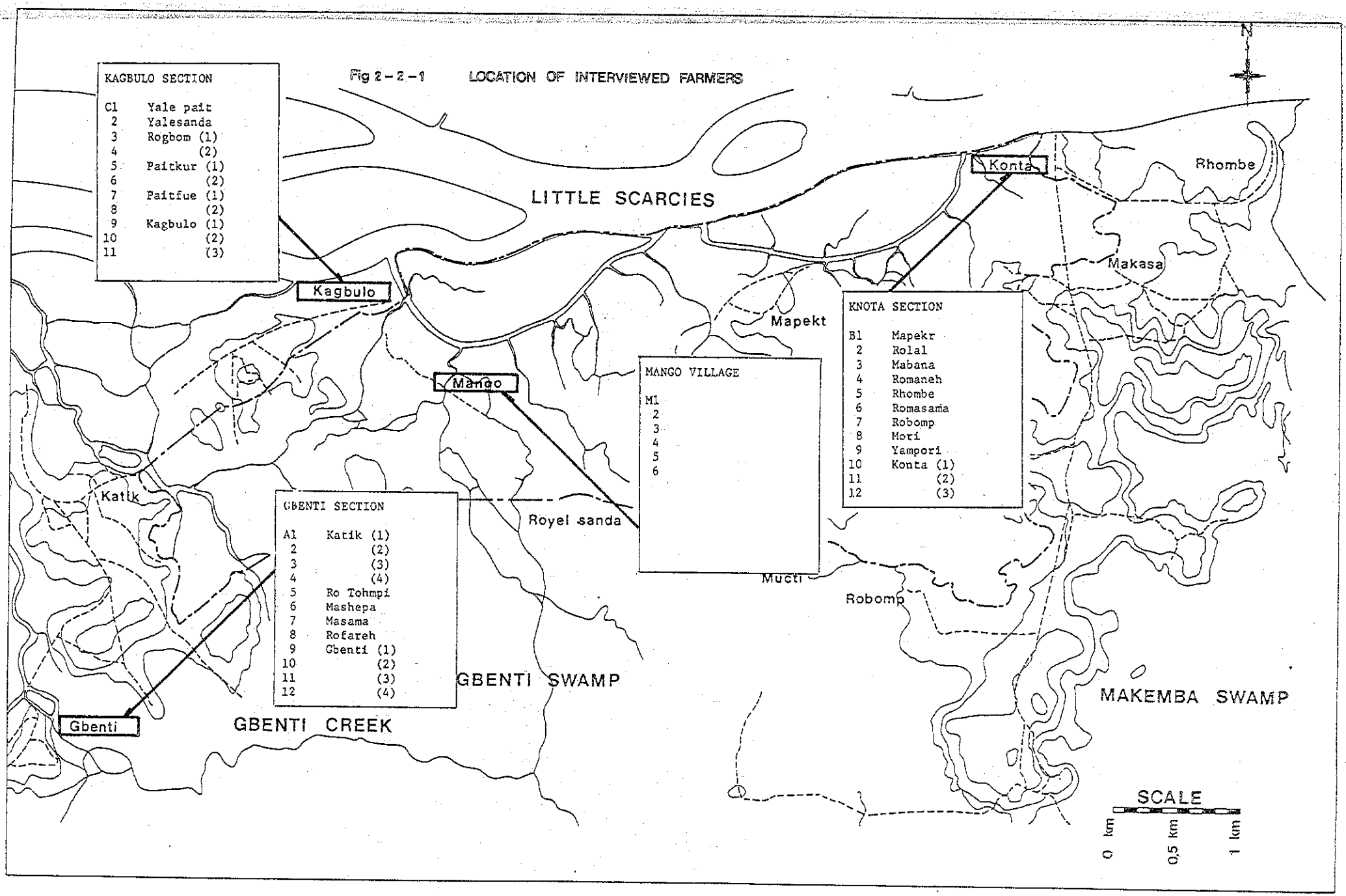


Fig 2-2-1 LOCATION OF INTERVIEWED FARMERS
KAGBULO SECTION
C1 Yale pait
2 Yalesanda
3 Rogbom (1)
4 (2)
5 Paitkur (1)
6 (2)
7 Paitfue (1)
8 (2)
9 Kagbulo (1)
10 (2)
11 (3)
GBENTI SECTION
A1 Katik (1)
2 (2)
3 (3)
4 (4)
5 Ro Tohmpi
6 Mashepa
7 Masama
8 Rofareh
9 Gbenti (1)
10 (2)
11 (3)
12 (4)
MANGO VILLAGE
M1
2
3
4
5
6
KNOTA SECTION
B1 Mapekr
2 Rolal
3 Mabana
4 Romaneh
5 Rhombe
6 Romasama
7 Robomp
8 Mori
9 Yampori
10 Konta (1)
11 (2)
12 (3)
LITTLE SCARCIES
Kagbulo
Mango
Katik
Royel sanda
Gbenti
GBENTI CREEK
GBENTI SWAMP
Mapekt
Konta
Rhombe
Makasa
Mucti
Robomp
MAKEMBA SWAMP
N
SCALE
0 km
0,5 km
1 km

the busy harvesting season.

2-2-2 Farming practices survey

The survey concentrated solely on rice cropping so here we will describe only the rice production.

(1) Varieties

The rice varieties cropped by sample farmers are shown in Table 2-2-2.

(2) Nursery

Every farmer answered all items on nursery (See Table 2-2-3).

The proportion of nursery area to paddy field is about 10% on an average. Most farmers commonly understand that one bushel of seed is sowed for one acre of field acreage. This acreage is not measured acreage, and farmers usually judge acreage by the quantity of seeds sown.

(3) Transplanting

Every item on transplanting was answered (See Table 2-2-4). Plowing twice for the land preparation is customary, but sometimes only once, when transplanting after September. Transplanting is effected by using a wooden or iron tool named "Dibra".

The common technique, trimming the top of the seedlings before transplanting, is observed in all the seedlings transplanted in June or July, but in 70% of seedlings after September.

Table 2-2-2 CROPPED VARIETIES BY INTERVIEWED FARMERS
(41 FARMERS, 250 HA)

		Cropped %	Approximate ha
1	Pa Sanphary	34	170
2	Pa Fatuyando	13	65
3	Pa Samayoka	11	55
4	C.P.4	9	45
5	Pa China	6	30
6	Pa Black	4	20
7	Pa Guinea	4	20
8	Pa Boloo	4	20
	Pa Koroma		
	Pa Thokoll		
	Pa Lead	16	80
	Pa Nanchin		
	Pa Yeino		
	Others		
		100%	250ha

Table 2-2-3 NURSERY AND SEEDLING

Sample No.	Seed Quantity (kg/ha of paddy field)	Sowing Time 1st (month)	Sowing Time 2nd (month)	Nursery Days 1st (days)	Nursery Days 2nd (days)	Height of Seedlings 1st (cm)	Height of Seedlings 2nd (cm)
Gbenti							
A 1	34	May	-	60	-	42	-
A 2	60	Jun	Aug	40	35	41	30
A 3	62	Jun	Sep	40	30	41	32
A 4	45	Jun	-	40	-	45	-
A 5	68	May	-	40	-	42	-
A 6	68	Jun	Oct	50	40	33	28
A 7	72	May	Sep	40	40	43	41
A 8	34	Jun	-	30	-	32	-
A 9	68	May	-	40	-	41	-
A10	68	Jul	-	40	-	41	-
A11	66	May	-	40	-	36	-
A12	68	May	Sep	40	40	40	40
Konta							
B 1	45	Jun	Oct	60	40	40	30
B 2	68	May	Oct	40	30	48	30
B 3	68	Jun	Sep	40	30	36	30
B 4	83	Jun	-	45	-	42	-
B 5	48	May	Oct	40	30	32	29
B 6	46	Jun	Oct	60	30	40	20
B 7	45	Jun	Aug	30	30	30	15
B 8	65	May	Aug	60	40	44	30
B 9	64	Jul	Jul	40	35	38	32
B10	59	Jun	Aug	50	45	40	38
B11	46	May	Sep	60	45	50	25
B12	50	Jun	Jun	40	30	37	25
Kagbulo							
C 1	34	Jun	Aug	60	45	40	23
C 2	44	May	Jun	40	40	47	47
C 3	68	Jun	Aug	60	50	40	38
C 4	50	Jun	Aug	40	45	44	45
C 5	36	May	-	40	-	40	-
C 6	45	Jun	Sep	60	45	28	23
C 7	56	May	Sep	45	40	46	23
C 8	68	May	Sep	45	40	40	38
C 9	34	May	Oct	60	40	32	30
C10	42	Jun	Aug	60	50	39	37
C11	34	May	aug	50	40	47	33
Mango							
M 1	49	May	Aug	40	40	45	40
M 2	39	Jun	Sep	40	38	46	37
M 3	45	Aug	Sep	40	30	37	30
M 4	45	May	-	45	-	40	-
M 5	58	May	Jul	45	40	46	44
M 6	68	Jun	Sep	40	30	48	39
Mean	54	May-Jun	Aug-Sep	46	38	40	33

Table 2-2-4 TRANSPLANTING

Sample No.	Transplant Time 1st (month)	2nd	Seedlings per Hill 1st	2nd	Hills Spacing 1st (cm x cm)	2nd	Hills per M^2 1st (estimated)	2nd
Gbenti								
A 1	Aug	-	10	-	15x25	15x20	27	-
A 2	Aug	Oct	8	3	10x35	15x20	29	33
A 3	Aug	Oct	8	4	20x35	20x30	14	17
A 4	Aug	-	5	-	35x20	-	14	-
A 5	Jul	-	10	-	20x35	-	14	-
A 6	Jul	Nov	10	5	20x15	20x20	33	25
A 7	Jul	Oct	9	8	20x15	20x15	33	33
A 8	Jul	-	6	-	20x15	-	33	-
A 9	Jun	-	3	-	25x20	-	20	-
A10	Aug	-	10	-	20x20	-	25	-
A11	Jul	-	9	-	20x30	-	17	-
A12	Jul	Nov	8	7	25x10	25x10	40	40
Konta								
B 1	Aug	Nov	4	2	25x15	20x15	27	33
B 2	Jul	Nov	8	5	30x10	25x10	33	40
B 3	Aug	Oct	10	4	25x25	15x20	16	33
B 4	Jul	-	10	-	20x20	-	25	-
B 5	Jul	Nov	8	6	20x15	20x15	33	33
B 6	Aug	Nov	10	5	20x20	20x15	25	33
B 7	Jul	Sep	10	2	20x15	15x15	33	44
B 8	Jul	Oct	8	2	30x30	25x30	11	13
B 9	Aug	Aug	8	4	20x20	20x20	25	25
B10	Aug	Sep	8	7	25x20	20x15	20	33
B11	Jul	Nov	10	3	25x20	20x15	20	33
B12	Jul	Oct	10	2	20x30	20x15	20	33
Kagbulo								
C 1	Aug	Oct	4	2	25x20	20x15	20	33
C 2	Jul	Aug	8	8	35x20	20x25	14	20
C 3	Aug	Oct	8	5	30x25	30x25	13	13
C 4	Aug	Oct	11	6	30x20	30x20	17	17
C 5	Jul	-	10	-	25x15	-	27	-
C 6	Aug	Oct	10	10	20x20	30x25	25	13
C 7	Jul	Oct	10	8	15x20	25x20	33	20
C 8	Jul	Oct	6	5	40x20	20x20	13	25
C 9	Jul	Nov	8	6	20x15	20x15	33	33
C10	Aug	Oct	9	6	25x25	30x25	16	13
C11	Jul	Oct	8	2	25x40	25x30	10	13
Mango								
M 1	Jul	Oct	10	4	30x25	20x15	13	33
M 2	Aug	Oct	9	6	30x20	20x15	17	33
M 3	Sep	Oct	4	2	20x20	20x15	25	33
M 4	Jul	b	8	-	30x20	-	17	-
M 5	Jul	Sep	10	2	30x25	20x15	13	33
M 6	Aug	Oct	9	4	30x30	20x20	11	25
Mean	Jul-Aug	Oct-Nov	8.3	4.7	20x23	20x18	22	28

(4) Harvesting

Harvesting survey is shown in the Table 2-2-5. Harvesting works, transportations and rice milling are usually paid for with harvested paddy. Farmers make it a rule to pay a 10% portion of the harvested paddy for harvesting work.

In this survey the reply to the average yield per ha was 1.256 t/ha (18.5 bu/acre) by sample farmers.

But every interviewer says that the sample farmer replied lower yields and higher costs or debts. Therefore, we have to review the yield per ha. It will be reviewed in 2-4-3 (Yield Survey).

(5) Cropping patterns

Fig. 2-2-2 shows the rice cropping patterns by the sample farmers.

Some farmers along the river were seen transplanting even at the beginning of December, but not among the sample farmers.

2-2-3 Farm household economy survey

(1) Rice production cost

The paddy rice production cost is composed of the following items (Table 2-2-6).

The cost of seeds is counted with the paddy price (Le. 10/bu) in the villages, although the governmental seed prices is Le. 15/bu. The cost of farming tools, paid wage, and transportation are counted with the average cost per ha among the

Table 2-2-5 HARVESTING

Sample No.	Harvest Month (Month) 1st	2nd	Soil Depth (cm) when Harvesting 1st	2nd	Yield per Unit Area bu/acre	t/ha
Gbenti						
A 1	Dec	-	32	-	12.5	0.85
A 2	Dec	Jan	32	32	22.2	1.51
A 3	Dec	Feb	39	11	18.5	1.26
A 4	Dec	-	42	-	17.4	1.16
A 5	Dec	-	36	-	15.0	1.02
A 6	Dec	Feb	24	20	16.7	1.14
A 7	Dec	Jan	24	23	21.5	1.46
A 8	Dec	-	15	-	25.0	1.70
A 9	Dec	-	26	-	13.3	0.90
A10	Dec	-	30	-	18.0	1.22
A11	Dec	-	40	-	21.1	1.43
A12	Dec	Feb	40	10	16.0	1.09
Konta						
B 1	Dec	Jan	10	18	15.0	1.02
B 2	Dec	Feb	20	12	50.0	3.40
B 3	Dec	Feb	28	4	10.5	0.70
B 4	Dec	-	29	-	19.5	1.33
B 5	Dec	Mar	8	5	24.0	1.63
B 6	Dec	Mar	6	7	32.3	2.20
B 7	Dec	Mar	22	18	15.6	1.06
B 8	Dec	Feb	15	40	12.0	0.82
B 9	Dec	Feb	38	35	15.5	1.05
B10	Dec	Feb	31?	29	10.3	0.70
B11	Dec	Feb	26	18	16.0	1.09
B12	Dec	Feb	5	33	36.3	2.47
Kagbulo						
C 1	Dec	Mar	27	18	12.0	0.82
C 2	Dec	Feb	42	16	10.3	0.70
C 3	Dec	Feb	16	34	18.5	1.26
C 4	Dec	Mar	3	38	12.6	0.86
C 5	Dec	-	27	-	17.0	1.16
C 6	Dec	Mar	19	46	16.5	1.12
C 7	Dec	Feb	40	30	14.7	1.00
C 8	Dec	Feb	2	3	20.0	1.36
C 9	Dec	Feb	12	36	12.0	0.82
C10	Dec	Feb	11	40	17.9	1.22
C11	Dec	Feb	39	8	10.7	0.73
Mango						
M 1	Dec	Feb	50	11	13.6	0.92
M 2	Dec	Feb	5	7	10.6	0.72
M 3	Jan	Mar	48	48	34.0	2.31
M 4	Dec	-	4	-	20.0	1.36
M 5	Dec	Feb	22	40	16.4	1.12
M 6	Dec	Feb	29	49	26.0	1.77
Mean	Dec	Feb	25	24	18.5	1.26

Fig. 2-2-2 RICE CROPPING PATTERN AT PRESENT

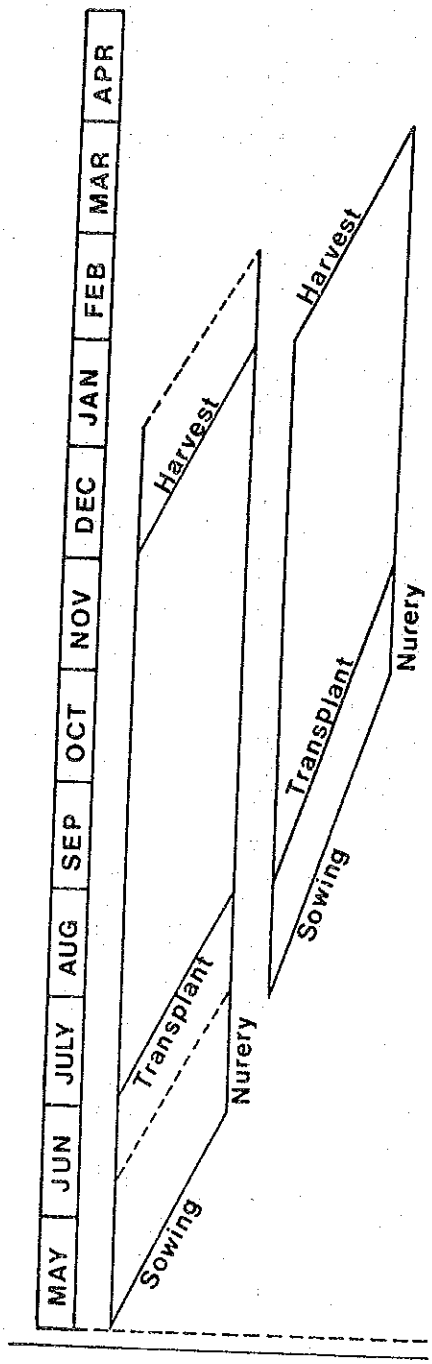


Table 2-2-6 RICE PRODUCTION COST PER HA*

	Quantity/ha	Unit Price	Cost/ha
Seed	56 kg	Le. 0.366	Le. 20
Farming Tools	-	-	8
Hired Labour	36 (M.D.)	Le. 2.6	Le. 94
Transportation	-	-	Le. 4
Total Cost per ha			Le. 126
Land Rental	-	Le.46	Le. 46
Total Cost per ha			Le. 172

* Production cost per ton of paddy yield

Le. 66.3/t

Le. 90.5/t (including Land Rental)

Table 2-2-7 LABOUR UTILIZATION PER HA AT PRESENT

		%
Nursery	2.2 Man Days	1.6
Transptanting	46.5	34.3
Harvesting	72.0	53.1
Land Preparation and Others	15.0	11.0
Total Labour	136.0	100

136. M.D. Family Labour ..... 100 M.D.
Hired Labour ..... 36 M.D.

sample farmers.

(2) Rice crop labour

According to the sample farmers count, (The average scale is 6.2 ha), the labour utilization per ha is shown as follows (Table 2-2-7).

As to the hired labour, to clearly divide between genuinely outside hired labour and neighbours or relatives who are helping out, is impossible.

When we compare our findings with the Table 2-2-8 reported by Rokupr R.R.S. we can deduce the following facts.

1) Total labour use in the Project area is nearly half the amount at Rokupr farm.
2) Land preparation and transplanting in the Project area are much easier than at Rokupr farm.

(3) The usage of harvested paddy

Harvested paddy is disposed of as follows (Table 2-2-9). Repayment of debts, owing to living expenditure and in a smaller measure to production costs (wages, etc), are not all fulfilled. Presents cannot be distinguished from wages and interest on debts, because paddy is given to neighbours as interest on debts as well as for their labour, because the farmers have no money.

(4) Farm household income

Gross income per ha by paddy cropping is Le. 699, counted from the estimated yield in 2-3-2 (Yield survey).

Net income per ha by paddy cropping is counted as

Table 2-2-8 LABOUR UTILIZATION (M.D./ha)
ON MANGROVE SWAMP RICE CROP IN ROKUPR

Activity	M.D. per ha. max.	min.	mean	(%)
Nursery and Land Preparation	64	8	41	(16%)
Transplanting	146	68	99	(40%)
Fertilizer Application (3 times)	50	16	29	(12%)
Harvesting	119	23	79	(32%)
Total	379	115	248	(100%)

Data: Rokupr R.R.S. 1980

Table 2-2-9 THE USAGE OF PRODUCED PADDY RICE

Seed	5.5%
Self-Consumption (eating)	21.4%
Repayment	21.6%
Paid Wage	13.8%
Land Rental	12.0%
Tax	0.4%
Present	6.7%
Sale	18.6%
Total	100%

follows. Le. 699 (Gross income) - Le. 126 (Production cost) = Le. 573.

The income from other crops is minimal as they are grown for self-sufficiency, and the answer to production costs for these outputs was given as "None" by every farmer.

Non-agriculture income stems mostly from fishing. Fishing nets are one of the few fishing costs.

The average income of one householder is estimated from 1.35 ha of the average scale of farming.

Table 2-2-10 shows the income and its origin, of the 41 sample farm householders (6.2 ha of the scale).

2-3 Additional Survey and Review

2-3-1 Seed selection by salty water

Table 2-3-1 shows the seed selection experiment by salty water. These values are the average ones taken from the same experiment conducted 5 times under the same conditions.

The local varieties are bigger in specific gravity and uniformly better in full ripening than the improved varieties.

This table means that the improved varieties are suitable for seed selection by the 1.12 of specific gravity, on the other hand, the local ones fit in with the 1.20 of specific gravity.

Table 2-2-10 RICE CROP INCOME

Sample No.	Total Produce Gross Income (Le.)	Self Consumtion Seed & Eating (Le.)	Debt Payment (Le.)	Sale (Le.)	Estimated Net Income (G.I.x0.82)
Gbenti					
A 1	2,500	600	760	600	2,050
A 2	3,550	2,100	800	-	2,911
A 3	1,020	300	250	200	836
A 4	670	260	150	50	549
A 5	100	50	30	-	82
A 6	500	400	-	-	410
A 7	1,610	600	300	400	1,320
A 8	1,000	890	-	40	820
A 9	2,000	830	500	500	1,640
A 10	3,600	2,950	400	-	2,952
A 11	3,900	3,210	460	-	3,198
A 12	2,400	650	750	500	1,968
Konta					
B 1	750	240	340	150	615
B 2	3,000	930	550	1,000	2,460
B 3	2,000	1,060	800	-	1,640
B 4	900	410	100	240	738
B 5	2,400	1,000	450	600	1,968
B 6	1,000	410	200	200	820
B 7	1,100	530	300	100	902
B 8	1,500	600	500	200	1,230
B 9	1,320	280	500	200	1,082
B 10	2,000	870	350	300	1,640
B 11	1,850	1,010	500	-	1,517
B 12	6,900	1,090	900	3,300	5,658
Kagbulo					
C 1	2,600	590	1,600	-	2,132
C 2	3,200	1,400	250	500	2,624
C 3	1,200	365	600	-	984
C 4	1,700	500	400	300	1,394
C 5	2,550	1,680	230	350	2,091
C 6	2,450	950	400	800	2,009
C 7	1,250	370	350	300	1,025
C 8	4,000	800	-	3,000	3,280
C 9	3,600	550	700	2,000	2,952
C 10	1,660	530	600	300	1,361
C 11	4,900	1,730	-	2,300	4,018
Mango					
M 1	3,000	1,260	800	200	2,460
M 2	740	160	150	200	607
M 3	4,510	1,730	1,000	1,280	3,698
M 4	5,400	2,400	1,230	600	4,428
M 5	2,300	1,600	300	200	1,886
M 6	1,300	300	500	500	1,066
mean	2,190	931	514	699	1,796

Table 2-3-1 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
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

2-3-2 Yield survey

The 1.26 t/ha of the average yield, which was counted in the Farming Practice Survey, should be reviewed using other data.

We also tried to carry out the yield survey at several fields in Konta village. But this shows such varied values (60 g/m^2 - 600 g/m^2), that we cannot guess the mean yield.

According to many different reports, some of the mean yields per ha were reported as in Table 2-3-2.

Rokupr farm also reported that the mean yield on mangrove swamp rice was 1.63 t/ha with no fertilizer in the 1979, annual report (See Table 2-4-4).

With the above mentioned data, the average yield in the project area is estimated 1.9 t/ha.

Table 2-3-2 AVERAGE RICE YIELDS ON MANGROVE SWAMP RICE FARMS

Source	Year	Region	Yield per ha (kg)
Spencer Survey[a/]	1971/72	North	3572
	1971/72	South	1711
	1971/72	Sierra Leone	2642
Central Statistics Office [b/]	1970/71	North	2615
	1970/71	Sierra Leone	2870
	1970/71	Sierra Leone	2616
Rice Research Station[c/]	1971/73	North	3238
Pillai[d/]	1921	North	2479

a/ Field Survey.

b/ Agricultural Statistical Survey of Sierra Leone.

c/ Will and Janakiram, Mean Yield of Unfertilized Improved Variety Rok - 5 in Rokupr trials.

d/ Report on Rice Cultivation.

2-4 Farming Plan and the Discussion

2-4-1 Cropping patterns and the choice of suitable varieties

We have made up three alternatives (Fig. 2-4-1) for double cropping patterns in the Project area. These three patterns are evaluated in the following items (Table 2-4-1)

Table 2-4-1 THE EVALUATION OF CROPPING PATTERNS ALTERNATIVES

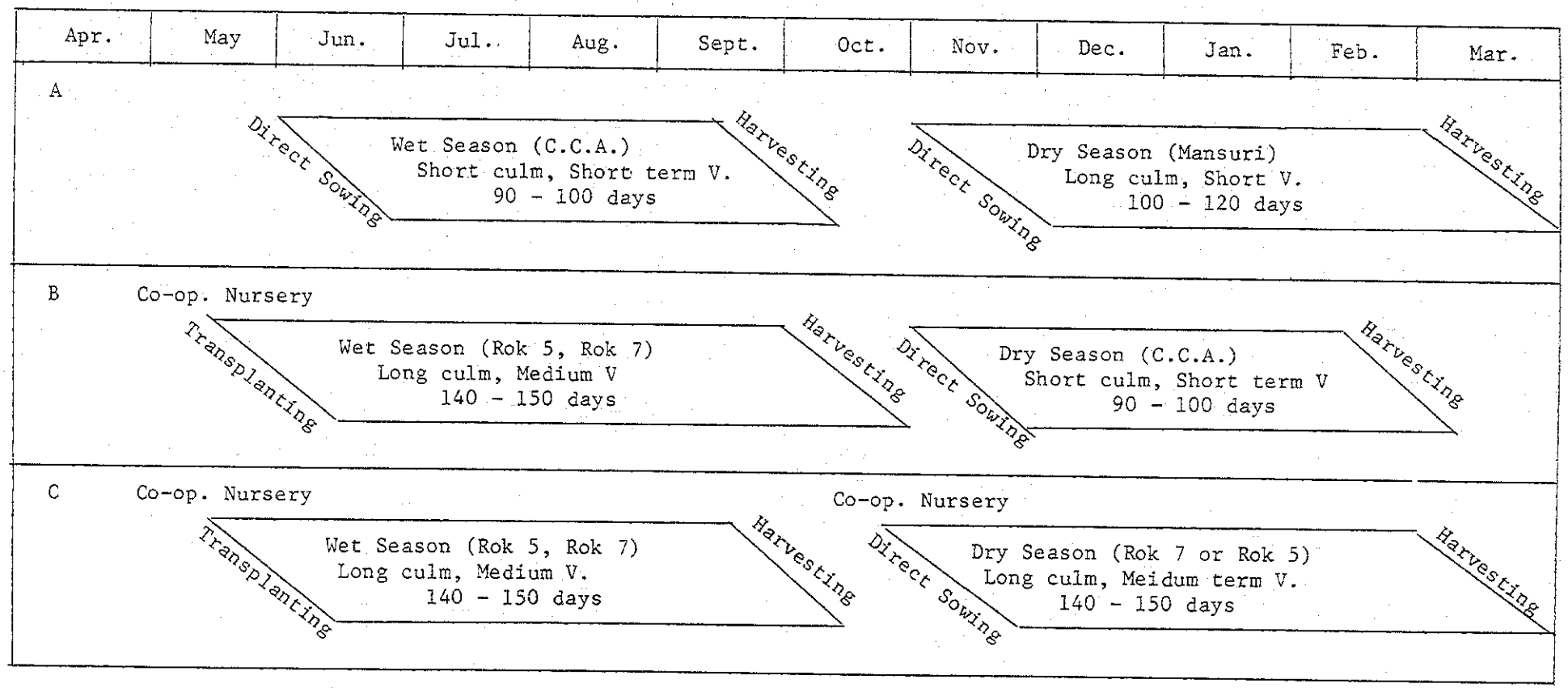
Alternatives		A	B	C
(1)	Irrigation for transplant in wet season	3	2	1
(2)	The rotation of labour arrangement	3	1	2
(3)	Seed supply	1	3	3
(4)	Salty water	2	3	2
(5)	Need of labour	3	2	1
(6)	Pest and disease	2	3	1
(7)	Field condition when harvesting in wet season	1	2	1
(8)	Customary practices	1	2	1
(9)	Yield	1	2	3
(10)	Evaluation	17	20	15

(Very good ... 3 points, Good ... 2 points, Bad ... 1 poin

2-4-2 Mechanization of the labour force

When we adopt the double cropping pattern, we have to solve the labour shortage which will be caused by concentrated cultivation. It will be necessary for farmers to prepare their fields all at once in the Project area (1,278 ha). Man power or working cattle are not fast enough.

Fig. 2-4-1 ALTERNATIVES ON THE CROPPING PATTERNS



So here we will compare the power tiller to the tractor (Table 2-4-2). How the one compares with the other under differing conditions (Table 2-4-3).

Table 2-4-3 THE EVALUATION OF MECHANIZATION ALTERNATIVES

Alternatives		10 HP Power tiller	50 HP Tractor
(1)	Machine Price (Initial Cost)	3	1
(2)	Repairing (Parts supply)	3	2
(3)	Ability	2	3
(4)	Operation or Movement	3	2
(5)	Extensional Effect	3	2
(6)	Running Cost (Fuel per/ha)	3	2
(7)	Annual Depreciation Cost (Total area)	3	1
(8)	Cultivating in November	3	2
(9)	Transportation Usage	3	2
(10)	Evaluation	26	17

(Very good ... 3 points, Good ... 2 points, Bad ... 1 poi

2-4-3 Fertilizer application and the yield

The paddy yield increases with Fertilizer Application. The proportional increase ratio depends on the type of fertilizer, method of application, soil and water condition, rice varieties, and so on.

Only nitrogen application could make the yield per ha reach 3.0 t/ha or more, according to the Rokupr's report (Table 2-4-4).

Table 2-4-2 ALTERNATIVES ON TWO TYPES OF MACHINE

Check points / Machine type	Machine Price (CIF)	Cultivative Ability hours/ha	Running Cost Fuel & Oil/ha	Durable Years	Needed units for the Project	Annual Depreciation Cost(total)	Depth of Cultivation	Weight of Machine
10 HP Power Tiller	Le. 840 per unit	* 25 hrs per ha	76 l/ha Le. 205	5 - 7 years	120 units	Le. 14,400	15 - 20 cm	0.5 - 1 t
50 HP Tractor	Le.61,300 per unit	10 hrs per ha	90 l/ha Le. 243	15-20 years	47 units	Le.144,055	20 - 30 cm	3 - 4 t
		(1 plowing) (1 following) (1 leveling)			(1,287ha/ 30 days)			

* Data: The List of Unit Price in Farm Operation (1979) JICA (Emigrant Section)

The soil in the Project area is said to abound in Potassium (K), so we had better apply the compound fertilizer with Nitrogen (N) and Phosphate (P). The Agriculture Officer in Katonga and the Chief of the Mange National Farm recommended the fertilizer of (20-20-0) for the Project area.

Table 2-4-4 NITROGEN APPLICATION AND THE YIELD/HA

Yield : Kg/ha

	Duration (Days)	NITROGEN LEVEL (Kg)				Variety Mean
		0	40	80	120	
Bali Grodak	162	1783	2945	2799	3790	2829
Djabon	162	1643	3169	4435	2861	3027
Rok 5	155	1740	3261	3416	3749	3041
CP 4	190	1522	2763	2898	2944	2532
BL 4-E	185	1421	2284	2826	2749	2320
RH 2	170	1679	2901	3663	3488	2933
Mean		1631	2887	3339	3263	2780
Index		100	177	205	200	170

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CHAPTER 3 HYDROGEOLOGY AND GROUNDWATER

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CHAPTER 3 HYDROGEOLOGY AND GROUNDWATER

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CHAPTER 3 HYDROGEOLOGY AND GROUNDWATER

3-1 General Geology

A relief of Sierra Leone is divided into three main regions eastward, i.e., a coastal plain, an interior lowland, and an interior plateau. Geology of Sierra Leone corresponds roughly with the topographical feature. The coastal plain is underlain by Bullom series which consists of Tertiary to Recent Formations. The interior region consists of Cambrian to Pre-Cambrian formation (Fig. 3-1-1).

The project area consists mainly of Bullom series, swamp deposits and lateritic deposits.

The Bullom series is composed of unconsolidated sediments with mixed layers of sand, silt, clay and gravel, with lignite. According to some lithological logs of MRT (1972), the thickness of these Bullom series sediments is about twenty meters at Katonga, which is about fifteen kilometers upstream from the project area, and is around fifty meters at Gbenti, which is five kilometers away southwestward.

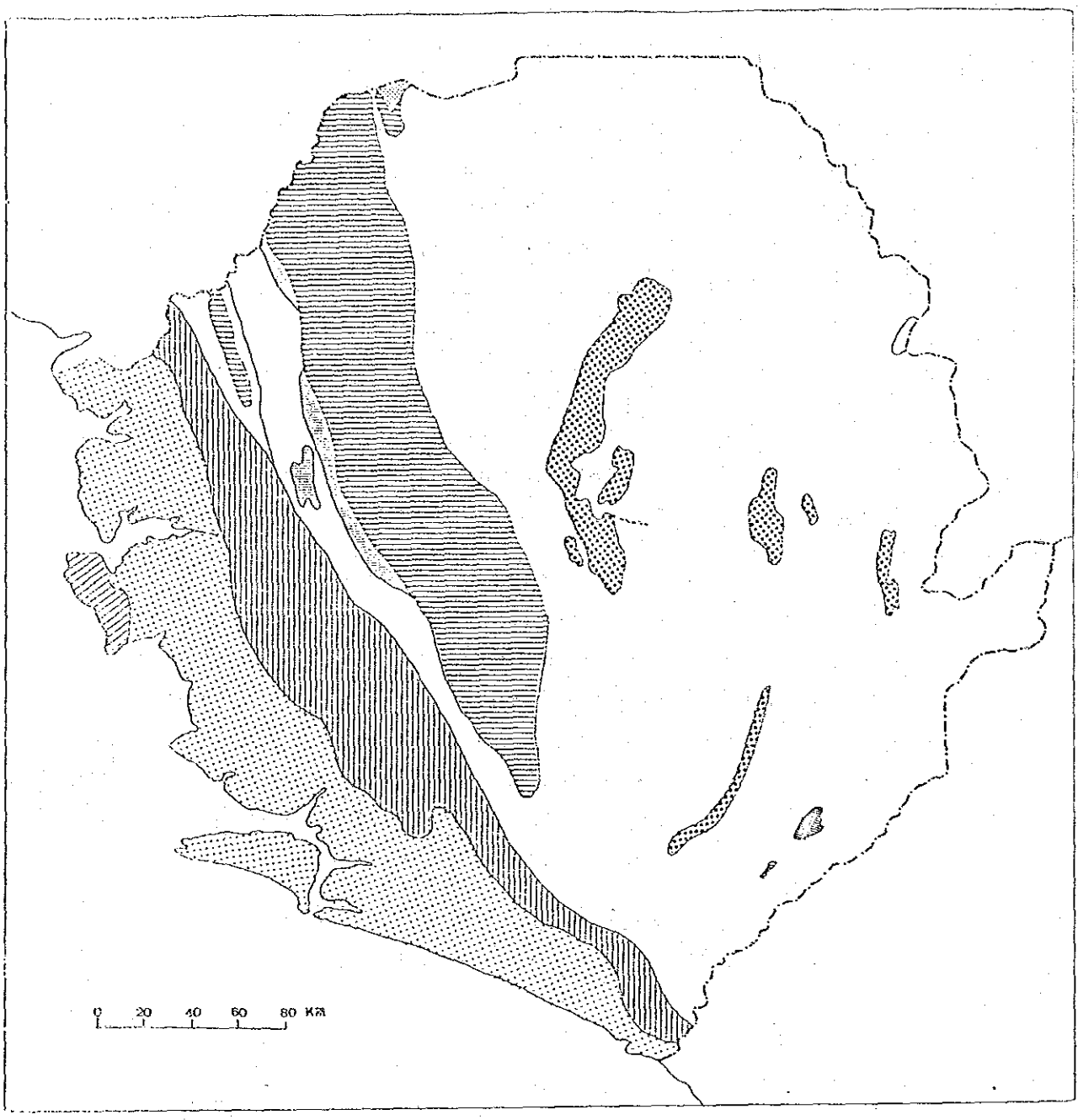
The Bullom series is underlain by metamorphic rocks which consist of gneiss and hornfels.

3-2 Hydrogeology

A hydrogeologically important formation in and around the project area is the Bullom series which consists of unconsolidated sediments, sand, gravel, silt and clay. Metamorphic rocks are considered to be an impermeable basement beneath the Bullom series.

Existing wells, which were dug up to a depth of five meters in the upper layer of Bullom series, are

Fig. 3-1-1 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

utilized as important water resources in the dry season in and around the project area. It is estimated from an observation of all of these wells that an aquifer of sands or clayey sands exists.

Lungi Airport Water Treatment Works, which is twenty five kilometers away from the project area, collects groundwater from the Bullom series through one gallery and two deep wells. It has been reported that one well was testpumped at 3,600 gallons per hour for a six feet drawdown. This discharge rate corresponds to a specific capacity of 210 m^3/day/m. It is likely that the Bullom series has higher permeability.

There have not been data regarding pumping tests for an aquifer of the Bullom series, however, MRT (1972) estimated that the permeability was 1.4×10^{-3} ft/sec from a particle size analysis of sand layers. Further, as these sand layers are 15 m to 20 m thick according to a result of MRT-boring at Gbenti, if they distribute horizontally, it is likely that they can be a source for groundwater development.

3-3 Electrical Soundings

In order to grasp a distribution of the Bullom series in and around the project area, electrical soundings were carried out at six locations. These locations are shown in Fig. 3-3-1.

3-3-1 Measurment of resitivity

The measurements were carried out by Geological Survey Section, Ministry of Mines.

As the surface condition was not good due to the dry season, the Schlumberger method, which has fewer number of electrode transfers, was applied for a distribution

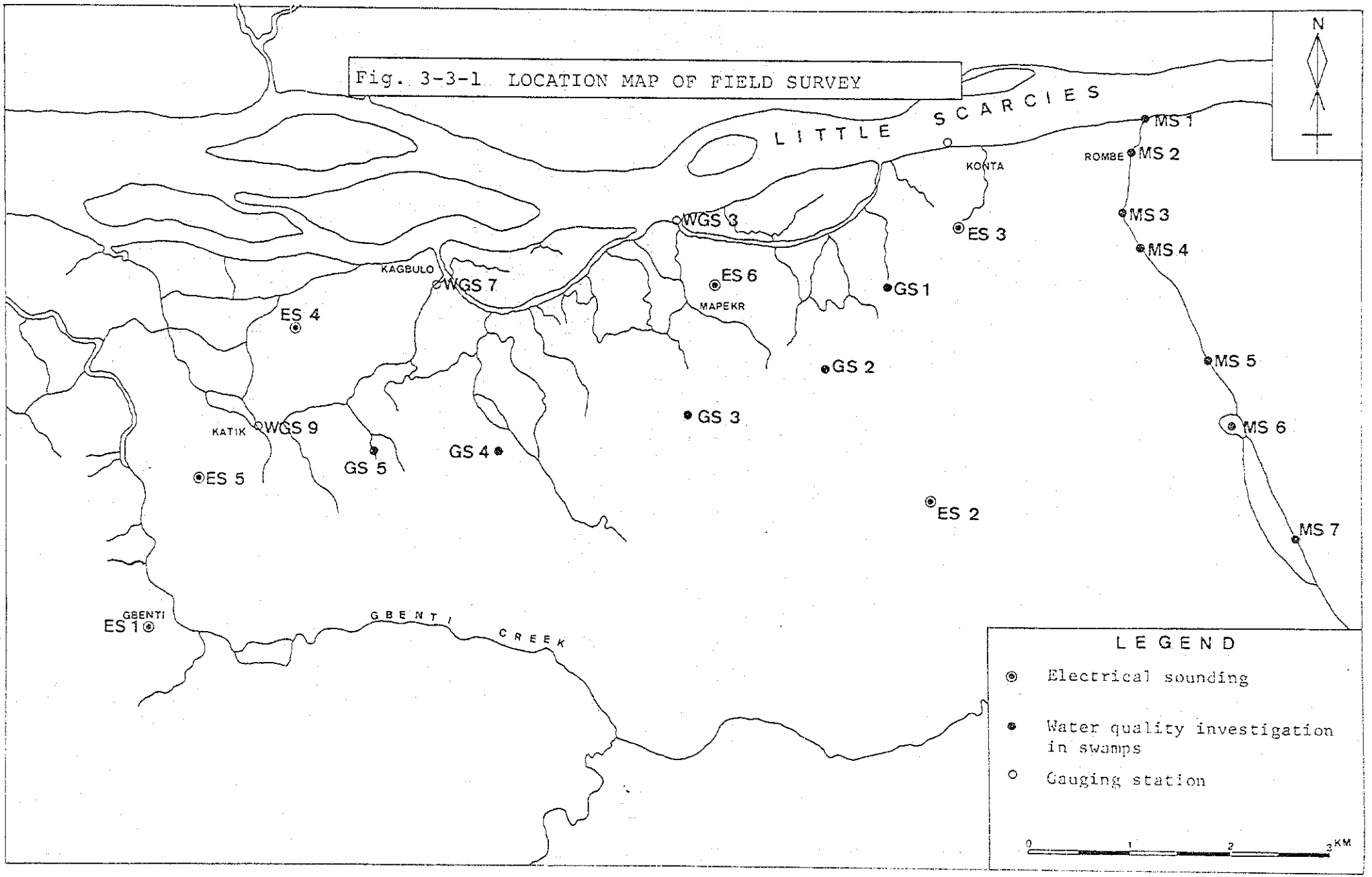


Fig. 3-3-1 LOCATION MAP OF FIELD SURVEY
N
LITTLE SCARCIES
KONTA
ROMBE
MS 1
MS 2
MS 3
MS 4
MS 5
MS 6
MS 7
WGS 3
ES 3
KAGBULO
WGS 7
ES 6
MAPEKR
GS 1
ES 4
GS 2
GS 3
KATIK
WGS 9
GS 5
GS 4
ES 5
ES 2
GBENTI
ES 1
GBENTI CREEK
LEGEND
Electrical sounding
Water quality investigation in swamps
Gauging station
0 1 2 3 KM

of electrode. An average depth of sounding of about 100 m and an average AB line of 400 m were maintained throughout this survey. The soundings were carried out by means of an ABEM TERRAMETER SAS 366 operated by a 12.8 volt power source.

3-3-2 Results of soundings

Result of soundings shows multi-layer curves (Fig.3-3-2 to 3-3-4). These curves were interpreted by means of Schblumergers' standard curve and its supplementary curve. As a result, the project area was divided into three to five resistivity layers.

Based on lithological logs, these resistivity layers were estimated respectively as the following geological formations.

A layer, which was below 100 ohm-m, was assumed to be swamp deposits, clayey layer of the Bullom series or a weathered basement.

A layer, which was 100 ohm-m to 1,000 ohm-m, was assumed to be sands or clayey sand of the Bullom series.

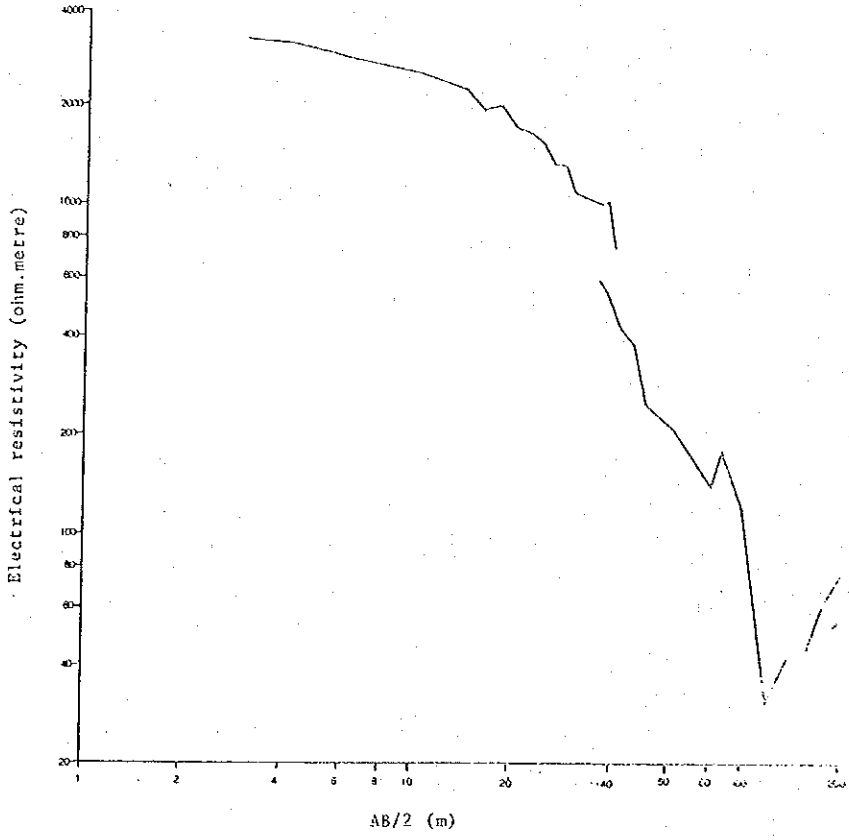
A layer, which was above 1,000 ohm-m, was assumed to be lateritic sediments or a basement.

These results are shown in Table 3-3-1. Based on Table 3-3-1, a hydrogeological cross section was made as shown in Fig. 3-3-5.

An impermeable basement is encountered at a depth of 10 to 20 m around Konta and Mapekr and is encountered at a depth of 60 to 80 m around Kagbulo and Gbenti and its depth increases westward.

Fig. 3-3-2 ρ-a GRAPH

ES-1 (Gbenti)



ES-2 (Malai)

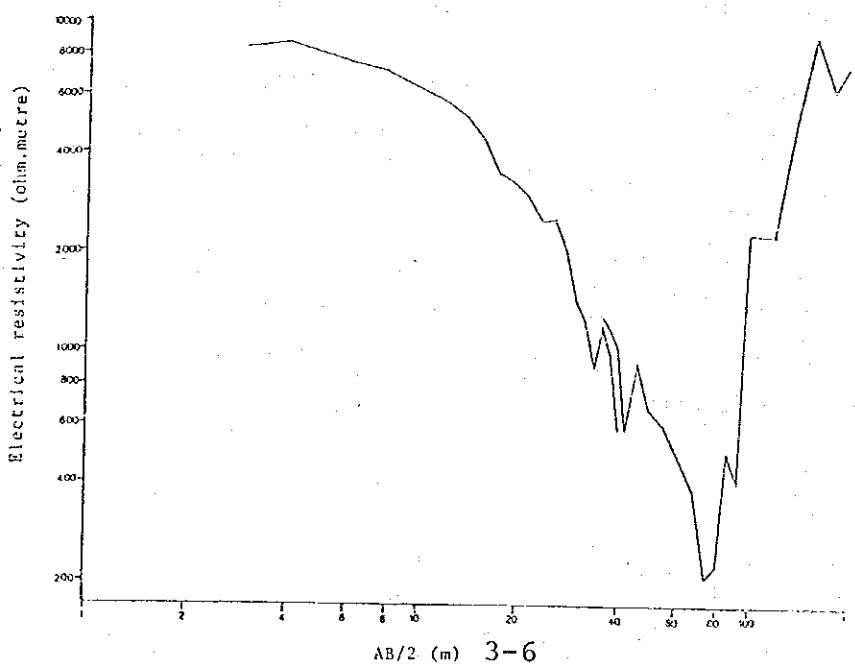
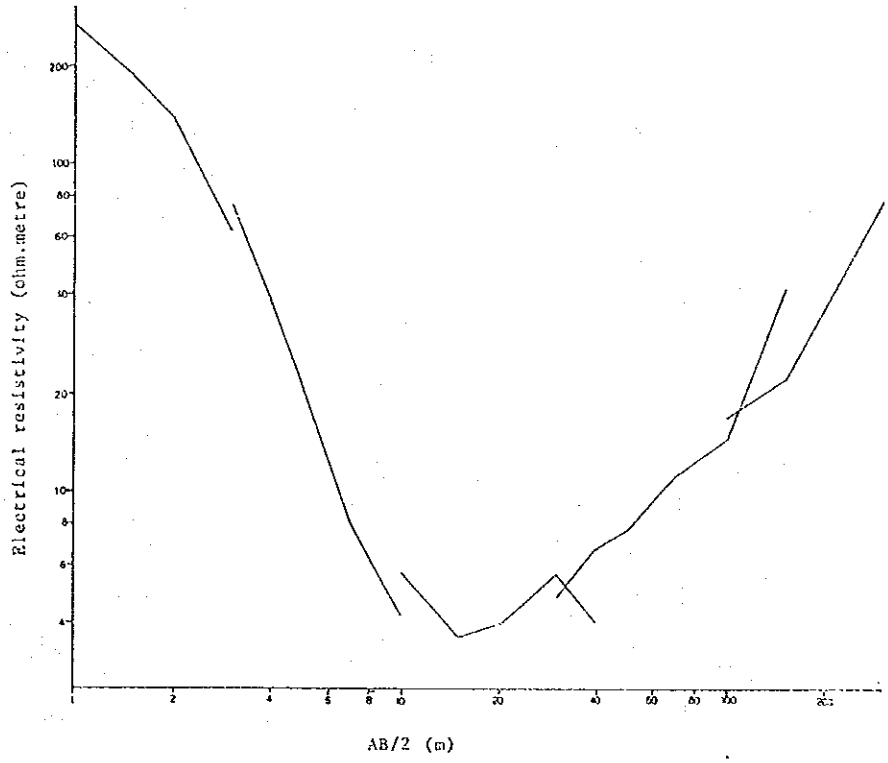


Fig. 3-3-3 ρ-a GRAPH

ES-3 (Konta)



ES-4 (Kagbulo)

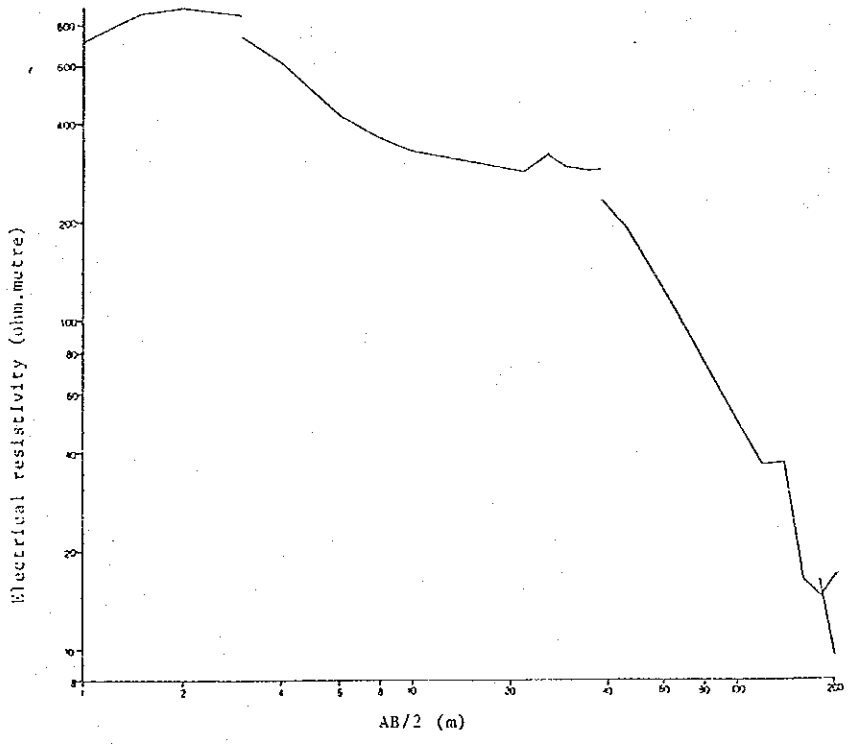
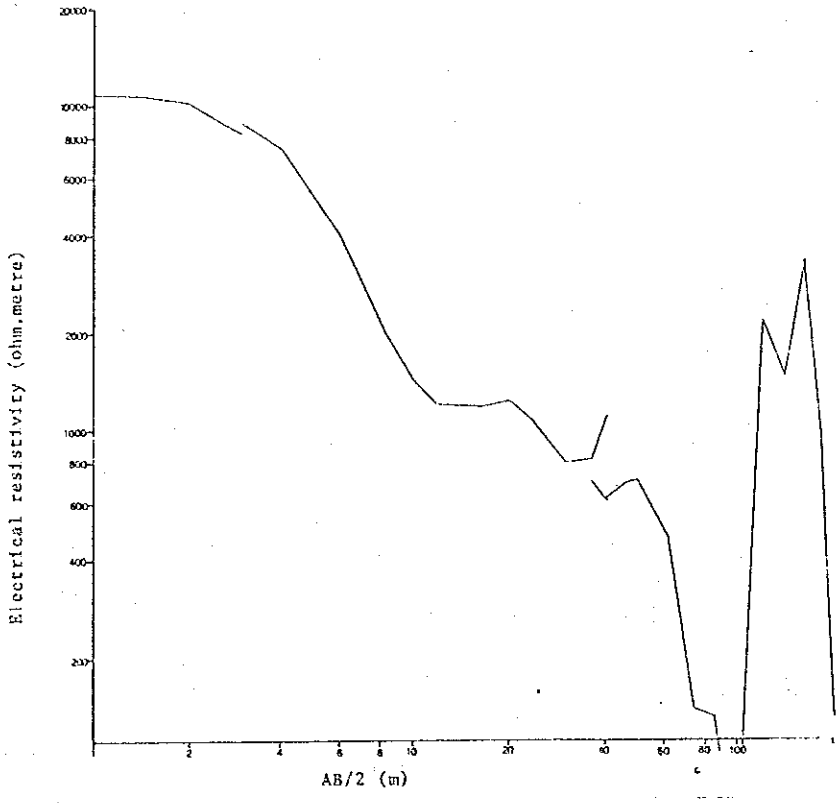


Fig. 3-3-4 ρ-a GRAPH

ES-5 (Katik)



ES-6 (Mapekr)

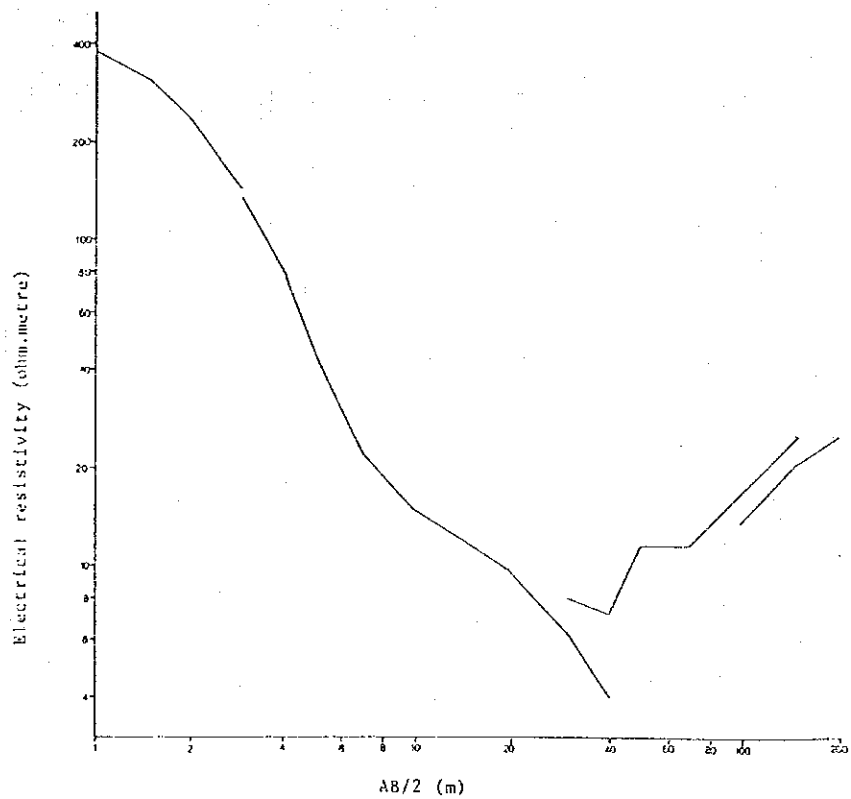
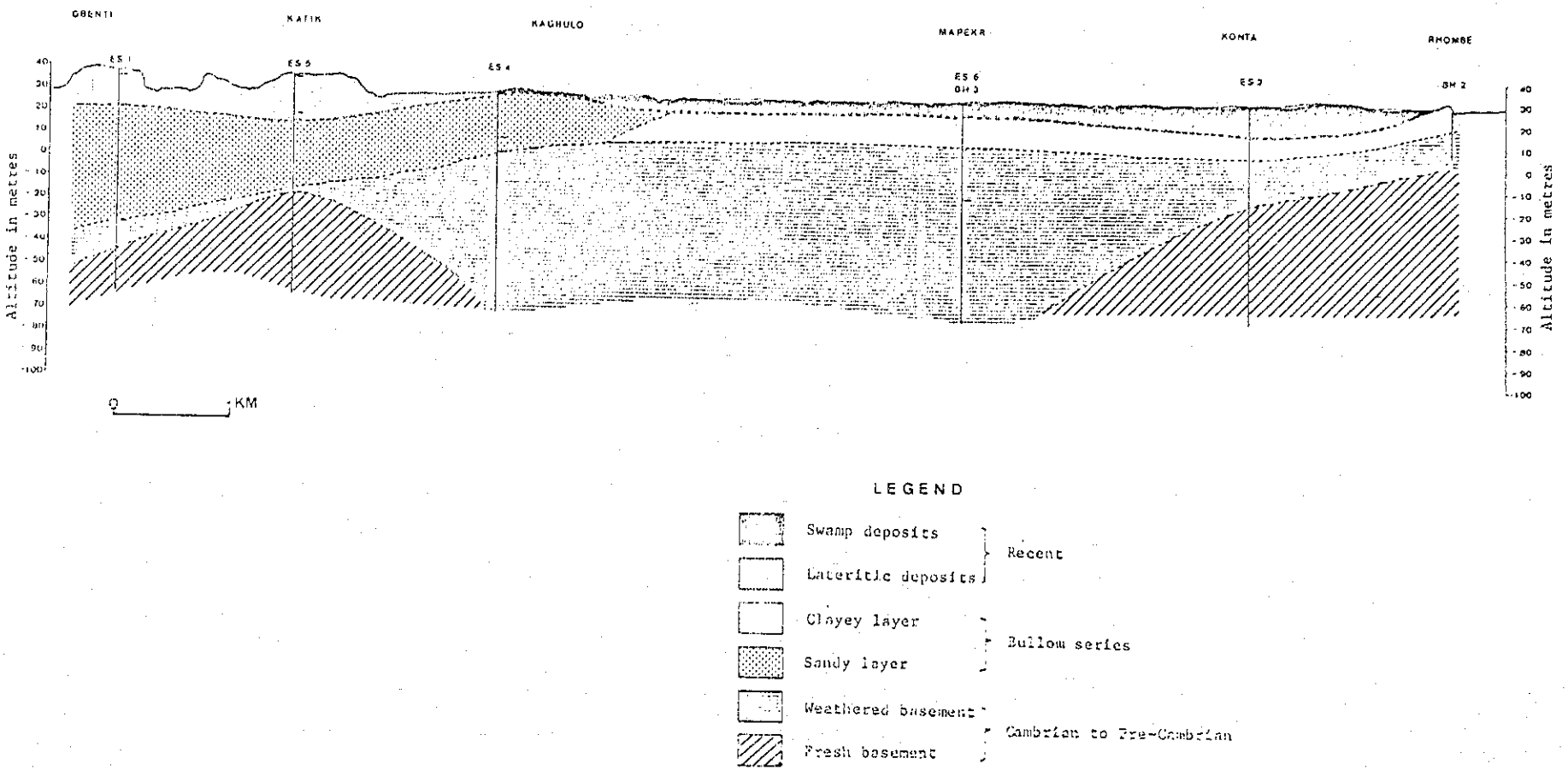


Table 3-3-1 RESULT OF INTERPRETATION

	1st layer	2nd layer	3rd layer	4th layer	5th layer
	depth resitivity layer to be estimated	depth resitivity layer to be estimated	depth resitivity layer to be estimated	depth resitivity layer to be estimated	depth resitivity layer to be estimated
ES-1 Gbenti	0 - 2.5m lateritic crust 3,500 ohm.meter	2.5 - 16.5m lateritic sand 2,100 ohm.meter	- 69.5m sand 210 ohm.meter	? weathered basement 44 ohm.meter	? fresh basement
ES-2 Malai	0 - 3.5m lateritic crust 8000 - 12,000 ohm.meter	- 13.5m lateritic sand 4,500 ohm.meter	- ? sand 235 ohm.meter	- ? fresh basement	
ES-3 Konta	0 - 1.2m Surface Soil 285 ohm.meter	- 15.5m swamp deposit 3 ohm.meter	- 46.5m silt, clay or weathered basement 30 ohm. meter	- fresh basement	
ES-4 Kagbulo	0 - 1.5m lateritic crust 530 - 1,060 ohm.meter	- 27.5m sand 300 - 360 ohm.meter	- silt, clay or weathered basement 17 ohm. meter		
ES-5 Katik	0 - 2.0m lateritic crust 11,200 ohm.meter	- 21.3m lateritic sand 1,120-1,440 ohm.meter	- ? sand 130 ohm.meter	- fresh basement	
ES-6 Mapekr	0 - 1.2m surface soil 400 ohm.meter	- 7.2m swamp deposit 20 ohm.meter	- 45m clay or meathered basement 6.9 ohm meter	- fresh or weathered basement 660 ohm. meter	

Fig. 3-3-5 ESTIMATED HYDROGEOLOGICAL CROSS SECTION



In the eastern part of the project area, swamp deposits or clayey layer of the Bullom series continue to the impermeable basement and there is lack of sand layer.

In the western part, a layer assumed to be a sands layer of the Bullom series distributes without clayey layer.

This sandy layer, which has a thickness of 25 to 50 m, is considered to be a surce for groundwater exploitation.

3-4 Groundwater

Sixteen existing wells which are located in and around the project area were surveyed for type, depth, usage, groundwater level and water quality. The locations are shown in Fig. 3-4-1 and the results are shown in Table 3-4-1.

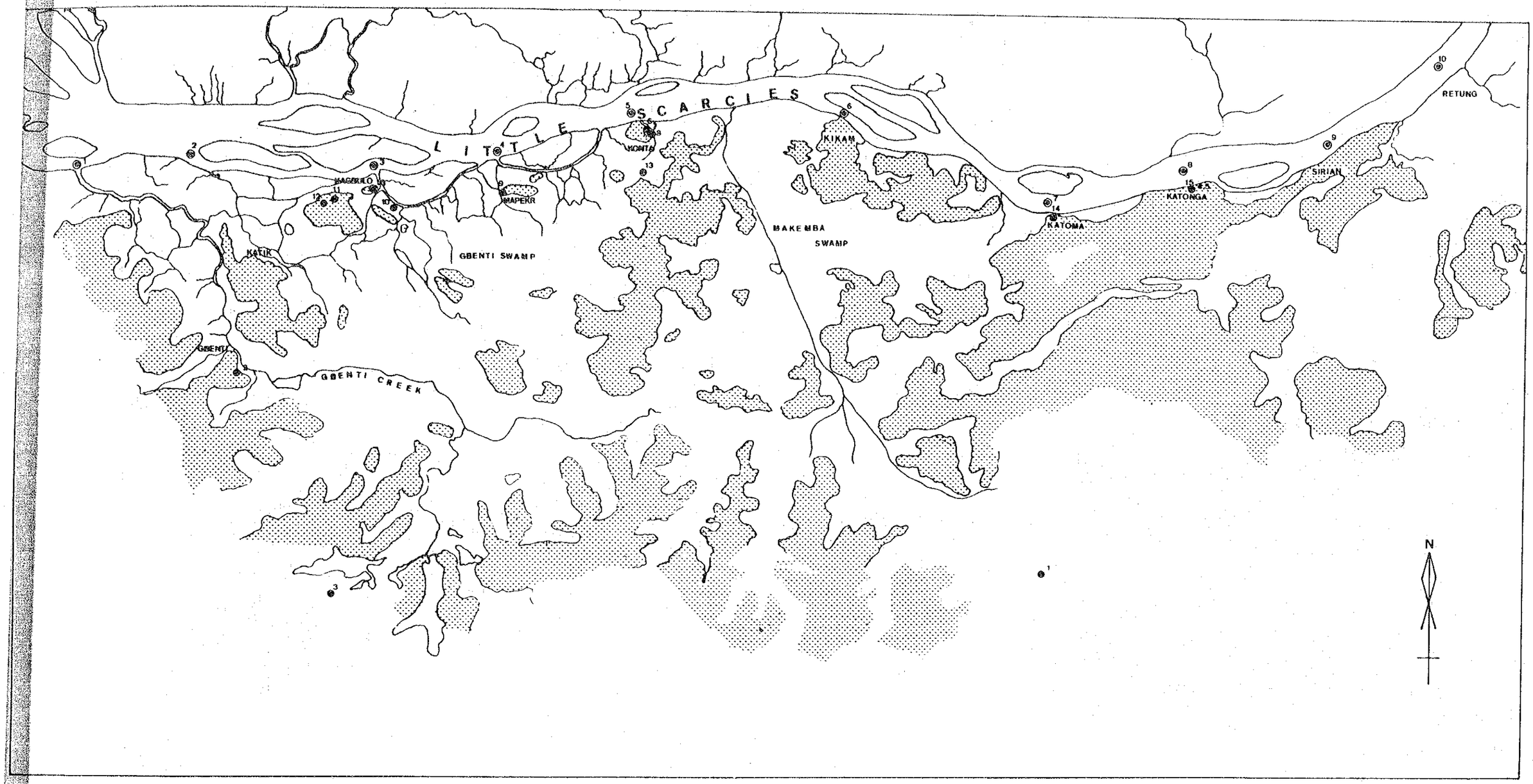
3-4-1 Groundwater usage

Every well is a hand-dug type that is commonly used in villages. The depth of wells ranges from 1.5 m to 5.4 m. The diameter varies from 0.8 m to 3.0 m, but many wells are around one meter in diameter.

People draw groundwater from these wells with buckets except for one well with a manual pump. The groundwater is used for domestic needs. There are few cases where the wells are used throughout the year; they are mostly used during the dry season.

3-4-2 Groundwater level and water quality

During the wet season, the groundwater level was usually shallow and varied from 0.2 m to 2.3 m below the ground



LEGEND

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

Fig. 3-4-1 LOCATION MAP OF FIELD SURVEY

0 1 2 3 4 5 KM

Table 3-4-1 INVENTORY OF EXISTING WELLS

No.	Date	Location	Type of well	Usage	Discharge Facilities	Diameter (m)	Depth (m)	Ground-water level (m)	Water depth (m)	Water Temperature (°c)	pH	Electrical Conductivity (mS/cm)	Total Salinity as NaCl (ppm)
1	11/9/82	Makeniko	dig well	domestic for dry season	bucket	-	approx. 2.0	-	-	26.5	4.7	13.0	6.2
2	"	Gbenti	"	domestic for all season	"	1.4	4.5	2.2	2.3	27.8	5.2	170	90
	13/12/82							3.2	1.3	26.2	5.2	110	55
3	11/9/82	Magbana	"	" for dry season	"	-	1.5	-	-	27.8	4.7	16.5	8.0
4	"	Katonga	"	" for all season	"	0.8	5.0	1.9	3.1	28.4	5.0	31.0	15.5
5	"	"	"	"	"	1.0	5.3	1.9	3.4	-	-	-	-
6	14/9/82	Konta	"	domestic for dry season	"	1.1	3.2	1.7	1.5	26.6	5.3	340	170
	3/12/82							2.2	1.0	26.5	5.9	330	160
7	14/9/82	"	"	"	"	1.2	3.1	1.4	1.7	26.0	5.1	320	160
8	"	"	"	"	"	2.5	2.8	1.9	0.9	27.5	5.2	130	65
9	"	Mapekr	"	"	"					(25.0)	5.1	28.0	14.0
10	"	Rogbom	"	"	"	1.1	3.2	0.2	3.0	26.1	5.8	320	160
	30/11/82							0.9	2.3	27.4	5.4	320	160
11	14/9/82	Kagbulo	"	domestic for all season	"	1.6	4.5	2.2	2.3	(30.8)	5.2	65.0	32.0
	30/11/82							3.0	1.5	27.2	5.2	38	18
12	14/9/82	"	"	"	"	1.9	4.2	1.8	2.4	(29.8)	5.2	110	53
	30/11/82							2.5	1.7	27.1	5.3	85	40
13	14/9/82	Yampmori	"	"	"	1.0	4.5	1.4	3.1	27.8	4.5	38	18
	3/12/82							2.6	1.9	26.8	4.4	22	10
14	14/9/82	Katoma	"	"	"	1.2	5.1	2.3	2.8	28.5	5.0	90	43
15	"	Katonga	"	"	hand pump		5.4	1.9	3.5	(28.7)	6.4	56	28
16	30/11/82	Kagbulo	"	"	bucket	3.0	2.4	1.6	0.8	27.4	5.8	130	63

surface. In the dry season, the groundwater level ranged from 0.9 m to 3.2 m - a decrease ranging from 0.5 m to 1.2 m compared with the wet season.

In order to grasp the relationship between groundwater and the Little Scarcies river, a continuous groundwater level measurement was carried out every hour for three days in the wet season at Katonga. Acoording to the results, the maximum daily fluctuation was about ten centimeters and there was no relation between groundwater and river water in the fluctuation. Further, the groundwater level was generally higher than the water level of the river. It is therefore considered that there is hardly any recharge from the river to the groundwater in the wet season.

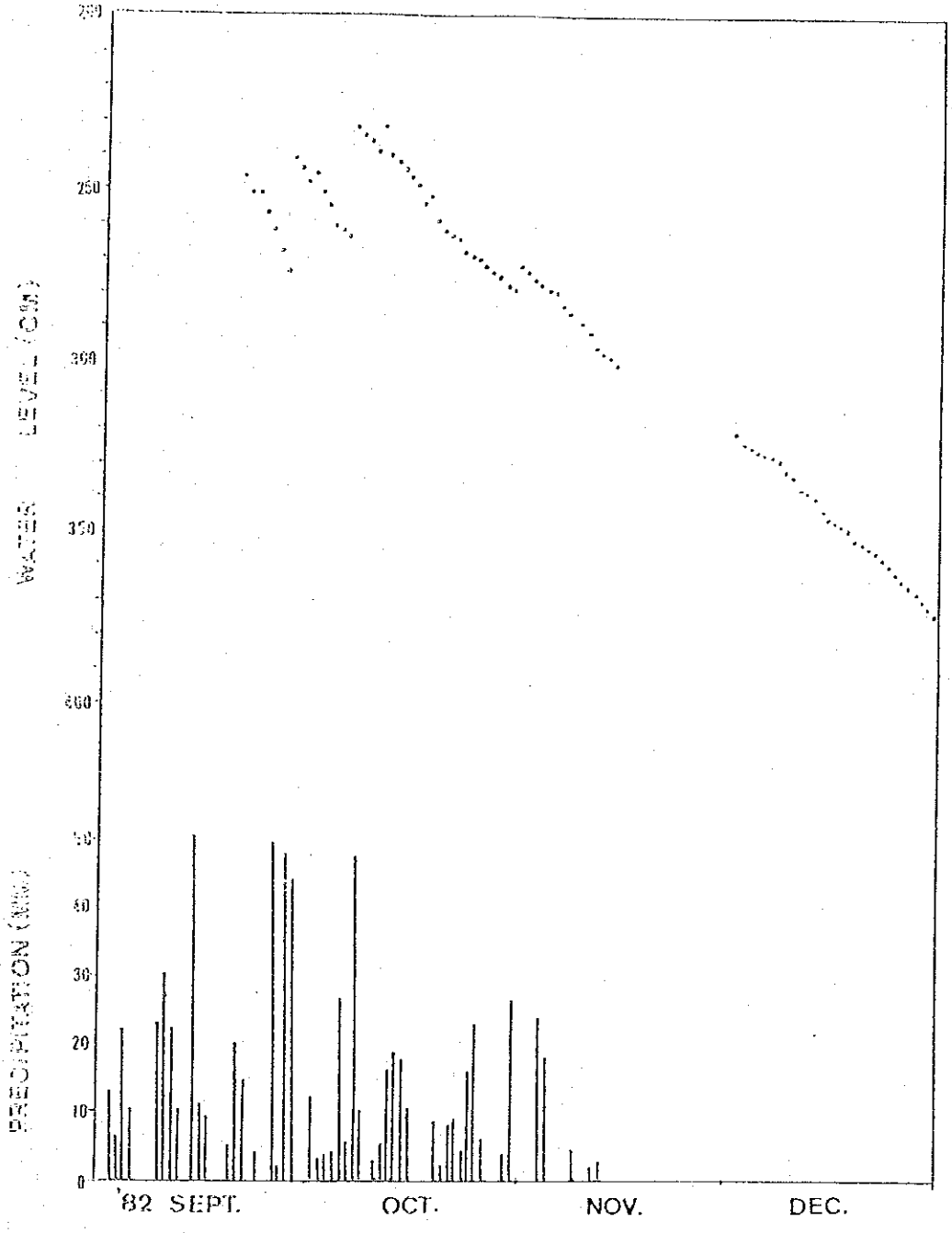
Another continuous groundwater level measurement was carried out once a day from Sept. 20th to Dec. 31st in 1982 at Kagbulo well. The result is shown in Fig. 3-4-2 and compared with precipitation at Rokpur. The groundwater level varies corresponding to fluctuation of the precipitation. After the wet season, the groundwater level drops linearly. Thus, it is estimated that the groundwater of the project area is mainly recharged from the precipitation.

The water temperature ranges from about 26.0°C to 28.5°C but is about 1°C lower in the dry season than the wet season. The pH varied from 4.4 to 6.4 and indicated strong acidity. Elctrical conductivity ranged from 13.0 to 340 micr-mho per centimeter.

Some wells which exceeded 200 micro-mho per centimeter were probably contaminated by domestic sewage.

The water quality in the dry season is scarcely different from the wet season. While the water quality of the Little Scarcies and creeks were affected by the

Fig. 3-4-2 WATER LEVEL FLUCTUATION AT KAGBULO WELL



seawater intrusion in the dry season, the water quality of groundwater was hardly influenced by the seawater intrusion. The groundwater is therefore considered to be a stable water resource for irrigation use.

CHAPTER 4 METEOROLOGY AND HYDROLOGY

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CHAPTER 4 METEOROLOGY AND HYDROLOGY

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CHAPTER 4 METEOROLOGY AND HYDROLOGY

4-1 Meteorology

4-1-1 General

There are 7 meteorological stations and 4 pluviometrical stations in and around the Little Scarcies river basin, as listed upon Table 4-1-1. Their locations are also illustrated on Fig. 4-1-1.

The available meteorological data at these stations were collected, compiled and analysed. These data include air temperature, relative humidity, sunshine hours, winds, evaporation and precipitation. The period of records available in each station is summarized in Figs. 4-1-2 and 4-1-3.

The data from Lungi Airport meteorological station is considered to be more sustained. This station is located about 25 kilometers to the south-west of the study area and has more reliable climatic data and similar climatic conditions to the study area. Therefore, with these factors having been taken into consideration, the meteorological data obtained from this station, excluding rainfall, were used as the basis for the agronomic and irrigation studies.

At the Lungi station, records of air temperature, relative humidity, evaporation, sunshine hours and winds are available for the last 22 years. Extrapolation was necessary due to the occurence of missing data in a few months.

With respect to precipitation, the records at Rokupr station from 1951 to 1982 are directly referred to in this study, considering the results of the MRT Study on the correlation of rainfall among Rokupr, Lungi and Port Loko.

Table 4-1-1 LIST OF METEOROLOGICAL AND PLUVIMETRICAL STATIONS

Stations	Latitude (N)	Longitude (W)	Altitude above M.S.L. (m)	Belonging
Meteorological				
Lungi	8°37'	31°12'	25	Meteorological Department
Rokupr	9°01'	12°47'	8	Agricultural Department
Port Loko	8°46'	12°47'	49	Agricultural Department
Marampa	8°41'	12°31'	67	Sierra Leone Development Company
Makeni	8°53'	12°03'	84	Agricultural Department
Kabala	9°35'	11°33'	464	Meteorological Department
Musaia	9°45'	11°34'	351	Agricultural Department
Pluviometrical				
Katonga	8°50'	12°56'	-	Agricultural Department
Batkgnu	9°04'	12°25'	64	Foresty Department
Kamakwie	9°35'	12°15'	101	Agricultural Department
Bafodia	9°41'	11°44'	360	A.W. Mission

Fig 4-1-1 LOCATION OF METEO-HYDROLOGICAL STASTION

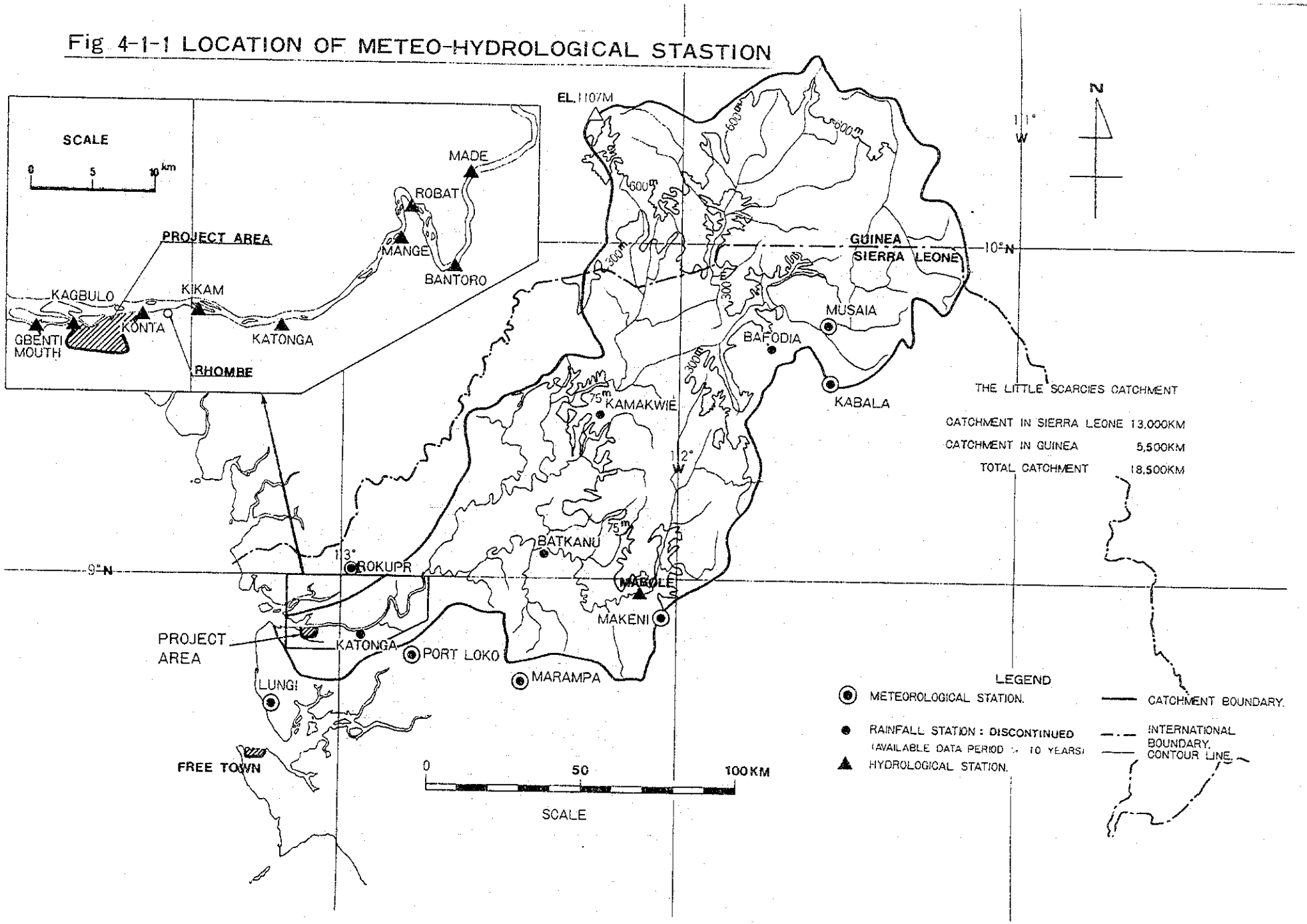


Fig. 4-1-2 Available Meteorological Record Obtained

LEGEND
Available
Partially available

Station	Item	
Lungi	Temperature	mean mean max. mean min.
	Evaporation	
	Relative Humidity	9:00 15:00
	Sunshine hours	
	Wind speed	
Rokupr	Temperature	mean mean max. mean min.
	Relative Humidity	9:00 15:00
	Sunshine hours	
Port Loko	Relative Humidity	9:00 15:00
Katonga (by MRT Study)	Temperature	mean mean max. mean min.
	Evaporation	
	Relative Humidity	9:00 15:00
	Sunshine hours	
	Wind speed	

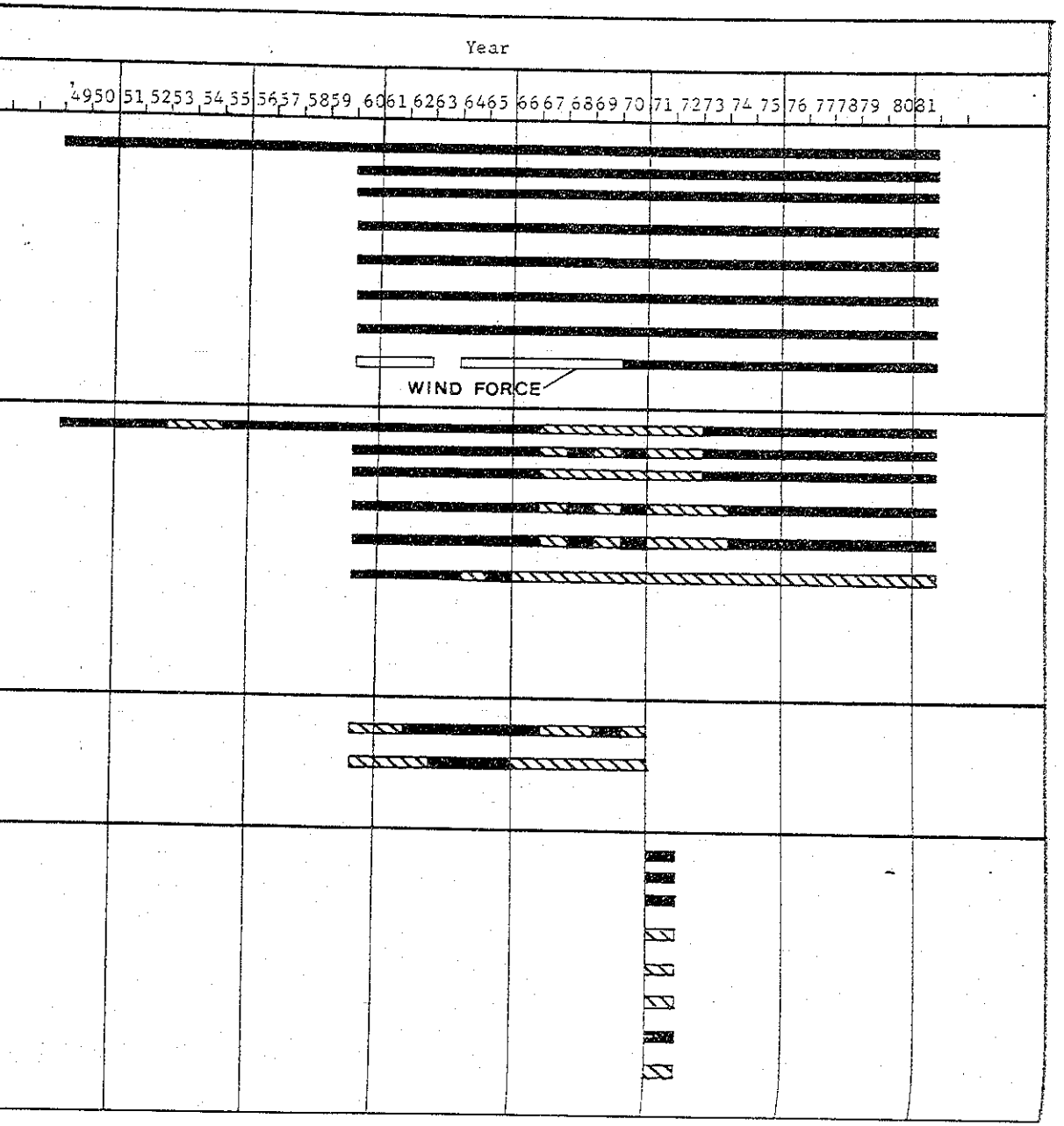
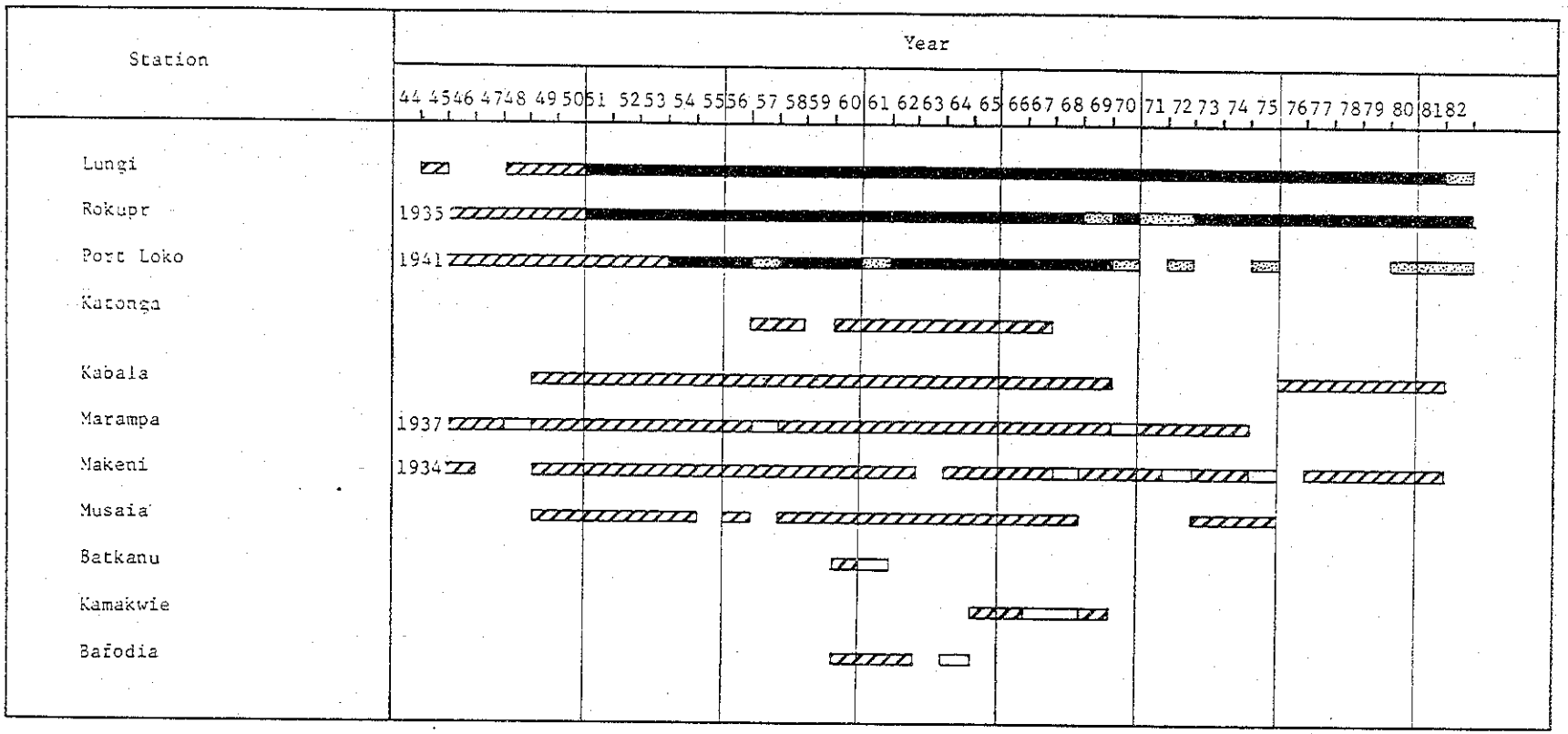


Fig 4-1-3 AVAILABLE RAINFALL RECORD OBTAINED



4-1-2 Air Temperature

The annual mean temperature at Lungi for the last 33 years is approximately 26.5°C and the monthly mean temperature shows little seasonal fluctuations. The variation between the highest and lowest monthly mean temperatures was about 3°C (Refer to Table 4-1-2 and Fig. 4-1-4). On the other hand, fluctuations of temperature within a day was relatively wide, or in the range of 4°C to 10°C.

Monthly mean maximum temperature is averaged at 30°C, while the mean monthly minimum temperature is 23°C.

4-1-3 Relative Humidity

The annual mean relative humidity at Lungi for the last 22 years is 82%. The relative humidity is high in the wet season and relatively low in the dry season. The seasonal fluctuation ranges from 75% in March to 89% in August (Refer to Table 4-1-3 and Fig. 4-1-4).

The mean relative humidity during 1963, and from 1970 to 1981 was estimated from the relative humidity obtained at 9:00 a.m. and 3:00 p.m. The longitude of the study area is 13°W and standard time in Sierra Leone is Greenwich Mean Time. Consequently between actual solar movement and local time in Sierra Leone, there is a lag of almost one hour. In view of this, the following formula is used and sufficient values are obtained.

$$RH\ mean = (RH(9:00) \times 2 + RH(15:00))/3$$

4-1-4 Sunshine Hours

At Lungi, the monthly sunshine hours averaged at 230 hours in the dry season and 140 hours in the wet

Table 4-1-2 MONTHLY MEAN AIR TEMPERATURE

Station: Lungi (°C)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1949	26.1	27.1	27.4	27.9	28.1	26.7	25.5	25.2	25.8	25.8	26.6	26.2	26.5
1950	26.1	26.7	27.8	28.6	27.3	26.4	25.4	24.9	25.2	25.5	26.5	26.9	26.4
1951	26.7	27.1	27.3	27.5	27.0	26.4	25.5	25.2	25.7	25.8	26.6	26.7	26.5
1952	26.5	27.4	27.8	28.1	27.2	26.1	25.5	24.9	25.7	26.2	26.2	26.5	26.5
1953	27.3	27.1	27.7	28.4	27.6	25.7	25.4	25.4	26.1	26.4	27.1	27.3	26.8
1954	26.8	27.8	27.3	27.6	26.8	25.9	24.8	24.4	25.7	25.7	26.2	26.7	26.3
1955	27.4	28.1	27.6	27.6	27.3	26.3	25.2	25.4	25.9	26.2	26.8	25.7	26.6
1956	26.2	27.1	27.1	28.0	27.1	25.9	24.6	24.8	25.7	25.8	26.4	25.8	26.2
1957	25.6	26.6	27.4	27.3	27.4	26.4	25.2	25.2	25.6	25.7	26.6	24.1	26.1
1958	27.6	27.6	27.9	27.1	26.7	26.1	24.9	24.7	25.3	26.1	25.8	26.2	26.3
1959	26.1	27.3	27.3	27.6	26.8	26.4	26.3	25.2	25.4	25.7	25.4	26.2	26.3
1960	26.2	27.4	27.2	27.4	27.3	26.2	25.2	25.3	25.7	26.2	26.6	24.0	26.2
1961	25.9	26.5	27.8	27.6	27.8	25.9	24.7	25.0	25.6	26.1	26.7	26.7	26.4
1962	26.8	26.6	27.5	28.3	27.2	25.8	25.9	24.9	25.2	25.8	26.1	26.5	26.4
1963	26.4	26.9	27.6	27.9	27.5	26.2	25.6	25.3	25.4	26.2	26.7	26.5	26.5
1964	26.4	27.4	27.4	27.6	27.4	26.2	25.2	24.1	24.2	25.5	25.4	25.8	26.1
1965	25.1	25.6	27.1	27.7	26.7	25.8	25.3	25.2	25.1	26.2	26.6	26.3	26.1
1966	25.8	26.0	27.6	28.5	27.6	25.9	25.8	25.3	25.4	25.8	25.8	26.6	26.3
1967	26.5	27.1	26.7	27.9	26.9	25.8	24.9	24.7	25.3	26.1	26.5	26.6	26.3
1968	26.4	26.4	26.4	27.1	26.9	26.2	25.4	25.9	25.6	26.4	26.4	26.9	26.4
1969	27.0	27.2	28.1	28.8	28.0	25.6	25.0	25.0	25.4	25.8	26.6	27.1	26.6
1970	27.2	27.4	28.0	28.7	27.4	26.7	25.4	25.1	25.4	26.1	26.2	26.2	26.7
1971	26.7	26.9	26.9	27.0	27.3	26.1	25.4	25.0	25.2	25.7	26.1	26.0	26.2
1972	26.6	26.8	27.6	28.0	27.9	26.0	25.7	25.5	25.9	26.0	27.1	26.6	26.6
1973	26.5	27.7	28.1	28.5	27.6	26.8	26.7	25.7	26.0	26.4	27.1	26.5	27.2
1974	26.0	27.7	27.2	27.1	27.2	26.6	25.6	25.2	25.5	27.0	26.8	27.2	26.3
1975	26.5	27.5	27.9	27.7	27.6	26.5	25.5	25.0	24.8	25.9	27.1	26.9	26.6
1976	26.7	27.1	27.1	27.2	25.7	25.7	25.0	25.0	25.9	25.7	26.3	26.6	26.2
1977	26.8	26.7	27.7	28.3	27.7	26.4	25.7	25.3	25.9	26.5	27.6	27.3	26.8
1978	27.9	27.8	27.3	28.1	27.3	26.0	25.3	25.2	25.7	26.2	26.0	26.8	26.6
1979	27.1	27.6	28.0	28.2	27.4	26.4	25.4	25.6	26.1	26.6	27.1	26.3	26.8
1980	27.1	27.0	27.6	28.7	27.7	26.8	25.9	25.8	26.4	26.5	26.8	26.3	26.9
1981	26.4	27.1	28.1	28.4	27.1	26.9	25.9	25.8	26.1	26.4	27.9	26.7	26.9
Average	26.6	27.1	27.5	27.9	27.3	26.2	25.4	25.2	25.6	26.1	26.5	26.4	26.5

Fig. 4-1-4 CLIMATOLOGICAL CHARACTERISTICS

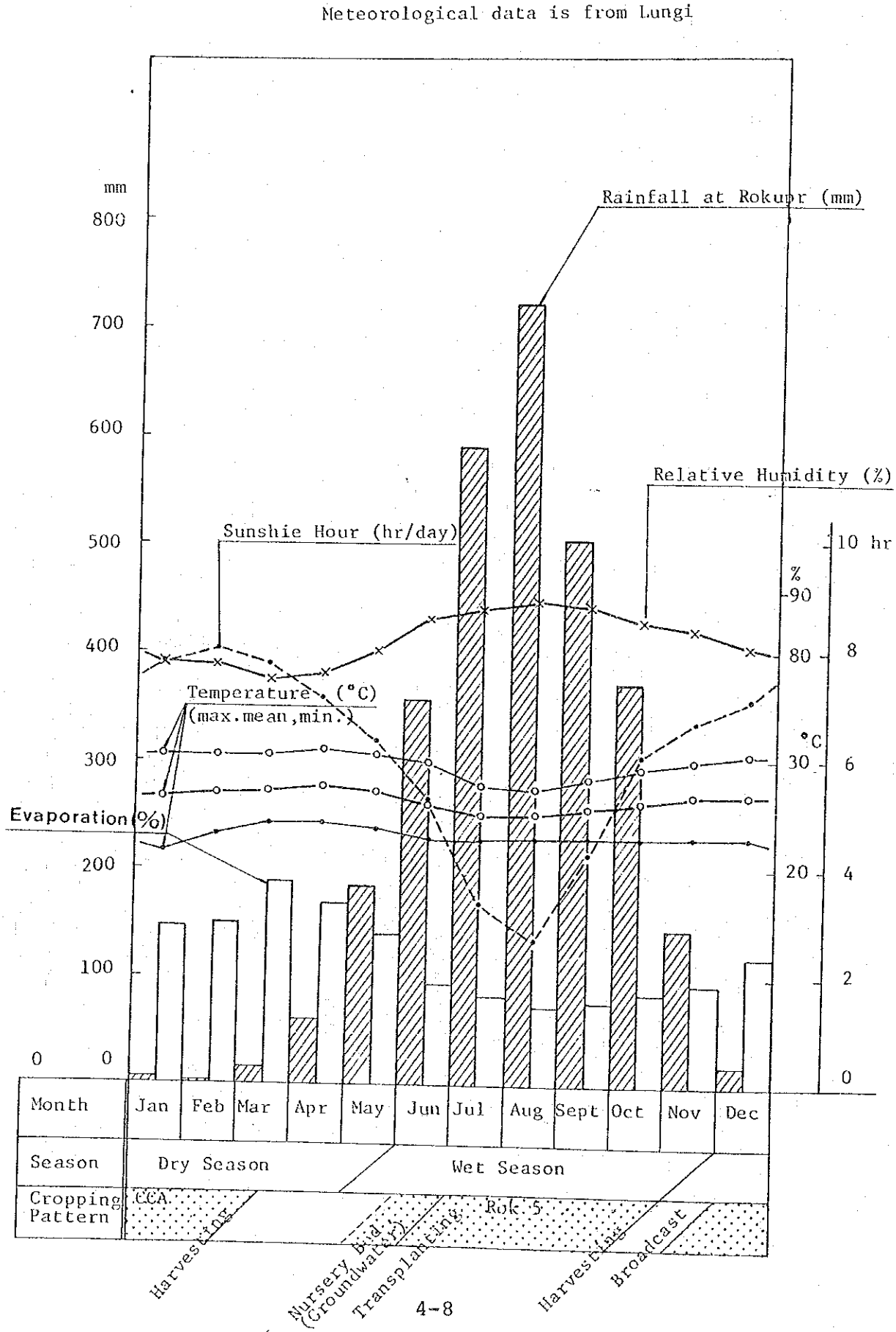


Table 4-1-3 MONTHLY RELATIVE HUMIDITY

Station: Lungi (%)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1960	82	81	82	79	83	87	88	90	89	85	86	78	84
1961	78	80	77	79	82	86	90	90	89	86	85	82	84
1962	81	74	79	80	83	87	88	88	89	88	87	78	84
1963	85	80	77	74	78	85	88	91	87	86	83	81	83
1964	81	79	76	75	82	85	87	92	89	87	86	83	84
1965	75	77	78	79	82	87	88	88	89	86	85	82	83
1966	82	82	78	79	82	87	88	89	90	88	85	83	84
1967	77	76	77	75	81	86	89	90	90	88	86	77	83
1968	77	77	77	75	84	88	88	89	88	85	86	85	83
1969	83	81	79	79	82	86	89	91	87	87	85	83	84
1970	83	76	73	75	80	84	89	88	87	83	83	81	82
1971	81	77	71	74	75	85	86	88	88	80	84	86	81
1972	85	79	76	73	81	87	87	89	86	83	84	85	83
1973	77	79	73	73	78	84	85	87	86	83	80	78	80
1974	73	77	72	70	74	83	88	89	86	82	77	80	79
1975	70	77	70	75	76	83	87	89	89	84	82	83	80
1976	77	76	72	75	81	87	87	88	89	90	85	78	82
1977	80	79	77	75	79	88	90	90	90	86	82	81	83
1978	80	78	73	75	81	86	88	91	88	85	81	81	82
1979	79	77	71	71	77	85	89	88	85	84	84	78	81
1980	77	75	73	76	80	85	88	89	86	83	83	77	81
1981	74	75	75	76	82	83	90	89	86	82	81	86	82
Average	78	78	75	76	80	86	88	89	88	85	84	81	82

Note: 1963, 1970 - 1981: Estimated by following formula

(RH9:00 x 2 + RH15:00)/3

season. The annual sunshine hours were approximately 2,200 hours (Refer to Table 4-1-4 and Fig. 4-1-4).

According to the sunshine hours records the wet season seems to start and end earlier in recent years.

4-1-5 Winds

In Sierrra Leone the desert air or harmattan is normally experienced from December to February. However, the harmattan reaches the study area along the coast for short periods only.

The study area has predominant winds of West to Southwest direction. Monthly mean wind speed recorded at Lungi ranges from 2.1 meter per second to 3.2 meter per second. The annual mean wind speed is averaged at 2.6 meters per second (Refer to Table 4-1-5 and Fig. 4-1-4). The wind speed recorded at 9:00 a.m., in general, is smaller than those recorded at 3:00 p.m. and 9:00 p.m. each day.

The wind speed for the period from 1960 to 1969 is converted from the standard Beaufort classification. The wind speed for the period from January 1970 to May 1977 is estimated on the assumption that these records were taken at the height of 12.2 m above ground level.

4-1-6 Evaporation

The annual evaporation measured at Lungi for the period from 1960 to 1981 is averaged at about 1,400 mm, which corresponded to approximately 45% of the annual precipitation in the study area. The monthly evaporation ranges from 70 mm in August to 190 mm in March (Refer to Table 4-1-6 and Fig. 4-1-4).

Table 4-1-4 MONTHLY SUNSHINE HOURS

Station: Lungi

(hours/day)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1960	7.6	7.9	8.4	8.2	6.2	5.1	3.7	2.4	3.7	7.1	6.8	7.6	6.2
1961	6.7	7.6	8.3	7.5	7.2	4.9	2.1	2.2	3.8	7.4	7.5	8.2	6.1
1962	8.3	7.4	8.1	6.9	7.0	4.9	3.7	1.9	3.6	5.9	5.9	8.7	6.0
1963	7.6	8.1	8.0	7.8	6.1	6.3	3.4	2.8	4.5	5.7	8.5	7.1	6.3
1964	8.0	8.1	8.3	7.2	5.7	5.7	3.3	1.3	3.6	5.2	6.6	6.2	5.8
1965	8.1	9.7	9.1	7.2	5.8	4.3	3.7	3.2	3.4	6.0	6.5	7.0	6.2
1966	7.0	8.1	8.2	6.8	6.4	4.6	4.3	2.4	3.0	5.5	6.3	7.5	5.8
1967	7.9	8.3	8.0	7.4	6.8	4.9	2.3	1.8	3.2	6.4	5.8	6.7	5.8
1968	7.9	8.0	8.1	8.8	5.9	4.9	3.7	4.0	4.3	6.9	5.7	6.4	6.2
1969	7.6	8.5	8.2	6.6	5.7	5.2	2.3	2.3	3.9	4.5	6.7	7.4	5.7
1970	8.2	8.2	8.5	7.0	5.6	6.8	3.2	2.4	4.8	6.0	6.5	6.7	6.2
1971	8.5	9.7	6.1	8.0	6.9	6.2	4.3	2.6	4.4	7.0	5.7	6.3	6.1
1972	7.5	9.0	7.5	6.8	5.9	5.0	4.5	3.4	5.3	6.3	5.0	6.3	6.0
1973	7.7	8.2	8.5	7.1	6.4	4.9	4.4	4.4	4.7	6.4	7.9	7.8	6.5
1974	7.8	7.3	6.7	6.5	8.3	5.7	3.2	2.3	4.0	6.4	8.3	6.9	6.1
1975	7.9	8.9	8.4	6.6	7.5	5.8	3.5	2.6	3.5	6.1	7.1	7.2	6.3
1976	8.3	8.7	7.1	8.0	6.3	5.7	3.4	3.3	5.1	4.1	6.6	8.1	6.2
1977	7.8	8.1	6.7	6.3	5.9	5.1	3.0	3.1	4.6	5.6	8.0	7.4	6.0
1978	7.8	7.8	8.1	7.0	6.0	4.6	3.5	2.6	4.5	5.5	6.5	7.0	5.9
1979	8.2	8.3	6.8	6.3	7.3	5.0	3.4	2.8	5.3	5.7	6.5	6.8	6.0
1980	7.6	7.2	7.8	7.7	5.7	5.4	3.1	2.9	5.2	6.6	6.4	6.9	6.0
1981	7.5	7.9	7.7	7.2	5.3	5.2	2.6	3.1	5.0	6.7	6.8	6.5	6.0
Average	7.8	8.1	7.8	7.2	6.4	5.3	3.4	2.7	4.2	6.0	6.7	7.1	6.1

Table 4-1-5 MONTHLY WIND SPEED

Station: Lungi

(m/sec: at 2m height)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1960	2.1	2.7	3.2	3.3	2.6	2.4	2.3	2.6	2.7	2.6	2.4	2.6	2.6
1961	1.2	2.6	3.3	3.2	3.2	2.6	2.4	3.0	2.7	2.4	1.6	1.2	2.5
1962	2.0	2.6	2.4	2.7	2.9	2.3	2.6	1.5	2.4	2.0	1.7	1.7	2.2
1963	2.0	2.7	3.0	3.2	2.7	2.4	2.4	2.7	2.4	2.6	2.0	2.0	2.5
1964	2.1	2.7	3.2	2.9	2.6	2.4	3.2	2.6	2.6	2.0	2.0	1.9	2.5
1965	2.0	3.0	3.3	3.2	2.4	2.4	2.4	2.9	2.6	2.4	2.3	2.0	2.6
1966	2.4	2.9	3.5	3.7	2.9	2.6	2.6	3.2	2.4	2.6	2.3	2.0	2.8
1967	2.6	3.0	3.3	3.5	3.2	2.9	3.2	3.7	2.4	2.1	2.0	1.7	2.8
1968	2.3	2.7	2.9	3.2	2.6	2.3	2.4	2.1	2.3	2.3	1.9	2.3	2.4
1969	1.9	2.4	2.7	3.0	2.7	1.6	1.6	3.2	1.4	2.7	2.4	2.6	2.4
1970	2.4	2.7	3.6	3.4	2.9	2.7	3.5	3.8	2.8	2.5	2.3	1.9	2.9
1971	2.6	3.5	3.8	3.5	3.3	2.6	2.6	3.3	3.0	2.9	2.8	2.6	3.0
1972	2.9	2.7	3.5	3.5	3.2	2.9	3.2	3.2	3.0	3.2	2.3	2.3	3.0
1973	2.7	3.5	3.6	3.8	2.3	3.1	3.5	3.5	3.3	2.9	2.8	2.6	3.1
1974	2.9	3.4	3.9	3.8	3.9	3.2	3.2	3.3	2.7	2.9	2.9	2.9	3.3
1975	3.0	3.8	3.4	3.5	3.3	2.9	2.9	3.3	3.2	2.2	2.5	2.6	3.1
1976	3.1	3.5	3.5	3.4	3.1	2.9	3.5	3.4	3.2	2.7	2.6	2.6	3.1
1977	3.1	3.4	3.6	3.8	3.5	2.9	2.5	2.8	2.2	2.1	1.9	1.7	2.8
1978	2.6	2.8	3.1	2.9	2.2	2.4	2.4	1.8	2.0	2.0	1.5	1.9	2.3
1979	2.3	2.6	2.7	2.9	2.6	2.6	2.1	2.1	2.3	2.3	1.8	1.4	2.3
1980	1.9	2.3	2.6	2.6	2.2	2.1	1.7	2.3	2.3	2.1	2.0	1.8	2.2
1981	1.3	1.5	1.8	2.1	1.9	1.8	1.9	2.1	2.4	2.6	2.6	1.9	2.0
1982	2.8	2.4	2.6	2.7	2.1	1.9	1.9	2.1	2.0	2.0	1.7	-	-
Average	2.2	2.8	3.2	3.2	2.8	2.5	2.6	2.8	2.7	2.4	2.2	2.1	2.6

Note: 1960 - 1969 : Converted from Beaufort force at the height of 12.2 m to wind speed at 2m height.
1963 : Estimated from average of 1960 - 1969 values
1970 - 1977 June: Wind speed at the height of 2m was estimated assuming the height of anemometer was at 12.2 m above ground level

Table 4-1-6 MONTHLY EVAPORATION

Station: Lungi

(mm/day)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1960	3.1	4.2	4.9	5.3	3.7	2.4	2.3	1.9	2.1	2.6	2.6	4.2	3.3
1961	4.1	4.0	6.1	5.3	4.5	2.8	2.0	2.2	2.4	2.9	3.3	3.9	3.6
1962	4.3	6.5	5.5	5.3	4.3	2.9	2.7	2.6	2.5	2.6	2.5	4.5	3.9
1963	4.0	4.9	5.8	5.9	4.7	3.4	2.8	2.1	2.9	2.7	3.4	3.9	3.9
1964	4.6	5.0	6.2	6.4	4.5	3.3	3.0	1.7	2.4	2.6	2.8	3.2	3.8
1965	5.0	5.1	5.3	5.2	4.2	3.0	2.7	3.0	2.7	3.1	3.1	3.6	3.8
1966	4.0	4.7	6.0	6.0	4.6	3.1	2.6	2.5	2.5	2.8	3.4	4.1	3.9
1967	5.6	6.7	7.5	7.5	5.3	3.3	2.7	2.4	2.7	3.2	3.5	5.8	4.7
1968	6.5	6.7	7.1	7.4	5.5	3.5	3.0	3.1	3.2	3.9	3.4	3.6	4.7
1969	4.4	5.5	6.1	5.5	4.3	3.5	2.5	2.3	3.0	3.1	3.6	4.6	4.0
1970	4.9	6.8	7.3	6.8	5.2	4.0	2.9	3.5	3.7	3.7	4.0	4.4	4.8
1971	5.3	6.9	8.3	5.7	5.9	3.9	4.0	2.9	2.9	3.2	3.3	3.7	4.7
1972	4.0	5.9	6.4	6.6	5.0	3.1	2.7	2.5	2.6	2.7	2.9	4.6	4.1
1973	5.1	5.1	6.3	5.7	3.8	2.7	2.5	2.1	2.3	3.0	3.4	4.5	3.9
1974	5.5	5.6	5.7	6.0	5.2	3.9	2.5	2.0	2.2	2.6	3.4	3.5	4.0
1975	5.6	4.5	5.4	4.7	4.1	2.8	2.3	2.2	2.1	2.5	2.8	2.7	3.5
1976	5.1	4.7	4.9	4.6	3.7	2.9	3.6	2.3	2.5	1.3	2.8	3.7	3.5
1977	3.6	4.5	4.7	5.3	4.1	3.0	2.0	1.8	2.2	2.4	3.3	3.3	3.4
1978	4.2	4.7	6.0	4.9	3.3	2.5	2.4	1.7	2.2	2.5	2.9	3.1	3.4
1979	3.6	4.4	4.8	5.8	4.2	2.5	2.0	1.4	1.9	2.3	2.8	4.1	3.4
1980	4.4	5.4	5.9	4.0	2.9	1.8	1.4	1.6	2.3	2.3	2.2	3.3	3.1
1981	5.0	4.3	4.4	3.8	2.6	2.6	1.9	2.8	2.1	2.1	2.4	2.1	3.0
Average	4.6	5.3	6.0	5.6	4.4	3.0	2.6	2.3	2.5	2.7	3.1	3.8	3.8

4-1-7 Precipitation

The most important factors which affect the climate of West Africa are the dry, dusty harmattan or trade winds from the north, and the moist, cloudy monsoon from the south.

In winter the Sahara desert becomes comparatively cool and a high-pressure area develops, from which winds blow away. These dry Sahara winds blow southwards and are particularly dominant in the dry season.

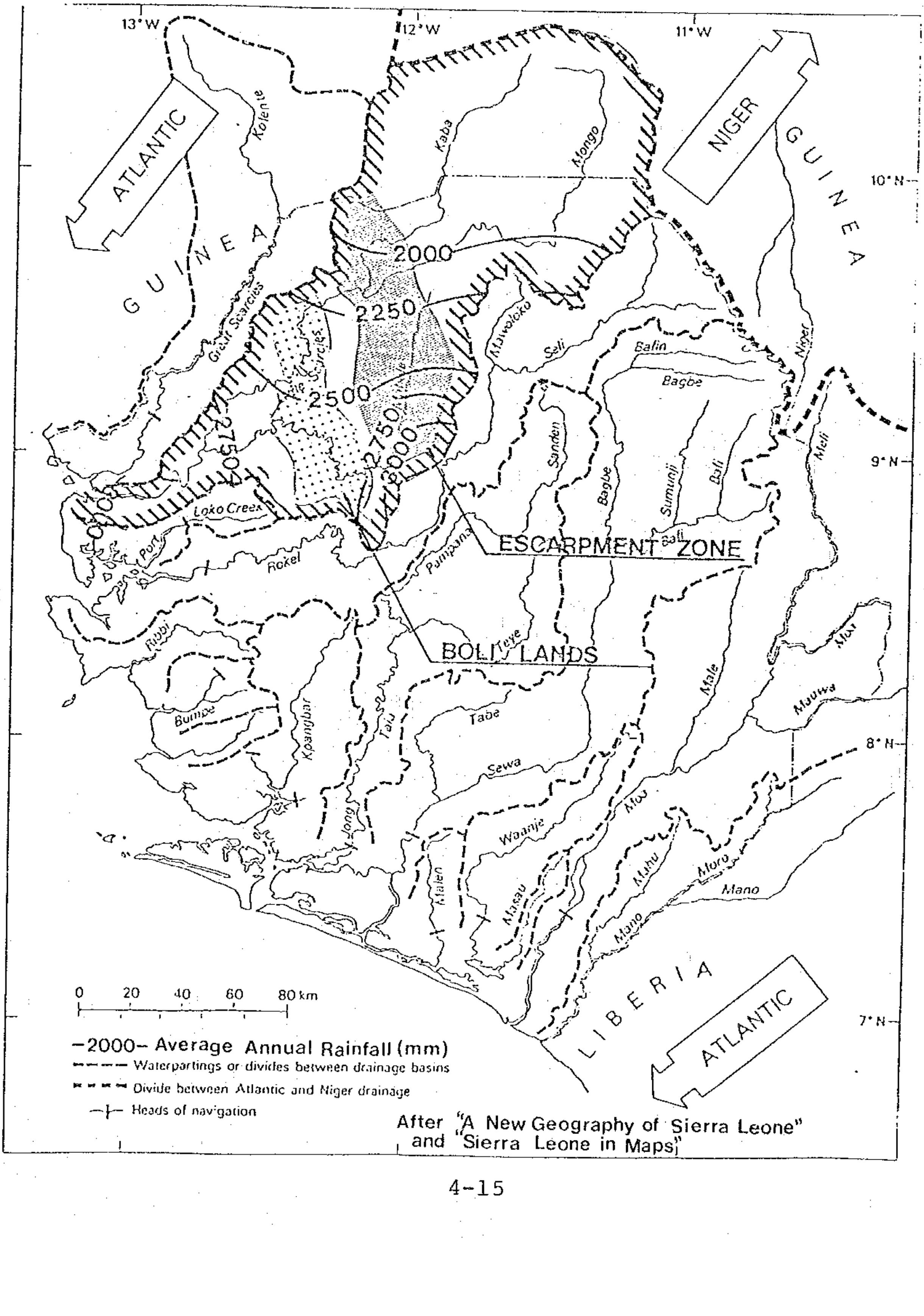
In summer the Sahara is very hot thus creating low pressure. The monsoon winds from the Equatorial and South Atlantic blow into West Africa and warm wet conditions prevail.

The rainfall of Sierra Leone is composed of two main elements. One is the convectional thunderstorm rains of the early and late wet season. These rains sometimes do not affect very large areas. Another is the steady monsoonal rains of the main wet season, roughly from mid-June to late September. In general, rainfall tends to decrease inland and northwards.

In the Little Scarcies river basin, rainfalls vary substantially by regions and from year to year. On the basis of available precipitation records, an isohyetal map of the upper Little Scarcies river basin has been prepared as illustrated on Fig. 4-1-5. The annual precipitation is less than 2,000 mm in the northern watershed which borders the upper Niger river basin, while it increases to more than 3,000 mm in the south-western coastal region. The average annual precipitation in the Little Scarcies river basin is estimated at about 2,400 mm as a whole.

According to the precipitation records at Rokupr from 1936 to 1982, the annual precipitation ranges from

Fig 4-1-5 ISOHYETAL MAP



After "A New Geography of Sierra Leone" and "Sierra Leone in Maps"

2,128 mm to 3,618 mm. The annual mean precipitation is calculated at 2,960 mm. More than 95% of the annual precipitation is concentrated in the wet season from May to November. More than 60% of the annual precipitation (or about 1,810 mm) is concentrated in a period from July to September (Refer to Table 4-1-7 and Fig. 4-1-4). Number of rainy days (not less than 5 mm) averaged at 105 days a year (Refer to Table 4-1-8)

The consecutive three-day probable precipitation is estimated by Weibull plot method at 252 mm for the return period of 5 years, on the basis of the daily precipitation at Rokupr. (Refer to Fig. 4-1-6).

The monthly rainfall at main stations are shown in Fig. 4-1-7 and the fluctuation of annual rainfall is shown in Fig. 4-1-8.

Table 4-1-7 MONTHLY RAINFALL (1/10)

(Summary)

(mm)

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	Period	Year
Rokupr	5	2	13	61	185	356	587	729	501	368	144	19	2,970	1936 - 82	47
Lungi	7	5	16	59	207	351	763	778	547	315	143	31	3,222	1949 - 82	34
Port Loko	8	6	26	60	179	345	534	616	416	344	142	28	2,704	1941 - 82	35
Makeni	7	9	31	89	228	388	488	658	531	419	195	31	2,282	1934 - 81	45
Marampa	6	5	29	76	206	305	429	565	447	379	184	24	2,655	1937 - 74	38
Kabala	6	11	47	100	196	297	310	376	390	322	109	15	2,189	1949 - 81	27
Musaia	8	10	35	75	197	274	308	325	360	278	104	18	1,992	1949 - 75	22
Katonga	19	1	7	40	163	334	511	624	452	353	161	19	2,684	1957 - 67	11

Table 4-1-7 MONTHLY RAINFALL (2/10)

Station: Rokupr

(mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1936	-	-	13	85	276	286	566	549	681	405	153	5	3,019*
1937	-	-	30	25	152	381	529	749	531	296	111	2	2,806*
1938	-	1	2	45	288	253	414	665	564	352	236	-	2,820*
1939	-	1	-	20	217	637	518	770	504	430	77	5	3,179*
1940	-	-	-	33	107	358	439	497	347	485	302	17	2,585*
1941	3	-	Tr.	25	98	411	669	581	388	504	93	-	2,772*
1942	Tr.	-	11	54	199	294	855	880	310	318	133	63	3,117*
1943	-	4	-	111	221	385	627	699	605	366	75	88	3,181*
1944	-	Tr.	25	40	86	224	489	900	255	310	136	31	2,496*
1945	-	Tr.	8	33	82	409	748	1,192	322	429	123	7	3,353*
1946	4	Tr.	22	53	259	407	821	984	365	459	230	14	3,618
1947	-	15	2	38	140	216	565	703	728	237	34	41	2,719*
1948	-	Tr.	6	6	193	345	672	990	377	225	139	1	2,954*
1949	Tr.	0	24	88	73	281	588	538	330	327	128	16	2,393
1950	0	Tr.	3	20	147	347	415	482	634	385	152	Tr.	2,585
1951	55	Tr.	35	33	290	353	486	777	493	451	260	7	3,240
1952	Tr.	1	Tr.	1	161	447	682	957	480	359	160	1	3,249
1953	6	1	10	54	122	496	670	550	294	482	75	16	2,776
1954	0	2	23	161	206	341	886	1,010	327	216	241	19	3,432
1955	1	0	62	198	213	317	619	922	426	322	156	57	3,293
1956	0	6	6	125	226	353	582	651	529	363	120	71	2,445
1957	Tr.	0	0	66	39	325	626	335	518	336	82	20	2,347
1958	5	1	7	142	278	392	310	467	622	407	430	54	3,115
1959	45	0	52	1	275	398	620	726	606	280	171	0	3,174
1960	0	0	Tr.	10	202	439	672	614	581	324	98	2	2,942
1961	0	Tr.	7	42	102	262	579	829	654	319	237	Tr.	3,031
1962	0	0	0	144	102	572	473	763	553	377	314	3	3,301
1963	16	2	8	Tr.	153	262	590	720	557	627	79	0	3,014
1964	0	0	8	13	302	423	683	979	693	352	107	2	3,562
1965	23	0	0	37	281	392	489	490	892	339	49	0	2,992
1966	0	0	3	13	256	398	370	821	603	435	146	37	3,082
1967	0	0	0	43	203	431	428	934	439	336	146	0	2,960
1968	0	7	0	14	143	434	363	535	533	451	198	57	2,735
1969	18	0	139	-	-	432	588	874	685	588	200	0	-
1970	0	0	0	17	256	279	890	859	656	292	192	3	3,444
1971	0	0	1	91	73	232	435	836	454	-	-	-	-
1972	0	-	-	227	202	260	469	504	379	326	27	0	2,394*
1973	0	0	-	72	220	249	389	434	369	288	107	0	2,128
1974	0	0	0	46	131	494	484	766	583	343	45	0	2,892
1975	0	0	0	20	181	263	472	440	844	335	50	62	2,667
1976	0	0	0	228	137	370	446	647	282	639	248	-	2,997
1977	0	0	8	0	220	230	1,032	854	530	292	37	33	3,236
1978	0	0	0	135	260	382	781	776	474	296	86	17	3,207
1979	0	0	0	0	193	210	582	660	406	307	100	16	2,474
1980	7	50	0	74	116	312	637	829	314	379	249	43	3,010
1981	0	0	18	49	312	322	783	695	437	274	28	0	2,918
1982	0	0	16	61	166	422	574	872	391	277	50	0	2,831
Average	5	2	13	61	185	356	587	729	501	368	144	19	2,970

Note: * an assessed record assuming rainfall in dry month is zero.

Table 4-1-7 MONTHLY RAINFALL (3/10)

Station: Lungi

(mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Total
1949	Tr.	0	Tr.	60	129	223	906	814	507	322	114	27	3,102
1950	0	Tr.	12	106	240	237	842	528	904	376	128	3	3,376
1951	68	4	3	33	146	437	603	846	593	638	166	6	3,543
1952	Tr.	19	1	3	375	287	594	1,138	536	276	202	14	3,445
1953	10	5	1	83	342	568	703	723	467	284	76	144	3,406
1954	1	13	38	107	245	364	854	1,180	344	289	260	16	3,711
1955	Tr.	1	127	170	183	350	746	837	527	319	130	187	3,577
1956	0	2	40	118	250	288	722	541	443	298	70	73	2,845
1957	0	Tr.	Tr.	36	171	390	998	691	553	313	133	27	3,312
1958	2	4	95	75	183	453	470	428	723	234	307	49	3,023
1959	69	1	18	Tr.	286	444	790	849	490	177	263	Tr.	3,387
1960	22	30	0	24	82	306	822	765	608	186	97	20	2,962
1961	Tr.	0	Tr.	169	129	443	1,234	814	419	171	107	0	3,486
1962	0	0	Tr.	74	255	416	370	813	456	259	215	0	2,858
1963	21	Tr.	Tr.	37	180	363	1,693	1,066	525	311	113	0	4,309
1964	Tr.	Tr.	Tr.	8	113	228	701	882	629	228	115	111	3,012
1965	18	Tr.	Tr.	61	240	438	271	763	575	191	125	0	2,682
1966	0	Tr.	38	0	216	327	298	856	752	338	163	69	3,057
1967	Tr.	Tr.	0	2	142	321	680	1,072	680	347	153	1	3,398
1968	Tr.	26	0	25	204	468	831	587	417	268	193	74	3,093
1969	Tr.	0	90	49	328	444	1,240	835	637	247	121	6	3,997
1970	0	Tr.	13	29	234	363	862	948	564	317	144	35	3,509
1971	0	1	0	89	127	280	620	660	458	351	159	45	2,790
1972	Tr.	0	9	1	145	417	488	714	393	424	45	5	2,641
1973	0	Tr.	0	88	146	292	683	545	505	277	85	38	2,659
1974	0	0	0	4	101	306	1,027	188	752	373	48	2	2,801
1975	0	0	4	93	123	293	792	546	759	289	46	43	2,988
1976	0	0	17	106	367	403	380	488	419	967	185	0	3,335
1977	0	Tr.	1	14	160	398	762	1,098	625	208	10	2	3,277
1978	11	Tr.	24	77	212	357	723	731	737	375	99	0	3,347
1979	12	0	1	1	233	334	714	1,168	494	259	138	4	3,355
1980	7	31	Tr.	79	270	380	802	768	379	177	173	32	3,095
1981	0	21	14	109	284	311	1,086	514	402	311	75	26	3,153
1982	0	0	Tr.	74	196	498	650	1,041	337	309	99	0*	3,204*
Average	7	5	16	59	207	351	763	778	547	315	143	31	3,222

* An assessed record

Table 4-1-7 MONTHLY RAINFALL (4/10)

Station: Port Loko (mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1941	21	0	0	63	172	280	412	684	413	304	158	-	2,507*
1942	24	-	32	43	175	308	613	533	339	374	158	34	2,633*
1943	-	8	21	186	266	420	629	472	542	280	112	57	2,993*
1944	-	0	27	72	85	269	657	680	297	293	238	1	2,619*
1945	-	-	18	70	73	473	478	1,078	245	427	84	64	3,010*
1946	-	2	9	46	156	350	658	948	424	536	296	106	3,531*
1947	-	Tr.	33	23	128	494	606	683	479	304	78	14	2,842*
1948	-	33	-	108	215	386	668	915	335	327	112	1	3,100*
1949	0	0	140	108	94	364	457	600	486	351	194	43	3,037
1950	0	0	20	46	167	376	359	383	390	288	231	3	2,263
1951	13	4	34	26	245	273	579	661	491	420	198	36	2,980
1952	0	53	10	60	280	410	611	715	319	389	174	14	3,035
1953	0	-	0	89	230	321	458	630	305	338	109	54	2,534*
1954	0	27	38	130	302	420	658	683	383	292	185	20	3,138
1955	0	0	40	129	247	276	450	535	428	327	60	33	2,525
1956	0	10	8	140	106	170	489	492	509	415	195	76	2,610
1957	0	0	2	7	94	266	-	-	-	-	-	-	-
1958	12	-	-	-	-	-	-	-	-	-	-	-	-
1959	0	0	58	0	-	306	577	492	295	-	165	-	-
1960	0	3	29	9	113	377	467	593	330	341	169	17	2,448
1961	0	0	-	-	-	213	857	487	267	415	48	0	-
1962	0	0	0	117	262	312	252	616	508	286	211	0	2,564
1963	54	2	11	38	186	333	495	614	417	378	115	0	2,643
1964	-	-	0	5	203	186	667	703	485	123	160	119	2,651*
1965	58	0	3	25	260	483	310	465	700	431	80	0	2,815
1966	-	6	25	26	241	431	417	749	477	319	101	47	2,839*
1967	-	-	0	11	222	425	507	537	408	219	62	0	2,391*
1968	0	0	0	15	200	401	370	337	344	236	104	0	2,007
1969	0	0	80	45	86	381	488	374	218	431	80	28	2,211
1970	-	-	87	108	108	274	387	692	315	-	-	-	-
1971	-	-	-	-	-	-	-	-	-	-	-	-	-
1972	-	-	44	18	128	353	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-	-	-	-	-	-	-
1974	-	-	-	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	150	368	772	1,014	668	-	-	-	-
1980	-	-	-	-	-	-	-	475	735	247	138	25	-
1981	0	0	0	-	-	-	469	406	358	340	-	0	-
1982	0	0	0	48	-	-	752	480	-	-	104	0	-
Average	8	6	26	60	179	345	534	616	416	344	142	28	2,704

* An assessed record

Table 4-1-7 MONTHLY RAINFALL (5/10)

Station: Mukeni

(mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1934	-	-	36	57	108	312	543	610	561	494	100	-	2,821*
1935	-	21	5	24	115	260	473	549	480	284	273	74	2,558*
1936	-	8	38	78	317	236	615	453	502	393	181	35	2,856*
1937	-	1	101	53	234	336	407	814	583	491	163	8	3,190*
1938	-	6	34	65	400	471	357	733	628	413	287	-	3,394*
1939	Tr.	0	Tr.	38	332	596	365	588	468	269	170	25	2,851
1940	1	-	20	22	197	374	473	569	451	449	244	46	2,846*
1941	25	-	-	67	86	611	633	813	579	356	194	-	3,369*
1942	-	-	32	73	353	340	458	526	444	609	141	100	3,058*
1943	2	14	50	145	152	419	434	510	555	555	127	39	3,002
1944	10	5	21	61	287	371	677	554	628	317	109	1	3,041
1945	0	3	23	163	192	238	631	853	520	339	228	25	3,215
1946	7	-	24	24	190	238	631	851	373	449	158	62	3,007*
1947	-	-	-	-	-	-	-	-	-	-	-	-	-
1948	-	-	-	-	-	-	-	-	-	-	-	-	-
1949	0	0	29	105	170	249	380	505	571	446	215	65	2,735
1950	0	Tr.	38	65	131	308	376	401	491	449	0	4	2,263
1951	21	27	36	111	249	392	417	615	519	643	160	3	3,193
1952	6	18	25	84	228	354	608	742	487	427	300	30	3,309
1953	38	3	33	136	139	504	584	710	658	415	166	69	3,455
1954	Tr.	21	37	199	371	394	439	667	375	425	393	16	3,337
1955	0	2	166	191	309	464	302	624	579	445	190	30	3,302
1956	0	37	54	102	221	249	454	532	592	324	143	58	2,766
1957	0	0	5	122	78	460	654	491	719	409	156	4	3,098
1958	10	0	169	200	199	321	231	486	616	422	293	35	2,882
1959	35	0	30	21	357	460	376	524	616	605	338	1	3,423
1960	28	21	0	0	285	515	404	478	703	345	202	21	3,002
1961	0	5	0	61	184	299	585	618	433	289	85	0	2,659
1962	0	0	3	242	317	364	604	720	591	323	379	11	3,554
1963	14	39	67	98	111	416	436	803	370	422	165	0	2,941
1964	0	0	12	56	177	346	456	1,008	634	342	197	68	3,296
1965	25	1	3	55	216	357	508	695	520	428	205	0	3,013
1966	0	10	35	112	238	369	290	725	622	324	264	32	3,021
1967	0	0	9	89	204	426	512	672	480	474	294	9	3,169
1968	0	27	-	46	289	589	389	593	745	495	185	45	3,403*
1969	0	4	44	133	238	453	475	696	570	448	188	52	3,302
1970	0	3	31	62	208	386	813	466	598	354	193	14	3,128
1971	0	-	1	298	121	303	509	701	741	323	192	130	3,319*
1972	0	6	46	95	256	432	-	-	-	391	24	-	-
1973	0	0	16	51	272	369	324	851	332	528	152	0	2,895
1974	0	0	0	63	193	407	478	544	660	423	177	0	2,945
1975	0	0	7	99	254	374	730	690	482	472	-	-	-
1976	-	-	-	-	-	-	-	-	-	-	-	-	-
1977	-	-	-	113	194	317	386	834	509	381	59	8	2,801*
1978	10	31	0	0	295	372	580	680	-	-	-	0	-
1979	15	0	0	2	272	621	500	826	-	636	196	47	-
1980	17	19	25	40	214	467	475	599	677	438	234	45	3,250
1981	0	19	11	71	311	331	518	1,024	718	611	31	-	3,645
Average	7	9	31	89	228	388	488	658	531	419	195	31	2,282

Note: * an assessed record assuming rainfall in dry month is zero.

Table 4-1-7 MONTHLY RAINFALL (6/10)

Station: Marampa (mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Spet.	Oct.	Nov.	Dec.	Annual
1937	-	-	50	30	124	349	426	548	596	491	178	9	2,801*
1938	-	-	17	66	253	323	372	634	523	420	104	-	2,712*
1939	16	5	2	91	191	445	317	570	382	404	116	13	2,552
1940	-	-	8	28	187	490	572	278	266	394	294	9	2,526*
1941	18	-	2	39	188	215	391	509	509	354	166	3	2,394*
1942	2	-	18	72	253	268	429	567	537	525	339	38	3,048*
1943	1	3	4	136	190	242	382	321	427	469	140	43	2,357
1944	-	-	16	113	190	255	426	785	422	360	206	18	2,791*
1945	2	8	23	93	83	351	384	680	450	386	182	9	2,651
1946	41	-	8	36	246	199	572	528	292	464	102	42	2,530*
1947	-	17	27	32	106	286	454	688	592	356	86	26	2,670*
1948	-	2	6	18	254	319	643	744	234	272	179	2	2,673*
1949	0	0	27	131	63	363	291	556	522	549	182	32	2,716
1950	0	0	42	126	196	259	490	351	495	347	173	11	2,490
1951	5	2	34	34	111	268	385	697	399	387	291	22	2,635
1952	1	29	15	23	278	380	598	802	422	447	191	34	2,220
1953	1	2	6	91	204	298	504	636	487	315	118	51	2,713
1954	0	22	52	230	335	345	349	546	418	425	333	23	3,078
1955	0	12	102	125	293	266	344	830	368	434	207	35	3,016
1956	0	8	54	128	245	340	384	326	551	439	138	62	2,675
1957	0	0	1	54	103	267	-	-	551	367	257	47	-
1958	5	1	152	210	339	251	307	338	317	384	432	49	2,785
1959	11	3	11	2	336	264	393	356	487	300	163	5	2,331
1960	34	8	59	9	132	315	254	721	547	239	85	42	2,448
1961	-	5	0	61	184	299	685	618	433	289	85	0	2,659
1962	0	0	9	130	226	340	490	582	483	394	297	0	2,951
1963	2	14	40	38	223	360	396	787	579	475	202	0	3,116
1964	0	0	19	56	185	207	438	701	468	313	129	23	2,539
1965	41	0	1	47	311	407	374	507	552	358	104	0	2,702
1966	0	0	45	44	232	344	420	512	281	325	166	0	2,369
1967	0	0	85	17	340	324	358	564	325	189	223	0	2,425
1968	0	0	0	153	319	355	483	340	415	305	233	26	2,629
1969	0	0	118	81	148	277	517	541	464	271	254	42	2,713
1970	0	0	14	76	222	214	-	554	358	238	198	0	-
1971	0	0	3	94	116	250	489	567	481	398	222	166	2,786
1972	5	2	21	36	61	298	361	582	449	409	37	12	2,273
1973	0	0	0	77	257	195	304	519	416	457	93	0	2,318
1974	0	0	3	44	111	370	459	514	503	441	100	0	2,545
Average	6	5	29	76	206	305	429	565	447	379	184	24	2,655

Note: * an assessed record assuming rainfall in dry month is zero.

Table 4-1-7 MONTHLY RAINFALL (7/10)

Station: Kabala

(mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1949	Tr.	0	18	123	192	167	277	329	411	280	53	5	1,855
1950	0	Tr.	49	26	120	340	249	290	361	285	58	0	1,778
1951	32	32	147	40	273	386	391	450	515	198	135	0	2,599
1952	0	35	33	24	192	263	275	331	434	163	107	16	1,874
1953	3	Tr.	152	60	112	436	402	563	388	320	68	97	2,601
1954	0	22	31	117	153	239	372	491	388	383	255	64	2,515
1955	17	6	129	203	181	358	400	383	500	465	69	15	2,726
1956	0	38	14	75	175	341	252	369	425	166	89	56	2,000
1957	Tr.	3	20	176	120	241	368	291	454	400	112	Tr.	2,185
1958	1	15	98	187	336	211	121	389	376	489	248	58	2,529
1959	1	4	13	95	232	309	239	332	402	213	151	0	1,991
1960	0	9	1	84	197	368	323	448	320	509	35	11	2,305
1961	Tr.	6	50	57	180	239	274	489	362	259	122	0	2,038
1962	0	0	14	368	188	363	304	497	396	217	263	0	2,610
1963	46	23	39	40	176	249	399	373	282	376	85	0	2,088
1964	0	0	28	41	162	215	254	293	497	182	182	41	1,895
1965	1	22	Tr.	41	158	212	328	221	367	339	45	0	1,734
1966	0	19	40	35	261	443	322	316	445	432	135	13	2,461
1967	0	Tr.	2	118	176	296	208	522	230	417	106	Tr.	2,075
1968	0	17	31	89	491	469	358	410	454	359	165	30	2,871
1969	5	2	149	115	129	421	346	524	372	482	24	0	2,570
1976	2	3	22	166	237	253	202	327	341	389	125	0	2,065
1977	Tr.	0	38	82	99	227	184	375	362	296	15	1	1,678
1978	31	44	56	94	155	261	350	218	332	375	40	1	1,957
1979	26	0	24	23	235	244	408	202	300	405	80	Tr.	1,946
1980	3	6	4	106	170	274	428	209	313	209	166	1	1,889
1981	0	0	74	102	203	189	344	501	497	347	9	2	2,267
Average	6	11	47	100	196	297	310	376	390	332	109	15	2,189

Table 4-1-7 MONTHLY RAINFALL (8/10)

Station: Musaia

(mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1949	Tr.	0	21	88	178	228	406	280	316	192	35	4	1,748
1950	0	0	31	24	182	244	187	273	283	238	61	0	1,523
1951	81	53	139	64	301	270	290	387	421	480	201	0	2,687
1952	1	16	19	4	150	345	315	307	200	212	152	22	1,743
1953	11	3	64	90	81	398	326	501	329	329	100	61	2,293
1954	0	17	109	104	218	262	570	454	506	303	231	27	2,801
1955	-	-	-	-	-	-	-	-	-	-	-	-	-
1956	0	40	32	100	101	355	265	315	341	134	98	36	1,817
1957	-	-	-	-	-	-	-	-	-	-	-	-	-
1958	40	23	54	121	179	179	208	254	432	353	227	0	2,070
1959	0	0	17	37	280	207	290	243	335	327	158	0	1,894
1960	0	6	10	48	235	277	348	267	446	442	50	0	2,129
1961	0	0	0	75	245	272	288	367	481	267	113	0	2,108
1962	0	0	21	144	221	261	453	398	400	162	211	0	2,271
1963	27	36	8	76	97	255	420	412	407	292	67	0	2,097
1964	0	0	91	67	92	149	193	161	469	213	68	23	1,526
1965	4	4	0	72	272	220	259	158	458	282	27	0	1,756
1966	0	0	29	102	178	358	272	277	381	181	98	0	1,876
1967	0	0	0	49	172	247	180	375	255	381	24	0	1,683
1968	0	15	46	24	276	355	327	415	229	273	68	164	2,192
1973	0	0	6	95	343	229	245	307	257	263	32	0	1,777
1974	0	0	28	109	137	332	389	338	243	221	107	0	1,904
1975	0	0	0	84	207	321	232	328	380	287	50	32	1,921
Average	8	10	35	75	197	274	308	325	360	278	104	18	1,992

Table 4-1-7 MONTHLY RAINFALL (9/10)

Station: Katonga

(mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1957	Tr.	0	2	11	50	322	625	374	448	468	119	28	2,454
1958	5	6	59	98	293	310	354	464	355	337	347	49	2,676
1959	-	-	-	-	-	-	-	-	-	-	-	-	-
1960	0	0	1	47	-	364	593	772	335	221	146	0	-
1961	0	0	2	24	120	248	801	611	468	350	65	0	2,689
1962	0	0	0	85	99	479	342	645	377	293	328	Tr.	2,649
1963	53	Tr.	0	18	173	438	495	691	471	533	197	-	3,070*
1964	0	0	0	17	181	362	539	949	637	268	132	31	3,120
1965	55	0	0	32	181	285	432	504	524	340	74	0	2,427*
1966	51	0	1	28	206	199	419	602	-	366	38	0	-
1967	34	-	-	-	-	-	-	-	-	-	-	-	-
Average	19	1	7	40	163	334	511	624	452	353	161	19	2,684

Note: * An assessed record assuming rainfall in dry month is zero.

Table 4-1-7 MONTHLY RAINFALL (10/10)

Station: Kamakwie

(mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1965	-	5	-	83	169	328	-	211	566	-	-	-	-
1966	-	0	14	89	-	-	-	-	-	414	84	25	-
1967	0	0	0	23	208	272	337	390	211	400	117	0	1,958
1968	0	47	0	47	154	270	401	490	369	517	83	7	2,384
1969	6	0	44	104	118	373	326	469	422	433	99	-	-

Station: Batkanu

Yera	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1960	0	3	0	0	206	542	405	321	251	346	121	0	2,195
1961	0	0	0	-	-	-	-	-	-	-	-	-	-

Station: Bafodia

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1960	0	2	0	58	258	318	195	234	506	360	2	0	1,964
1961	0	0	13	88	170	232	311	357	340	211	95	0	1,816
1962	0	0	12	115	318	273	259	473	467	141	223	0	2,282
1963	-	-	-	-	-	-	-	-	-	-	-	-	-
1964	0	0	-	78	162	207	296	233	474	226	53	-	-

Table 4-1-8 NUMBERS OF RAINY DAYS

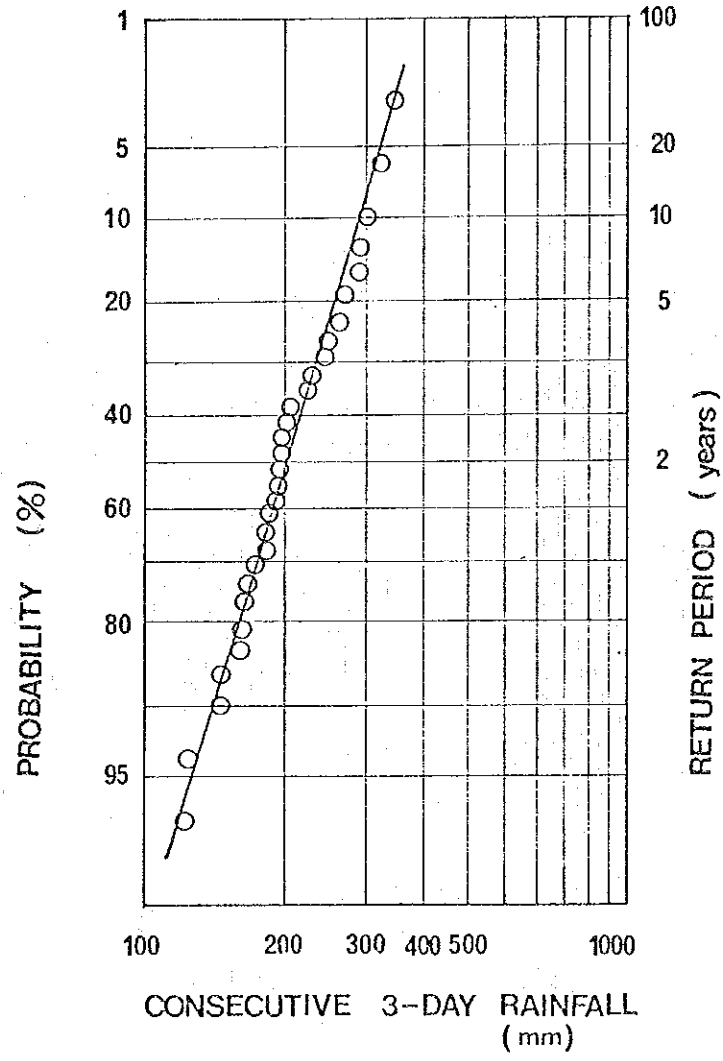
Station: Rokupr

(days not less than 5mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1951	3	0	2	2	12	17	19	17	16	16	12	1	117
1952	0	0	0	0	8	16	24	23	17	20	9	0	117
1953	0	0	1	3	2	16	18	20	18	20	6	1	105
1954	0	0	1	4	10	16	22	20	11	14	10	2	110
1955	0	0	4	7	14	15	19	23	13	14	6	2	117
1956	0	0	1	5	11	17	19	19	14	15	8	4	113
1957	0	0	0	3	3	14	23	13	21	17	5	1	100
1958	1	0	1	6	13	18	15	16	21	21	13	3	128
1959	1	0	2	0	8	19	21	17	17	15	7	0	107
1960	0	0	0	1	12	16	19	21	21	15	6	0	111
1961	0	0	1	3	5	15	22	20	23	17	8	0	114
1962	0	0	0	5	7	15	21	25	21	14	11	0	119
1963	1	0	1	0	6	11	20	20	15	14	3	0	91
1964	0	0	1	1	9	16	17	25	22	18	8	0	117
1965	1	0	0	3	10	17	21	20	25	15	2	0	101
1966	0	0	0	1	10	19	18	18	19	12	8	1	106
1967	0	0	0	1	7	20	16	23	19	18	8	0	112
1968	0	0	0	1	9	16	16	14	18	13	5	1	92
1969	1	0	4	-	-	19	19	26	19	19	6	0	113
1970	0	0	0	2	4	13	18	21	17	10	5	0	90
1971	0	0	0	5	6	14	18	27	16	0	0	0	86
1972	0	0	0	11	11	18	20	24	20	14	2	0	120
1973	0	0	0	4	8	11	14	16	20	10	5	1	89
1974	0	0	0	8	1	15	22	20	19	13	2	0	76
1975	0	0	0	2	8	12	21	22	21	15	2	1	112
1976	0	0	0	6	6	16	15	25	15	16	6	0	105
1977	0	0	1	0	9	13	27	22	22	15	1	2	112
1978	0	0	0	4	9	14	19	23	16	14	5	1	105
1979	0	0	0	0	10	13	20	22	18	13	4	1	100
1980	1	2	0	2	7	10	23	22	14	7	10	1	99
1981	0	0	1	3	15	12	23	21	18	15	4	0	112
1982	0	0	1	4	8	17	20	21	16	16	2	0	105
Average	0	0	1	3	8	15	20	21	18	15	3	1	105

Fig 4 – 1 – 6 PROBABLE CONSECUTIVE 3-DAY RAINFALL

Station : ROKUPR



WEIBULL (THOMAS) PLOT METHOD

Fig 4-1-7 MONTHLY RAINFALL

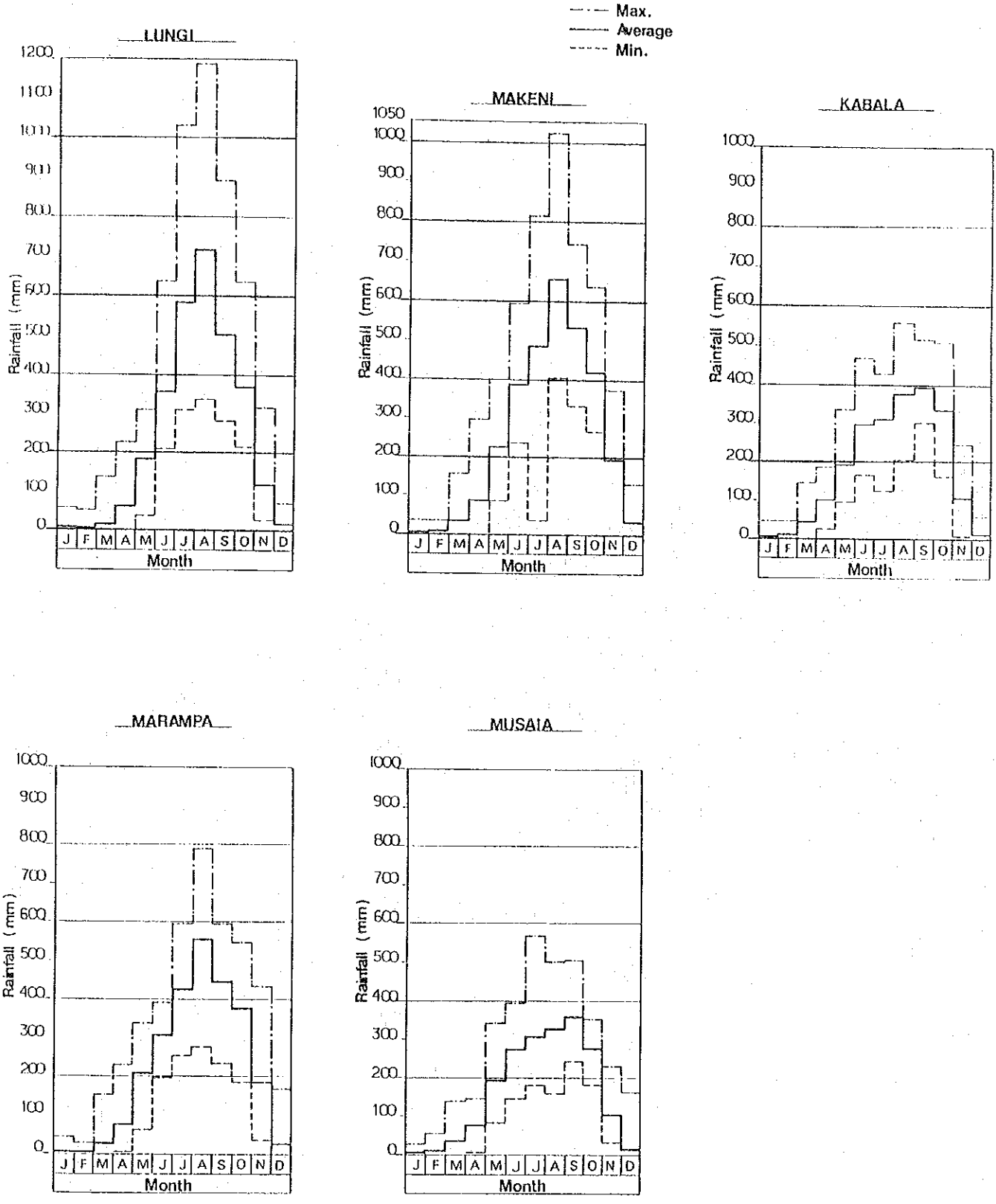


Fig 4-1-8 FLUCTUATION OF ANNUAL RAINFALL (1/3)

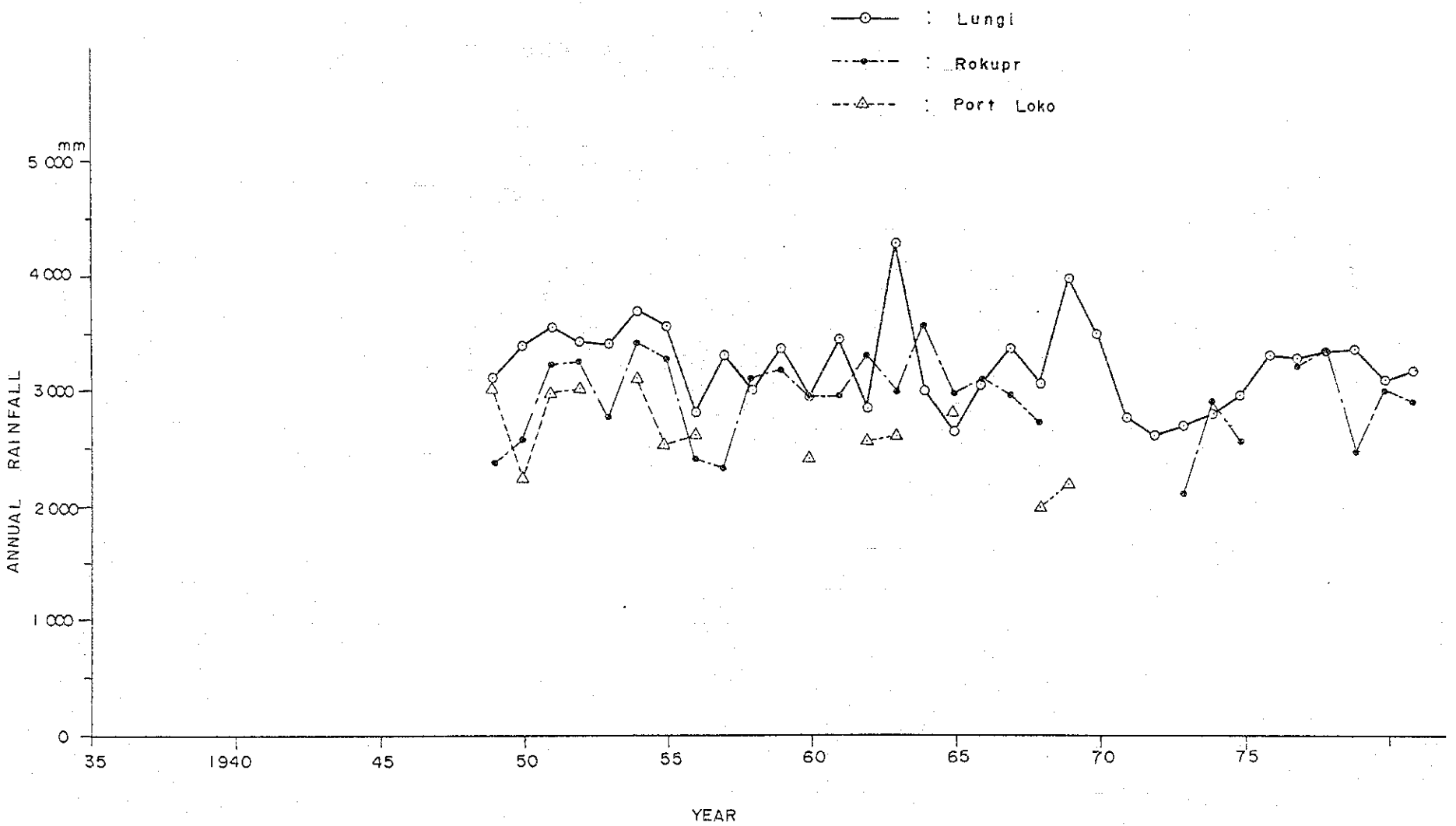


Fig 4-1-8 FLUCTUATION OF ANNUAL RAINFALL (2/3)

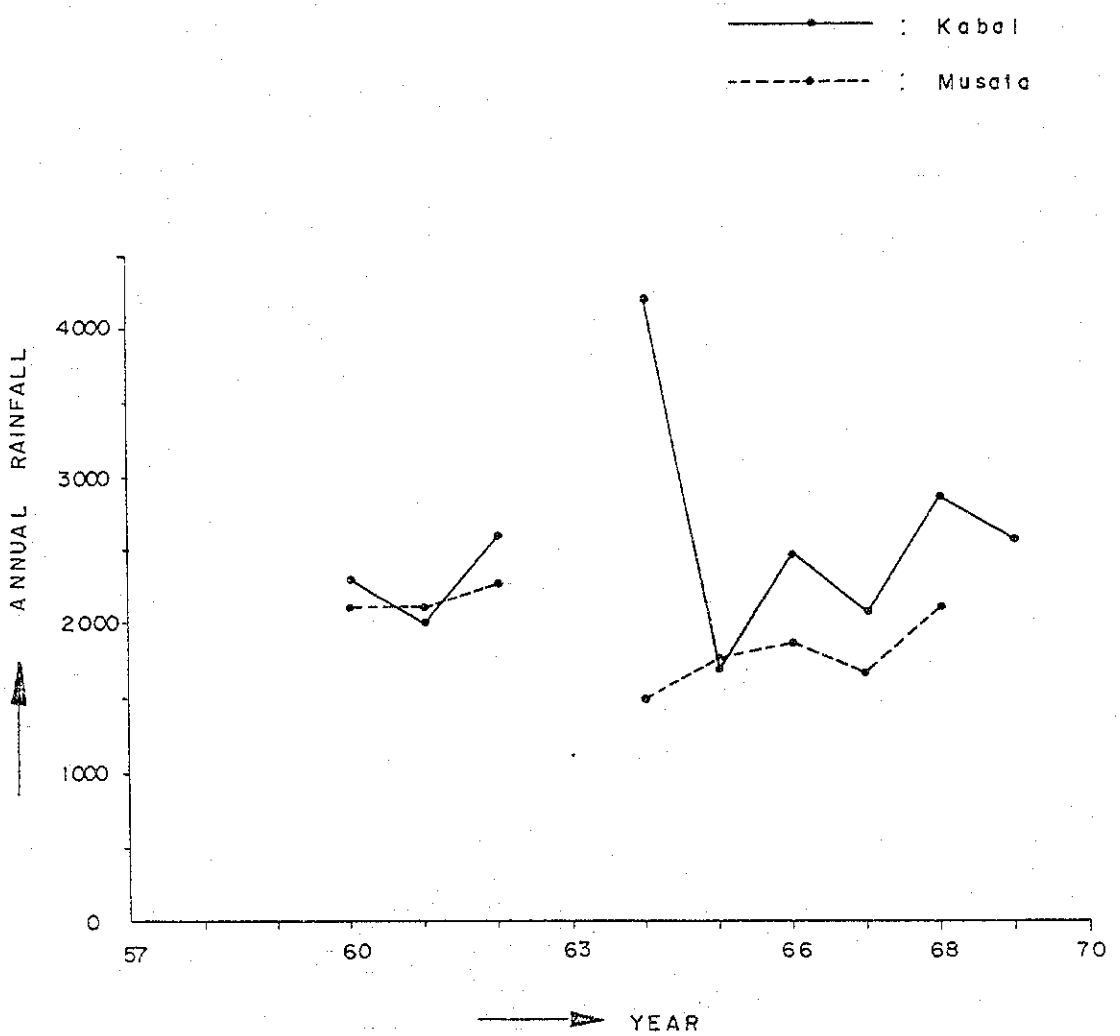
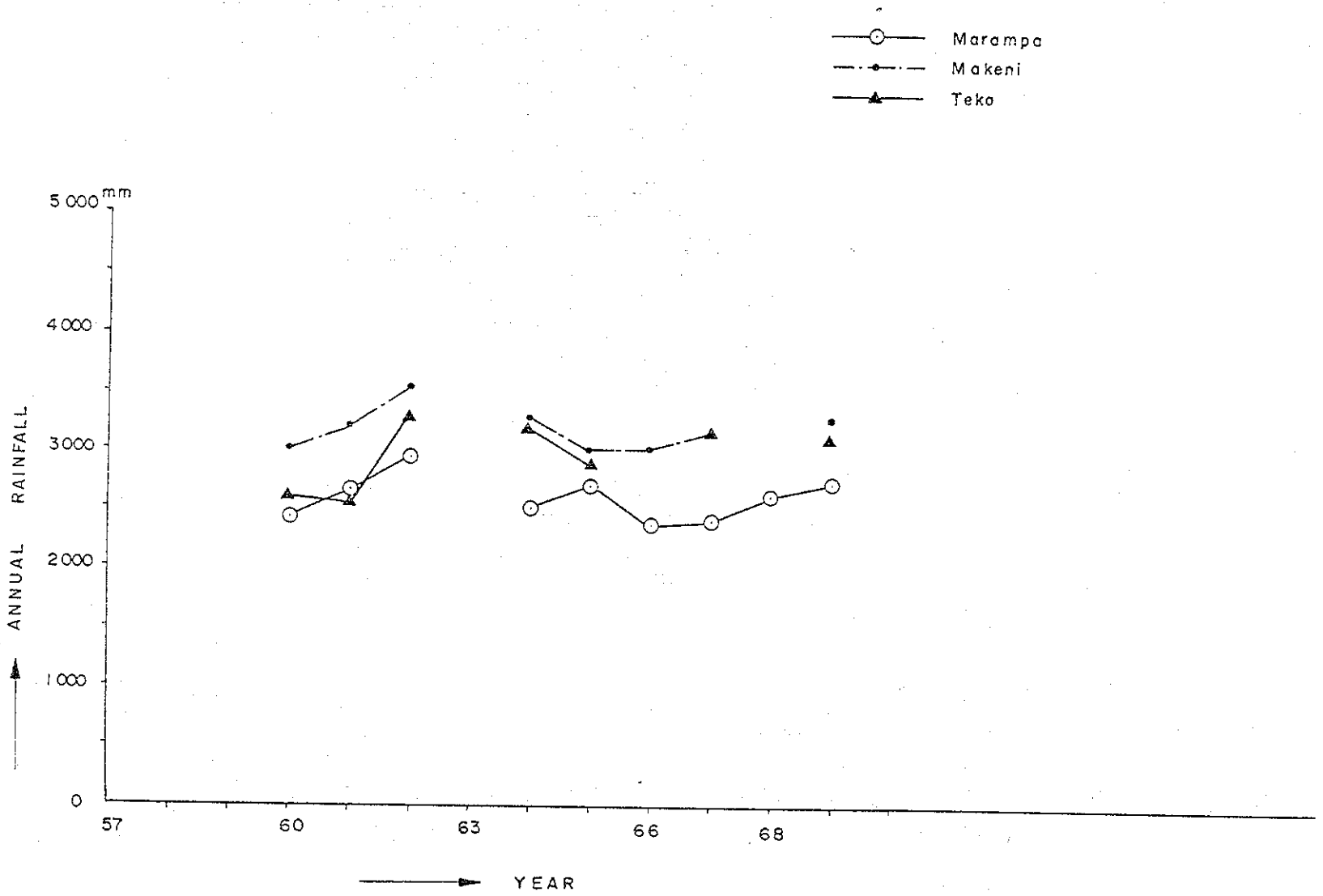


Fig 4-1-8 FLUCTUATION OF ANNUAL RAINFALL



4-2 Hydrology

4-2-1 General

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 north-east to southwest as shown in Fig. 4-1-1. The highest peak of about 1,100 m in altitude is on the northern boundary, which lies between the Little Scarcies basin and the neighbouring upper Niger and Senegal river basins. 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 are in the Republic of Guinea.

The catchment can be divided into three physiographic regions which run approximately north to south. They are the coastal plain, interior lowlands and interior plateau regions.

The coastal region is generally a low, level and swampy area extending some 30 km inland from the coast. The coastal swamp is underlain by the Bullom series of marine and riverine sediments. Submergence was the cause of the drowned estuary and also the sand bar across the mouth of the river which has a ponding effect of fresh river water. Also tidal mangrove creeks are the result of the drowning of some river systems by sea water. According to the aerial photo-graph, a zone from Kotoma, Makemba North Swamp, Robis, Gbenti Creek to Gbenti Mouth is considered to be an old river course. The project area lies only a few metres above sea level and its soils are muddy in general.

The interior lowlands are approximately 80 km wide and the topography is that of an old peneplained

continental land mass. The western limit of this region is the rapids at Mange, where navigable waterway and tidal effect ends. The soils of this area are mainly reddish-brown lateritic soils, and the cover is secondary forest growth with scattered savannah. Most of the area is less than 150 metres above sea level and the ground is generally undulating. The rocks under the surface of this region are mostly granites and other crystalline rocks of the Precambrian to Cambrian periods. This region includes the flat treeless and seasonally swampy grasslands known as the bolilands, which is thought to be the site of a delta formed at a period of higher sea level. After debouching from the plateau valleys, the Little Scarcies river and its tributaries flow meandering over this alluvial deposit. Much of this area, including many old river channels, is flooded in the wet season but becomes quite dry in the dry season. The bolilands have many retarding basins.

The interior plateau region rises rapidly above the Interior Lowlands to a height of 300 to 600 metres. The scarp separating the two regions of the Interior lowland and plateau is developed along the western side of this region,particularly near Makeni. The number of inselbergs rises within this region near the border with the Republic of Guinea. The northern part of this region, which is mainly in the territory of Guinea, is another scarp or southern slope of the Fouta Djallon Plateau. The soil cover is secondary forest growth.

The area height relationship and area of each region of the Little Scarcies catchment are summarized in Table 4-2-1 and 4-2-2.

Table 4-2-1 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

Table 4-2-2 AREA 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

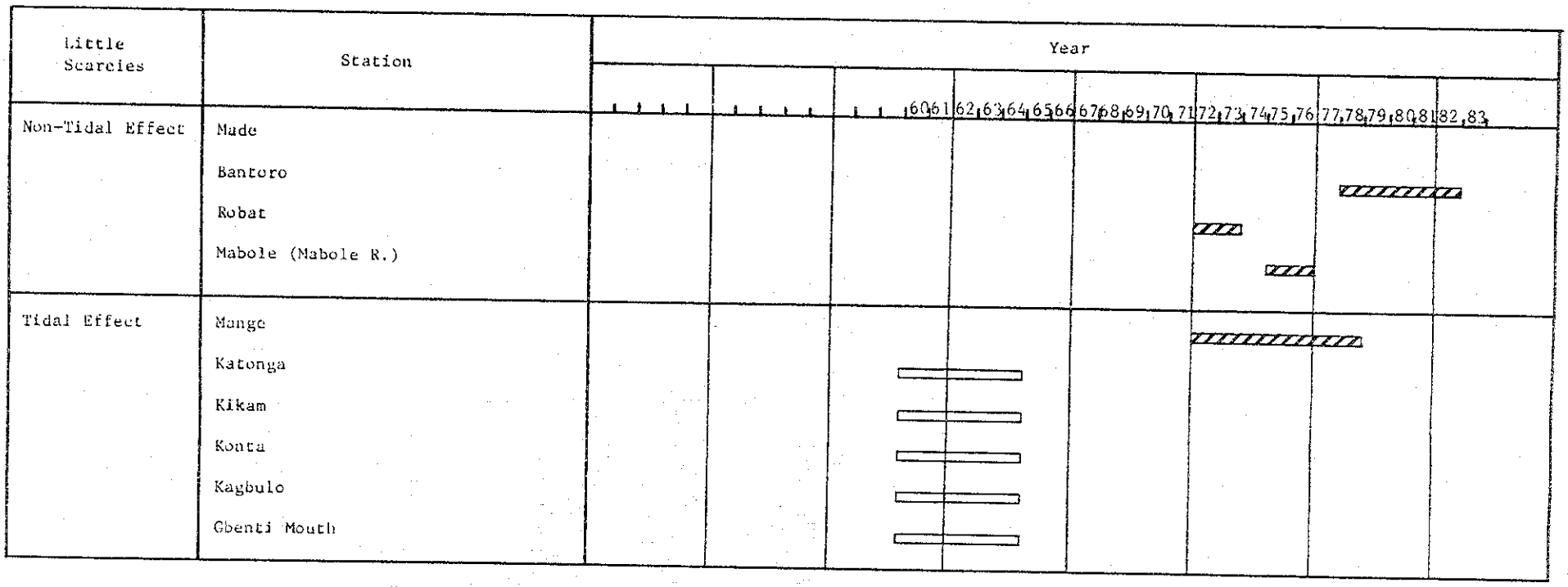
4-2-2 Available Data

Hydrological records available at some water level gauging stations on the Little Scarcies river are compiled and analyzed. The location of these stations and the period of water level recording are shown in Fig. 4-1-1 and Fig. 4-2-1 respectively. Discharge Measurement by the MRT team was conducted 12 times at the Robat gauging station in 1971 and 1972. However, it is reported that no discharge measurement has been carried out at any station since 1973.

Consequently on the Little Scarcies, there is only one available rating curve for the whole range of flows, which was prepared during the period from 1971 to 1972 at Robat. Rating curves for peak flows at Made, Sirian and Katoma were built up by the MRT consultants. The period of observation at each station is not sufficient for an accurate analysis. The Mange and Robat stations were monitored from 1972 until 1978, then they were closed down and the hydrological station transferred to Bantoro.

Water level records at the Mange station indicate tidal effect except at high river flow as shown in Fig. 4-2-2 and 4-2-3 and Table 4-2-3. At the Bantoro station, the water level drops below the 0 metre of the gauging staff in the low water season as shown in Fig. 4-2-2 and 4-2-4 and Table 4-2-3. The water level has been recorded at Mange and Bantoro by means of a staff reading, every one hour from 9 a.m. to 4 p.m. The water level at Robat was read weekly during 1971 and 1972, and observation was continued until 1978. However these records are said to have been mislaid as well as those at Made. The water level at the Mabole station, which is located on the Mabole river (one of main distributaries of the Little Scarcies), is shown in Table 4-2-3. Basic tidal information and the correlation between the Storey datum and the tide tables datum (the chart datum) are shown in Table 4-2-4.

Fig. 4-2-1 HYDROLOGICAL DATA AVAILABLE

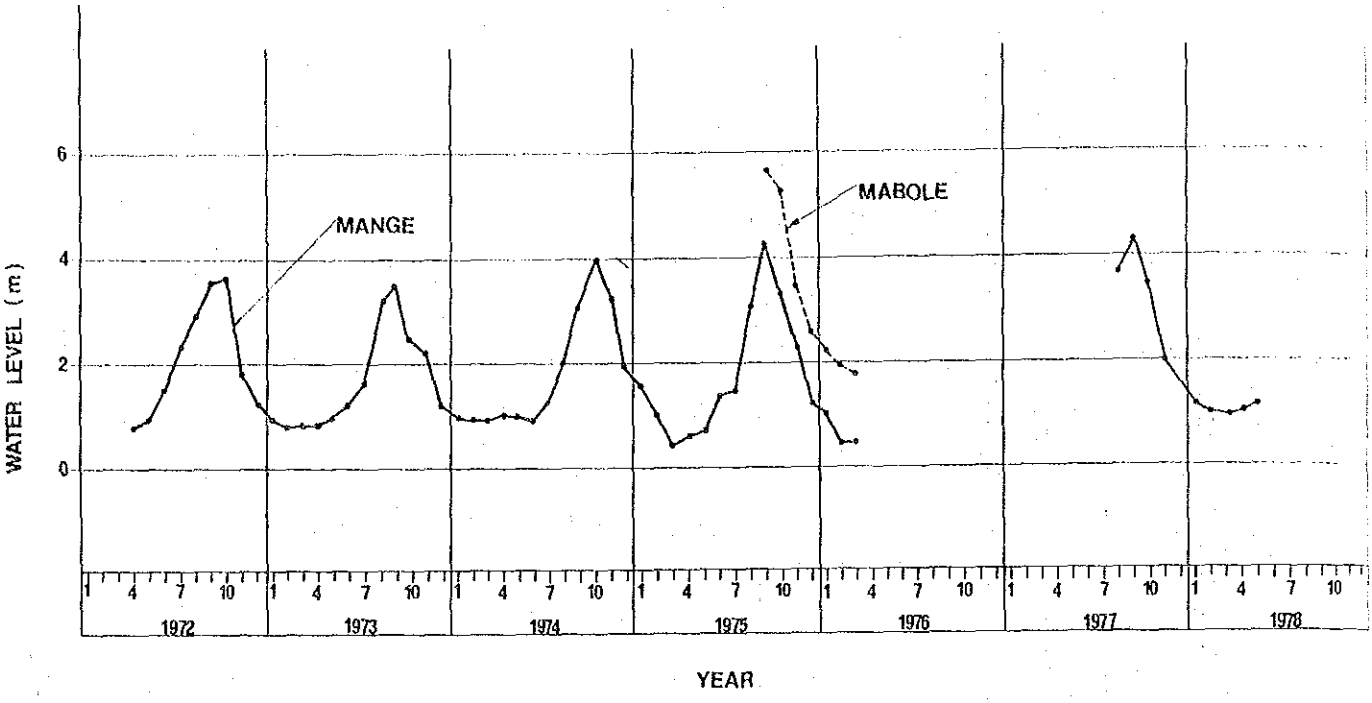


Note: Daily water level record including month of no or little data

Monthly water level range from MRT report

Fig 4-2-2 MONTHLY WATER LEVEL

MANGE & MABOLE



BANTORO

It is assumed that staff gauge condition was changed and reading altered to be 1 m smaller than before.

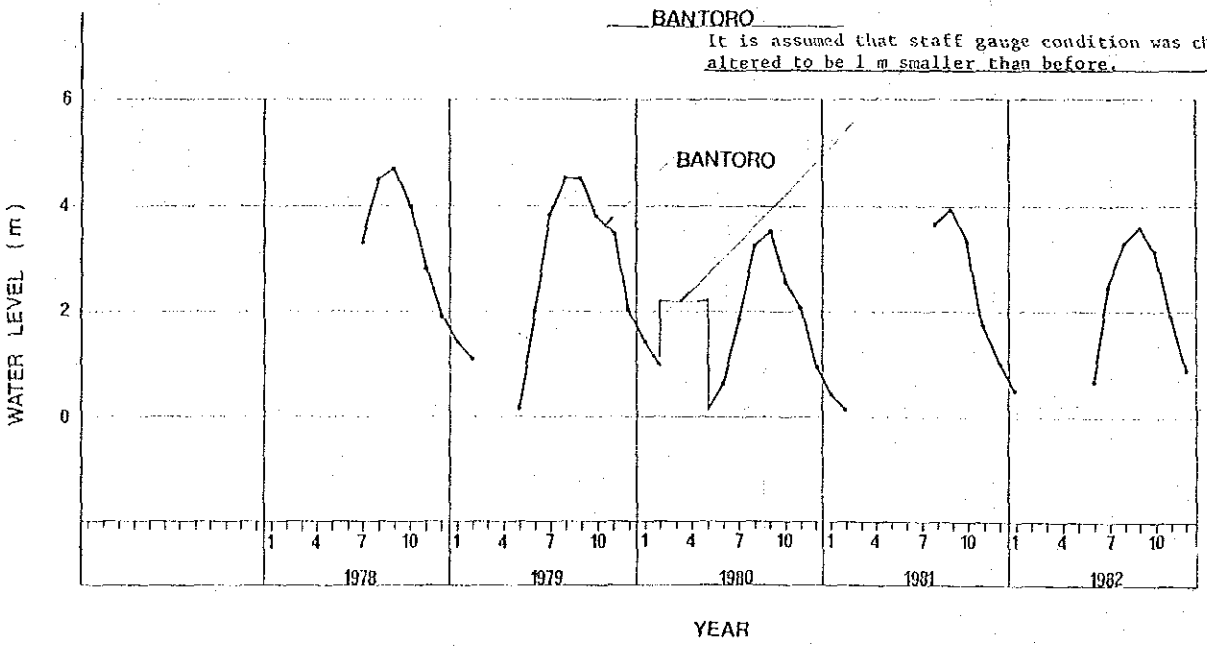


Fig. 4-2-3 DAILY WATER LEVEL AT MANGE (1/7)

YEAR : 1972

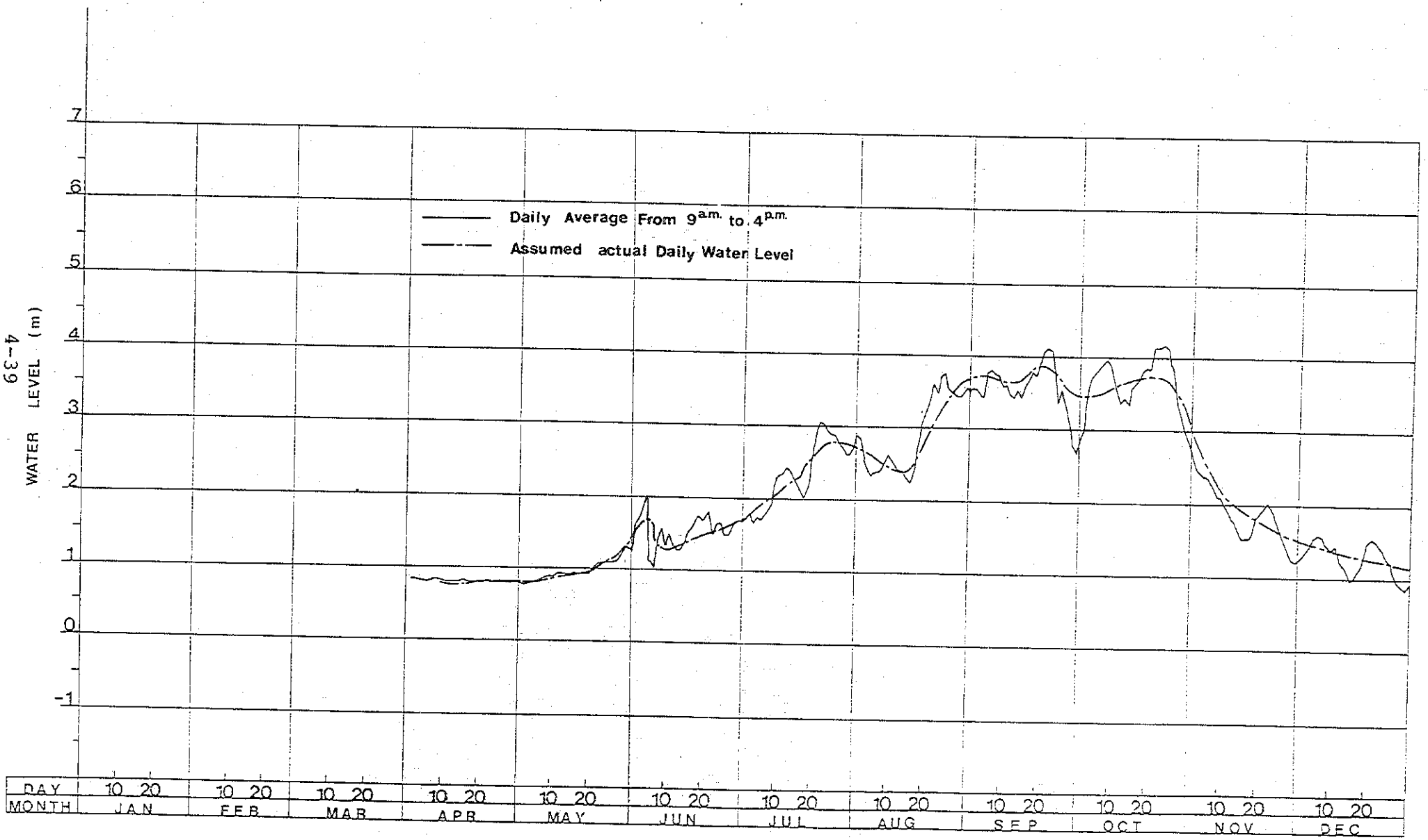


Fig. 4-2-3 DAILY WATER LEVEL AT MANGE (2/7)

YEAR : 1973

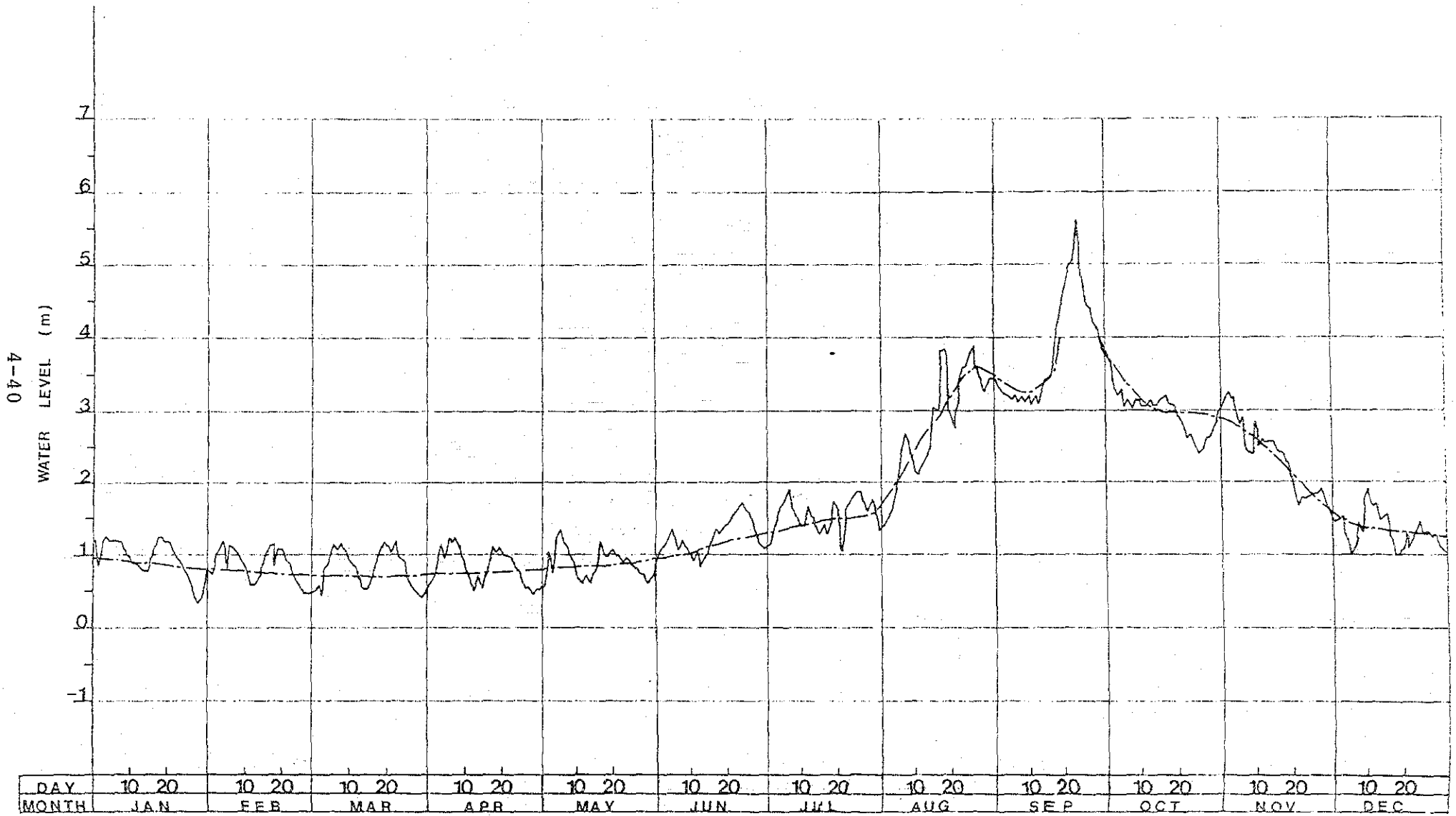


Fig. 4-2-3 DAILY WATER LEVEL AT MANGE (3/7)

YEAR : 1974

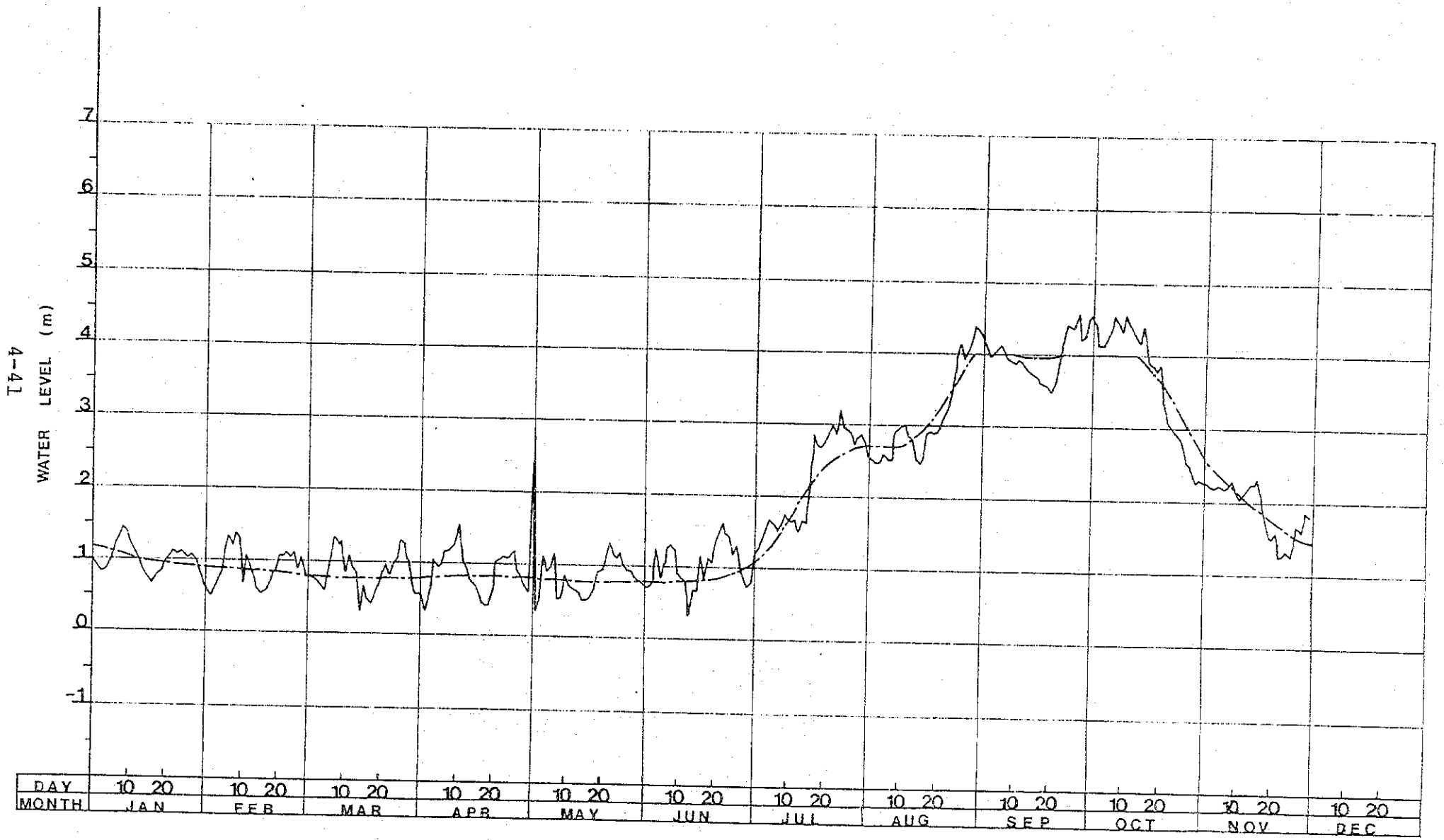


Fig. 4-2-3 DAILY WATER LEVEL AT MANGE (4/7)

YEAR : 1975

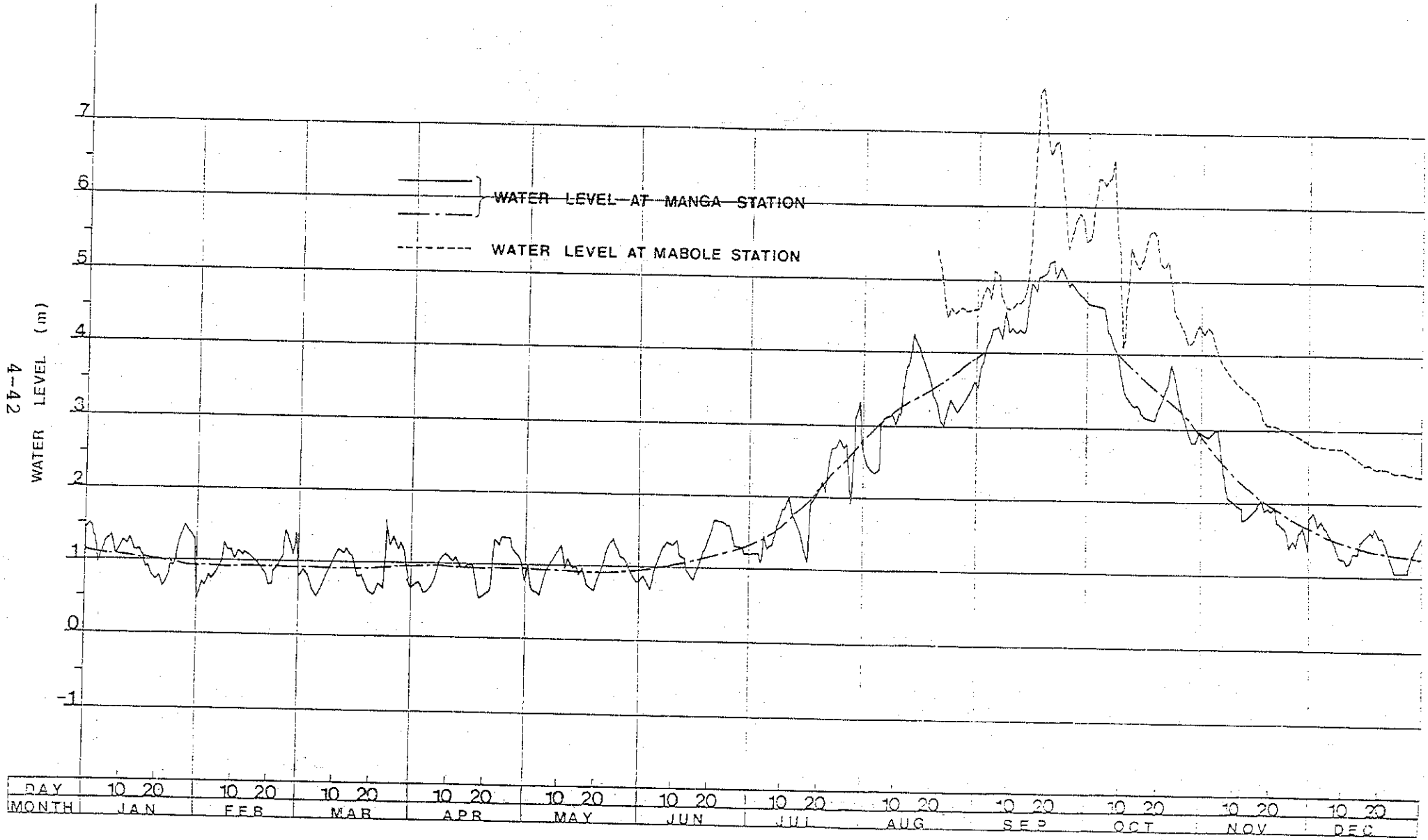


Fig. 4-2-3 DAILY WATER LEVEL AT MANGE (5/7)

YEAR : 1976

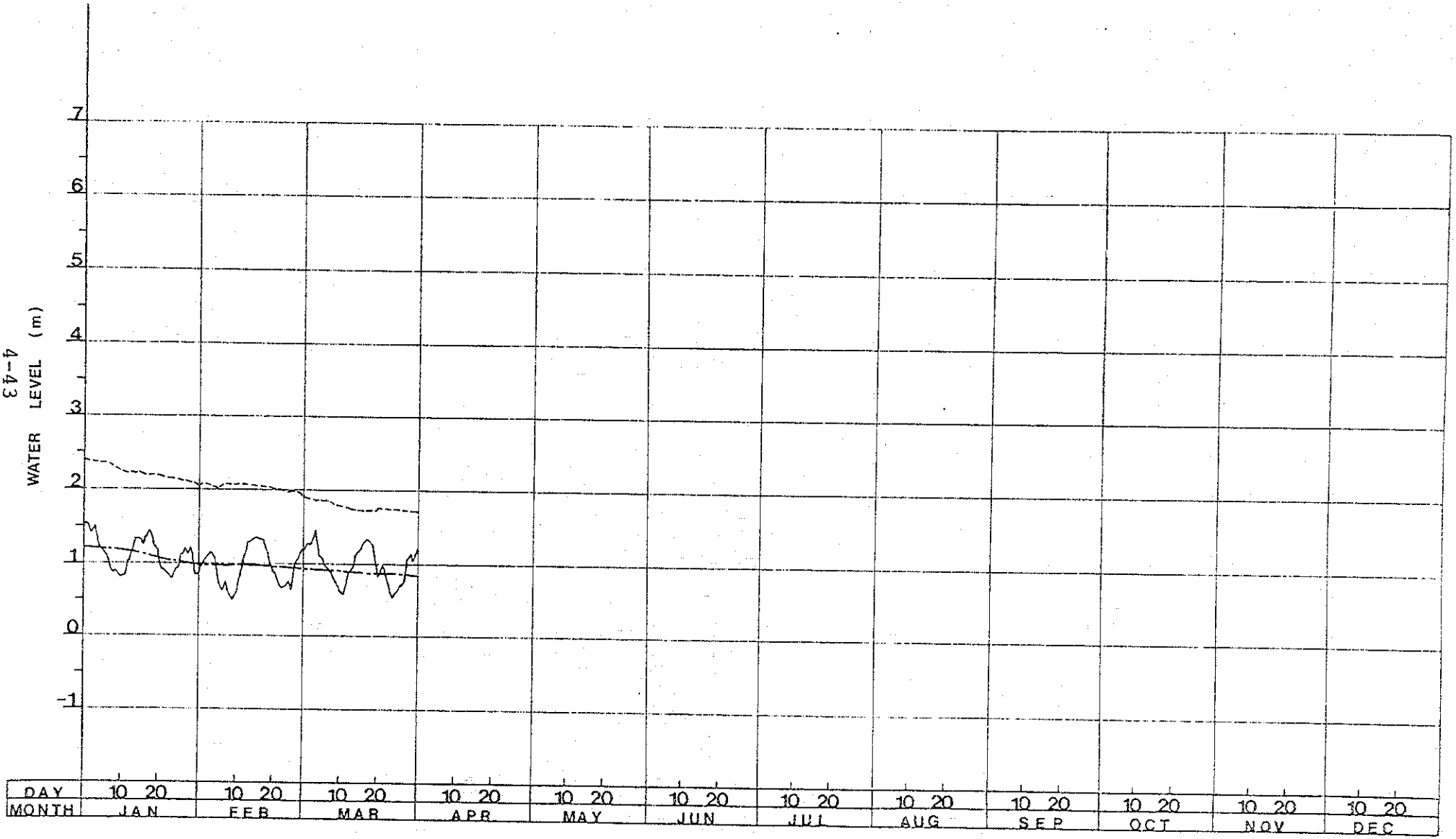


Fig. 4-2-3 DAILY WATER LEVEL AT MANGE (6/7)

YEAR : 1977

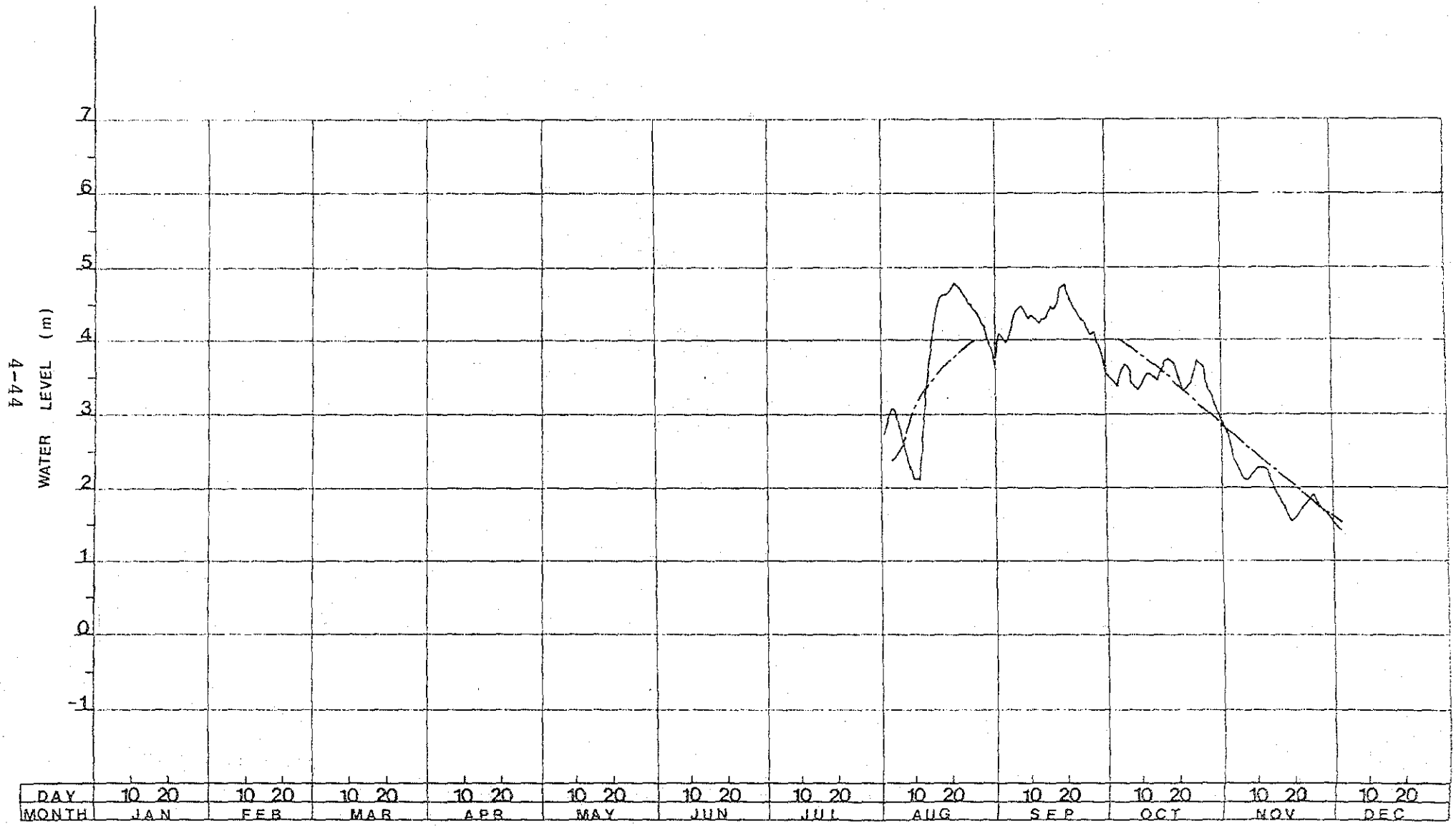


Fig. 4-2-3 DAILY WATER LEVEL AT MANGE (7/7)

YEAR : 1978

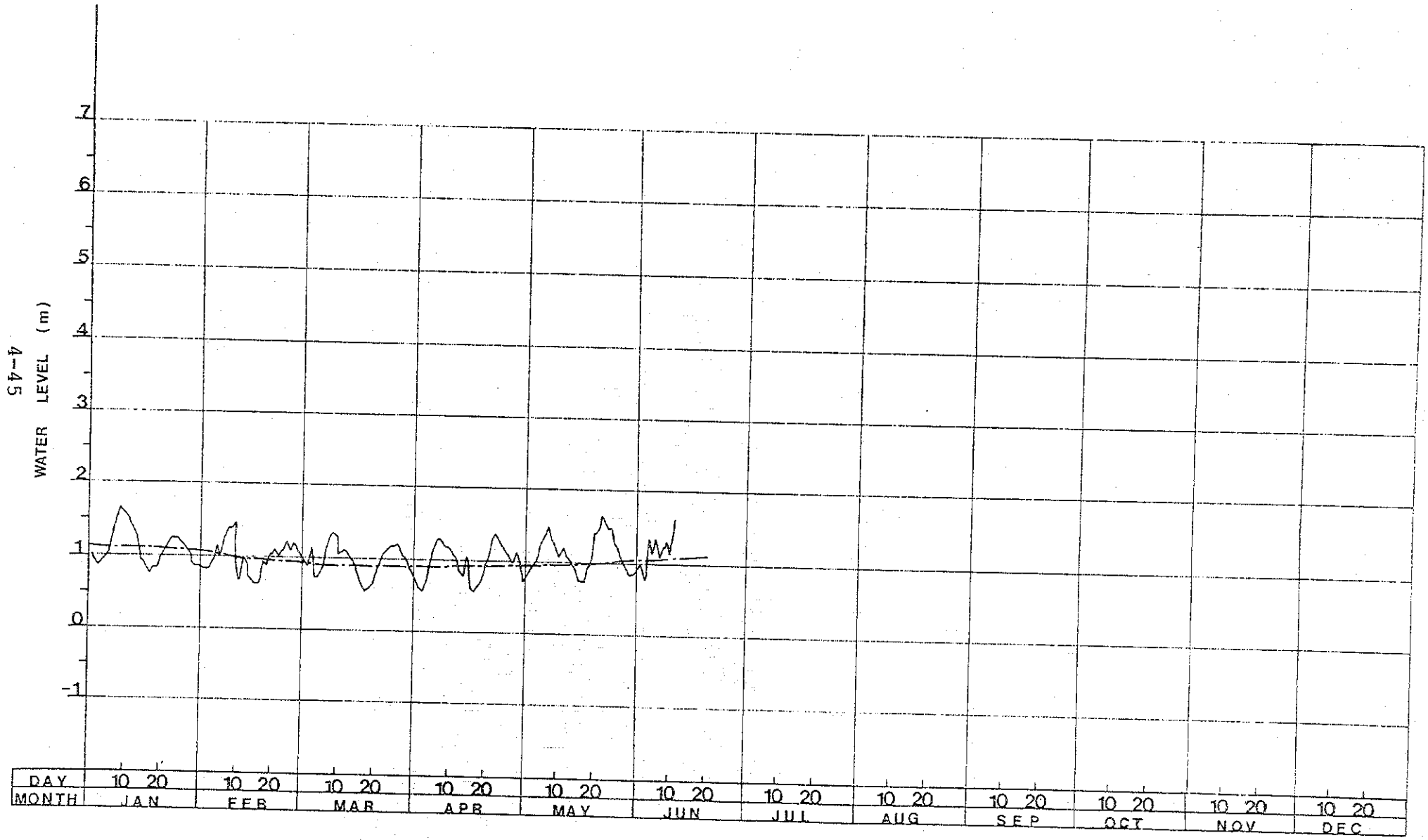


Table 4-2-3 MONTHLY WATER LEVEL

Station: Mange

(m)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1972	-	-	-	0.80	0.97	1.54	2.38	2.90	3.54	3.62	1.82	1.25	-
1973	0.95	0.81	0.83	0.85	0.92	1.28	1.60	3.12	3.91	2.95	2.20	1.33	1.73
1974	0.99	0.91	0.85	0.95	0.82	1.04	2.25	3.16	4.00	3.44	1.93	-	-
1975	1.11	1.00	0.91	0.93	0.94	1.18	1.97	3.28	4.58	3.67	2.06	1.42	1.92
1976	1.18	0.96	0.97	-	-	-	-	-	-	-	-	-	-
1977	-	-	-	-	-	-	-	3.66	4.27	3.47	2.00	-	-
1978	1.12	0.99	0.97	1.00	1.12	-	-	-	-	-	-	-	-
Average	1.07	0.93	0.91	0.91	0.95	1.26	2.05	3.22	5.08	3,43	2.00	1.33	1.93

Station: Bantoro

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1978	-	-	-	-	-	-	3.38	4.52	4.78	4.06	2.85	1.97	-
1979	1.47	1.13	-	-	-	2.08	3.88	4.54	4.52	3.81	3.50	2.04	-
1980	1.48	1.17*	-**	-	0.06*	0.64	1.86	3.27	3.54	2.54	2.08	0.97	-
1981	0.42	0.12	-	-	-	-	-	4.05*	3.90	3.22*	1.90*	1.01*	-
1982	0.49	-	-	-	-	0.69	2.49	3.30	3.59	3.17	1.93	0.9 3	-
1983	0.45*	-	-	-	-	-	-	-	-	-	-	-	-
Average													
78-Feb.80	1.48	1.15	-	-	-	2.08	3.63	4.53	4.65	3.94	3.18	2.01	-
May 80-83	1.45	0.12	-	-	-	0.67	2.18	3.54	3.68	2.98	1.97	0.97	-

* An estimated record

** It is assumed that staff gauge condition was changed and reading was altered to be 1 m smaller than before.

Station: Mabole

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1975	-	-	-	-	-	-	-	-	5.62	5.25	3.44	2.60	-
1976	2.21	1.96	1.79	-	-	-	-	-	-	-	-	-	-

Fig 4-2-4 DAILY WATER LEVEL AT BANTORO (1/6)

YEAR : 1978

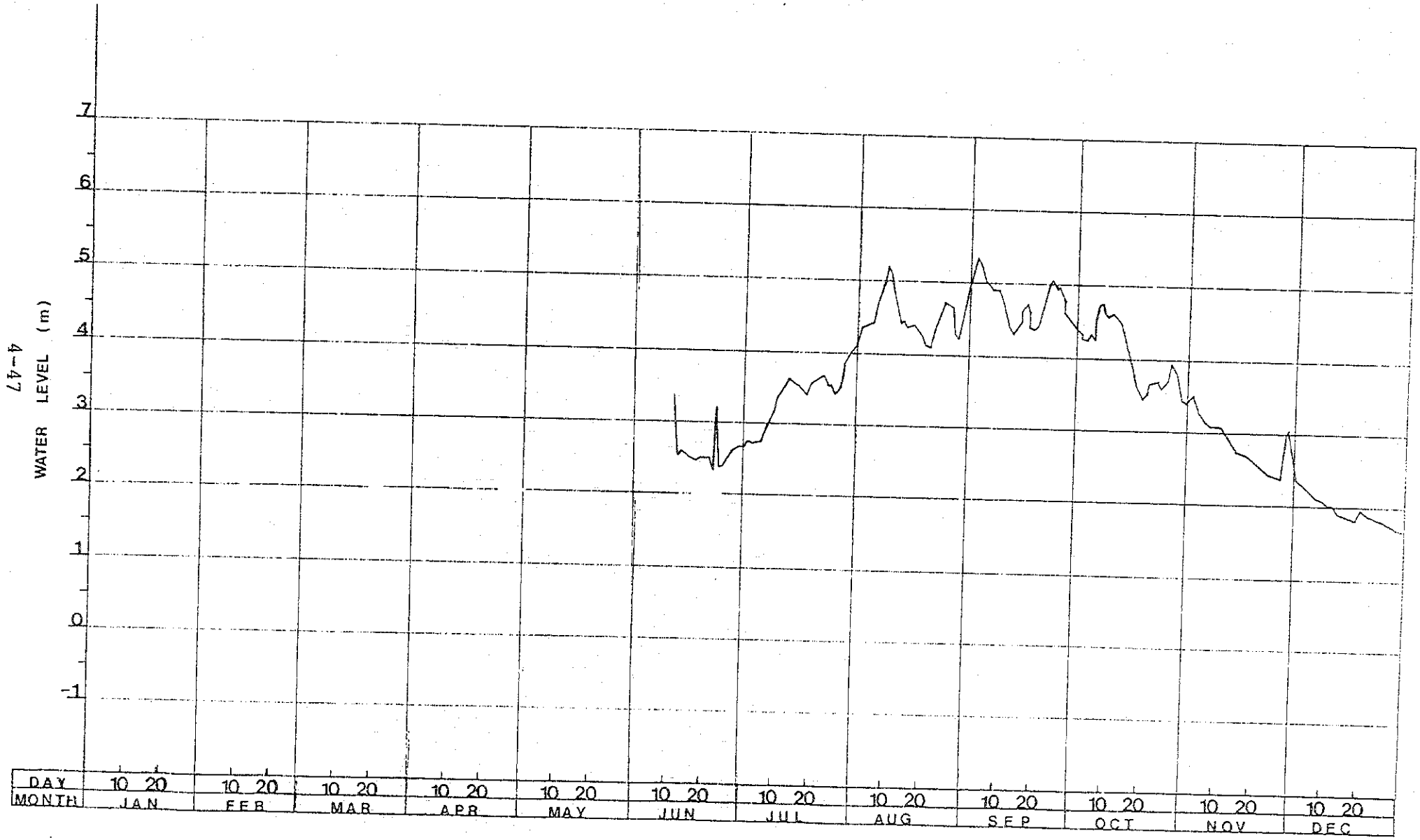


Fig 4-2-4 DAILY WATER LEVEL AT BANTORO (2/6)

YEAR : 1979

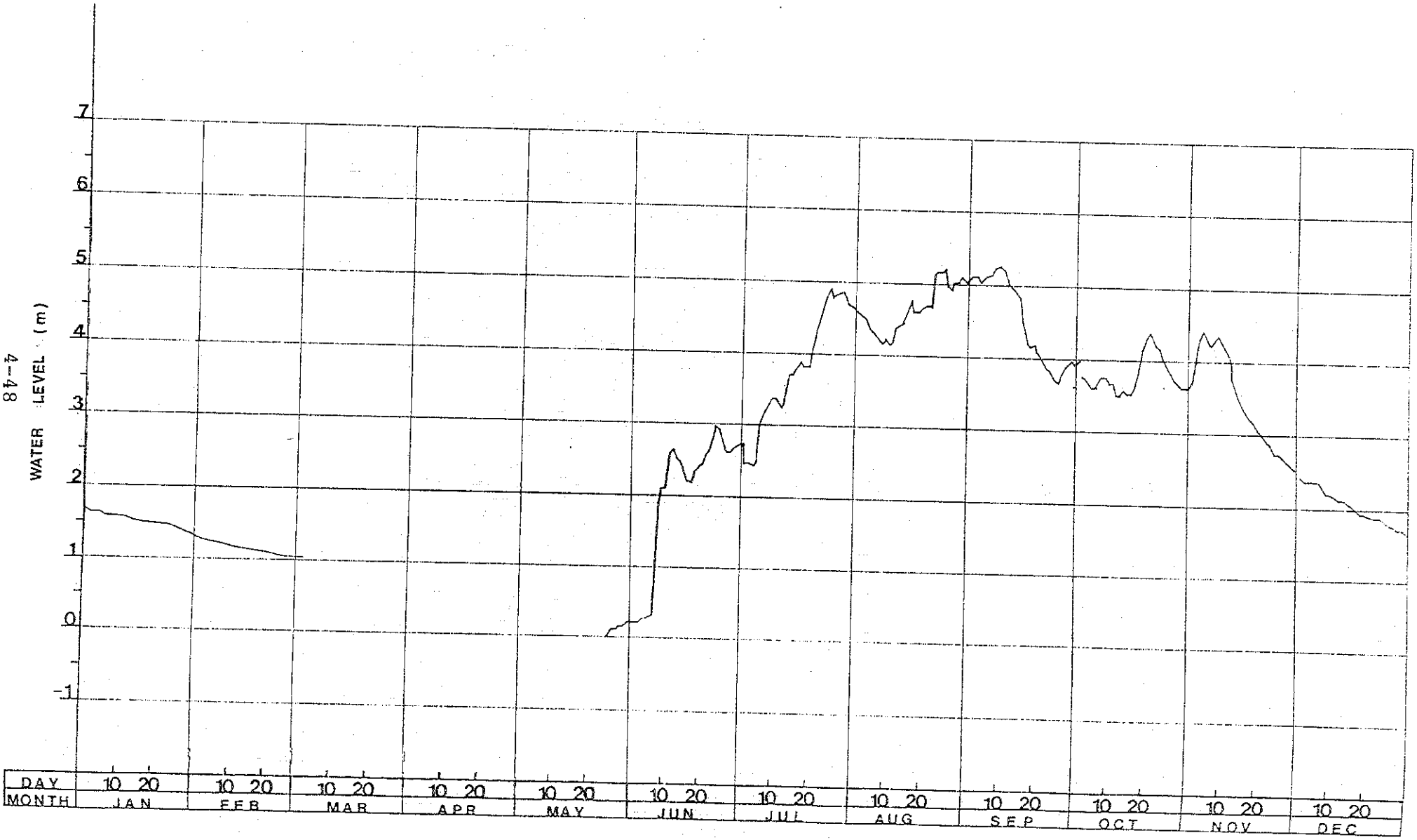


Fig 4-2-4 DAILY WATER LEVEL AT BANTORO (3/6)

YEAR : 1980

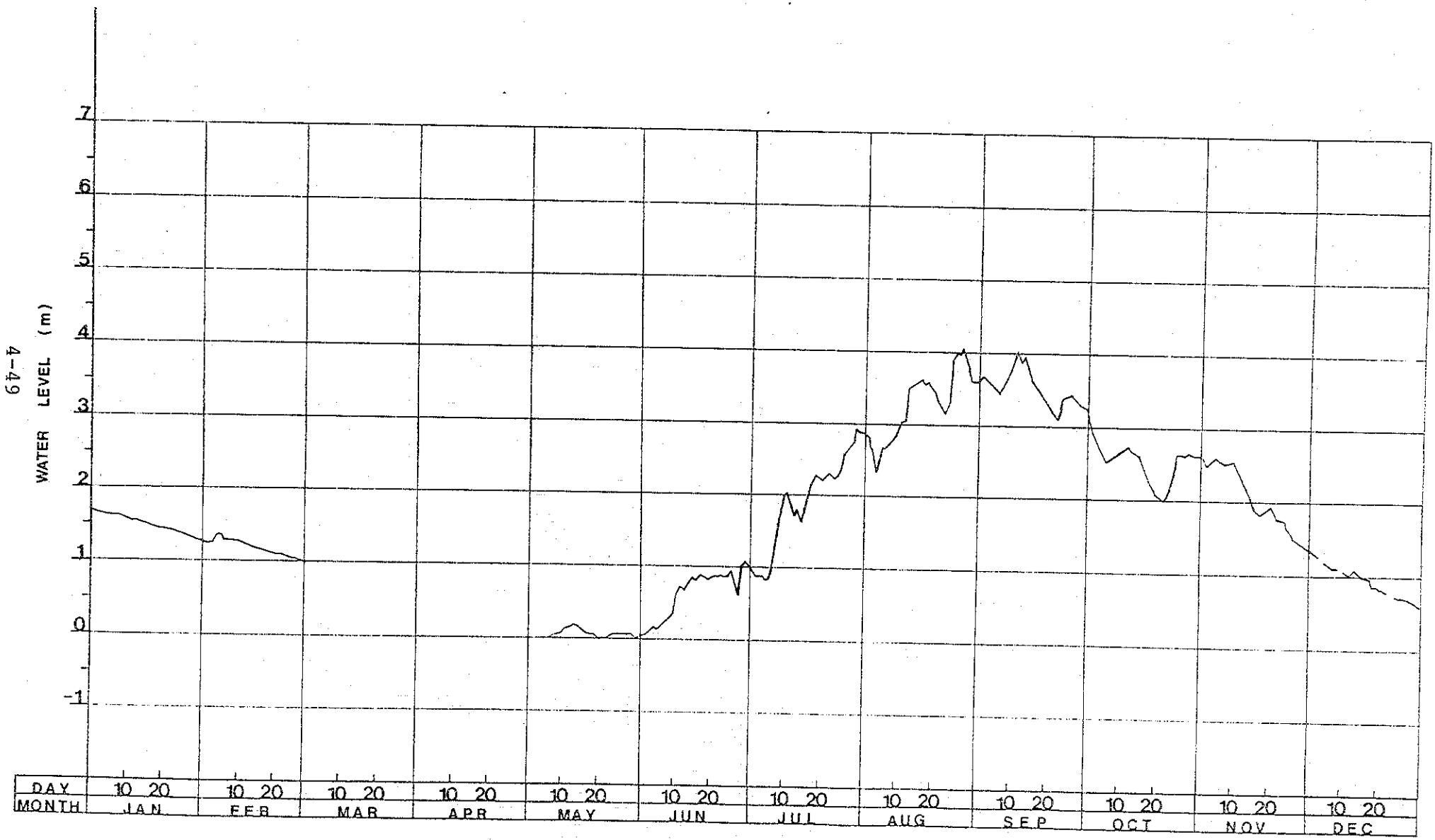


Fig 4-2-4 DAILY WATER LEVEL AT BANTORO (4/6)

YEAR : 1981

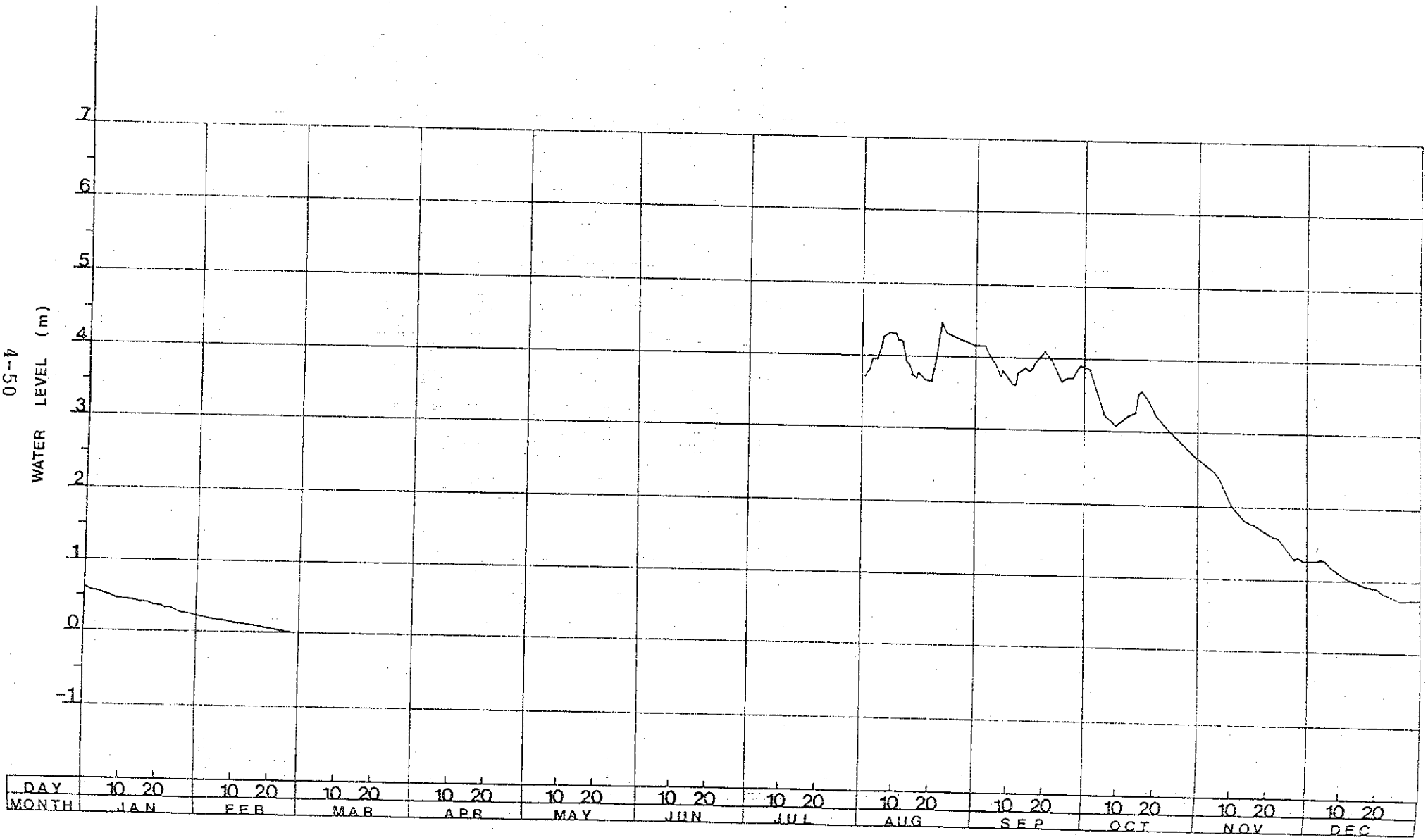


Fig 4-2-4 DAILY WATER LEVEL AT BANTORO (5/6)

YEAR : 1982

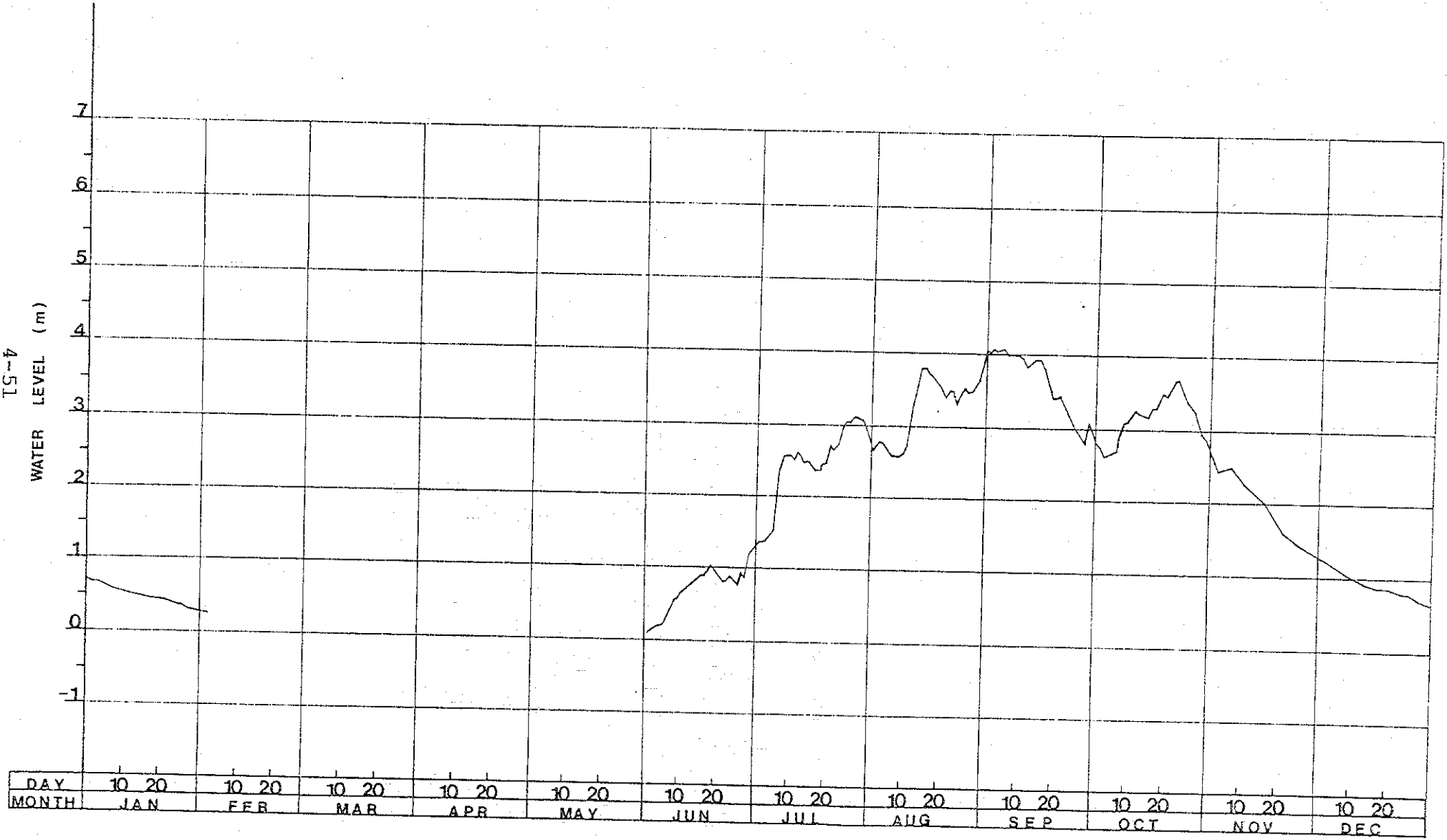


Fig 4-2-4 DAILY WATER LEVEL AT BANTORO (6/6)

YEAR : 1983

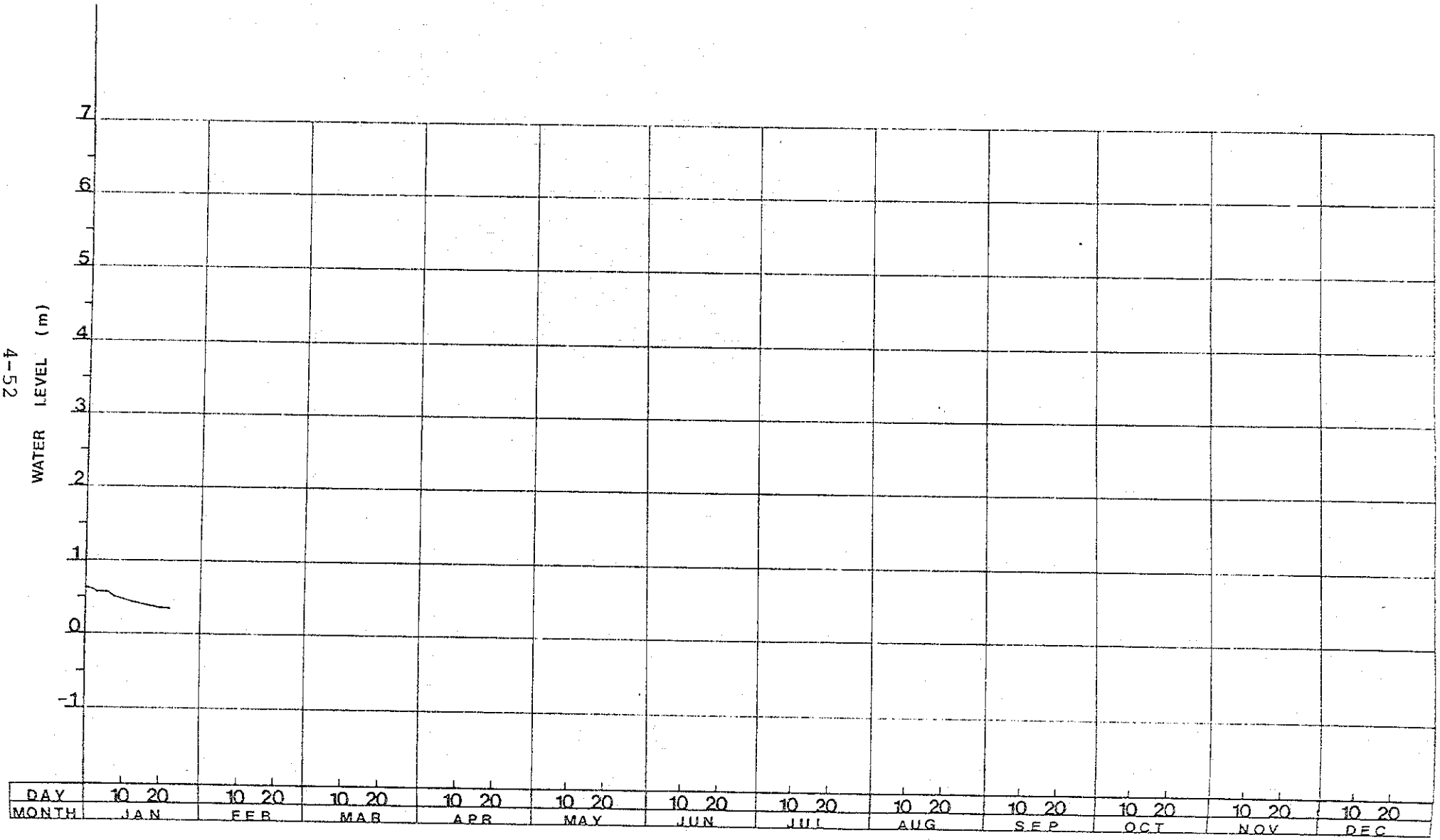


Table 4-2-4 TIDAL INFORMATION

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