FEASIBILITY REPORT
ON
BOHOL INTEGRATED AGRICULTURAL DEVELOPMENT PROJECT
IN
THE PHILIPPINES

(APPENDIX)

MAY 1978

JAPAN INTERNATIONAL COOPERATION AGENCY

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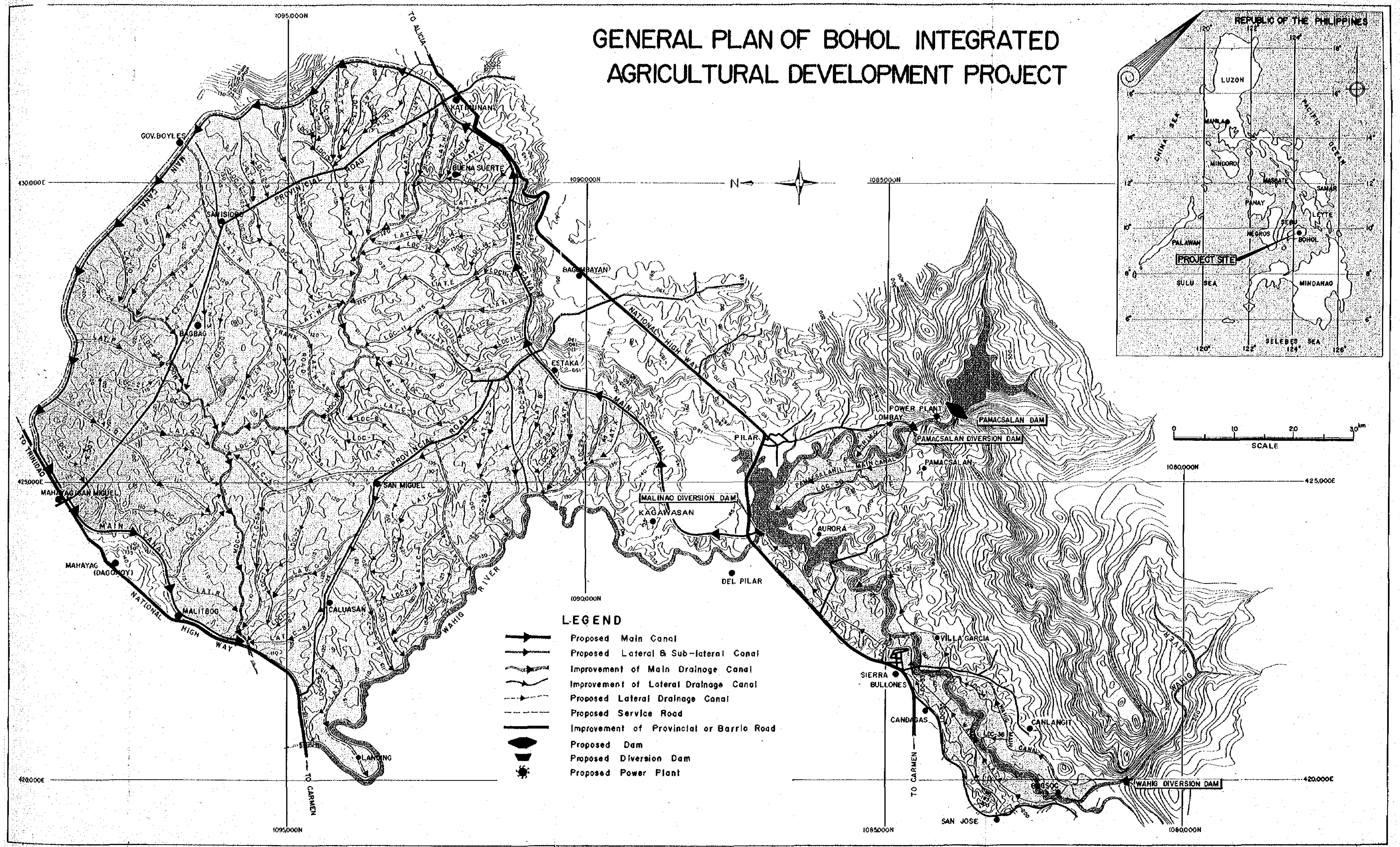
GENERAL PLAN OF BOHOL INTEGRATED AGRICULTURAL DEVELOPMENT PROJECT



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CHAPTER I INTRODUCTION

Personnel Concerns the Team Contacted

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Mr. Marcos Auguis	Mayor of Pilar

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Mr. Yasushi Miyazaki	Project Manager of Consultants, LBDPIC, SCI
Mr. Yasushi Ishiyama	Project Manager of Consultants, NISIS, SCI

Data List used for Feasibility Study

A. Hydrology

1. Water Supply Bulletin, prepared by the Bureau of Public Work, Water Resources Survey Division

2. Annual Climatological Review, prepared by the Philippine Atomospheric Geophysical Astoronomical Survices Administration

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4. Disastrous Tropical Cyclones 1948-1975, prepared by the Philippine Atomospheric Climatological Services Administration

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B. Agriculture

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8. Paddy Production by Region, Philippines, 1968-1976 prepared by BAEcon.

9. Farm Management Survey of Bohol Integrated Agricultural Development, NIA, Aug. 1977.

10. 16 Steps Masagana 99 Irrigated Transplanted Rice Culture, Final Draft, 1977, prepared by NFAC.

11. Adapted List of Recommended Pesticides for the Use of Masagana 99 Rice Production Program, 1977 prepared by NFAC.

12. Effects of Levels of Nitrogen on the Grain Yield of Rice Varieties and Promising Lines at Three Locations, 1975, prepared by BPI

C. Irrigation and Drainage

Maps

13. Military Map showing Bohol Island, 1/50,000

14. Contour Map of the Project Area, 1/4,000

Report and Other Data

15. Method of Plowing Terraced Land Using Conventional One-way Plow, prepared by Bureau of Soil.

16. Handbook of Bench Terracing, prepared by Bureau of Soil.

17. Design Criteria for Gravity Irrigation System, prepared by NIA.

18. Digest of Proceedings, prepared by NIA

19. Area Resources Study for the Wahig Pamacsalan Project, prepared by NEDA

20. Integrate Development Package for Bohol, prepared by CCC.

21. Report on Preliminary Survey on Bohol Integrated Agricultural Development Project, prepared by JICA, 1977

D. Design and Cost Estimate

Maps

22. Map showing Resorvoir Area of Pamacsalan Dam, 1/4,000

23. Map showing Resorvoir Area of Wahig Dam, 1/4,000

24. Contour Map of Pamacsalan Damsite, 1/1,000

25. Contour Map of Wahig Damsite, 1/1,000

26. Profile of Pamacsalan Dam Axis

27. Profile of Wahig Dam Axis

28. Profile and Cross-section of Wahig River on Malinao Diversion Damsite

29. Contour Map of Sample area, 1/2,000

Reports and Other Data

30. Design Criteria for Dams, prepared by Japanese National Committee on Large Dams

31. Observation Data for Earthquake, prepared by Philippine Atomospheric, Geophysical and Astronomical Services Administration

32. Canal and Related Structures, prepared by U.S Bureau of Reclamation.

33. The Criteria for Diversion Dam, prepared by Agricultural Structural Improvement Bureau, Ministry of Agriculture and Forestry, JAPAN

34. The Criteria for Canals, prepared by Agricultural Structural Improvement Bureau, Ministry of Agriculture and Forestry, JAPAN

35. Construction Cost by using Heavy Equipment, prepared by Yasuo Itami

36. Construction Planning Equipment and Methods, prepared by R.L Peurifoy.

E. Economy

37. Integrated Census of the Population and Its Economic Activities, Bohol, 1975, National Census and Statistical Office, NEDA

38. Census of Population, Bohol, 1970, NCSO, NEDA

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42. Philippine Economics Indicators, Aug., 1977, NEDA

43. Long-Term and Five Year (1976-82) Development Plans Draft Summary, 1977, NEDA

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Proposed Practices for Economic Analysis of River Basin Projects. Report to the Inter-Agency Committee on Water Resources Prepared by the Subcommittee on Evaluation Standards., U.S.A, May, 1959 (Translated to Japanese)

49. Guidelines for Economic Evaluation of ADB Projects, April, 1970.

50. Guidelines for the Preparation of Feasibility Studies for Irrigation and Drainage Projects, FAO/IBRD, Dec., 1970

51. Jalaaru Irrigation Project Appraisal Report, Oct., 1976, World Bank

52. Cagayan Integrated Agricultural Development Project Feasibility Report, Apr. 1976, JICA

CHAPTER II. ECONOMIC AND SECTORAL BACKGROUND

Table 2A-1 Total Population, 1877-1974

Year	Census population[a]	Estimated midyear population[b]	Annual intercensal growth rate
1877	5,567,685		
1887	5,984,727		
1896	6,261,339		
1903	7,635,426		2.9
1918	10,314,310		1.9
1936	16,000,303		2.2
1948	19,234,182		1.9
1960	27,087,685	27,372,420	3.1
1961		28,174,753	
1962		29,001,656	
1963		29,858,498	
1964		30,749,682	
1965		31,673,693	
1966		32,633,087	
1967		33,629,509	
1968		34,664,683	
1969		35,740,434	
1970	36,684,468	36,851,954	3.0
1971		37,919,096	
1972		39,040,439	
1973		40,218,819	
1974		41,432,623	
1975[c]		42,517,000	

a/ Data to 1896 excludes non-Christian population.

b/ The 1960-69 estimates are interpolated from census populations. The 1970-72 estimates are from L. Baal, C. Que, and P. Yunkin, "New Population Projections by Age and Sex for the Philippines and Each Province, 1970-2000", Bureau of the Census and Statistics (BCS), Population Research Division (Manila, n.d.).

Source: BCS, Yearbook of Philippine Statistics, 1966, and Monthly Bulletin of Statistics (March 1972).

Derived from "The Philippines, Priorities and Prospects for Development", 1976, World Bank

c/ Source of C is Long-Term and Five Year Development Plans, 1977, NEDA.

Table 2A-2 Population, Land Area and Density of the Population

Region and Province	Population (in thousands) 1975 1/ (May 1)	1970 (May 6)	1960 (Feb. 15)	Land Area (sq.km)	Density (persons / sq.km) 1975 (May 1)	1970 (May 6)	1960 (Feb. 15)
Philippines	41,831	36,684	27,088	300,000	139	122	90
VII. Central Visayas	3,363	3,032	2,523	14,952	225	203	169
Bohol	753	683	592	4,117	183	166	144
Cebu	1,805	1,634	1,333	5,088	355	321	262
Negros Oriental	737	652	538	5,402	136	121	100
Siquijor	68	63	60	344	198	183	175

Note: 1/ Preliminary
Source: National Statistics, 1976.

Table 2A-3 Expenditures on Gross National Product at 1967 Constant Prices
(In millions of pesos)

Item	1960	1965	1968	1969	1970	1971	1972	1973	1974
Private consumption	15,057	19,319	22,146	23,178	23,872	24,897	25,735	27,545	29,214
General government consumption	1,911	2,436	2,648	9,902	2,683	2,905	3,135	3,356	3,658
Fixed capital formation	3,000	4,643	5,933	5,942	5,622	5,921	6,031	6,690	8,217
Increase in stocks	308	537	543	557	775	723	785	986	1,252
Exports (goods and nonfactor services)	2,518	4,340	4,221	4,018	4,548	4,591	5,945	6,155	4,673
Less: Imports (goods and nonfactor services)	3,255	4,072	5,643	5,479	5,041	4,832	4,794	5,995	7,218
Gross domestic product	19,539	27,203	29,848	31,118	32,459	34,205	36,837	38,737	39,796
Net factor income from abroad	-331	-127	-411	-296	-480	-305	-383	-200	86
Statistical discrepancy	-418	-2,723	-1,046	-786	-297	-364	-1,508	-122	773
Gross national product	18,790	24,353	28,391	30,036	31,682	33,536	34,946	38,415	40,655
Rate of Chainge from Previons Year (%)		29.6	16.6	5.8	5.5	5.8	4.2	9.9	5.8

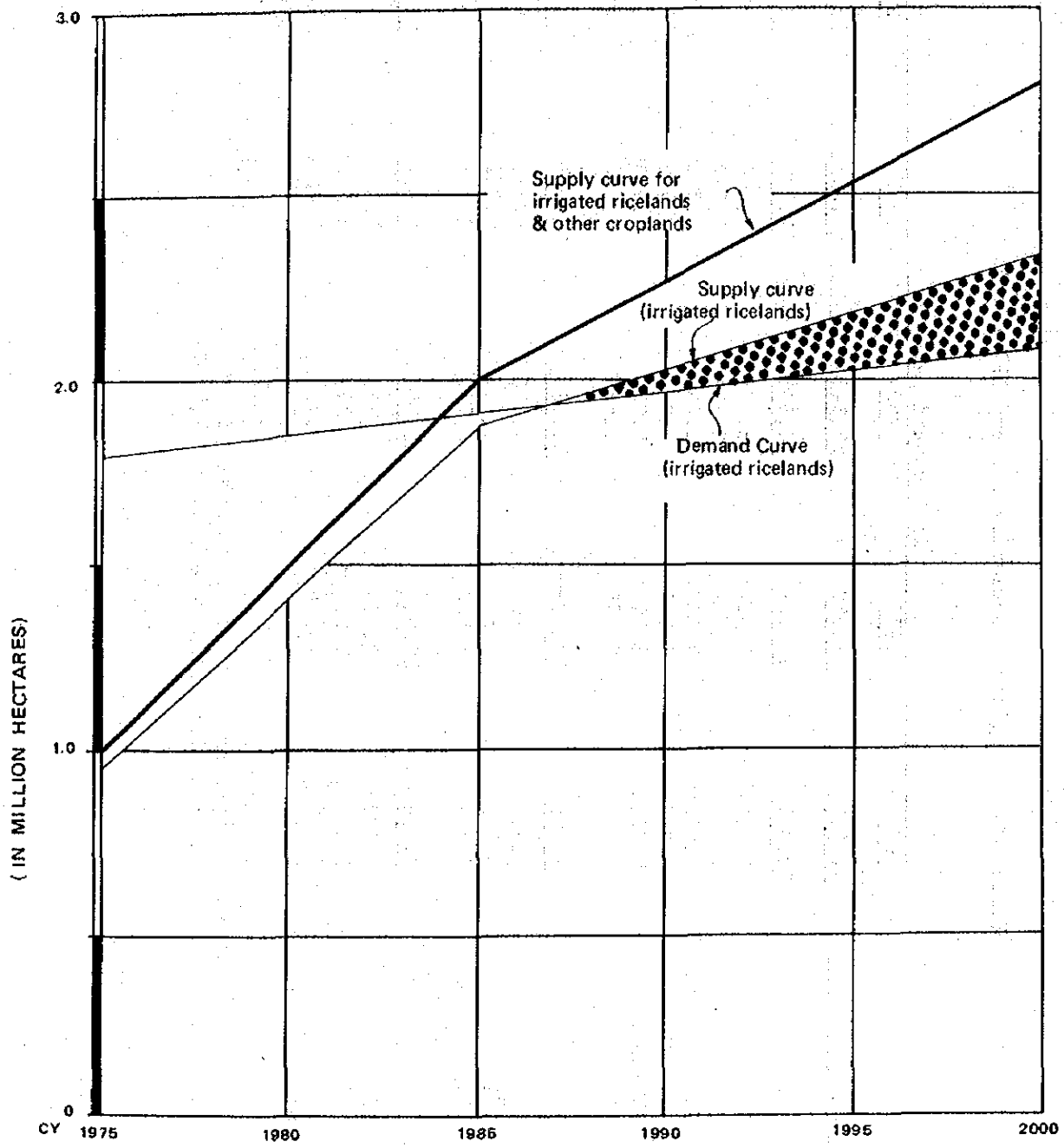
Source: NEDA, National Accounts Staff, Statistical Office
Derived from "The Philippines, Priorities and Prospects for Development". 1976, World Bank.
Rate of Change from Previous Year was calculated by Consultants.

Table 2A-4 Gross Domestic Products by Industry (1971-1976)
(1972 year Constant Price)

Industry	G D P (10^6 peso)						Growth Rate (%)				
	1971	1972	1973	1974	1975	1976	1971/72	1972/73	1973/74	1974/75	1975/76
Agriculture etc.	15,457	16,040	17,026	17,465	18,095	19,144	3.77	6.15	2.58	3.61	5.80
Mining	1,282	1,346	1,400	1,403	1,423	1,457	4.99	4.01	2.14	1.43	2.39
Manufacture	12,611	13,388	15,252	15,981	16,537	17,464	6.16	13.92	4.78	3.48	5.61
Construction	1,889	2,240	2,433	2,665	4,059	4,952	18.58	8.62	9.54	52.31	22.00
Electric etc.	440	468	501	581	618	664	6.37	7.05	15.97	6.37	7.44
Commercial	12,484	12,688	13,589	14,200	14,991	15,786	1.63	7.10	4.50	5.57	5.30
Service	7,179	7,487	8,073	8,680	9,124	9,525	4.29	7.83	7.52	5.12	4.40
Transportation	2,184	2,418	2,657	2,933	3,263	3,491	10.71	9.88	10.39	11.25	6.99
G D P	53,526	56,075	60,931	63,908	68,291	72,576	4.76	8.66	4.80	6.87	6.27

Source: NEDA, Philippine Economic Indicators, Sept. 1976

FIGURE 2A-1 25-YEAR IRRIGATION DEVELOPMENT PROGRAMS



Source: NIA/Programming Staff Long-Term Development Plans, NEDA

Allowance for risks and losses from pests, floods and other calamities

Table 2B-1 Regional Population Targets 1975-2000

	In thousand persons				
	1975	1977	1982	1987	2000
Philippines	42,517	45,252	52,348	59,204	83,444
Luzon	22,927	24,551	28,606	32,344	44,485
Region I	3,310	3,437	3,778	4,170	5,387
II	1,933	2,039	2,324	2,642	3,660
III	4,402	4,908	6,041	6,735	8,940
IV - (MMA)	5,212	5,692	6,904	8,043	11,905
IV - A	4,823	5,117	5,868	6,639	9,180
V	3,247	3,358	3,691	4,115	5,413
Visayas	9,791	10,088	10,958	11,873	15,479
Region VI	3,896	3,998	4,313	4,739	6,029
VII	3,371	3,500	3,867	4,312	5,704
VIII	2,524	2,590	2,778	2,922	3,746
Mindanao	9,799	19,613	12,784	14,887	23,480
Region IX	2,233	2,387	2,803	3,265	2,891
X	2,421	2,634	3,197	3,797	5,966
XI	2,812	3,088	3,817	4,555	7,274
XII	2,333	2,504	2,967	3,270	5,349

Source: Long-Term and Five Year (1978-82) Development Plans (Draft Summary), 1977

Table 2B-2 Per Capita Gross Regional Domestic Product, 1975-2000

	In Pesos at 1972 Prices per Person				
	1975	1977	1982	1987	2000
Philippines	1,601	1,734	2,150	2,807	5,617
Luzon	1,911	2,047	2,483	3,207	6,122
Region I	955	1,026	1,226	1,834	3,655
II	917	1,016	1,312	2,013	3,970
III	1,300	1,324	1,701	2,295	5,505
IV - (MMA)	4,515	4,637	5,087	5,848	9,174
IV - A	1,529	1,719	2,329	3,004	6,637
V	791	886	1,163	2,019	3,463
Visayas	1,333	1,462	1,828	2,346	5,239
Region VI	1,728	1,877	2,285	2,666	5,442
VII	1,257	1,405	1,842	2,390	6,163
VIII	825	896	1,098	1,764	3,504
Mindanao	1,141	1,269	1,680	2,311	4,911
Region IX	928	1,018	1,291	1,934	3,834
X	1,098	1,230	1,662	2,145	4,871
XI	1,629	1,821	2,461	3,211	6,960
XII	800	867	1,064	1,627	3,155

Source: NEDA

CHAPTER III. THE PROJECT AREA

Population

Table 3A-1 Total Population of Municipality Concerned

Municipality	1970 persons	1975 persons	Annual Growth Rate %
Alicia	12,717	14,770	3.0
Dagohoy	7,291	8,578	3.3
Pilar	10,888	13,928	5.0
San Miguel	10,051	11,117	2.1
Sierra Bulones	13,807	15,132	2.0
Total	54,754	63,525	3.0
Bohol Province	683,927	759,370	2.1

Table 3A-2 Numbers of Household of Municipality Concerned

Municipality	1975
Alicia	2,588
Dagohoy	1,497
Pilar	2,439
San Miguel	1,976
Sierra Bulones	2,573
Total	11,073

Table 3A-3 Experienced Workers 10 Years Old and Over, Major Occupation, 1970

Major Occupation	Bohol	Sierra Bullones	Pilar	Dagohoy	San Miguel	Alicia	Five Municipal	(%)
All Occupation	239,658	3,980	3,840	2,369	4,901	3,278	18,368	(%)
Professional, Technical and Related Works	12,822	349	126	94	179	144	892	(4.9)
Administrative, Executive and Managerial Workers	2,120	-	26	-	66	25	117	(0.6)
Cerical Workers	3,374	102	-	43	-	22	167	(0.9)
Sales Workers	16,372	262	25	23	115	74	499	(2.7)
Farmers, Fishermen, Hunters, Loggers and Related	135,673	2,552	3,032	1,829	2,779	2,608	12,800	(69.7)
Miners, Quarrymen, and Related Workers	356	-	-	-	22	-	22	(0.1)
Workers in Transpor and Communication	4,494	20	-	-	133	46	199	(1.1)
Craftsmen, Production Process Workers and Laborers	44,766	150	277	291	1,537	264	2,519	(13.7)
Service Sport and Related Workers	14,334	352	329	18	46	95	840	(4.6)
Stevedores and Related Freight Handlers & Laborers	3,334	98	-	71	-	-	169	(0.9)
Occupation Unidentifiable Members of the Armed Forces	530	-	-	-	-	-	-	
Not stated	1,483	95	25	-	24	-	144	(0.8)

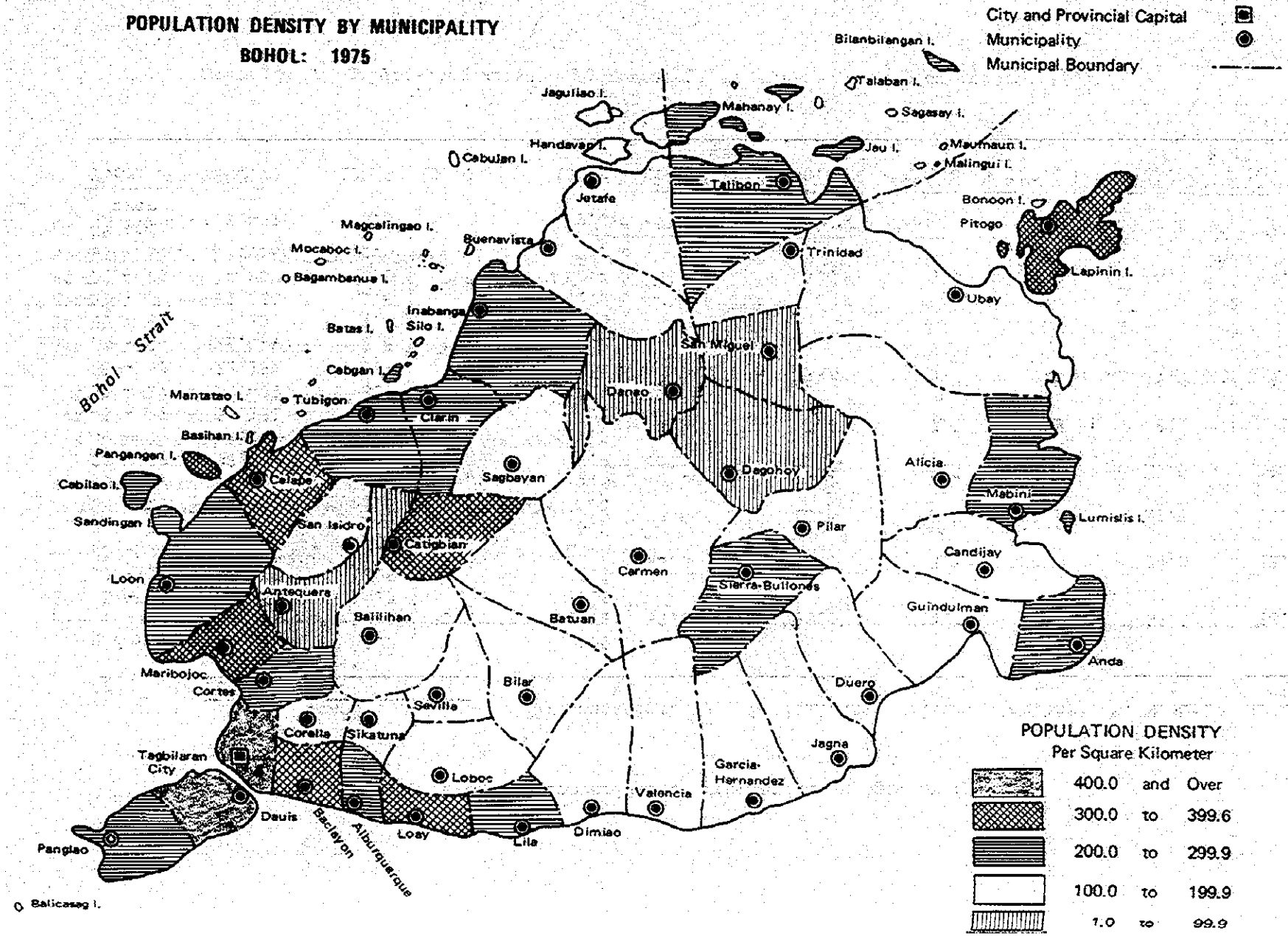
Table 3A-4 Comparison of Population by Age, 1975

Age	Bohol Persons	Bohol %		Five Municipality %		S. Bullones %	Pilar %	Dagohoy %	S. Miguel %	Alicia %
under 1	23,941	3.2		3.9						
1 - 4	92,845	12.2	30.1	13.8	33.5	33.0	34.6	33.7	32.5	33.3
5 - 9	111,358	14.7		15.8						
10 - 14	102,617	13.5		13.9						
15 - 19	78,746	10.5	24.0	10.0	23.9	24.2	23.5	24.3	24.6	23.6
20 - 24	55,044	7.2		6.9						
25 - 29	44,044	5.8	13.0	5.9	12.8	12.4	12.7	13.1	13.6	12.3
30 - 34	42,424	5.6		5.8						
35 - 39	38,905	5.1	10.7	5.3	11.1	10.9	11.5	11.5	11.0	11.1
40 - 44	33,018	4.3		4.2						
45 - 49	30,181	4.0	8.3	3.7	7.9	7.8	7.9	7.9	8.1	7.8
50 - 54	25,400	3.3		2.9						
55 - 59	22,184	2.9	6.2	2.5	5.4	5.7	4.7	4.7	5.3	6.1
60 - 64	21,044	2.8		2.2						
65 - 69	14,006	1.8		1.3						
70 - 74	12,236	1.6		1.0						
75 - 79	4,857	0.6	7.7	0.4	5.4	6.0	5.1	4.8	4.9	5.8
80 - 84	3,058	0.4		0.2						
85 and over	3,462	0.5		0.3						
Total	759,370	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

FIGURE 3A-1

POPULATION DENSITY BY MUNICIPALITY

BOHOL: 1975



Municipality	Barrio	Area (ha)	Population Total (1)	Population Farmer (2)	Household Total (3)	Household Farmer (4)	Person/Family (2)/(4)
1. Sierra Bullones	(1) Poblacion	130	1,685	674	274	110	6.1
	(2) Ambongan	22	525	157	102	31	5.1
	(3) Santa Cruz	36	576	230	108	43	5.3
	(4) Villa Garucia	112	725	580	129	106	5.6
	(5) Salvador	52	1,026	308	175	52	5.9
	(6) San Jose	47	425	212	72	36	5.9
	(7) Bogsoc	25	1,224	245	209	41	5.9
	(8) Canlangit	99	1,083	541	176	87	6.2
	Sub-total	523	7,269	2,947	1,218	506	6.0
2. Pilar	(9) Del Pilar	26	338	67	57	11	5.9
	(10) Lunboy	151	935	561	148	89	6.3
	(11) Caguwasan	154	364	218	62	37	5.9
	(12) Estaca	520	913	913	148	148	6.2
	(13) Buenasuerte	737	823	823	132	132	6.2
	(14) Sun Isidro	439	825	825	123	123	6.7
	(15) La Suerte	188	402	402	71	71	5.7
	Sub-total	2,215	4,600	3,809	741	611	6.2
3. Dagohoy	(16) Pobla cion	97	1,367	136	232	23	5.9
	(17) Malitbog	522	940	940	170	170	5.5
	(18) Malitbog	877	735	735	114	114	6.5
	(19) Caluwasan	562	788	788	143	143	5.5
	(20) Mahayag	349	381	381	62	62	6.1
	(21) Babag	473	617	617	112	112	5.5
	Sub-total	2,881	4,828	3,597	833	624	5.8
4. San Miguel	(22) Mahayag	384	913	548	155	93	5.9
	(23) Sanpascual 1/	150	2,360	117	398	31	3.8
	Sub-total	534	3,273	665	553	124	5.4
5. Alicia	(24) Katipunun	970	1,314	1,183	228	204	5.8
	Sub-total	970	1,314	1,183	228	204	5.8
	Total	7,300	21,284	12,200	3,600	2,069	6.0

Note: 1/ San Pascual is included in Ubay municipality

Source: 1975 Integrated Census of the Population and its Economic Activities, Population Bohol.

Meteorological and Hydrological Studies

Table of Contents

A. General

1. Type of Climate Zone in the Philippines

The main air currents of the Philippines is generally divided into three groups; (a) the others (loosely called Northeast Monsoon), streaming along the easterly and south-easterly side of the Great Asiatic high pressure area; (b) the trade wind, reaching the islands from a generally easterly direction and coming from the tropical high-pressure area of the Pacific; and (c) equatorial air (loosely called the southwest Monsoon), pushing its way across the equator from the strong tropical high-pressure areas of the southern hemisphere.

Since temperature differentials in the archipelago are very slight, the classification of Philippine climate was based on rainfall differences which are decidely variant due to combined influence of topography and air stream direction.

Based upon the monthly distribution of rainfall, the climatic types have been categolized into four types as shown in Figure 3B-1 and the feature of each climatic type is explained as follows.

First Type Two pronounced season; one dry from November to April, the other wet during the rest of the year. All the regions on the western part of the Islands of Luzon, Mindoro, Negros and Palawan are of this type.

Second Type No dry season; with a very pronounced maximum rain period from November to January. In this climate fall Catanduanes, Sorsogon, the eastern part of Albay, the eastern and northern parts of Camarines Norte and Camarines Sur, a great portion of the eastern part of Quezon, Samar, the eastern part of Leyte, and a large portion of eastern Mindanao.

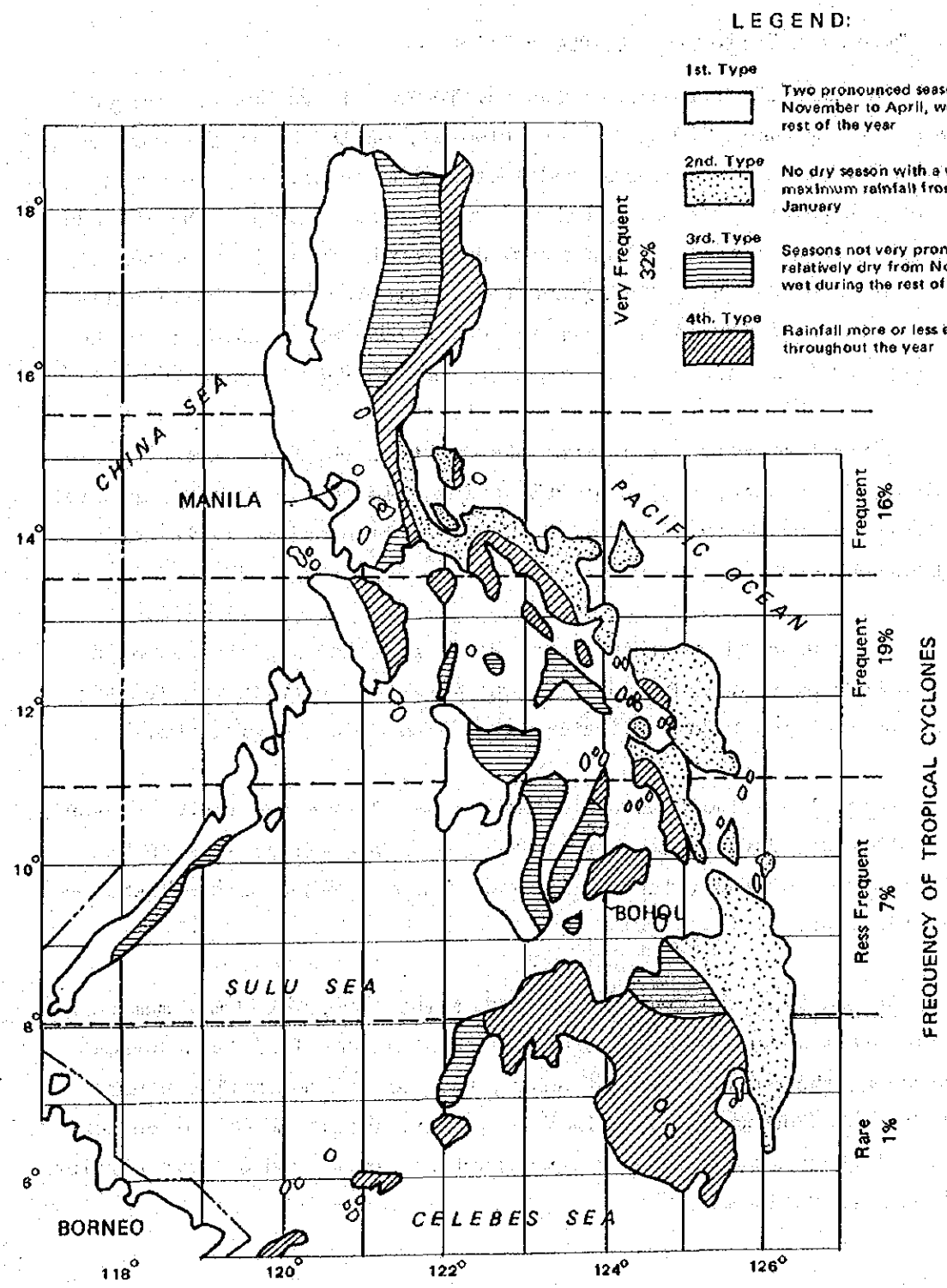


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FIGURE 3B-1 CLIMATE MAP IN THE PHILIPPINES

Third Type Seasons not very pronounced; relatively dry from November to April and wet during the rest of the year. Regions with this type of climate are the western part of Cagayan, Isabela, Nueva Vizcaya, the eastern portion of the Mountain Province, Southern Quezon, Masbate, Romblon, Northeast Panay, Eastern Negros, Central and Southern Cebu, part of Northern Mindanao, and most of Eastern Palawan.

Fourth Type Rainfall more or less evenly distributed throughout the year. Regions affected by this type are the Batanes Province, northeastern Luzon, southwestern part of Camarines Norte, Western parts of Camarines Sur and Albay, Bondoc Peninsula, Eastern Mindoro, Marinduque, Western Leyte, Northern Cebu, Bohol and most of Central, Eastern and Southern Mindanao.

As seen from Figure 3B-1 , the Bohol island belongs to the fourth climatic type. The annual average rainfall, however, in the Tagbilaran is 1,486 mm/year and that of in Dagohoy is 2,134 mm/year. The difference between them is 648 mm/year, so the characteristic of the rainfall distribution in the project area would be somewhat different from the fourth climatic type. The characteristic of rainfall in the project area is explaned later.

2. Existing Hydrometeorological Stations

As shown in Figure 3B-2 , the location of existing synoptic stations, climatorogical stations, rainfall stations and water level gauging stations in the Visaya region are illustrated. In the Bohol Island, there are five raingauge stations at Tagbilaran, Tubigon, Ubay, Dagohoy, and Pamacsalan and there is no meteorological station in the Project area.

3. Newly Installed Hydrological Stations

Two self-recording raingauges have been conceded by the Government of Japan. The type of raingauge is Tamaya SKI-III type (3-month record) and recording paper is AWL-1017 type (3-month record, 17mm x 15meters). The two rainfauges have been installed at Matinao and

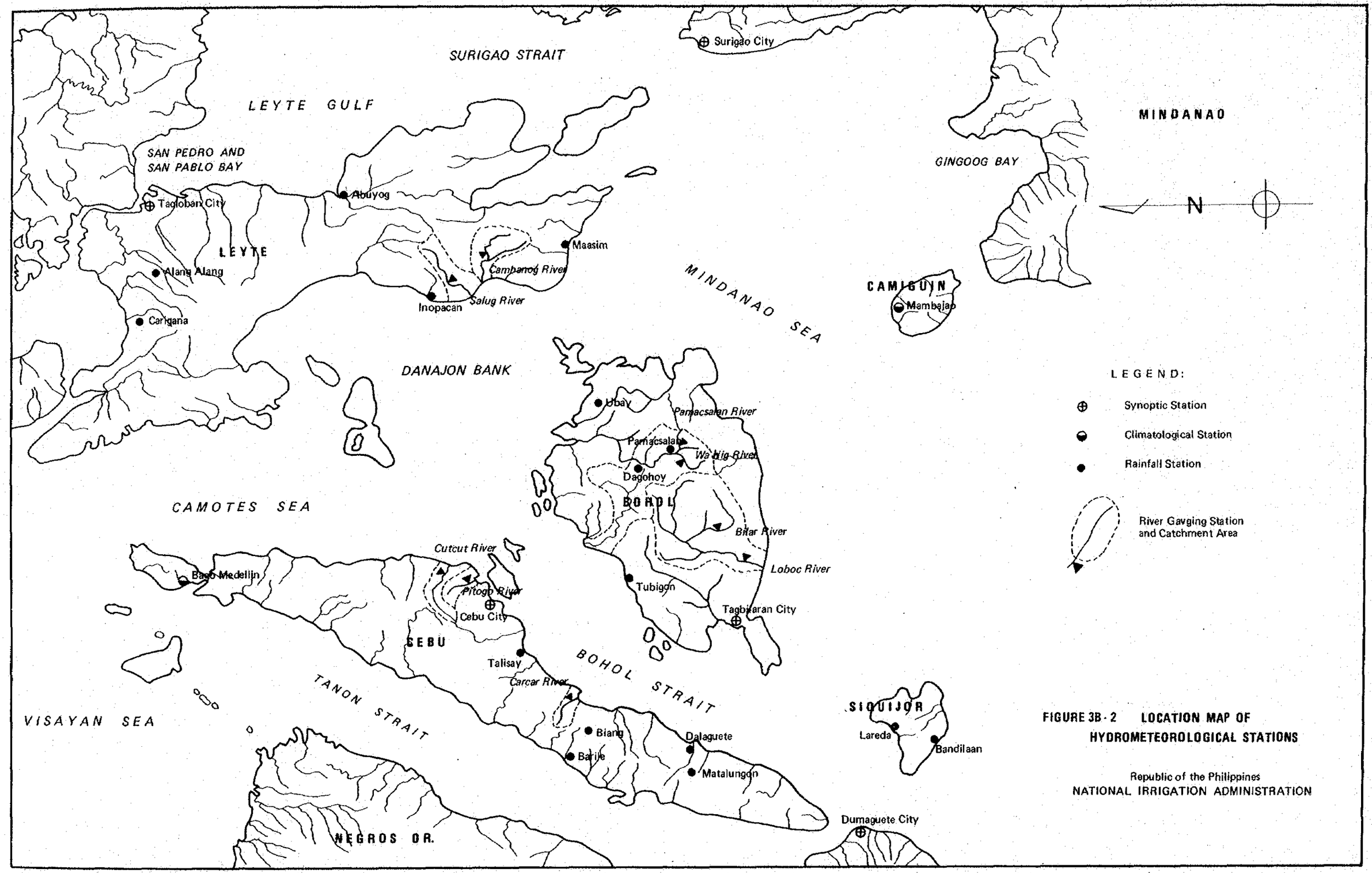

FIGURE 3B-2 LOCATION MAP OF HYDROMETEOROLOGICAL STATIONS

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Abakanan, respectively. Four standard raingauges and two square type evaporation pans have been fablicated in the Philippines. Six ribbon type staff gauges have also been brought by the Team. An automatic water level gauge has been found in the gauge keeper's house in the Wahig river, which was originally installed in the Wahig river near the proposed dam site, but the gauging station was flushed out in 1967. Considering the main reservoir of the project, re-installation of the gauge to the Pamacsalan river has been negotiated with the B.P.W. and obtained the agreement from the B.P.W.

The newly installed gauging stations and the location together with the existing stations are explained in Table 3B-1 and the location of each gauging station is illustrated in Figure 3B-3.

4. Meteorological Features

The general meteorological informations obtained from the synoptic station at Tagbilaran are summarized in Table 3B-2. Generally, the feature of the meteorology in the Bohol Island such as mean monthly temperature, relative humidity and wind velocity shows quite moderate fluctuation throughout a year. Mean monthly values vary from 25.9°C to 28.4°C on temperature, 79 percent to 84 percent on relative humidity and 4 km/hour to 6 km/hour on wind velocity. As for the privailing wind direction, the Bohol Island is affected by the north-east monsoon from October to May and by the south-west monsoon from June to September.

Twenty three typhoons that have passed or come near the Bohol island were recorded during 28 years period from 1948 to 1975, out of which 9 typhoons, that is about 40 percent of total typhoons were concentrated in November.

The monthly average temperature and relative humidity at Tagbilaran are shown in Table 3B-3 and Table 3B-4, respectively

Table 3B-1 Hydrological Stations in the Project Area

(1) Raingauge and Evaporation Stations

	Name of Station	Location of Station	Type of Gauge	Observation Period and Remarks	Station No. in Fig. 3B-3
Existing Stations	Dagohoy	North-West boundary of Project area (Operated by PAGASA)	Automatic R.G. Standard R.G.	Sep.1975 - May 1976 1956 - Present	(R-1)
	Pamacsalan	Down-stream of proposed Pamacsalan Dam Site (Operated by BPW)	Standard R.G.	1967 - Present	(R-2)
Newly Installed Stations	Matinao	Boundary of Pamacsalan an Wahig river catchment area	Automatic R.G. Standard R.G.	3-month record	(R-3)
	Abakanan	Pamacsalan river catchment area	Automatic R.G. Standard R.G. Evaporation	3-month record	(R-4)
	Danicop	Wahig river catchment area	Standard R.G. Evaporation Pan		(R-5)
	Catagda-an	Babun-an river catchment area	Standard R.G.		(R-6)

(2) Water Level Gauging Station

	Name of Station	Location of Station	Type of Gauge	Remarks	Station No. in Fig. 3B-3
Existing Stations	Pamacsalan	One kilometer down-stream of the proposed dam site	Staff gauge	1956 - Present	(WL-1)
	Wahig	100-meters down-stream of confluence of Wahig and Binabae rivers	Automatic Staff gauge	1964 - 1967 1956 - Present	(WL-2)
Newly Installed Stations	Pamacsalan	50-meters down-stream of proposed Pamacsalan Dam Site	Automatic Staff gauge		(WL-3)
	Malinao	Bridge near the proposed diversion weir	Staff gauge		(WL-4)
	Bagunan	Bridge near the Pilar in the Bagunan river	Staff gauge		(WL-5)
	Siera Buliones	Concrete bridge of the Wahig river	Staff gauge		(WL-6)
	Wahig Bogsok	100 meters upstream of the confluence of the Binabae river	Staff gauge		(WL-7)
	Binabae Bogsok	100-meters upstream of the confluence of the Wahig river	Staff gauge		(WL-8)

FIGURE 3B-3

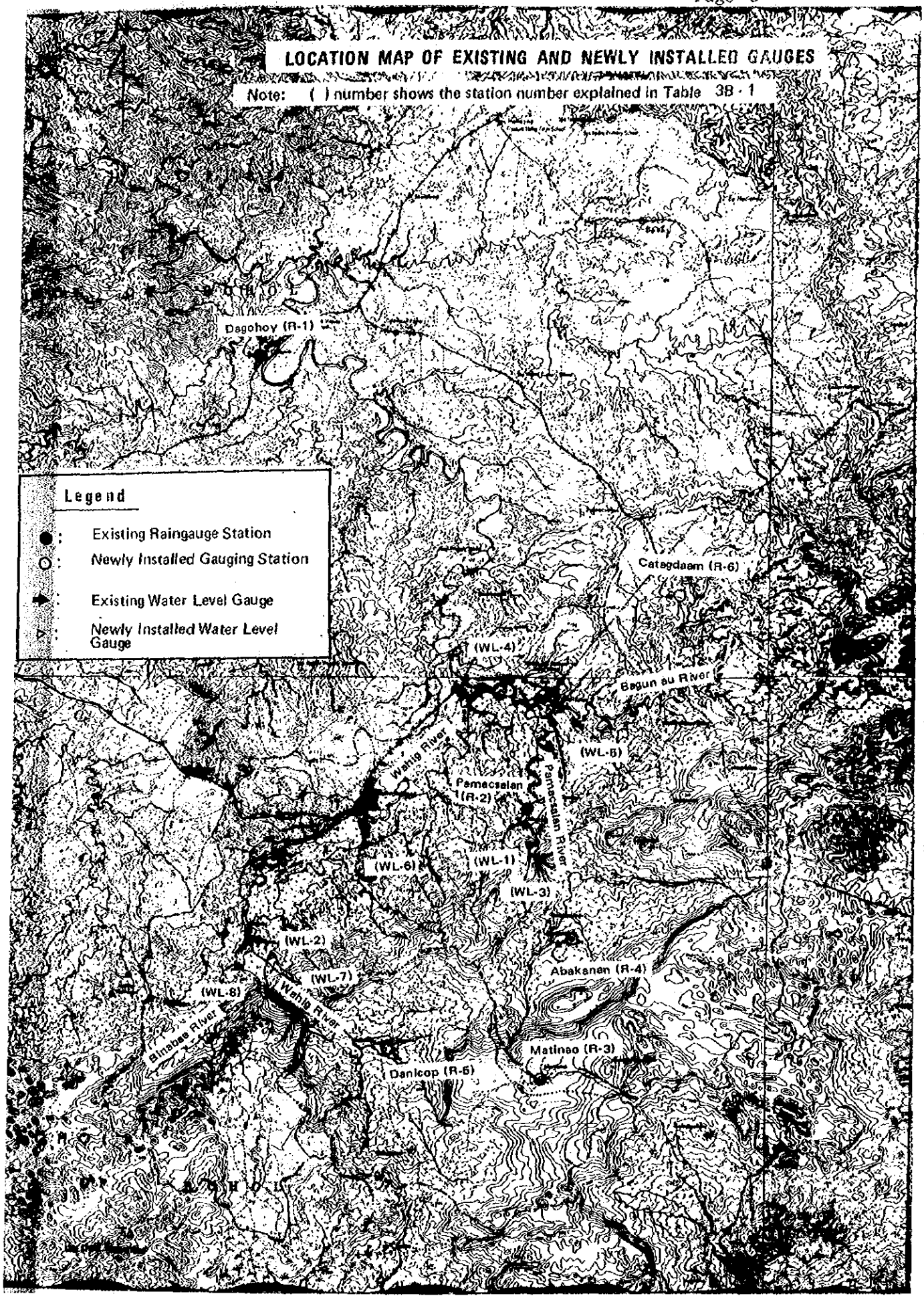

LOCATION MAP OF EXISTING AND NEWLY INSTALLED GAUGES
Note: ( ) number shows the station number explained in Table 3B - 1
Legend
Existing Raingauge Station
Newly Installed Gauging Station
Existing Water Level Gauge
Newly Installed Water Level Gauge
Dagohoy (R-1)
Catagdaan (R-6)
(WL-4)
Bagun au River
(WL-5)
Wahig River
Pamacsalan (R-2)
Pamacsalan River
(WL-6)
(WL-1)
(WL-3)
(WL-2)
(WL-7)
(WL-8)
Wahig River
Binabae River
Abakanan (R-4)
Matinao (R-3)
Danicop (R-5)

Table 3B-2 Climatological Data at Tagbilaran

Data	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Rainfall (Tagbilaran City)1/													
Average (mm)	101	94	95	71	90	150	130	119	127	181	218	110	1,486
Maximum (mm)	249	183	155	234	181	303	231	186	327	385	383	192	3,009
Minimum (mm)	18	3	8	10	19	9	10	58	47	71	129	51	433
Number of rainy days2/	14	11	16	9	9	15	15	14	12	18	16	19	162
Relative Humidity (%)3/	83	82	80	79	79	82	82	79	80	84	84	84	82
Temperature4/													
Mean (°C)	25.9	26.0	26.6	27.4	28.4	28.0	27.9	28.0	28.3	27.7	27.3	26.8	27.4
Mean Maximum (°C)	30.6	30.7	31.8	33.0	33.5	32.9	32.5	32.8	33.1	32.6	32.1	31.6	
Mean Minimum (°C)	21.2	21.3	21.4	22.2	23.4	23.2	23.3	23.3	23.5	22.8	22.5	22.0	
Evaporation (mm)5/	111	103	125	142	137	114	107	122	114	115	104	101	1,395
Prevailing wind direction6/	NE	NE	NE	NE	NE	SE	SW	WSW	WSW	NE	NE	NE	
Wind velocity (km/hr)6/	6	6	6	6	4	4	6	6	6	4	4	6	6
Number of Typhoons7/	2	0	0	2	2	2	2	0	0	1	9	3	23

1/ Period of Observation 1960 - 1975
2/ Period of Observation 1960 - 1975
3/ Period of Observation 1960 - 1975
4/ Period of Observation 1960 - 1975
5/ Period of Observation 1960 - 1975 (Evap. data by: Penman at Tagbilaran City)
6/ Period of Observation 1951 - 1970
7/ Period of Observation 1948 - 1975

Table 3B-3 Mean Monthly Temperature - Tagbilaran City, Bohol

(Unit: °C)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
1960	-	-	-	-	-	27.4	27.7	28.8	27.5	27.4	26.9	25.9	
1961	25.1	26.2	26.4	27.4	28.1	27.7	27.7	28.2	28.4	27.4	27.2	26.9	
1962	26.0	25.5	26.4	27.8	28.7	28.0	27.9	27.7	27.8	28.1	27.7	26.8	
1963	25.3	25.3	26.3	27.4	28.7	29.1	28.5	27.9	28.5	27.5	27.2	27.2	
1964	27.0	26.1	26.7	27.4	28.1	27.6	27.7	28.6	27.9	27.7	27.3	26.9	
1965	25.5	26.0	26.5	27.4	27.9	28.0	27.3	27.7	27.9	27.6	27.3	26.9	
1966	26.6	26.5	26.9	28.4	28.7	28.2	27.4	28.4	28.8	27.7	27.7	27.1	
1967	25.8	26.1	26.0	27.0	28.2	28.5	28.5	28.6	28.6	27.6	26.9	26.0	
1968	26.1	25.8	26.9	27.3	28.4	28.2	28.6	28.3	28.8	27.6	26.5	26.4	
1969	26.0	26.3	26.9	28.0	29.3	-	28.4	28.3	28.7	28.2	28.0	27.4	
1970	-	-	-	-	-	-	-	-	-	-	-	-	
1971	-	-	-	-	-	-	-	-	-	-	-	-	
1972	-	-	-	-	-	-	-	-	-	-	-	-	
1973	-	-	-	-	-	-	-	-	-	-	-	-	
1974	25.8	26.1	-	27.5	27.7	27.5	27.5	-	-	-	-	-	
1975	-	-	-	-	-	-	-	-	-	-	-	-	
Mean	25.9	26.0	26.6	27.6	28.4	28.0	27.9	28.0	28.3	27.7	27.3	26.8	27.4 (mean)

-; missing data

Table 3B-4 Mean Monthly Relative Humidity - Tagbilaran City, Bohol

(Unit: %)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
1960	-	-	-	-	-	90.0	85.0	77.0	86.0	85.0	89.0	85.0	
1961	80.0	82.0	81.0	83.0	82.0	84.0	80.0	78.0	78.0	82.0	84.0	85.0	
1962	83.0	84.0	85.0	79.0	78.0	84.0	84.0	83.0	84.0	84.0	84.0	84.0	
1963	87.0	84.0	84.0	77.0	76.0	74.0	78.0	83.0	81.0	84.0	87.0	85.0	
1964	83.0	83.0	77.0	84.0	83.0	84.0	84.0	84.0	76.0	85.0	85.0	85.0	
1965	86.0	82.0	85.0	83.0	82.0	82.0	81.0	83.0	81.0	85.0	85.0	82.0	
1966	78.0	78.0	78.0	72.0	76.0	80.0	84.0	80.0	75.0	84.0	85.0	86.0	
1967	85.0	82.0	82.0	77.0	78.0	76.0	80.0	76.0	75.0	80.0	82.0	83.0	
1968	81.0	81.0	76.0	74.0	77.0	79.0	78.0	77.0	74.0	81.0	79.0	82.0	
1969	78.0	74.0	73.0	71.0	75.0	80.0	80.0	81.0	79.0	83.0	80.0	-	
1970	-	-	-	-	-	-	-	-	-	-	-	-	
1971	-	-	-	-	-	-	-	-	-	-	-	-	
1972	-	-	-	-	-	-	-	-	-	-	-	-	
1973	-	-	-	-	-	-	-	-	-	-	-	-	
1974	85.0	86.0	-	84.0	84.0	85.0	84.0	-	-	-	-	-	
1975	-	-	-	-	-	-	-	-	-	-	86.0	-	
Mean	83.0	82.0	80.0	79.0	79.0	82.0	82.0	79.0	80.0	84.0	84.0	84.0	81.5 (mean)

B. Available Hydrological Data

1. Rainfall Data

(a) Daily Rainfall Data

A total of five stations at Tagbilaran, Ubay, Tubigon, Dagohoy and Pamacsalan have been operated in the Bohol Island, out of which two stations at Dagohoy operated by PAGASA, and Pamacsalan operated by BPW are located in the Project area. The period of record at each station is shown in Figure 3B-4.

Observation of Dagohoy station where is located at the north-west boundary of the irrigation service area was started from January 1956 and continued upto now, and almost complete data is available. The monthly total rainfall is shown in Table 3B-5. The observation of Pamacsalan station where is located at down-stream of the proposed Pamacsalan dam site, was started from February 1967 and continued upto now but the data are included some of missing data. The monthly total rainfall is shown in Table 3B-6.

In order to find the long term trend of rainfall characteristic, monthly rainfall data at Tagbilaran station has been collected from June 1902 to August 1940 and 1960 to 1975. The monthly total rainfall is shown in Table 3B-7. The annual average of rainfall from 1902 to 1940 is 1,703.9 mm/year while the one from 1960 to 1975 is 1,485.5 mm/hear.

As for the annual average rainfall at Dagohoy station is 2,133.6 mm/year and the one at Pamacsalan station is 2,089.4 mm/year. So the annual rainfall at Dagohoy is about 44 percent higher than the one at Tagbilaran station.

(b) Hourly Rainfall Data

There are very few hourly rainfall data in the Bohol Island. At Dagohoy station, the hourly rainfall from 28th September 1975 to 18th

FIGURE 3B-4. HISTRIC RECORDS OF HYDROLOGICAL DATA

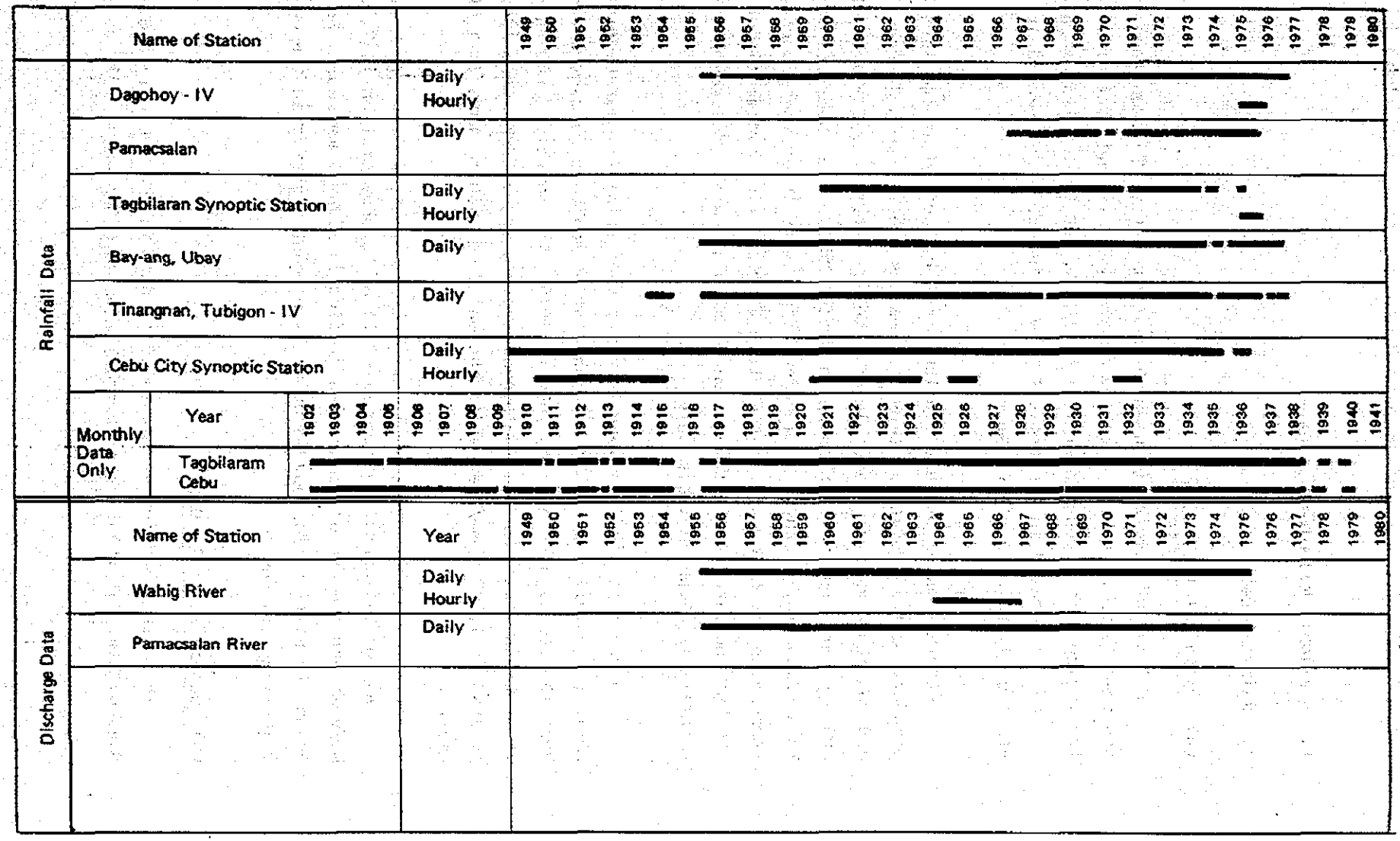


Table 3B-5 Monthly Total Rainfall at Dagohoy

(Unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1956	180.6	35.1	118.5	221.7	302.4	171.2	252.1	--	161.0	107.2	201.8	458.2	-
1957	195.4	187.2	101.9	143.4	47.4	310.9	409.7	177.5	134.5	309.3	123.7	91.0	2,231.9
1958	131.9	108.3	75.3	104.1	67.0	159.1	252.1	152.1	130.4	72.8	163.9	62.8	1,479.8
1959	264.8	84.0	238.7	16.8	89.3	116.8	442.9	207.2	178.0	116.9	128.2	154.7	2,038.3
1960	261.0	97.1	56.8	168.9	124.5	285.8	172.7	90.5	244.5	158.1	264.1	154.5	2,078.5
1961	179.7	101.9	54.9	106.0	69.1	103.3	410.4	123.1	240.3	395.7	182.2	179.1	2,145.7
1962	124.9	291.1	185.7	21.9	132.5	232.1	240.0	297.4	300.3	130.2	390.9	161.3	2,508.3
1963	317.0	152.5	221.4	52.8	6.3	47.4	326.9	232.3	288.6	331.8	168.6	75.2	2,220.8
1964	139.2	320.2	19.4	80.5	366.5	107.6	206.4	56.4	269.7	179.1	934.3	251.9	2,937.2
1965	364.9	171.5	136.4	72.9	9.8	326.6	155.4	173.9	150.1	206.2	122.3	189.2	2,079.2
1966	93.0	58.4	29.1	65.6	215.9	61.3	372.3	219.4	106.8	353.5	108.5	187.0	1,870.8
1967	436.9	260.7	255.7	49.6	78.4	129.0	141.2	112.6	189.2	144.3	186.9	191.6	2,176.1
1968	123.8	51.7	82.7	4.5	3.3	149.9	115.9	110.8	210.3	262.3	399.5	319.9	1,834.6
1969	30.2	9.4	81.6	16.1	95.1	151.0	248.7	119.3	86.2	273.6	229.7	195.2	1,536.1
1970	78.4	216.2	34.3	20.8	42.2	350.3	263.6	140.5	153.6	381.6	209.1	124.8	2,015.4
1971	267.2	195.1	157.5	115.6	248.6	339.5	212.8	179.9	202.6	214.3	330.5	98.3	2,561.9
1972	252.8	150.3	133.8	78.7	12.5	246.9	263.9	88.8	280.3	368.0	180.6	211.6	2,167.9
1973	43.7	24.6	13.9	27.0	4.1	111.9	205.2	215.3	249.9	290.3	255.5	336.7	1,778.1
1974	231.0	253.2	132.5	79.9	110.8	342.7	96.6	129.4	82.0	259.8	151.0	141.0	2,009.9
1975	286.8	251.5	148.7	42.6	124.7	86.2	316.5	101.1	284.5	179.1	167.3	186.2	2,175.2
1976	120.2	278.5	43.6	17.7	46.9	118.0	170.0	332.9	161.1	60.9	53.9	260.3	1,664.0
1977	179.5	417.3	269.2	14.2	15.0	227.2	229.6	288.7	-	-	-	-	-
Average	195.6	168.9	117.8	69.6	100.1	189.8	250.2	169.0	195.4	223.6	235.8	192.2	2,075.5

Note: underlined figures indicate monthly rainfall less than 100 mm/month

Table 3B-6 Monthly Total Rainfall at Pamacsalan Raingauge Station

(Unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1967	-	290.7	221.3	6.1	19.4	151.1	142.0	153.4	89.4	222.4	243.4	392.1	-
1968	227.2	129.7	56.2	0.0	46.8	155.5	192.0	64.0	192.7	109.3	391.1	278.1	1,842.6
1969	47.3	16.7	144.2	48.9	85.3	124.9	101.3	214.7	119.0	185.9	142.9	307.2	1,538.3
1970	134.0	254.3	61.0	0.0	8.6	390.0	279.7	171.9	94.2	-	202.7	160.6	-
1971	-	-	141.4	91.0	123.4	512.4	206.4	220.0	210.7	266.8	400.5	75.7	-
1972	312.1	63.8	236.3	56.3	249.9	194.1	28.7	169.6	218.5	201.4	131.0	203.5	2,065.2
1973	18.5	43.7	19.6	7.6	0.0	249.9	175.3	207.0	320.8	163.1	571.0	239.6	2,016.1
1974	99.9	341.4	238.7	138.4	42.2	188.2	116.8	98.1	189.8	246.8	169.1	363.0	2,232.4
1975	481.8	155.2	37.3	109.7	15.2	257.9	139.1	46.0	312.2	197.3	61.5	280.8	2,094.0
1976	374.9	132.8	62.8	26.4	131.7	218.8	-	-	-	-	-	-	-
Average	212.0	158.7	121.9	48.4	72.3	244.3	153.5	149.4	194.1	199.1	257.0	255.6	2,066.3

Table 3B-7-1 Monthly Total Rainfall at Tagbilaran

(Unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1902	-	-	-	-	-	224.0	1,379.7	67.2	472.4	1,142.4	104.4	58.7	-
1903	164.3	21.4	35.8	17.7	161.5	183.1	395.3	188.2	100.4	172.6	141.8	305.3	1,957.4
1904	93.0	93.0	75.7	203.0	70.2	66.7	73.5	74.7	79.2	380.2	259.6	35.8	1,504.6
1905	11.2	19.3	13.4	11.2	85.1	68.3	-	132.8	100.3	110.6	166.2	98.5	-
1906	78.6	16.5	17.2	4.5	79.3	277.4	95.2	109.1	131.2	109.7	161.2	232.9	1,312.8
1907	40.5	142.9	197.3	10.0	32.7	67.9	163.8	108.3	31.4	150.2	117.7	159.5	1,222.2
1908	90.5	106.0	81.9	29.8	47.4	194.6	230.7	39.8	310.7	158.4	204.7	159.7	1,654.2
1909	48.1	50.7	66.6	15.0	56.9	78.7	97.9	165.5	225.1	166.5	281.6	382.5	1,635.1
1910	163.0	160.8	94.6	172.1	98.5	204.7	68.5	168.5	129.7	144.6	213.7	208.1	1,826.8
1911	82.4	124.5	126.6	-	126.5	-	98.2	8.1	177.9	-	-	32.4	-
1912	4.5	156.0	4.6	57.5	1.5	46.7	564.9	250.8	227.0	199.5	200.5	40.3	1,753.8
1913	30.2	-	-	35.3	15.6	-	-	139.2	119.0	-	130.8	119.1	-
1914	61.9	0	-	15.0	28.1	111.9	56.7	192.0	84.1	106.6	97.1	74.3	-
1915	21.6	0	3.6	20.1	59.3	-	133.1	117.7	293.8	212.4	74.2	98.4	-
1916	-	-	-	-	-	-	-	-	-	-	-	-	-
1917	117.8	91.7	-	38.1	142.3	159.4	-	172.8	160.7	215.7	251.6	219.5	-
1918	201.8	47.5	83.9	173.2	53.5	230.8	27.2	74.6	79.4	189.4	109.6	120.0	1,385.9
1919	41.4	18.2	64.0	11.4	51.9	120.7	177.1	24.9	264.2	270.1	181.1	278.4	1,503.4
1920	108.8	59.4	52.6	124.1	48.9	19.2	69.3	42.3	171.6	169.2	398.6	159.9	1,423.9
1921	127.0	101.2	70.0	174.2	167.0	240.5	295.1	150.2	145.9	183.2	273.4	99.1	2,032.8
1922	239.2	132.5	70.2	45.6	245.4	142.8	127.4	79.3	153.5	139.1	221.4	156.4	1,746.8
1923	155.6	42.7	213.3	135.7	166.5	76.4	85.3	80.1	84.7	226.2	171.2	80.3	1,518.0
1924	102.0	57.8	168.4	7.4	74.8	198.7	22.1	198.5	135.3	181.2	244.9	254.5	1,645.6
1925	78.5	208.3	139.6	148.6	95.3	135.9	99.6	134.7	70.2	185.0	217.5	124.8	1,638.0
1926	265.4	58.7	98.1	1.0	25.0	70.2	286.0	145.6	270.4	177.1	334.5	190.5	1,922.5
1927	171.1	56.0	68.8	25.0	108.7	119.9	222.4	189.5	126.2	126.1	171.8	188.1	1,573.6
1928	283.5	224.6	129.3	203.7	241.3	154.0	237.6	83.8	22.8	72.6	182.2	126.7	1,962.1
1929	267.8	79.7	157.9	85.5	121.2	96.5	157.2	113.1	117.0	133.2	341.1	203.8	1,874.0
1930	88.8	31.2	24.9	58.9	140.2	218.7	64.2	182.2	111.9	184.3	191.4	198.4	1,495.1
1931	85.2	10.8	11.2	36.4	62.9	100.0	243.8	110.3	266.4	151.9	161.6	95.9	1,336.4
1932	281.5	104.0	126.7	69.2	227.0	200.9	285.9	112.2	206.0	268.7	228.9	182.7	2,293.7
1933	229.1	100.1	13.2	43.3	154.2	225.0	202.3	307.8	351.9	313.4	261.6	167.5	2,369.4
1934	240.7	220.5	255.2	141.8	132.1	168.1	177.2	232.5	165.2	140.1	323.7	168.8	2,365.9
1935	112.8	31.8	83.7	155.8	118.8	150.2	119.3	156.6	144.4	260.4	267.0	99.4	1,700.2
1936	97.9	13.2	141.7	179.1	46.8	143.1	150.0	197.7	106.5	198.1	183.2	179.4	1,636.7
1937	133.2	47.9	68.2	49.1	125.8	94.4	170.5	153.0	167.7	262.4	92.1	64.8	1,429.1
1938	80.5	129.0	71.6	136.4	66.0	179.9	132.2	52.3	159.9	381.6	221.6	81.5	1,692.5
1939	-	-	128.8	49.2	242.5	84.8	67.2	144.7	-	-	-	-	-
1940	109.6	-	5.7	177.5	35.8	97.6	90.7	131.3	-	-	-	-	-

Table 3B-7-2 Monthly Total Rainfall at Tagbilaran

(Unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1960	-	-	-	-	-	200.9	128.8	152.9	98.9	226.3	230.4	50.6	-
1961	116.3	66.8	149.9	86.1	92.7	135.6	125.5	72.4	73.7	119.6	128.8	165.9	1,333.2
1962	49.5	148.3	132.6	18.3	56.1	190.2	145.8	158.8	159.0	183.6	181.6	78.7	1,502.7
1963	130.8	95.2	141.0	35.3	18.5	9.4	83.6	153.4	93.7	113.3	286.5	65.5	1,226.3
1964	104.5	175.4	7.6	233.9	164.4	121.2	193.4	73.0	230.5	199.0	307.5	112.5	1,923.2
1965	143.0	66.2	114.0	117.0	44.6	110.3	95.0	103.8	110.6	200.2	161.0	56.7	1,322.4
1966	20.1	86.9	43.9	10.1	72.6	106.9	227.8	123.2	63.0	154.1	226.0	192.1	1,326.7
1967	248.9	160.8	155.4	67.5	82.1	130.7	166.1	65.0	47.3	232.9	175.8	120.0	1,652.5
1968	45.1	40.3	44.9	38.5	81.5	150.7	52.5	93.9	87.9	112.2	235.8	107.4	1,090.7
1969	24.6	3.0	30.1	14.3	34.3	236.5	145.4	147.8	76.0	193.0	134.6	108.4	1,148.0
1970	159.1	61.6	55.3	14.0	73.0	303.4	65.0	58.0	99.2	155.5	219.6	96.0	1,359.9
1971	117.0	182.8	104.8	65.7	181.3	-	-	-	107.4	384.9	217.4	82.8	-
1972	166.1	83.5	130.7	25.4	137.2	105.7	10.4	164.1	200.2	72.4	169.4	120.4	1,303.9
1973	17.9	10.3	129.5	70.2	50.7	30.9	231.1	185.6	326.5	126.9	383.3	175.8	1,738.7
1974	70.4	131.7	-	196.1	167.7	267.7	144.8	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	239.9	-	-	-
Mean	101.0	93.8	95.4	70.9	89.8	150.0	129.7	119.4	126.7	180.9	218.4	109.5	1,485.5

November 1976 is available and at Tagbilaran station from 1st March 1976 to now is available. However, no remarkable high rainfall was recorded at both stations.

In order to find the hourly rainfall characteristic, Cebu station and Surigao station in the Northern Mindanao Island, have been selected from the same climatic zone. However, it could not be obtained to collect a continuous data from both station. The obtained hourly rainfall is shown in Table 3B-8 and illustrated in Figure 3B-5.

As mentioned before, no remarkable hourly rainfall was recorded at Dagohoy and Tagbilaran stations. According to the results of daily maximum rainfall analysis, the probability values at Dagohoy and Pamacsalan are quite similar to that of Cebu station. The hourly rainfall data at Cebu station has been collected though the data is quite fragmentary. The maximum rainfall and different duration of hourly rainfall in each year are shown in Table 3B-9.

2. Streamflow Data

(a) Daily Discharge Data

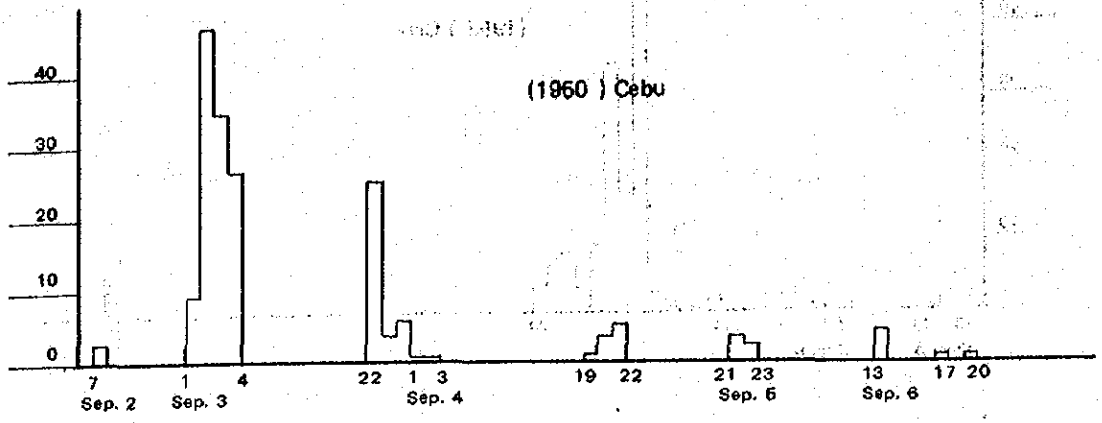
B.P.W. started a observation of water level by a staff gauge at the Pamacsalan river and the Wahig river since September 1956 and January 1955, respectively. No discharge data were available at the proposed diversion weir site, the Bagun-an river and the Binabae river. Both stations, however, are affected by communal intakes located in the upstream of which intake discharge data could not be obtained. In addition, the Wahig gauging station had been replaced several years ago, however the discharge rating curve, which had been prepared on 5th March 1959, has not been changed upto now. So, the discharge data at the Wahig river station will not have sufficient reliability. While the Pamacsalan river station is affected by only one communal intake from brash dam located about 200 meters upstream of the station and the observed data is included very few missing data. Accordingly, the Pamacsalan streamflow data has been used for

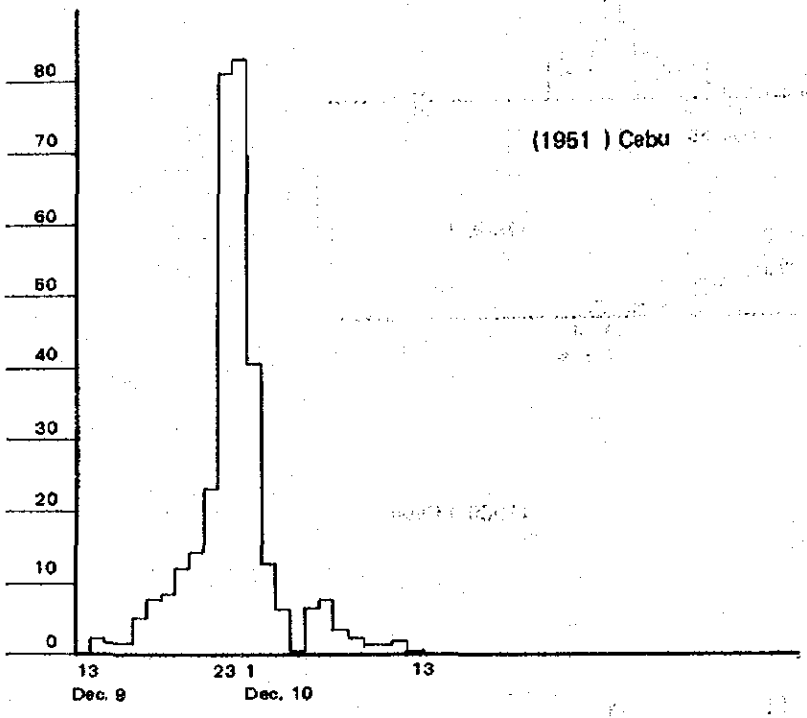
Table 3B-8 Hourly Rainfall Data at Cebu and Surigao Del Norte

(Unit: mm)

	Cebu Station																								Surigao Del Norte		
	September 1950						December 1951				July 1952				Dec. 1953			Dec. 1954			Feb. 1956			Jun. 1960			Nov. 1968		
Time	1	2	3	4	5	6	8	9	10	11	1	2	3	4	4	5	6	24	25	26	4	5	6	22	23	24	17	18	19
12 - 1	0		9.1	5.6					82.8				1.8	0.3								4.8							61.0
1 - 2	0.3		46.7	0.8		0.3			40.6		0.3		1.5						0.5			5.1	2.0		0.5			0.4	73.0
2 - 3	0.3		34.5	0.8					12.7										2.0		1.3	1.5	0.5	0.3			0.3	4.7	82.0
3 - 4			26.7			0.5			6.6			0.5	0.3	0.8			0.5		4.6			6.4		0.5	0.5		0.3	3.5	87.0
4 - 5			0.3						0.5			1.8		0.5			0.8		2.5			1.3					2.0	6.6	54.0
5 - 6			0.5						6.9		0.3	5.3	7.1					0.3	3.8			0.3			0.3		2.0	4.7	45.0
6 - 7									7.9			7.6	1.5				3.6	0.5	5.8	0.3							2.0	4.7	0.5
7 - 8	0.3	2.8				0.3			3.6			14.0	0.3				1.5	0.3	6.1			0.3						0.4	
8 - 9									2.5			5.3							10.4		0.3	1.8						16.5	
9 - 10									1.3			1.8						1.5	16.3		0.5	1.8					0.4	6.5	
10 - 11									1.3				1.3					2.0	7.1		0.3	6.1					0.8	14.0	
11 - 12									2.0				2.3				2.0	3.3	4.1		1.3	6.6				0.8	10.5	11.0	
12 - 13									0.3				3.6				0.5	1.5	3.8		0.3	6.9			4.6		0.8	10.5	
13 - 14						4.6		0.5			0.3	1.0	0.5		5.6		0.3	0.5	7.1			5.6			42.2			12.0	
14 - 15								2.5				0.3	0.3		2.3		0.5					6.6						4.5	
15 - 16								1.8				0.8			0.5		2.8	1.5				5.1		0.8	0.2			10.0	
16 - 17								1.8									47.8	2.0				5.1		0.5	0.2			9.0	7.4
17 - 18						1.3		5.3				2.3					15.7	0.5		0.3		4.1	1.3					1.0	3.9
18 - 19								7.9				5.6					34.3	2.0		0.8		4.8						6.0	2.0
19 - 20				1.0		1.0		8.4				37.1	0.3				9.4					1.8						10.0	3.9
20 - 21				3.3	0.3	0.5		12.2			1.5	56.9					0.5	0.3				1.5						17.0	1.0
21 - 22				5.1	3.6	0.3		14.2				31.0	0.3				8.4	1.0			1.8	1.3			7.1			17.0	0.5
22 - 23			25.1	0.3	2.3			23.6				2.3	0.5				7.4	0.5	1.0			1.3			3.6			17.0	
23 - 24			3.6			0.3		80.5			0.3	5.6					3.6				0.8	0.3			0.3	6.1		13.0	
Total	0.9	2.8	146.5	16.9	6.2	9.1		158.7	169.0		2.7	179.2	21.6	1.6	8.4		139.6	17.7	75.1	1.4	6.6	80.4	3.8	2.1	59.5	6.9	19.1	208.0	421.2

FIGURE 3B-5-1 HOURLY RAINFALL PATTERN AT CEBU AND SURIGAO DEL NORTE





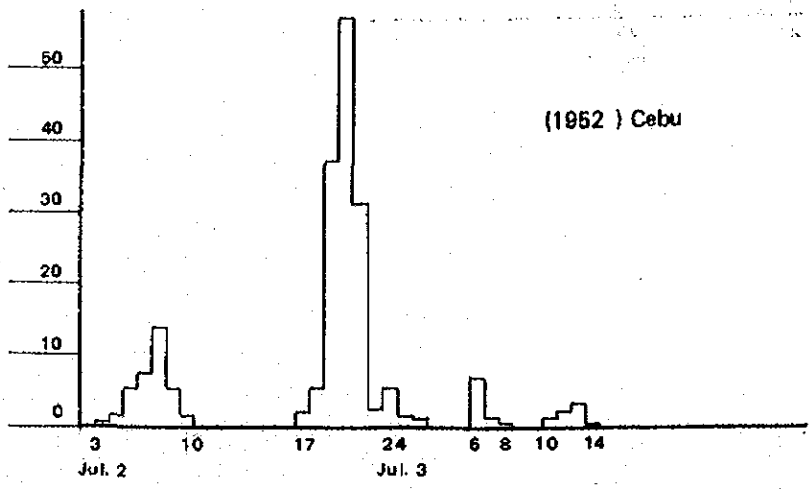


FIGURE 3B-5-2 HOURLY RAINFALL PATTERN AT CEBU AND SURIGAO DEL NORTE

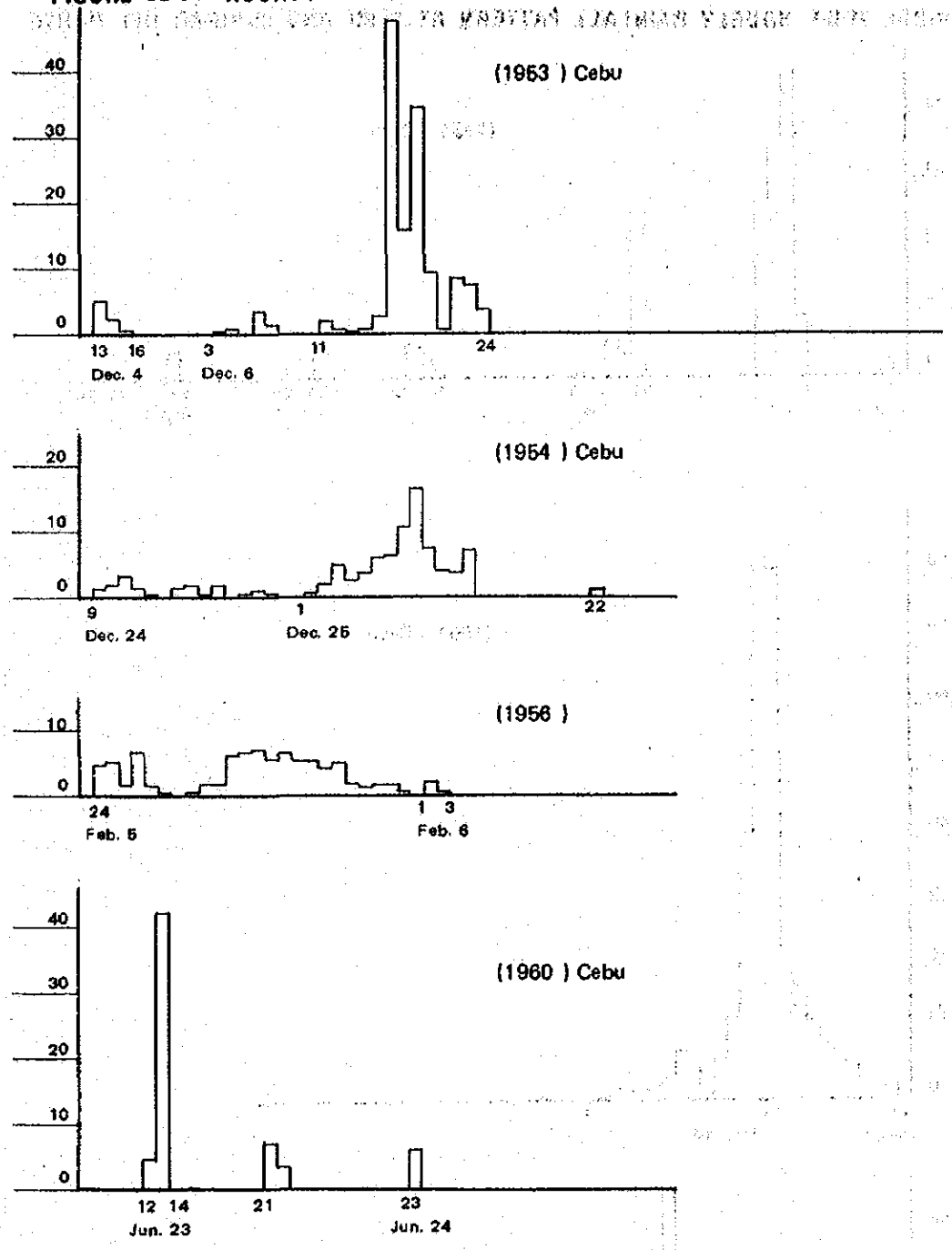


FIGURE 3B-5-3 HOURLY RAINFALL PATTERN AT CEBU AND SURIGAO DEL NORTE

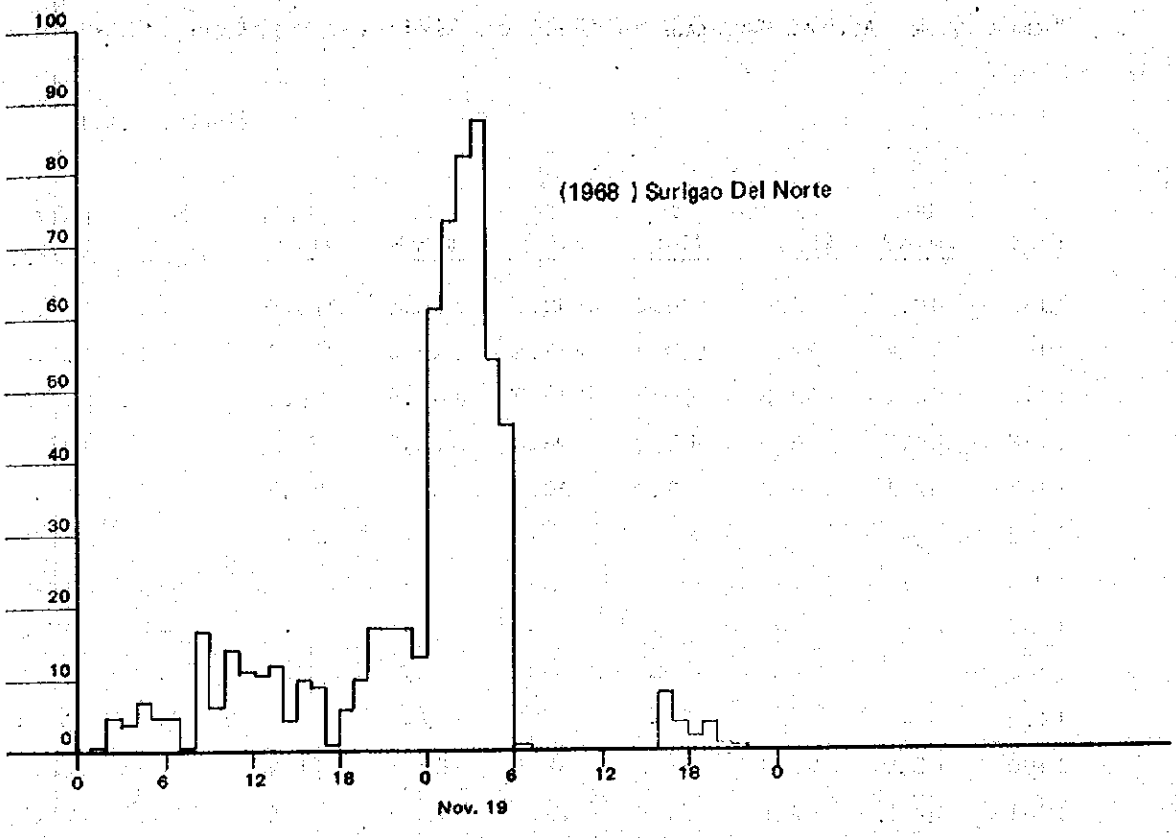


Table 3B-9 Annual Maximum Rainfall on Different Duration at Cebu Station

(Unit: mm)

Year	30 (min)	1 (hr)	2 (hr)	3 (hr)	6 (hr)	12 (hr)	24 (hr)	Daily (max)
1950	48.5	66.0	106.2	108.2	118.1	118.9		118.9
1951	57.4	89.4	167.9	208.8	257.3	298.2		321.6
1952	42.2	62.0	106.9	125.7	140.5	148.8		165.1
1953	44.7	48.0	63.0	98.0	116.3	136.9		138.9
1954	52.1	84.8	89.2	90.7	92.5	92.5		214.6(?)
1955	-	-	-	-	-	-	-	87.9
1956	-	-	-	-	-	-	-	62.7
1957	-	-	-	-	-	-	-	97.8
1958	-	-	-	-	-	-	-	53.1
1959	-	-	-	-	-	-	-	90.4
1960	40.4	47.0	51.8	54.6	68.1	71.4	-	125.5
1961	32.5	52.8	74.9	79.8	81.3	93.5		101.1
1962	30.7	35.3	48.3	48.8	50.8	87.9		93.2
1963	33.3	41.2	54.4	54.6	53.1	55.1		125.7
1964	-	-	-	-	-	-	-	119.1
1965	56.9	66.6	69.9	69.9	69.9	74.7		68.6
1966	-	-	-	-	-	-	-	61.5
1967	-	-	-	-	-	-	-	96.0
1968	-	-	-	-	-	-	-	81.7
1969	-	-	-	-	-	-	-	47.7
1970	-	-	-	-	-	-	-	82.1
1971	38.1	51.0	59.7	59.7	96.3	101.0		101.3
1972	-	-	-	-	-	-	-	79.0
1973	-	-	-	-	-	-	-	127.8
1974	-	-	-	-	-	-	-	102.2
1975	-	-	-	-	-	-	-	75.7
1976	-	-	-	-	-	-	-	-

Table 3B-10 Observed Monthly Average Discharge at Pamacsalan Station

(Unit: cu.m/sec)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
1956	-	-	-	-	-	-	-	-	1.633	1.302	1.076	5.171	
1957	0.841	0.735	0.372	0.983	0.237	0.289	0.301	1.229	0.128	0.773	0.646	0.169	0.558
1958	0.201	0.684	0.342	0.243	0.207	0.165	1.419	0.819	0.176	0.442	1.929	1.556	0.683
1959	2.647	0.439	1.740	1.112	0.699	0.731	1.913	0.773	0.819	1.972	0.948	0.330	1.186
1960	1.123	0.687	0.118	0.778	0.628	2.784	0.975	0.561	1.704	2.111	1.784	2.585	1.318
1961	2.552	1.676	0.765	0.755	0.283	0.270	0.729	0.577	0.818	1.690	1.438	1.686	1.102
1962	1.268	3.747	1.851	0.964	0.517	1.191	1.625	2.095	1.444	2.253	1.705	2.244	1.730
1963	2.579	1.462	0.988	0.524	0.391	0.247	1.115	1.676	1.015	2.099	1.665	0.421	1.183
1964	0.765	2.614	1.017	1.096	1.645	1.312	1.198	0.752	0.947	1.660	4.401	4.273	1.801
1965	3.681	2.555	4.225	1.388	0.569	0.642	0.636	0.213	0.824	2.385	1.645	2.135	1.742
1966	1.285	0.461	0.384	0.337	0.667	0.185	2.510	1.930	0.707	2.280	2.087	1.853	1.234
1967	3.941	3.182	2.589	0.908	0.655	0.361	0.378	0.304	0.193	0.958	2.094	2.231	1.475
1968	2.064	0.953	0.388	0.118	0.135	0.219	0.529	0.243	0.291	0.383	0.126	0.862	0.527
1969	0.849	0.252	0.289	0.265	0.213	0.301	0.293	0.689	0.573	1.100	1.012	1.190	0.589
1970	0.623	1.644	0.494	0.325	0.267	0.484	0.780	0.363	0.331	1.632	1.702	1.597	0.849
1971	1.852	2.833	1.400	0.571	1.284	3.122	2.334	0.739	1.093	2.774	4.992	1.143	2.000
1972	3.924	0.992	1.595	0.854	0.887	1.148	0.962	0.941	1.460	1.284	0.866	4.679	1.642
1973	0.499	0.541	0.571	0.403	0.328	0.444	1.049	0.926	3.116	2.105	5.409	5.267	1.724
1974	1.961	6.225	3.332	4.747	1.306	8.281	1.310	1.056	1.203	3.020	2.319	2.429	3.062
1975	5.962	2.987	1.622	1.426	1.184	1.573	2.382	1.575	2.718	3.873	2.524	2.500	2.528
Average	1.931	1.730	1.204	0.890	0.605	1.187	1.122	0.933	1.060	1.805	2.018	2.216	1.418

the consequent long term streamflow analysis to estimate a natural condition of streamflow. The monthly average discharge of the observed at Pamacsalan are shown in Table 3B-10.

(b) Hourly Discharge Data

An automatic water level recorder was installed in 1964 at Wahig river near the weir site of existing communal intake but the gauging station was flushed out around in 1967. A flood hydrograph of water level on 18th November 1964 of which daily rainfall at Dagohoy was 513.3 mm/day, was recorded and the peak was occured at 19:30 o'clock on the water level of 2.56 meters. However, no hourly rainfall data is available on the same date of that, in addition it would be questionable to use the rating curve on this water level record, because the rating curve had been prepared in 1956 and no high flood of discharge measurements had been included.

3. Discharge Measurements

The following discharge measurements have been performed at the Pamacsalan proposed dam site, the Wahig proposed dam site, confluence of the Pamacsalan and the Wahig river that is proposed Malyrao diversion dam site, the Bagun-an river near the bridge at Pilar and the Binabae river near the Bugsoc.

(a) Proposed Malinao Diversion Dam Site

Date	Width of Water Surface (m)	Area (m^2)	Velocity (m/sec)	Discharge (m^3/sec)	Average Discharge (m^3/sec)
Sep. 14,1977	16.75	7.773	0.206	1.603	1.607
Sep. 14,1977	16.75	7.773	0.207	1.612	
Sep. 17,1977	16.00	6.830	0.216	1.479	1.465
Sep. 17,1977	17.00	7.740	0.187	1.452	

(b) Proposed Pamacsalan Dam Site

Date	Width of Water Surface (m)	Area (m^2)	Velocity (m/sec)	Discharge (m^3/sec)	Average Discharge (m^3/sec)
Sep. 14, 1977	4.50	1.346	0.583	0.784	0.776
Sep. 14, 1977	4.50	1.346	0.570	0.768	
Sep. 17, 1977	7.25	2.303	0.237	0.546	0.536
Sep. 17, 1977	7.25	2.303	0.228	0.525	

(c) Proposed Wahig Dam Site

Date	Width of Water Surface (m)	Area (m^2)	Velocity (m/sec)	Discharge (m^3/sec)	Average Discharge (m^3/sec)
Sep. 15, 1977	6.00	1.819	0.318	0.578	0.582
Sep. 15, 1977	6.00	1.755	0.334	0.586	
Sep. 17, 1977	5.04	1.538	0.343	0.527	0.521
Sep. 17, 1977	5.04	1.538	0.335	0.516	

(d) Bagunan River at the bridge in Pilar

Date	Width of Water Surface (m)	Area (m^2)	Velocity (m/sec)	Discharge (m^3/sec)	Average Discharge (m^3/sec)
Sep. 14, 1977	4.10	0.545	0.224	0.122	0.132
Sep. 14, 1977	4.00	0.536	0.265	0.142	
Sep. 17, 1977	3.60	0.509	0.199	0.098	0.101
Sep. 17, 1977	3.60	0.509	0.206	0.105	

(e) Binabae River at 200 meters upstream from the confluence of the Wahig River

Date	Width of Water Surface (m)	Area (m^2)	Velocity (m/sec)	Discharge (m^3/sec)	Average Discharge (m^3/sec)	Upper Communal Intake (m^3/sec)	Reviced Discharge (m^3/sec)
Sep. 15, 1977	1.70	0.401	0.284	0.114	0.116	0.10	0.216
Sep. 15, 1977	1.70	0.401	0.296	0.119			
Sep. 17, 1977	1.85	0.274	0.412	0.113	0.112	0.10	0.212
Sep. 17, 1977	1.85	0.271	0.410	0.111			

C. Hydrological Analysis

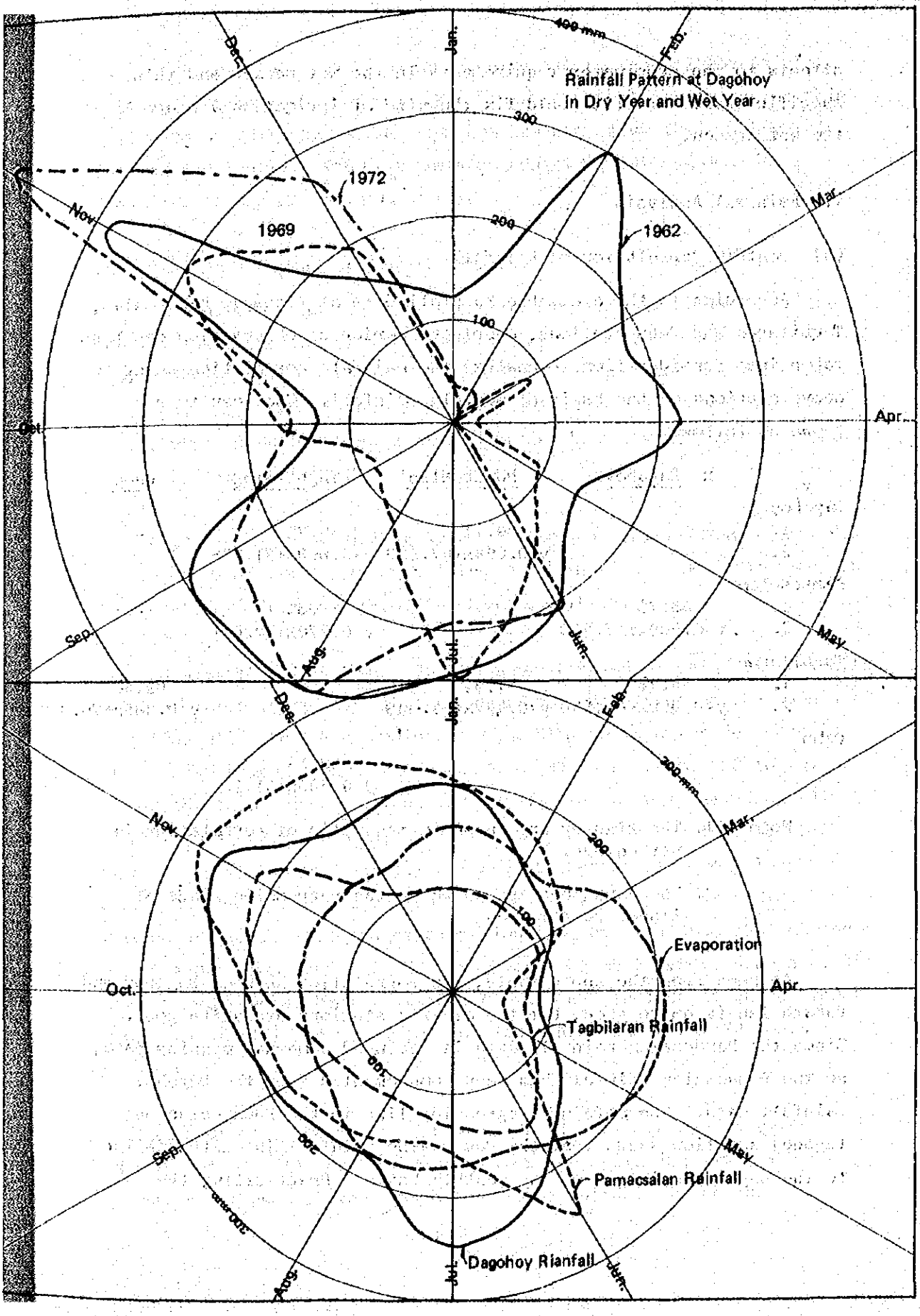
1. Features of Rainfall Pattern

The Bohol island belongs to the climate type IV of which monthly rainfall is more or less evenly distributed throughout a year. As seen from Table 3B - 5, the distribution of average monthly rainfall at Dagohoy shows certainly rather moderate fluctuation throughout a year. However, the monthly rainfall pattern in each year shows quite distinct dry month for about one to five month in a year. Especially, in 1969 and 1973, it is clear that there is a five month dry season from January to May, and the total rainfall in the 5-month in 1973 is only 103.4 mm/5-month at Dagohoy and 89.4 mm/5-month at Pamacsalan, that is almost same condition as the climate type I prevailing in Ilocos Norte.

In Table 3B-5 , the underlined figures show that the monthly rainfall amount is less than 100 mm/month, that would be indicate rather dry month in a year. The start of dry season as will as the duration of dry season fluctuate year by year. As a results, when monthly average for 20 years are taken, the average would become rather flat fluctuation throughout a year. It might, however, not means that there is not so much distinct dry season, but it can be said that there is a distinct dry season in almost every year but the starting month and duration of the dry season fluctuate year by year.

A comparison of monthly average rainfall at Dagohoy, Pamacsalan and Tagbilaran to the adjusted monthly evaporation, which is explained in later, is shown in Figure 3B-6 . The dry season can be said that the evaporation amount exceeds the monthly rainfall, so in average, the dry season can be said from middle of February to the late May. In August, however, the evaporation and the rainfall is almost same in the amount. As seen from Table 3B-5 , the monthly rainfall less than 100 mm/month occures 5 times in August and September during 21 years. So, some of a year in August or September, the rainfall falls in a dry month. Considering the frequency of such a characteristic, it might

FIGURE 3B-6 COMPARISON OF MONTHLY AVERAGE RAINFALL AND EVAPORATION



affects to the crop water requirements in the wet season and this specific characteristic would fix the size of irrigation acreage in the wet season.

2. Rainfall Analysis

(a) Monthly Correlation of Rainfall

According to the available rainfall data at Dagohoy, Pamacsalan, Tagbilaran and Cebu stations, overlaped period of observation has been taken into consideration to analyze the rainfall correlation among the above stations on the basis of monthly rainfall. The results are shown as follows.

y \ x	Dagohoy	Pamacsalan	Tagbilaran	Cebu
Dagohoy				
1.		80.7%	55.7%	-
2.		y=0.694x+47.553	y=0.893x+71.475	
Pamacsalan				
1.	80.7%		57.3%	-
2.	y=0.939x+17.533		y=0.770x+72.041	-
Tagbilaran				
1.	55.7%	57.3%		49.5%
2.	y=0.350x+61.940	y=0.427x+55.498		y=0.485x+76.098
Cebu				
1.	-	-	49.5%	
			y=0.505x+61.121	

Note: 1. The figures are shown in the ratio of correlation in percentage.

2. The equations are shown in the regression lines of linear correlation

As seen from the above table, the correlation between Dagohoy and Pamacsalan is quite good, but the other's stations are quite poor. Since the Pamacsalan rainfall data is included somewhat missing data, so the Pamacsalan rainfall has been complemented from the Dagohoy rainfall data. The obtained regression line in the Pamascalan on Dagohoy satation shows that the Pamacsalan rainfall is quite similar to the Dagohoy rainfall on the monthly basis. Practically, the

Pamascalan rainfall can be think about equal to the Dagohoy rainfall on the daily basis. Accordingly, the missing part of Pamacsalan rainfall data on daily basis has been complemented from the Dagohoy rainfall data directly. The complemented monthly total rainfall at Pamacsalan is shown in Table 3B-11.

(b) Stochastic Trend of Annual Rainfall

In order to find the long term trend of rainfall pattern in the Bohol island, the annual rainfalls at Tagbilaran from 1902 to 1975 have been collected, though the data from 1941 to 1960 could not be obtained. Also the 10-year moving average of annual rainfall at Manila from 1900 to 1964 has been quoted from the "A study of the water balance in the Philippines" by M.M. Obradovich.

3-year and 5-year moving average of annual rainfall at Tagbilaran and Dagohoy stations have been illustrated in Figure 3B-7 together with the 10-year moving average of the Manila station.

As seen from the Figure 3B-7 , general trend of rainfall at Manila and Tagbilaran is rather similar, though the magnitude of the rainfall is different. The annual rainfall from 1910 to 1940 for 30 years is rather high compared with the successive 30 years from 1940 to 1970. As for the Tabgilaran station, the average annual rainfall from 1917 to 1939 is 1,742.4 mm/year, while the one from 1960 to 1975 is 1,485.5 mm/year, so the annual rainfall of recent year became about 15 percent less than the former year. The same tendency can be observed at Manila station as well. The droughtest period is occured around 1965 during the 70 years from 1900 to 1970. However, the most severe drough condition is recorded at Manila station during 1870 to 1900 of which average annual rainfall is about 10 percent less than the recent 20 years average.

Accordingly, the recent 20-year period would belong to rather drought period. As for as a reservoir water operation study is concerned, the recent 20-year period would be suitable to decide a

Table 3B-11 Complemented Monthly Total Rainfall at Pamacsalan Raingauge Station

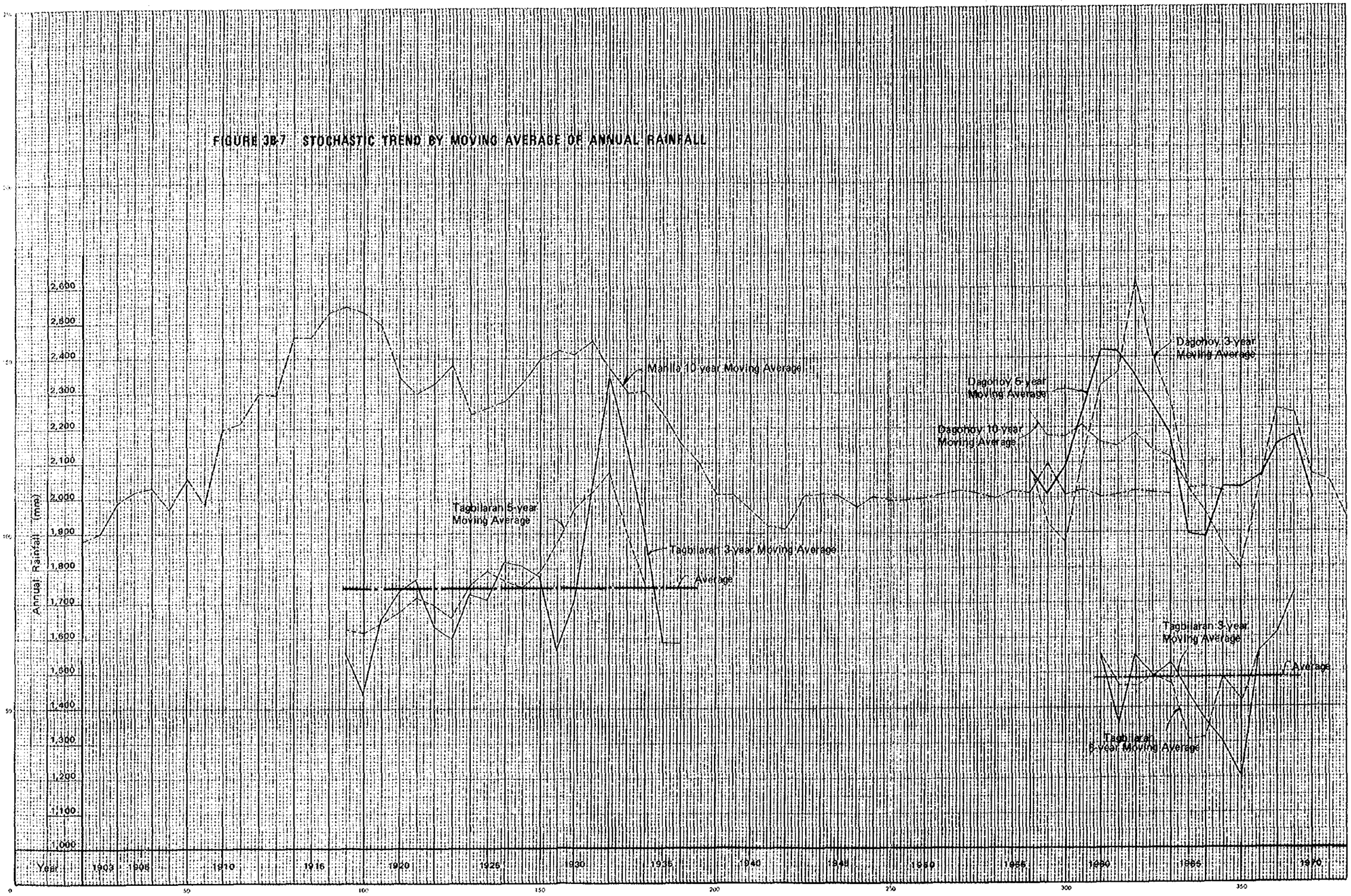
(Unit: mm/month)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1956	180.6	35.1	118.5	221.7	302.4	171.2	252.1	-	161.0	107.2	201.8	458.2	-
1957	195.4	187.2	101.9	143.4	47.4	310.9	409.7	177.5	134.5	309.3	123.7	91.0	2,231.9
1958	131.9	108.3	75.3	104.1	67.0	159.7	252.1	152.1	130.4	72.8	163.9	62.8	1,479.8
1959	264.8	84.0	238.7	16.8	89.3	116.8	442.9	207.2	178.0	116.9	128.2	154.7	2,038.3
1960	261.0	97.1	56.8	168.9	124.5	285.8	172.7	90.5	244.5	158.1	264.1	154.5	2,078.5
1961	179.7	101.9	54.9	106.0	69.1	103.3	410.4	123.1	240.3	395.7	182.7	179.7	2,145.7
1962	124.9	291.1	185.7	21.9	132.5	232.1	240.0	297.4	300.3	130.2	390.9	161.3	2,508.3
1963	317.0	152.5	221.4	52.8	6.3	47.4	326.9	232.3	288.6	331.8	168.6	75.2	2,220.8
1964	139.2	320.2	19.4	80.5	366.5	107.6	206.4	56.4	269.7	179.1	934.1	257.9	2,937.2
1965	364.9	171.5	136.4	72.9	9.8	326.6	155.4	173.9	150.1	206.1	122.3	189.2	2,079.2
1966	93.0	58.4	29.1	65.6	215.9	61.3	372.3	219.4	106.8	353.5	108.5	187.0	1,870.8
1967	436.9*	290.7	221.3	6.1	19.4	151.1	142.0	153.4	89.4	222.4	243.4	392.1	2,368.2
1968	227.2	129.7	56.2	0	46.8	155.5	192.0	64.0	192.7	109.3	391.1	278.1	1,842.6
1969	47.3	16.7	144.2	48.9	85.3	124.9	101.3	214.7	119.0	185.9	142.9	307.2	1,538.3
1970	134.0	254.3	61.0	0	8.6	390.0	279.7	171.9	94.2	381.6*	202.7	160.6	2,138.6
1971	267.2*	195.1*	141.4	91.0	123.4	512.4	206.4	220.0	210.7	266.8	400.5	75.7	2,710.6
1972	312.1	63.8	236.3	56.3	249.9	194.1	28.7	169.6	218.5	201.4	131.0	203.5	2,065.2
1973	18.5	43.7	19.6	7.6	0	249.9	175.3	207.0	320.8	163.1	571.0	239.6	2,016.1
1974	99.9	341.4	238.7	138.4	42.2	188.2	116.8	98.1	189.8	246.8	169.1	363.0	2,232.4
1975	481.8	155.2	37.3	109.7	15.2	257.9	139.1	46.0	312.2	197.3	61.5	280.8	2,094.0
1976	374.9	132.8	62.8	26.4	131.7	218.8	170.0*	332.9*	161.1*	60.9*	53.9*	260.3*	1,986.5
1977	179.5	417.3	269.2	14.2	15.0	227.2	229.6	288.7	53.6	-	-	-	-
	219.6	165.8	123.9	70.6	98.6	208.8	228.3	176.0	189.4	209.3	245.5	215.8	2,129.2

Estimated from Dagohoy Station

Note: * marked values are estimated from Dagohoy Station.
underlined figures show that the monthly rainfall amount becomes less than 100 mm/month.

FIGURE 3B-7 STOCHASTIC TREND BY MOVING AVERAGE OF ANNUAL RAINFALL



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required storage capacity. Considering the available hydrologic data in the project area, the period of 1956 to 1976 for 21 years has been selected for the reservoir water operation studies.

(c) Maximum Rainfall Analysis

Annual Daily Maximum Rainfall

In order to estimate the probability of daily maximum rainfall, the Dagohoy, Pamacsalan and Cebu stations have been selected. Since no remarkable hourly rainfall was observed, as well as the observation period was limited within one year in Bohol island, the maximum daily rainfalls at Dagohoy, Pamacsalan in the Bohol island and Cebu city are compared.

The annual maximum rainfall at above three stations are shown in Table 3B-12 and the probability analysis for them are shown in Figure 3B-8. As for the Dagohoy station, the maximum observed value is 513.3 mm/day, which is abnormally high rainfall in the Visaya region. Normally, a capacity of drainage discharge in the irrigation area can be adopted 5-year to 10-year return period, so the observed maximum rainfall of 513.3 mm/day has been neglected from the probability analysis. The maximum observed value, however, should be considered to deside the size of spillway for dam, which is explained in later.

Comparing the probability rainfall at Cebu and Dagohoy, the Cebu value is a little bit higher than the one in the Dagohoy. On the other hand, the tendency and the size of rainfall at Pamacsalan are quite similar.

Annual Maximum of Successive Rainfall at Dagohoy

As for the drainage discharge capacity for irrigation area, 2-day to 3-day successive rainfall would sometimes bring a high peak discharge. The annual maximum successive rainfall from 2-day to 4-day have been analyzed as shown in Table 3B-13. According to the result of the probability analysis, the incremental ratios from 2-day to

Table 3B-12 Annual Daily Maximum Rainfall

(Unit: mm/day)

Year	Dagohoy	Order	%	Pamacsalan	Order	%	Cebu	Order	%
1950	-			-			118.9	9	32.7
1951	-			-			321.6	1	1.9
1952	-			-			165.1	3	9.6
1953	-			-			138.9	4	13.5
1954	-			-			214.6	2	5.8
1955	-			-			87.9	17	63.5
1956	101.6	9	40.5	-			62.7	23	86.5
1957	124.5	5	21.4	-			97.8	13	48.1
1958	100.1	11	50.0	-			53.1	25	94.2
1959	96.3	12	54.8	-			90.4	16	59.6
1960	88.9	14	64.3	-			125.5	7	25.0
1961	69.8	21	97.6	-			101.1	12	44.2
1962	150.4	3	11.9	-			93.2	15	55.8
1963	81.8	16	73.8	-			125.7	6	21.2
1964	513.3	1	2.4	-			119.1	8	28.8
1965	86.4	15	69.0	-			68.6	22	82.7
1966	70.3	20	92.9	-			61.5	24	90.4
1967	73.6	18	83.3	104.1	7	72.2	96.0	14	51.9
1968	159.5	2	7.1	160.3	2	16.7	81.7	19	71.2
1969	73.4	19	88.1	78.7	8	83.3	47.7	26	98.1
1970	76.2	17	78.6	76.2	9	94.4	82.1	18	67.3
1971	95.3	13	59.5	146.6	4	38.9	101.3	11	40.4
1972	103.4	8	35.7	147.3	3	27.8	79.0	20	75.0
1973	122.7	6	26.2	189.7	1	5.6	127.8	5	17.3
1974	148.6	4	16.7	106.7	6	61.1	102.2	10	36.5
1975	108.2	7	31.0	146.0	5	50.0	75.7	21	78.8
1976	100.8	10	45.2	-			-		

FIGURE 3B-8 PROBABILITY ANALYSIS OF ANNUAL DAILY MAXIMUM RAINFALL

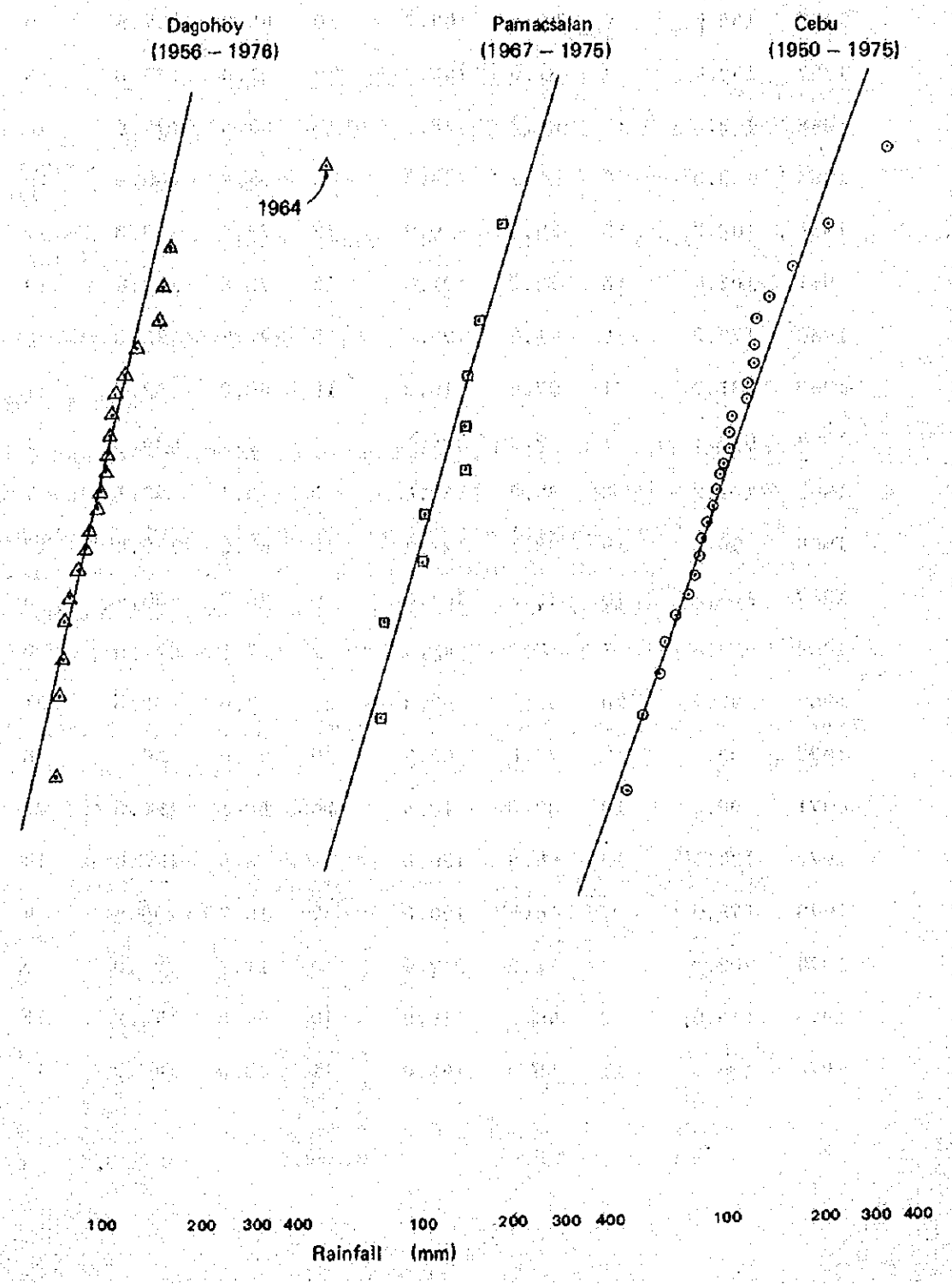


Table 3B-13 Annual Maximum Successive Rainfall at Dagohoy Station

Year	Successive 2-day Rainfall			Successive 3-day Rainfall			Successive 4-day Rainfall		
	Rainfall (mm/2-day)	Order	%	Rainfall (mm/3-day)	Order	%	Rainfall (mm/4-day)	Order	%
1956	138.4	9	40.5	149.8	10	45.2	167.8	9	40.5
1957	153.4	7	31.0	165.8	7	31.0	175.8	8	35.7
1958	113.3	14	64.3	128.8	13	59.5	129.6	18	83.3
1959	159.3	6	26.2	159.3	8	35.7	159.3	10	45.2
1960	108.2	15	69.0	119.9	17	78.6	133.3	17	78.6
1961	103.4	16	73.8	121.6	16	73.8	122.4	19	88.1
1962	172.2	5	21.4	176.8	5	21.4	193.8	5	21.4
1963	91.7	21	97.6	116.3	18	83.3	152.7	11	50.0
1964	613.1	1	2.4	628.1	1	2.4	639.3	1	2.4
1965	141.2	8	35.7	152.6	9	40.5	182.1	7	31.0
1966	96.5	19	88.1	122.4	15	69.0	150.4	12	54.8
1967	135.2	10	45.2	167.0	6	26.2	189.4	6	26.2
1968	242.8	2	7.1	245.4	2	7.1	247.9	2	7.1
1969	92.2	20	92.9	97.3	21	97.6	98.8	21	97.6
1970	96.8	17	78.6	109.2	20	92.9	136.2	16	73.8
1971	96.6	18	83.3	110.5	19	88.1	121.5	20	92.9
1972	124.0	12	54.8	126.8	14	64.3	146.4	14	64.3
1973	178.9	4	16.7	190.3	4	16.7	200.5	4	16.7
1974	202.7	3	11.9	212.9	3	11.9	221.0	3	11.9
1975	116.6	13	59.5	135.9	12	54.8	143.5	15	69.0
1976	134.8	11	50.0	145.0	11	50.0	148.2	13	59.5

3-day and 3-day to 4-day are quite small. Considering these characteristic of successive rainfall, up to the 2-day successive rainfall would be necessary to consider to decide the capacity of drainage.

The probability of daily and 2-day successive rainfall on each return period are shown as follows. (See Figure 3B-9)

(unit: mm)

Items	Return Period						
	2-year	5-year	10-year	20-year	50-year	100-year	Maximum Observed
Daily Maximum Rainfall	97.0	120.0	135.0	150.0	160.0	180.0	513.3
2-day Successive Rainfall	135.0	168.0	185.0	203.0	225.0	240.0	613.1

3. Long Term Streamflow Analysis

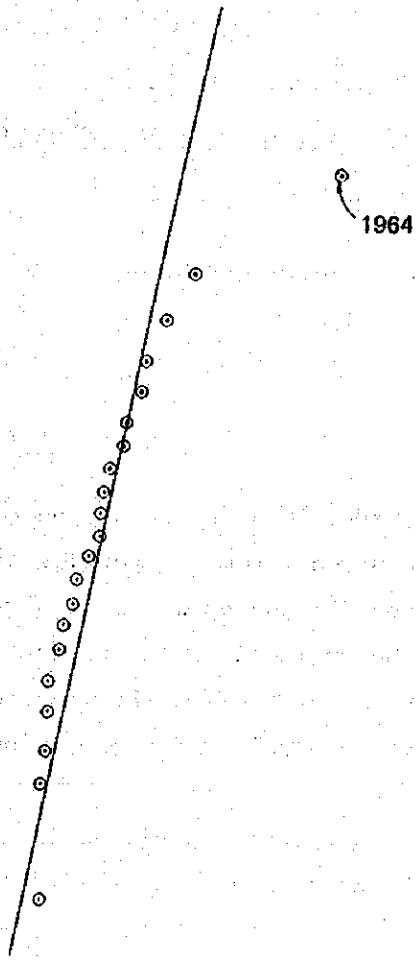
(a) Runoff Model

The Pamacsalan observed discharge is affected by the communal intake located about 200 meters upstream from the gauging station. Unfortunately, the intake discharge for the communal area was not observed. The communal area can be included in the project area in future, so natural condition of river streamflow should be estimated in order to perform the successive reservoir water operation studies.

In addition, a reliability of the observed discharge data has been checked by the rainfall data at Pamacsalan and observed discharge data on annual basis as shown below.

Year	Pamacsalan Rainfall (mm/year)	Pamacsalan Discharge Height (mm/year)	Catchment Area Ross (mm/year)	Runoff Coefficient (%)
1967	2,368.2	1,661.7	706.5	70.2
1968	1,842.6	595.6	1,247.0	32.3
1969	1,538.3	663.1	875.2	43.1
1970	2,138.6	955.7	1,182.9	44.7
1971	2,710.6	2,252.4	458.2	83.1
1972	2,065.2	1,854.5	210.7	89.8
1973	2,016.1	1,942.2	73.9	96.3
1974	2,232.4	3,448.7	-1,216.3	154.5
1975	2,094.0	2,847.8	-753.8	136.0

FIGURE 3B-9 PROBABILITY ANALYSIS OF ANNUAL MAXIMUM 2-DAY SUCCESSIVE RAINFALL AT DAGOHOY STATION



100 2 3 4 5 7 100 2 3 4 5
Rainfall (mm/2-day)

As seen from the above table, since 1971 the runoff coefficient becomes very high, on the other hand the one before 1969 becomes very low. In 1974 and 1975, the discharge height becomes higher than the Pamacsalan rainfall. Consequently, it would be rather dangerous to use the observed discharge data directly for reservoir water operation studies.

In order to verify the observed data and to estimate the natural condition of streamflow in the Pamacsalan river at proposed dam site, the Tank Model Method has been adopted and the observed data and the computed value on daily basis has been compared.

Since the observation of Pamacsalan rainfall was started from 1967, the verification period has been selected from 1967 to 1975. The establishment of the each coefficient of the tank model required so many times of trial-and-error method.

The final conclusion of the configuration of the tank model is shown in Figure 3B-10 together with the comparison of observed value and computed value in the discharge depth, milimeter order, on daily basis from 1967 to 1973.

In the first part of the year from around March to September, the computed value is about 1 mm/day, that is 0.32 cu.m/sec is higher than that of observed value. This would be an affection of communal intake in the upstream of observed station, however, during flooding time in November and December, the both values show rather good matching in general. In 1972 and 1973, the computed values show rather good matching with the observed one throughout the years and the correlation of computed and observed on daily basis could be obtained more than 80 percent.

As for the difference between computed and observed values, the computed values in 1967 to 1968 is about one milimeter higher than the observed one, however, the difference becomes gradually smaller and

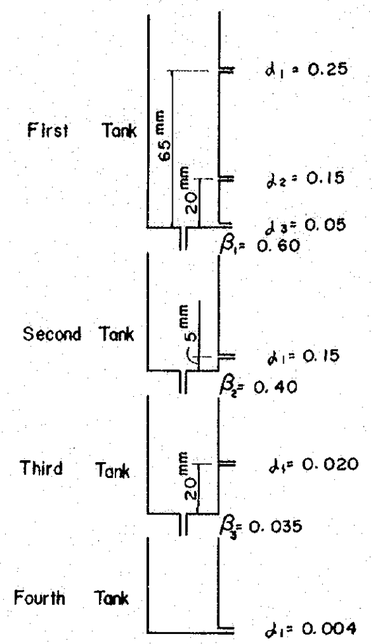


FIGURE 3B-10 RESULTS OF RUNOFF SYNTHESIS by TANK MODEL METHOD

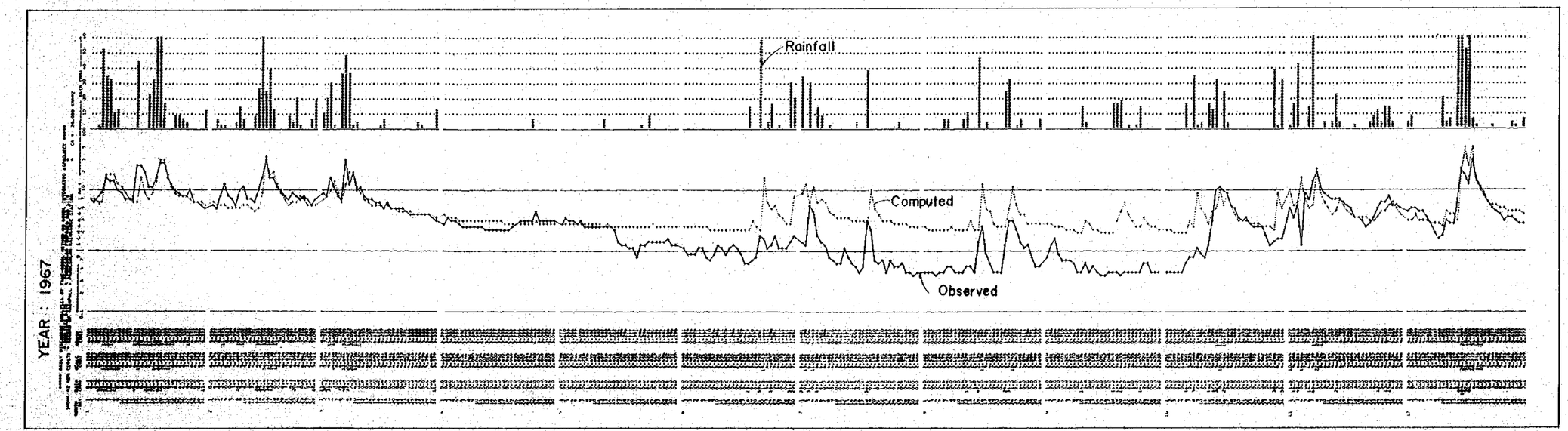


FIGURE 3B-10 **RESULTS OF RUNOFF SYNTHESIS by TANK MODEL METHOD**

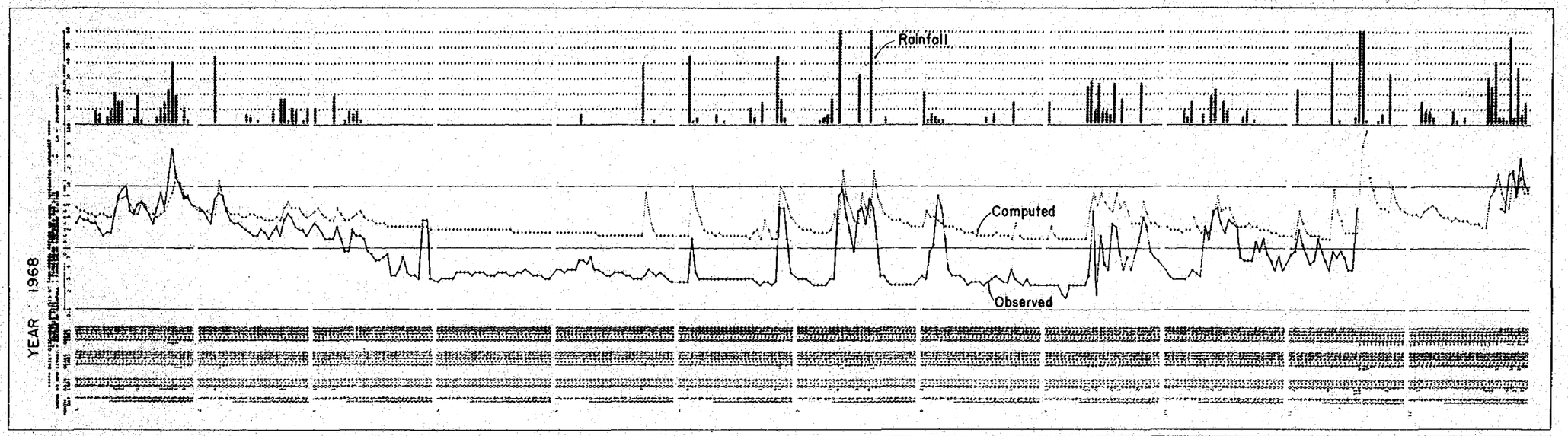
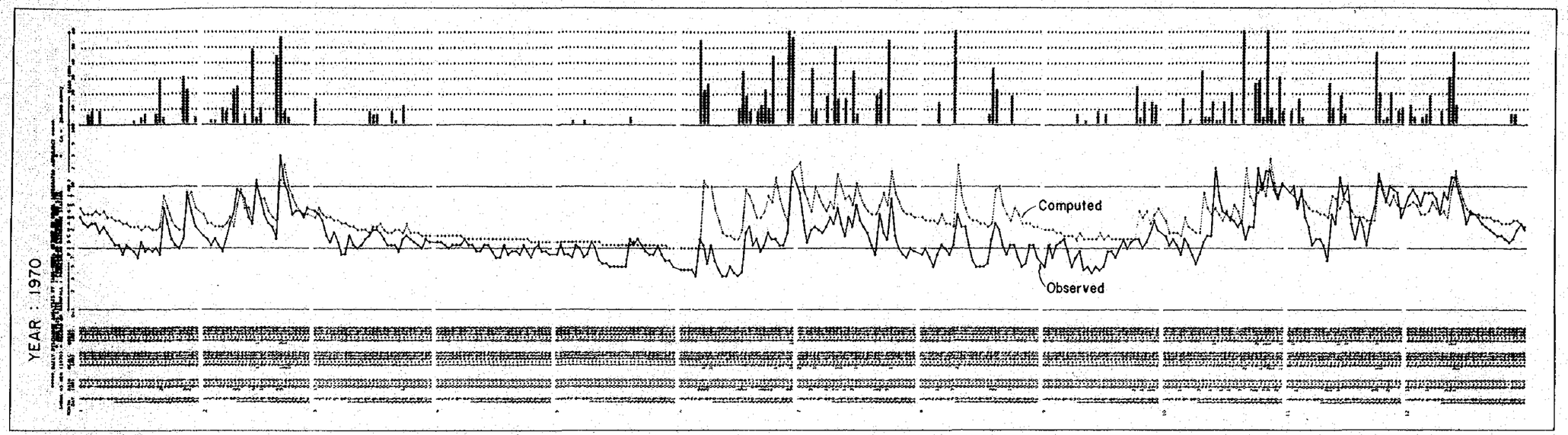


FIGURE 3B-10 RESULTS OF RUNOFF SYNTHESIS by TANK MODEL METHOD



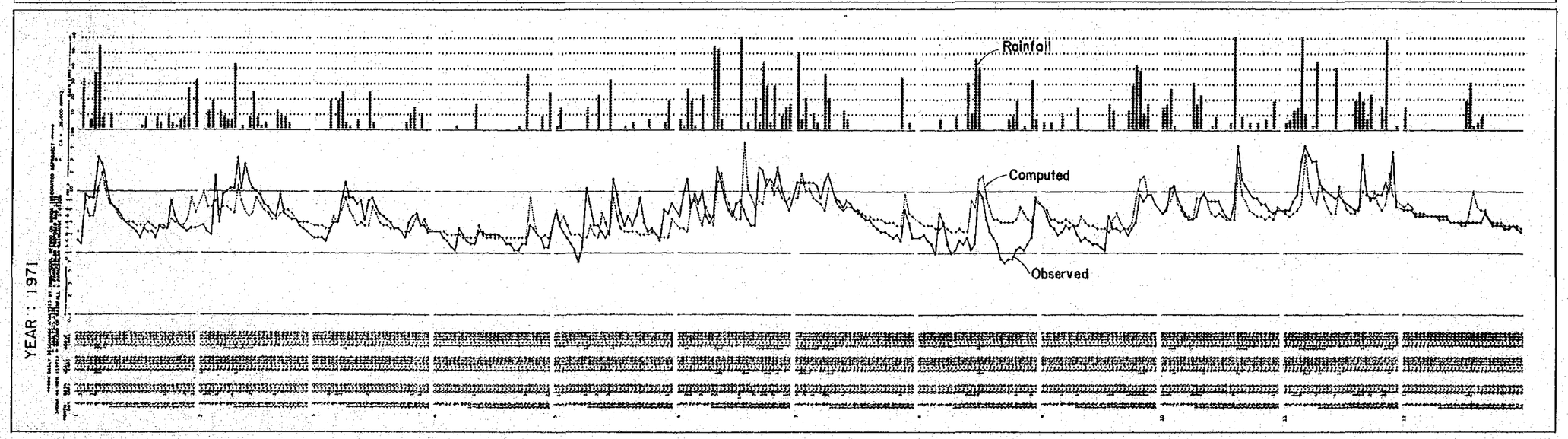
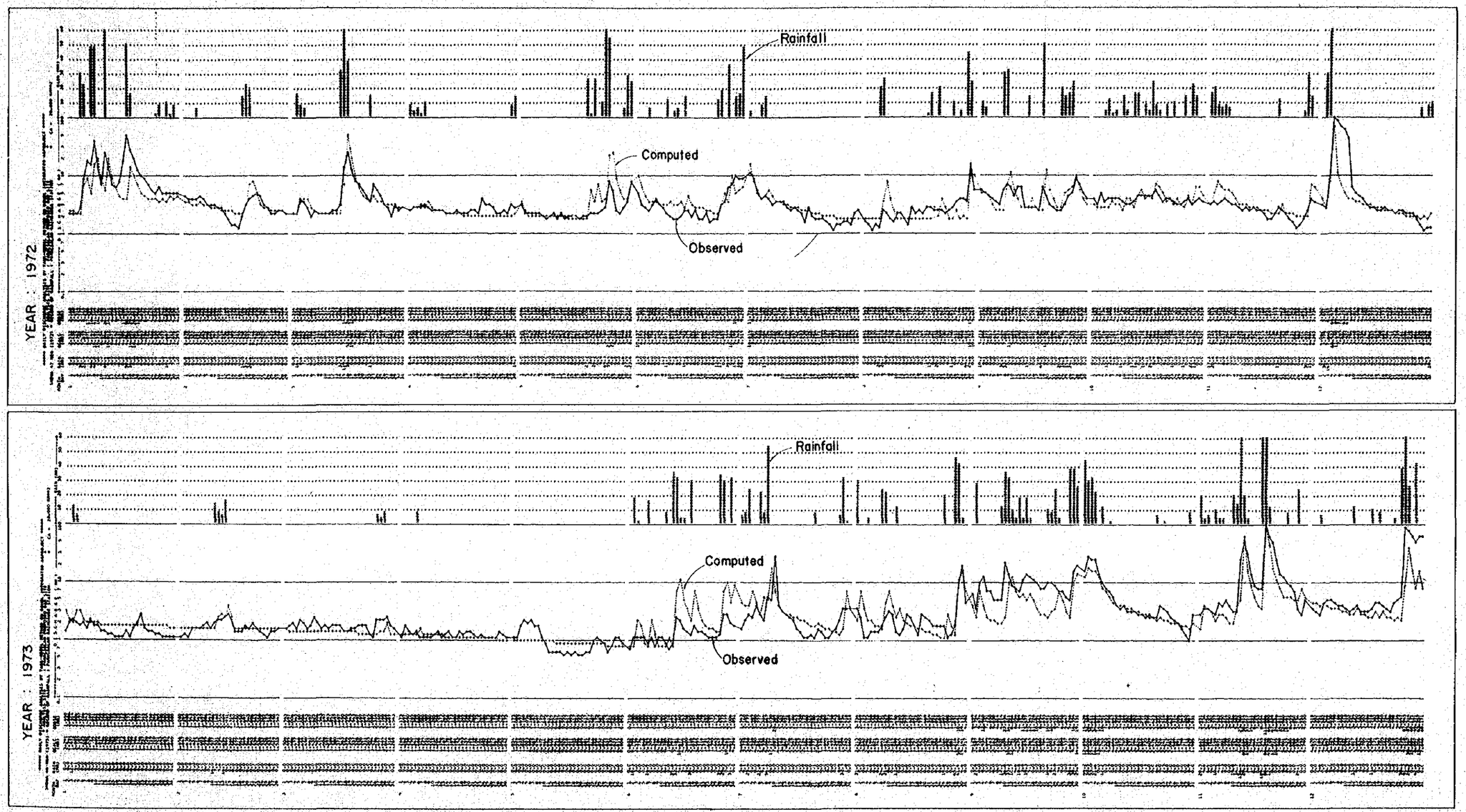


FIGURE 3B-10 RESULTS OF RUNOFF SYNTHESIS by TANK MODEL METHOD



and smaller then in 1972 and 1973 the difference becomes almost zero. In 1974 and 1975, though the comparison is not shown, the observed values become higher than the computed one, that is shown in the previous table. The observed total discharge hight in 1974 and 1975 become higher than the Pamacsalan rainfall, that is the runoff coefficient is more than 100 percent. Considering these condition, the river bed would rise year by year, consequently, in 1972 and 1973, the affection of river bed increase would become the same values of the communal intake discharge.

The coefficient of correlation between observed and computed values on monthly basis could be obtained 83 percent from 1967 to 1973. The one from 1956 to 1973 could be obtained only about 70 percent, this would be caused by the rainfall data because the rainfall from 1956 to 1966 has been complemented from Dagohoy station. Since the dry years in 1968, 1969 and 1973 have been included in the good correlation part there would be no problem in the reservoir water operation studies.

Accordingly, the computed values have been considered in the natural condition of the Pamacsalan river and have been used for the subsequent reservoir water operation studies. The monthly average discharge of the computed values are shown in Table 3B-14.

(b) Estimation of Discharge at Each Proposed Structure Site

The available discharge data in the project area are limited to the Pamacsalan river near the proposed dam site and the Wahig river near the proposed dam site. There is no discharge data at the Bagunan river, Binabae river and the proposed Malinao diversion weir site. In order to perform the subsequent reservoir water operation studies, the discharge at each proposed structure site should be estimated, especially, the discharge at the Malinao diversion weir site that would play a very important role in the deciding the scale of the project futures.

Table 3B-14 Computed Monthly Average Discharge at Pamacsalan Staton

(Unit: cu.m/sec)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
1956	1.568	0.585	0.591	1.201	1.825	1.194	1.599	-	0.795	0.776	1.180	2.465	1.198
1957	1.799	1.670	0.861	1.176	0.565	1.180	2.616	1.349	0.992	2.185	1.128	0.788	1.409
1958	0.926	0.894	0.706	0.750	0.520	0.817	1.523	0.955	0.801	0.615	0.865	0.611	0.832
1959	1.544	0.789	1.223	0.546	0.492	0.539	2.384	1.528	1.144	0.933	9.890	1.020	1.092
1960	1.550	1.035	0.614	1.069	0.845	1.664	1.192	0.860	1.369	1.046	1.681	1.179	1.173
1961	1.265	1.028	0.602	0.621	0.527	0.669	2.122	1.125	1.497	2.288	1.484	1.356	1.218
1962	1.162	1.968	1.528	0.703	0.821	1.464	1.692	1.899	2.067	1.133	2.669	1.456	1.541
1963	2.264	1.540	1.706	0.967	0.647	0.585	1.462	1.680	1.817	2.404	1.583	0.852	1.461
1964	0.950	2.130	0.834	0.649	1.874	1.124	1.405	0.710	1.605	1.241	6.453	2.411	1.773
1965	2.813	1.712	1.522	0.940	0.741	2.028	1.375	1.179	1.051	1.587	0.957	1.328	1.436
1966	0.855	0.642	0.555	0.494	1.193	0.486	1.823	1.427	0.998	2.006	1.058	1.191	1.067
1967	2.747	2.239	1.976	0.768	0.614	0.917	1.166	0.900	0.680	1.169	1.649	2.679	1.457
1968	1.538	1.188	0.811	0.539	0.512	0.770	1.167	0.528	0.992	0.710	2.432	1.676	1.070
1969	0.871	0.499	0.872	0.483	0.543	0.528	0.577	0.962	0.829	1.066	0.818	1.592	0.807
1970	1.027	1.698	0.739	0.461	0.344	1.714	1.962	1.283	0.664	1.918	1.609	1.415	1.234
1971	1.585	1.632	1.117	0.783	0.856	2.965	1.929	1.518	1.542	1.931	2.758	1.323	1.658
1972	2.157	1.079	1.830	0.808	1.497	1.349	0.933	0.963	1.434	1.256	1.127	1.742	1.351
1973	0.619	0.565	0.409	0.307	0.197	0.944	1.027	0.991	1.600	1.471	3.613	1.811	1.129
1974	1.135	2.536	1.758	1.176	0.675	1.112	0.961	0.749	1.133	1.456	1.332	2.063	1.332
1975	3.457	1.684	0.951	0.853	0.584	1.508	1.123	0.556	1.686	1.400	0.713	1.576	1.340
1976	2.324	1.425	0.789	0.563	0.862	1.261	1.052	1.831	1.419	0.718	0.547	1.419	1.185
Average	1.626	1.359	1.047	0.755	0.797	1.182	1.480	1.050	1.244	1.396	1.740	1.522	1.274

According to the discharge measurements in each river, and the characteristics of each catchment area, it would be rather dangerous to use a ratio of catchment area directly. Nomally, a river slope would fix a runoff characteristics of a river. Based upon the available data, the following three ratios of runoff have been compared.

i) Ratio of catchment area
ii) Ratio of simultaneous discharge measurement data
iii) Correlation of specific annual average discharge and weighted average of river slope.

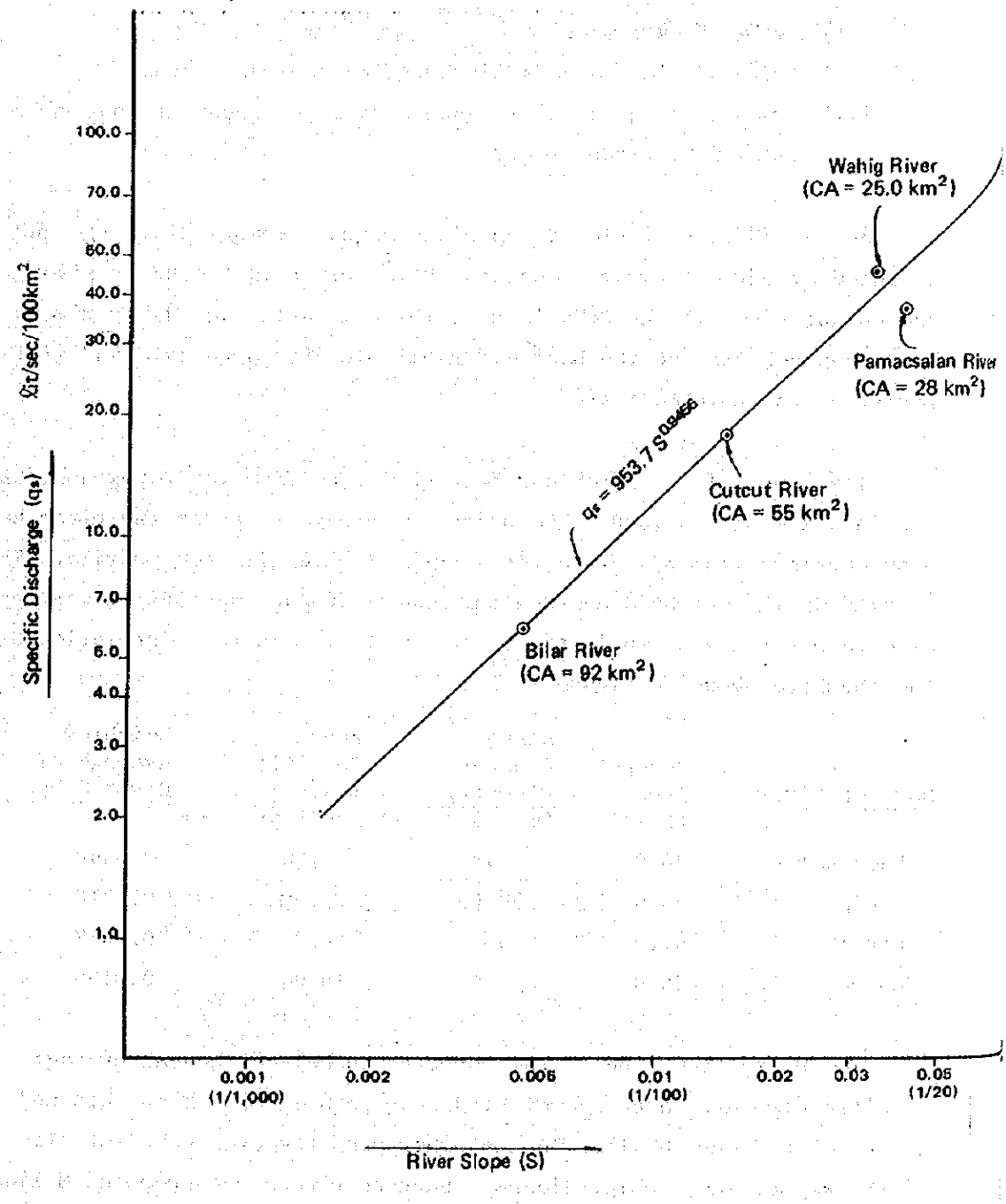
As for the correlation of specific annual average discharge and weighted average of river slope, the Bilar river in the Loboc river, the Cutaut river in the Cebu island, the Pamacsalan and Wahig rivers have been selected on the basis of available discharge data and similarity of the catchment area.

The slope of the river has been estimated from the topographical map in scale of 1:50,000. The weighted average slope of the river has been obtained from the slope and length of river in each profile. The results of the weighted average and annual average specific discharge at each river are shown in the following table and the correlation of the them are shown in Figure 3B-11.

Name of River	Catchment Area (km^2)	Annual Average Discharge (m^3/sec)	Annual Specific Discharge ($\ell/sec/100km^2$)	Weighted Average of River Slope
Pamacsalan	28.0	1.274	45.50	0.0343
Wahig	25.0	0.910	36.40	0.0416
Biral	92.0	0.552	6.00	0.0047
Cutcut	55.0	0.990	18.00	0.0150

The regression line of the correlation between annual average specific discharge and the weighted average slope has been obtained as shown in Figure 3B-11. On the other hand the average river slopes of the Pamacsalan, Wahig, Binabae, Bagunan rivers and proposed Malinao

FIGURE 3B-11 CORRELATION OF ANNUAL AVERAGE SPECIFIC DISCHARGE AND WEIGHTED AVERAGE OF RIVER SLOPE



diversion weir site have been estimated from the topographical map and the obtained values of the slope have been adopted the obtained equation of the regression line.

As for the simultaneous discharge measurements, the measurements on 17th September 1977 has been used to estimate the ratio of discharge.

The comparison of the obtained ratios of discharge in the respective method are tabulated in Table 3B-15. In order to obtaine a comservative result, the lowest ratio among the three methods has been used to estimate the discharge at each proposed structure site.

4. Evapotranspiration Analysis

Normally, a crop water requirement and evaporation have a good correlation, especially, a correlation of a crop water requirement of paddy rice and pan-evaporation data has been researched in the Philippines. The result of correlation has been obtained more than 80 percent, so the estimation of crop water requirement for paddy rice has been used the evaporation data directly.

As mentioned before, however, there is very few observed evaporation data in the Visaya region and there is no data of the evaporation in the Bohol island. So, the evaporation value has been estimated by Penman's formula using the climatorogical data at Tagbilaran. Normally, a computed evaporation value becomes a little bit lower than a observed pan-evaporation data. In order to revise the computed evaporation value, Lullimas University, Dumaguete City in Negros Oriental, which has a observed Open Pan-evaporation data and climatic data, has been selected within the same climatic region of Bohol island. At first, the monthly revision factors have been estimated at the above station comparing with the computed evaporation values by Penman's formula from the climatorogic data and observed pan-evaporation data on monthly basis. The comparison of observed data, computed value and

Table 3B-15 Ratio of Discharge at each Proposed Structure Site

Discharge Site	Catchment Area		Correlation of Average River Slope				Discharge Measurements		Adopted Ratio of Discharge
	Catchment Area (km^2)	Ratio of Catchment Area	Average River Slope	Annual Specific Discharge 1/ (ℓ/sec/100km^2)	Annual Average Discharge 2/ (m^3/sec)	Ratio of Discharge	Discharge 3/ (m^3/sec)	Ratio of Discharge	
Pamacsalan Proposed Dam Site	28.0	1.000	0.0343	39.299	1.100	1.000	0.536	1.000	1.000
Wahig Proposed Dam Site	23.1	0.825	0.0416	47.166	1.090	0.991	0.521	0.972	0.825
Binabae River	13.2	0.471	0.0426	48.237	0.637	0.579	0.212	0.396	0.396
Bagun-an River	33.1	1.182	0.0059	7.439	0.246	0.224	0.101	0.188	0.188
Malinao Proposed Diversion Dam Site	138.8	4.957	0.0207	24.378	3.384	3.076	1.465	2.736	2.736

Note: 1/ Annual specific discharge is obtained from the equation of $qs = 953.7\ S^{0.9456}$

2/ The annual average discharge is obtained from the obtained qs times the catchment area.

3/ The simultaneous discharge measurement on 17th September 1977 has been taken.

monthly revision factors are shown in Table 3B-16. The obtained monthly revision factors have been adopted to the computed evaporation value at Tagbilaran. Considering the same climatic region at Tagbilaran and project area, the obtained reviced evaporation value has been adopted as a evapotranspiration of paddy rice in the project area.

The computed evaporation values by Penman method and the adjusted evaporation values on monthly basis from 1960 to 1975 are shown in Table 3B-17 and Table 3B-18, respectively. As for the reservoir water operation studies, the period of 1956 to 1976 has been selected, so the year which has not climatorogic data has been used the monthly average values.

5. Flood Analysis

Flood peak discharge should be estimated to decide the size of spillway for Pamacsalan dam and Malinao diversion dam. In order to estimate a design flood for dam and diversion dam, simultaneous observation of flood hydrograph and hourly rainfall data should be required. However, such dependable data could not be obtained in the project area.

As for the daily maximum rainfall, the rainfall amount of 513.3 mm/day was observed at Dagohoy station on 19th November 1964 and also the water level of the Wahig river at the same date was recorded by an automatic water level recorder. However, the rating curve for such high flood has not any reliability.

Considering the condition of the available data, firstly, the rainfall November 1964 in the Visaya region have been collected to check the size of rainfall area as shown in Table 3B-19 . No such high rainfall has been observed in November 1964 and also the rainfall stations in the climatic type IV in the Visaya region is checked by the historic records but the maximum daily rainfall is limited upto about 300 mm/day only. However, at the Surigao Del Norte in the Mindanao island which is belongs to the climatic type II, 582.1 mm/24hour rainfall was observed on 18th November 1968.

Table 3B-16 Comparison of Evaporation Data

(Unit: mm/month)

Lullimas University, Dumaguete City, Negros Or.
(Open Evaporation) (Observed Value)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1957	-	-	-	-	-	-	145.5	169.4	153.4	162.0	167.9	157.0	-
1958	166.6	152.4	201.9	197.9	208.3	190.8	189.7	162.8	104.4	136.6	137.7	129.5	2,210.6
1959	153.4	185.2	174.8	200.7	187.2	176.8	163.3	150.1	158.0	161.5	157.7	153.9	2,022.6
1960	180.6	156.2	209.6	192.5	204.7	161.5	190.0	-	-	-	-	161.5	-
Mean	166.9	164.6	195.4	197.0	200.1	176.4	172.1	160.8	138.6	153.4	154.4	150.5	

Dumaguete City Synoptic Status
(Estimated by Penman Method)

1957	-	-	-	-	-	-	109.7	114.7	114.6	126.2	109.8	109.7	-
1958	107.9	113.1	142.3	137.1	138.0	124.5	116.9	114.1	109.8	108.8	100.2	109.1	1,422.4
1959	100.4	113.1	127.1	131.4	125.9	109.8	107.6	109.7	102.0	123.1	119.1	116.6	1,385.8
1960	131.8	120.1	153.8	136.2	136.1	117.6	126.5	-	-	-	-	114.39	-
Mean	113.4	115.0	141.1	134.9	133.3	117.3	115.2	112.8	108.8	119.4	109.7	112.4	-
Ratio	1.47	1.37	1.38	1.46	1.50	1.50	1.49	1.42	1.27	1.28	1.41	1.34	

Table 3B-17 Monthly Total Evaporation by Penman Method Tagbilaran City, Bohol

(Unit: mm/month)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1960	91.1	88.2	116.3	123.0	118.4	95.4	114.4	131.8	98.4	112.2	93.0	96.1	1,278.3
1961	133.3	116.2	157.5	131.4	134.2	107.7	145.1	160.9	152.4	132.7	129.0	105.4	1,605.8
1962	114.7	96.6	127.1	158.4	153.5	108.9	102.3	115.3	96.0	108.5	113.4	106.9	1,401.6
1963	141.1	84.0	107.0	160.5	156.6	132.6	121.5	101.4	119.1	102.3	102.6	111.6	1,440.3
1964	124.0	113.1	148.5	141.0	136.4	103.8	124.9	168.3	127.5	123.4	97.5	138.3	1,546.7
1965	102.3	115.6	122.5	139.5	146.6	130.5	108.5	144.8	115.5	130.2	121.5	114.7	1,492.2
1966	133.3	128.8	186.9	157.5	138.0	136.5	107.0	134.2	141.9	116.3	104.4	99.2	1,584.0
1967	89.0	95.8	132.7	149.1	144.2	141.9	132.7	121.5	133.5	129.9	116.4	111.6	1,498.3
1968	107.0	104.4	153.5	162.0	155.0	121.5	131.8	125.6	141.6	122.8	117.0	103.9	1,546.1
1969	121.8	122.1	149.4	158.4	153.5	106.5	122.5	122.5	126.5	134.9	117.6	90.8	1,526.6
1970	117.8	117.0	152.5	163.5	150.4	125.4	102.3	115.3	111.0	136.4	106.8	97.7	1,496.1
1971	108.5	106.4	97.7	134.4	117.8	102.6	106.6	98.9	89.4	93.0	76.5	86.8	1,218.6
1972	80.6	91.1	115.0	127.2	124.0	102.0	117.8	98.6	79.2	112.2	103.5	99.5	1,250.7
1973	126.8	100.8	115.3	127.5	125.2	109.5	89.9	98.6	88.8	89.3	81.0	79.1	1,231.8
1974	86.8	73.9	115.3	109.5	112.5	96.6	87.4	108.5	99.0	102.3	98.4	87.4	1,177.6
1975	95.5	89.6	115.0	123.6	120.3	102.0	102.3	107.0	99.3	99.2	79.2	87.4	1,220.4
Mean	110.9	102.7	132.0	141.7	136.7	114.0	113.6	122.1	113.7	115.4	103.6	101.0	1,393.4

Table 3B-18 Monthly Total of Adjusted Evaporation

(Unit: mm/month)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1960	133.9	120.8	160.5	179.6	177.6	143.1	170.4	187.2	125.0	143.6	131.1	128.8	1,801.6
1961	196.0	159.2	217.4	191.8	203.1	161.6	216.2	228. 5	193.5	169.8	181.9	141.2	2,260.2
1962	168.6	132.3	175.4	231.3	230.2	163.4	152.4	163.7	121.9	138.9	159.9	143.2	1,981.2
1963	207.4	115.1	147.7	234.3	234.9	198.9	181.0	144.0	151.2	130.9	144.7	149.5	2,039.6
1964	182.3	154.9	204.9	205.9	204.6	155.7	186.1	239.0	161.9	158.0	137.5	185.3	2,176.1
1965	150.4	158.4	169.0	203.7	219.9	195.8	161.7	204.5	146.7	166.6	171.3	153.7	2,101.7
1966	196.0	176.4	257.9	230.0	207.0	204.8	159.4	190.6	180.2	148.9	147.2	132.9	2,380.2
1967	130.8	131.2	183.1	217.7	211.8	212.8	197.7	172.5	169.5	166.3	164.1	149.5	2,107.0
1968	157.3	143.0	211.8	236.5	232.5	182.2	196.4	178.3	179.8	157.2	165.0	139.2	2,179.2
1969	177.9	167.3	206.2	231.3	230.2	159.8	182.5	174.0	160.8	172.7	165.8	121.7	2,150.2
1970	173.2	160.3	210.4	238.7	225.6	188.1	152.4	163.7	141.0	174.6	150.6	130.9	2,109.5
1971	159.5	145.8	134.8	196.2	176.7	153.9	158.8	140.4	113.5	119.0	107.9	116.3	1,722.8
1972	118.5	124.8	158.7	185.7	186.0	153.0	175.5	140.0	100.6	143.6	145.9	133.3	1,765.6
1973	186.4	138.1	159.1	186.2	187.8	164.2	134.0	140.0	112.8	114.3	114.2	106.0	1,743.1
1974	127.6	101.2	159.1	159.9	168.8	144.9	130.2	154.1	125.7	130.9	138.7	117.1	1,658.2
1975	140.4	122.7	158.7	180.4	180.4	153.0	152.4	151.9	126.1	127.0	111.7	117.1	1,721.8
Mean	163.0	140.7	182.2	206.9	205.0	171.0	169.2	173.4	144.4	147.7	146.1	135.3	1,993.625
Mean (mm/day)	5.3	5.0	5.9	6.9	6.6	5.7	5.5	5.6	4.8	4.8	4.9	4.4	5.5

Table 3B-19 Daily Rainfall Data at Various Stations in November 1964

(Unit mm)

Station	Date															
	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1. Bay-Ang Ubay, Bohol	0	0	0	0	11.4	0	0	0	71.1	17.8	0	0	0	0	0	20.3
2. Dagohoy, Bohol	3.6	0	15.5	0	0	0	11.2	15.0	99.8	513.3	0	0	2.3	0	7.9	7.4
3. Tubigon, Bohol	0	0	0	0	0	0	0	8.9	65.3	105.9	99.6	2.8	9.4	16.0	0	0
4. Tagbilaran City	2.0	0	0	0.1	3.0	0	7.0	0.3	48.3	140.5	0	0	0	T	0	10.6
5. Inopacan, Leyte	12.7	22.9	8.9	8.4	6.9	10.9	8.1	12.7	17.8	83.8	10.2	7.6	0	10.9	10.2	8.9
6. Abuyog, Leyte	0	0	0	0	0	0	16.8	0	162.6	93.0	0	0	0	0	0	1.3
7. Cebu City	38.6	0	0	4.6	0	0	0.8	17.1	50.8	119.1	0.8	0	1.8	T	5.6	4.6
8. Camp 7 Minglanilla Cebu	1.8	-	-	-	1.0	-	18.5	8.9	13.5	4.3	2.3	1.3	14.2	1.3	2.8	7.4
9. Mantalongon Dalaguete Cebu	0	0	27.4	0	19.3	0	8.4	6.6	1.8	38.1	152.4	0	0	6.6	6.1	1.8
10. Lahug, Cebu City	25.2	0	0	2.5	0	0	0	14.0	50.8	152.4	0	0	0	2.5	7.6	3.8
11. Masbate, Masbate	2.0	0.3	4.8	20.6	0	0	19.5	14.2	5.0	170.0	64.0	5.1	0	1.5	T	0.5
12. Poblacion, Milagros Masbate	.0	51.3	50.8	0	0	0	0	25.4	50.8	26.2	52.6	0	2.3	2.0	0	0
13. Nipa Palanas Masbate	22.1	5.8	0	9.6	0	0	0	15.8	24.1	202.4	43.3	0	0	0	1.9	0
14. Poblacion, Bayawan, Negros Or.	0	0	80.3	131.8	4.3	31.0	40.1	54.9	55.4	154.4	92.5	55.4	107.2	133.9	181.9	159.8
15. Siaton, Negros Oriental	0	1.0	35.0	33.0	4.3	0	0	4.6	18.0	15.8	9.4	10.2	25.9	25.4	17.0	10.2
16. Dumaguete City, Negros Or.	4.1	0	0	T	45.5	0	1.8	0	49.0	51.8	0	0	T	0	0	3.5

On the other hand, a flood mark in a old church near the Lobac river, which is the biggest river in the Bohol island and adjusted to the Wahig river, was found and dated in November 1867. Considering these data, the rainfall of 19th November 1964 would have a frequency of about 50-year return period. The value of 513.3 mm/day at Dagohoy was daily rainfall on 19th November 1964 and also 99.8 mm/day was observed in the former day of 18th November 1964, therefore 24-hour rainfall would become more than 550 mm/day. This value is quite similar to that of the Ilocos Norte or Ilocos Sur in the climate type I.

As for the peak discharge to be considered for the designing of the splillway for Pamacsalan dam and Malinao diversion dam, several equations are proposed to estimate the peak discharge in the Philippines. One of which M. M. Obradorich has recommended in the report of "Envelope Curves for Peak Discharges in the Republic of the Philippines" as following equations in different regions based upon the maximum observed peak discharge.

The whole country	$Qp = 308A^{0.5}$
Cagayan River Basin	$Qp = 269A^{0.5}$
Pampanga River Basin	$Qp = 126A^{0.5}$
Mindanao Island	$Qp = 134A^{0.5}$ -----(1)

and for the drainage basins smaller than 100 sq.km in specific discharge is $q_p = 22.5A^{(1.1A^{-0.05}-1)}$ ---(2)

where; Qp is the peak discharge in cu.m/sec
A is the drainage area in sq.km
and q_p is the specific peak discharge in cu.m/sec/sq.km

Considering the climate type in Bohol island, the equation of Mindanao island can be adopted for the estimation of peak discharge. The results of the peak discharge obtained from the above equations are shown as follows.

	Catchment Area (sq.km)	Equation ① (cu.m/sec)	Equation ② (cu.m/sec)
Pamacsalan Dam Site	28.0	709.1	500.9
Malinao Diversion Dam Site	138.8	1,635.3	1,565.4

On the other hand, the B.P.W. proposed the peak discharge in the Philippines in the different frequencies as shown in Figure 3B-12 The equation of "Extreme" can be adopted to the design discharge for spillway.

The equation is

$$Qp = 235 \times A/\sqrt{A+22}$$

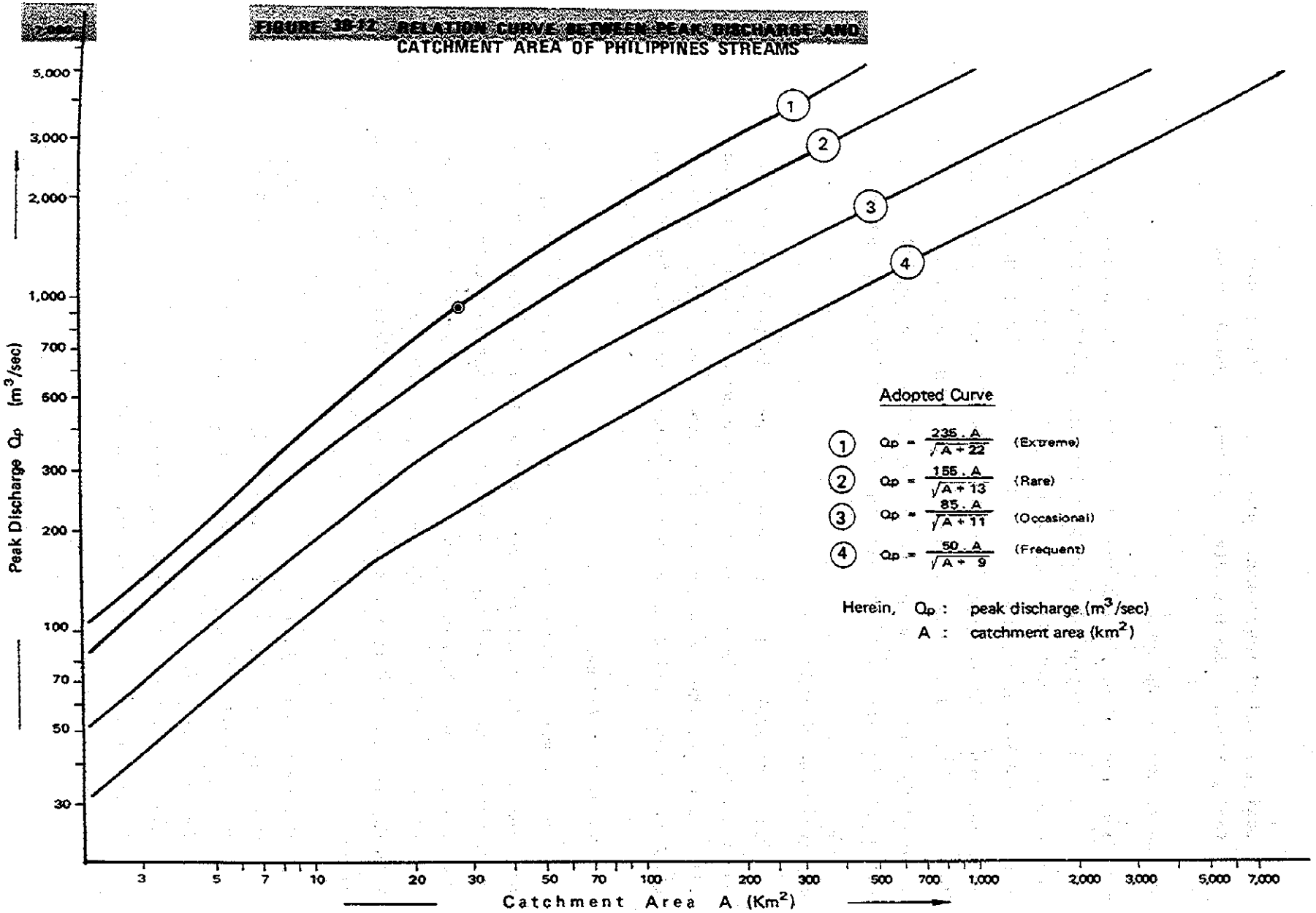
Therefore, the peak discharge for Pamacsalan dam and Malinao diversion dam sites are 930.6 cu.m/sec and 2,572.3 cu.m/sec, respectively. Comparing the results of the two equations, and importance of the structure, the peak discharge for Pamacsalan dam would be better to adapt the higher value of 930.6 cu.m/sec.

As for the Malinao diversion dam site, it has been found that the discharge from Bagun-an river, which is include in the catchment area of the Malinao diversion dam site, is quite small compared with the size of its catchment area. In addition, the peak discharge on 19th November 1964 has been checked from the river cross section, the average slope and flood mark obtained from the local people by Manning formula. The peak discharge would be about 1,100 cu.m/sec at the bridge site. Moreover, in future, the Pamacsalan reservoir can control the peak discharge in the upstream of the Malinao site.

Considering these condition and estimated flood peak discharge 1,600 cu.m/sec can be adopted to the design flood of Malinao diversion dam.

Consequently, the design flood of peak discharges for the Pamacsalan dam and Malinao diversion dam are decided as follows.

FIGURE 3D-12 RELATION CURVE BETWEEN PEAK DISCHARGE AND CATCHMENT AREA OF PHILIPPINES STREAMS



Design flood of Pamacsalan Dam: 930.6 cu.m/sec
Design Flood of Malinao Diversion Dam: 1,600.0 cu.m/sec

D. Water Quality Analysis

Two times of water sampling at the site have been made on 12th July 1975 and 18th September 1977. The water quality analysis have been conducted at the Laboradory Services Division of the Bureau of Soil for the former samples and at the Bureau of Public Works for the later samples. The results of the water quality analysis are shown in Table 3B-20. According to the results of the analysis, no peculiar chemical contents have been found in the river water and it can be conducted that the water is quite suitable for irrigation purpose.

E. Sediment Analysis

It is desirable that the sediment storage in the reservoir is estimated by the observed data such as suspended and bed load in the site. However, the available data of sediment and runoff can not be obtained for the periods of before and during the Feasibility Study.

1. Calculation Methods

The sediment storage in one hundred years of reservoir life would be assumed with the following mentioned of four different methods and these methods were consist of the statistical analysis with the relation between the affecting factors of sediment storage and obtained data of the existing reservoir except for the observed water samples method. The basic data for the culculation are shown in the following table.

Catchment area (km^2)	28.0
Max. elevation in catchment area (EL. m)	720,783
Min. elevation in catchment area (EL. m)	190
Relief amount (m)[1/]	561.5
Average elevation in catchment area (EL. m)[2/]	470.8
Length from max. elevation point to site (m)	7,700

Table 3B-20 Results of Water Quality Analysis

Date of Sampling: 18th September 1977

Sample Number	Bagun-an River	Pamacsalan River	Confluence of Wahig and Pamacsalan	Wahig River	Binabae River
PH	7.6	7.4	7.4	7.25	7.4
Chloride (ppm)	21	20	19	17	16
Calcium (ppm)	60	32	60	52	80
Hardness ($CaCO_3$) (ppm)	190	180	190	220	200
CO_3 (ppm)	0	0	0	0	0
HCO_3 (ppm)	195	190	211	217	253
Total Alkalinity	160	156	173	178	207
TDS 1/ (ppm)	240	240	260	260	253
Specific Conductance (mmho/mm)	370	370	400	400	390
Magnesium (ppm)	10	24	10	22	0
Potassium (ppm)	1.76	0.74	1.33	2.3	1.68

Note: 1/ TDS is Total Disolved Solid

Date of Sampling: 12th July 1975

Sample Number		Wahig River	Pamacsalan River
PH		7.82	7.91
Conductivity	(mmho/cm)	0.557	0.348
Total Soluble Salts	(ppm)	389.92	243.6
Residual Sodium Carbonate	(epm)	0.589	0.457
Chloride	(ppm)	28.902	19.268
Sulfate	(ppm)	28.5	Trace
Boron	(ppm)	Trace	Trace
Sodium percentage	(%)	12.69	8.55

Relief amount ratio 3/	0.073
Average annual rainfall (mm)	2,100
Reservoir capacity ($\times 10^3 m^3$)	31,300

1/ max. elevation in C.A.-min. elevation in C.A.

2/ 1/2 (max. elevation in C.A. + min. elevation in C.A.)

3/ releif amount/length from max. elevation point to site along runoff path.

(a) Design Criteria for Fill Type Dam's Method-----①

This method is assumed due to the table of specific sediment amount ($m^3/km^2/year$) as a function of the topography, geology and scale of catchment which was made up by the observed data of the catchment area less than one hundred square kilometers, prepared by the Ministry of Agriculture and Forestry in Japan. Taking into account for the mature stage of the topography and the reservoir basin consists mainly of the alternation of shale and sandstone formation where will be possible to the occurence of the land sliding in reservoir filling, the specific sediment amount is assumed of 350 cubic meters per square kilometer per year (350 $m^3/km^2/year$) by the above mentioned table.

(b) Kira's Method -----②

This method can be obtained from the following equation.

$$\gamma = 0.00012 \ (x \ \Gamma/C)^{0.868}$$

$$q_s = C \cdot \gamma / \Gamma \ (m^3/km^2/year)$$

herein, γ; average yearly sediment percent (%)

x; relief amount (m)

Γ; catchment area (m^2)

C; reservoir capacity (m^3)

q_s; specific sediment amount ($m^3/km^2/year$)

(c) Multiple Regressional Analysis Method -----③

This method is assumed from the following equation.

$$\log q_s = -3.198 - 0.2059 \log\Gamma + 0.9687 \log\bar{R} + 1.213 \log Me + 0.6757 \log\bar{X}$$

herein, q_s; specific sediment amount ($m^3/km^2/year$)
F; catchment area (km^2)
$\overline{R}$; average annual rainfall (mm), $\overline{R}$ is 2,100mm adopted
Me; average elevation in catchment area (m)
$\overline{X}$; relief amount ratio

(d) L.C. Gottschalk's Method ----- ④

This method can be obtained from the following equation.

$$Qs = 0.0552C + 0.0027F + 0.2681T - 1.7974$$

herein, Qs; total sediment accumulation in acre-feet
F; catchment area in acres
T; age in years. (T is 100 years adopted)
(1 acre = 4,046.72m^2, 1 acre-feet = 1,233.4 m^3)

2. Calculation Results

The calculation results of the above mentioned methods are shown in the following table.

	① Method	② Method	③ Method	④ Method
$q_s(m^3/km^2/year)$ 1/	350.0	296.5	184.9	602.8
$Qs(x10^3m^3)$ 2/	980.0	830.2	517.7	1,687.8

1/ specific sediment amount
2/ sediment storage Qs = 100·sq·F, F; catchment area (km^2)

According to the above mentioned methods, the estimated specific sediment amount of the Pamacsalan dam was scottered on the wide range, however the most of them located on the comparative low side. This is due to the general geological conditions of the Pamacsalan dam basin and featuring mature stage of the topography which does not favour erosion and also can be understood judging from the existing deposit condition along the river course and densely vegetated slopes conditon.

3. Sediment Storage

For the design purpose, a specific sediment amount of 350 cubic meters per square kilometer per year (350 $m^3/km^2/year$) was intermediately assumed, and to this value some of 50 cubic meters per square kilometer per year were added, considering for geological condition of the reservoir basin. The total specific sediment amount was therefore fixed at 400 cubic meters per square kilometer per year, corresponding to the about 40,000 cubic meters per square kilometer in one hundred years.

Over the one hundred years of reservoir life, the sediment storage and corresponding to elevation in the reservoir of the Pamacsalan dam can be fixed as shown in the following table.

Dam	Catchment area (km^2)	Sediment storage ($\times 10^3 m^3$)	Corresponding elevation (EL. m)
Pamacsalan	28.0	1,120	207.5

SOIL AND LAND CLASSIFICATION

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B. The project area

C. Geology and parent materials

D. Topography

E. Land use
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   2. Farm land
      a) Paddy field
      b) Upland field
   3. Coconut field
   4. Grassland

F. Soil classification and description
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   2. Canlangit series
   3. Ubay series

G. Physical and chemical properties
   1. Soil texture
   2. Soil depth
   3. Permeability under flooding
   4. Soil structure
   5. pH in soil
   6. Cation exchange Capacity (CEC)
   7. Organic matter
   8. Phosphorous
   9. Nitrogen

H. Land classification for irrigation paddy field
   1. Basic specification
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SOIL AND LAND CLASSIFICATION

A. Introduction

The Soil Survey has been conducted to clarify the following items:

1) To review the soil survey report conducted in the Project Area
2) To re-examine the present soil condition
3) To collect the necessary data for the feasibility study
4) To collect the soil samples for laboratory analysis

As to the field survey, topographic map with the scale of 1:10,000 and soil map prepared by NIA were used as the base mpa. And also the soil survey report on Wahig-pamacsaln Project and relvant data were collected for the study.

During the field survey, land use survey, boring test, test pit digging and soil sampling were conducted and necessary data and information were collected.

B. The Project Area

The Project Area under study comprise about 7,300 ha and is bounded in the north by national highway No.3 from Carmen to San Migel, in the east by hill line at the edge of the Project Area, in the south by the proposed dame sites of Pamacsalan and in the west by the Wahig River and national highway from Sierra Bullones to Alicia.

The manicipalities to the Project Area are Sierra Bullones, Pilar, Dagohoy, San Miguel and Alicia, and the Project Area comprises 24 Barrios as the administrative unit.

The Project Area can be divided into the Upper area and Lower area. The Upper area is situated at the south from Sieria Bullones-Pilar line under the proposed dam sides and the Lower area is situated in the north

between the Pilar-Alicia and Dagohoy-San Migel national highways.

The Project Area is drained by the Wahig River and its many tributaries. Upper stream of the Wahig River and the Pamacsalan River are the main stream which drains the Upper area. The central to east portions of the Lower area are drained by the Malltag River and Camanaga Creek through minor intermittent stream channels. The southern portion of the Lower area is drained by the Wahig River through its minor tributaries.

C. Geology and Parent Material

The Project Area is underlain by limestone and sedimentary rocks (shale, sandstone, slabby to calstic limestone beds, siltstone, mudstone and marl). Generally, they are low dipping and interbeded with each other and assume a highly tuffaceous nature. The soils of the Project Area is derived from these formations.

Outlines of geological feature of Project Area is divided into the Upper and the ower area. The Lower area is covered with the soils originated from shale, sandstone and mudstone, while most of the Upper area lies in a limestone area.

D. Topography

The topography of the Project Area shows somewhat different feature between the Upper and Lower area. The Upper area comprises flat or almost flat river terrace along the Wahig River and gently sloping Valleys and undulating to rolling terrain spreaded between the river terrace areas and the project boundary with the elevation from 145 to 240 meters.

On the other hand, the elevation of the Lower area is between 100 and 145 meters in average. The area undulates as far as the eye can be see and linked with undulating, almost flat and depressions. Most of slightly deep and narrow depression areas are formerly creeks and provide the run-off channels draining the area.

E. Land Use

1. Introduction

The hectares of whole Project Area is 7,300 ha, of which 2,000 ha is used as the farmland and remaining 5,300 hectares comprises grassland, creeks, roads, residential area and others.

Most of paddy fields in the Upper area have been operated under the communal irrigation system, while paddy fields of the Lower area are under the rainfed condition with few exceptions. The farmlands are mainly used for paddy rice cultivation and followed by coconut, corn, cassava and other upland crops.

From the present situation of land use, it appears that one of the major constraints of intensive agriculture in the Lower area is the lack of irrigation system. On the other hand, the Upper area seems that there are no major constraints for paddy rice cultivation from the point of irrigation agriculture except lack of drainage system. Table 3B-21 shows the present land use situation by soil mapping unit, and also present situation of land use is shown in Figure 3B-13.

2. Farmland

As a rule, the lowlying parts, depression (mainly formerly creeks) and strips along the active rivers and creeks are used for paddy field under the rainfed condition except small areas by pumping irrigation. The higher portions which situated on undurating area are used for mainly coconut and upland crops (corn, upland rice, cassava, and etc.). The above mentioned situation is generalized land utilization pattern of the Lower area. On the other hand, the land utilization pattern of the Upper area is somewhat different from the pattern of Lower area. That is, most of the area have been used as irrigated paddy field due to prevalence of the communal irrigation system.

a) Paddy Field

In the Upper area, most of the soils belong to Canlangit soil with

Table 3B-21 Present Land Use by Mapping Unit

(unit: ha)

	Project Area	Paddy Field			Upland Field			Coconut Field	Glassland[6]	Village Area	Others[7]	Total
		PrI[3]	Pr[4]	Total	Rice	Others[5]	Total					
Upper Area												
CnB[1]	164	132	8	140				3	-		21	164
C	54	38	7	45				-	-		9	54
D	62	19	34	53				3	4		2	62
E	54	0	10	10				-	41		3	54
Sub-total	334	189	59	248	-	-	-	6	45	-	35	334
UbB[2]	96	75	7	82	-	-	-	2	4	-	8	96
UbC	102	81	5	86	-	-	-	2	-	-	14	102
UbD	104	29	14	43	-	3	3	6	19	-	33	104
UbE	64	20	7	27	-	-	-	1	20	-	16	64
Sub-total	366	205	33	238	-	3	3	11	43	-	71	366
Total	700	394	92	486	-	3	3	17	88	-	106	700
Lower Area												
UbB	2,271	29	361	390	213	4	217	64	1,525	3	72	2,277
C	1,313	12	456	468	33	2	35	30	760	6	14	1,313
D	2,059	26	36	62	41	3	44	74	1,817	23	39	2,059
E	957	7	115	122	-	-	-	9	790	4	32	957
sub-total	6,600	74	968	1,042	287	9	296	177	4,892	36	157	6,600
Total	7,300	468	1,060	1,528	287	12	299	194	4,980	36	263	7,300

Notes:
1/ Cn. ... Canlangit soil series; Ub. ... Ubay soil series
2/ B... 1-2 % slope; C ... 2-3 % slope; D ... 3-5 % slope; E ... 5-7 % slope
3/ PrI ... Irrigated paddy field
4/ Pr... Rainfed paddy field
5/ Otehrs ... Upland crops (mainly corn, cassava, etc.)
6/ Grassland ... Scattered minor field of upland crops are included
7/ Others ... Some of homestead area, road, creek, and etc. are included

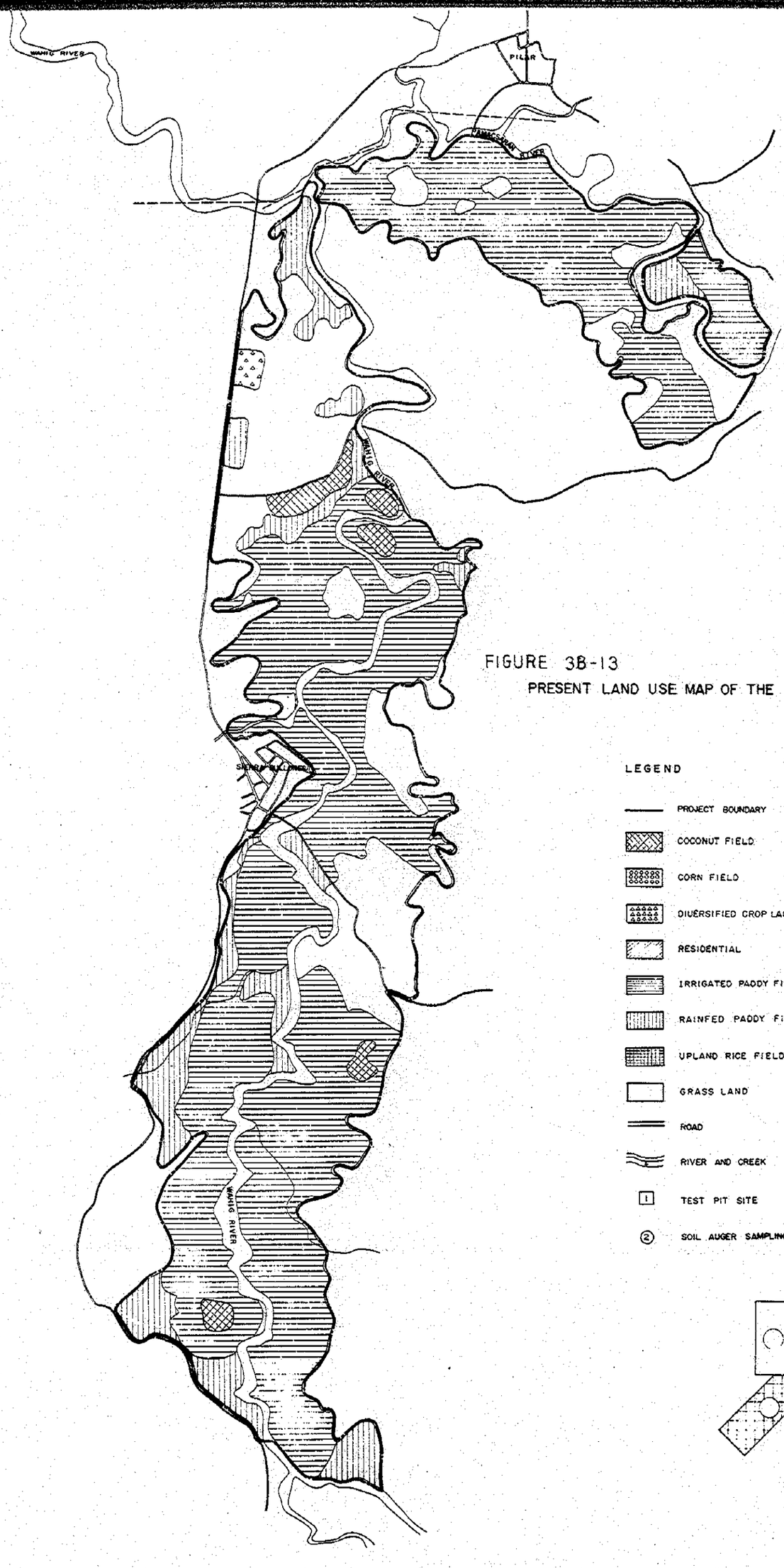
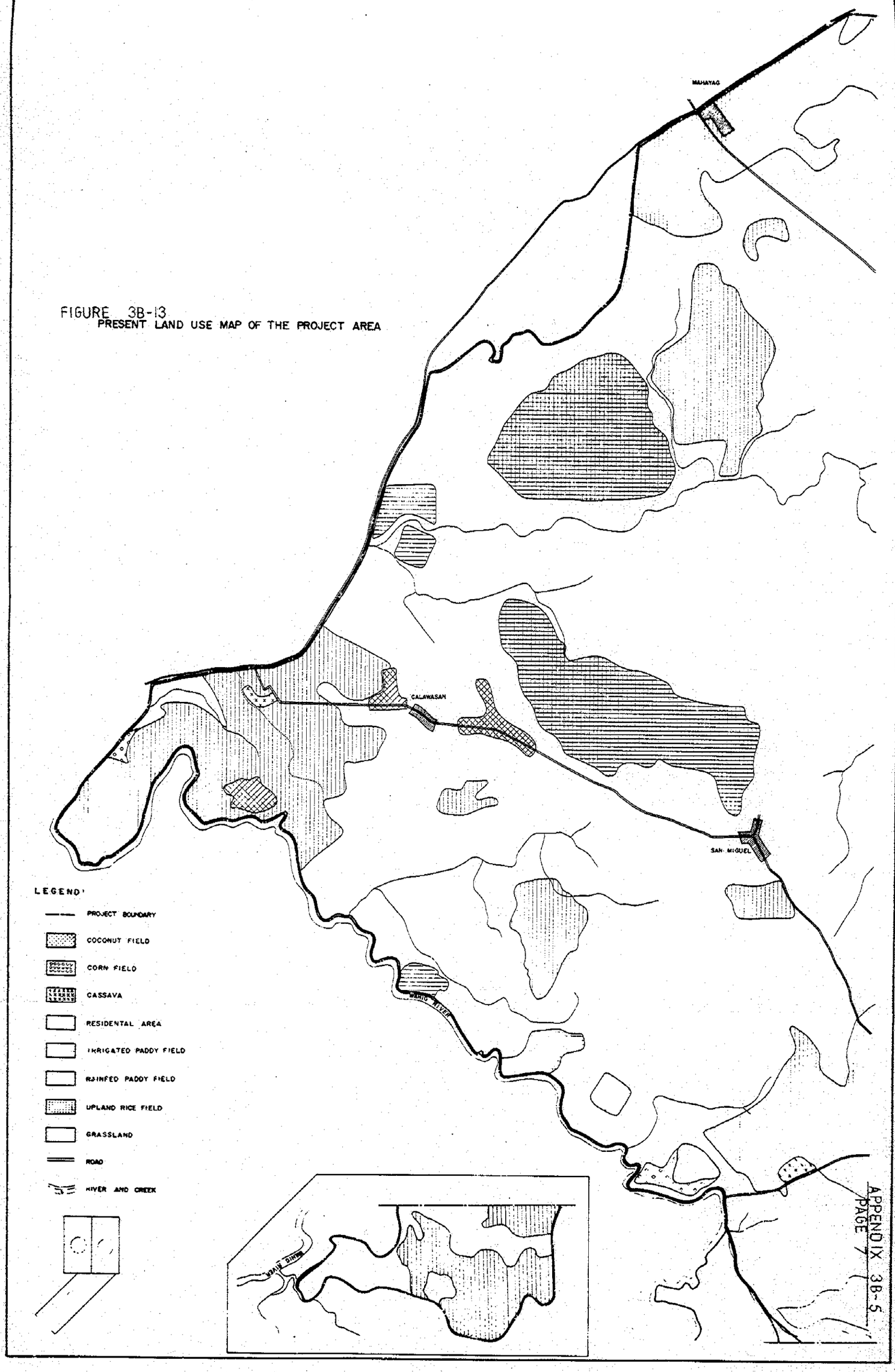
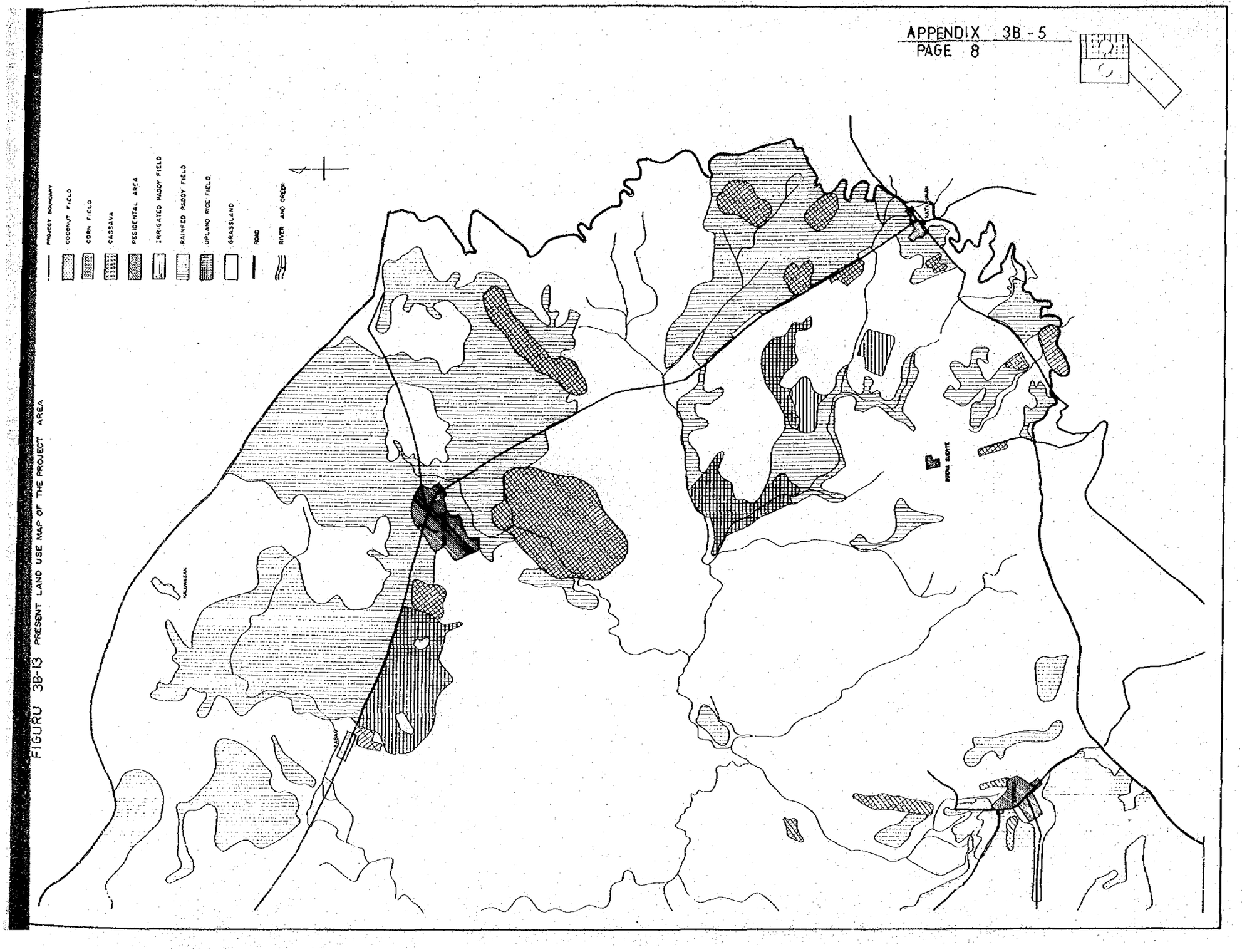


FIGURE 3B-13

PRESENT LAND USE MAP OF THE PROJECT AREA

FIGURE 3B-13
PRESENT LAND USE MAP OF THE PROJECT AREA





FIGURU 3B-13 PRESENT LAND USE MAP OF THE PROJECT AREA

slightly slow drainage and paddy fields are extended not only on the river terraces but also on the top of higher terraces. Existing 486 ha of paddy fields in the Upper area comprise 394 ha of irrigated and 90 ha of rainfed paddy fields. On the contrary, out of 1,042 ha of paddy fields, only 74 ha of paddy fields are under the irrigation in the Lower area.

In the Lower area, most of the lowlying portions, depressions and river or creek sites are utilized for paddy rice cultivation under the rainfed condition. Prevailed cropping pattern is one paddy rice a year system during the wet season. Some of paddy fields, however are used for paddy rice even in the dry season, expecting the unexpected rain during the dry season. According to the rainfall data at Daghoy, the precipitation is about 900 mm in total from November to March. Therefore, it assums that the farmers are going to plant paddy rice as the second crop even cannot expect enough rain and good yields from the second paddy rice.

b) Upland field

In generally, higher parts on slightly undulating portions are used for upland crop such as corn, upland rice and cassava. Corn is harvested three times a year as the general case. About 300 ha of upland fields are found in the Project Area. Most of them are in the Lower area and used for upland rice followed by corn and cassava. In the Upper area small size upland fields are scattered on river side areas or high portions.

3. Coconut field

As a rule, coconut is planted under the plantation system on the somewhat higher portions than paddy field and upland field. In some portions, coconut fields with corn or cassava are found, especially in the vicinity of homestead area.

4. Grassland

There are vast non-utilized grassland throughout the Lower area. This grassland occupies not only on higher undulating portions but also on lowlying portions and it totals about 4,900 hectares (74 % of Lower area). In general, these lands are covered with natural vegetations such as Cogon or Talihib and used for grazing. However, there are many scattered fallow grassland which are found on transitional portions between lowlying area used for paddy rice and higher portions on slightly sloping area. These lands to be used for paddy rice have a dike, but they lie fallow as grassland at present time. The similar land utilization pattern is found on grassland which situated on high undulating portions, where corn or cassava had been planted.

F. Soil Classification and Description

1. Introduction

Canlangit and Ubay series were found in the Project Area. Canlangit soil is found in the Upper area and contains large amount of very fine $CaCo_3$ particles originated from limestone. Therefore, this soil can be distinguished from Ubay soil by effervesence with 10 percent Hcl solution.

Canlangit soil is a member of the fine clayey moderately deep and somewhat poorly drained soils. Most of the soil is used for paddy field under the communal irrigation system.

The Lower area is occupied by the Ubay soil. This soil is also fine clayey, moderatly deep and slightly well drained. This soil characteristically contains somewhat large volume of gravels (3-6 mm) between the surface and 80 cm depth.

During the field survey, indurated irostone concretion horizon was found in the sample area B. This portion is about 0.2 ha, but

the presence of such ironstone concretions indicates that such a horizon may be present in elsewhere within the Lower area. Therefore, detailed survey would be needed prior to the detailed design stage.

Poor drainage paddy fields were found in depressions or lowlying portions throughout the area. This poor drainage seems mainly due to the presence of weathering shale and sandstone layer (from 1.5 to 2.0 m from the surface). Therefore, adequate drainage system would be needed in those portions. At present time, most of depressions (formerly creeks) have been utilized for paddy field. However, some of those portions will be converted into drainage canal to the Project. Therefore, careful consideration would be paid to these facts at the time of project implementation.

The extent of each soil mapping units in the Project Area are summarized as follows;

Soil Mapping Units in the Project Area

Soil Mapping Unit	Upper Area (ha)	Lower Area (ha)	Total (ha)	Percentage (%)	Major Vegetation
CnB	164	-	164	2.3	paddy rice
CnC	54	-	54	0.7	paddy rice
CnD	62	-	62	0.9	paddy rice
CnE	54	-	54	0.7	grassland
sub-total	334	-	334	4.6	
UbB	96	2,271	2,367	32.4	paddy rice, grass-land, coconut field.
UbC	102	1,313	1,415	19.4	
UbD	104	2,059	2,163	29.6	grassland, coconut-field
UbE	64	957	1,021	14.0	grassland
sub-total	366	6,600	6,966	95.4	
Total	700	6,600	7,300	100.0	

Distribution of these soils are shown in Soil Map. (Figure 3B-14)

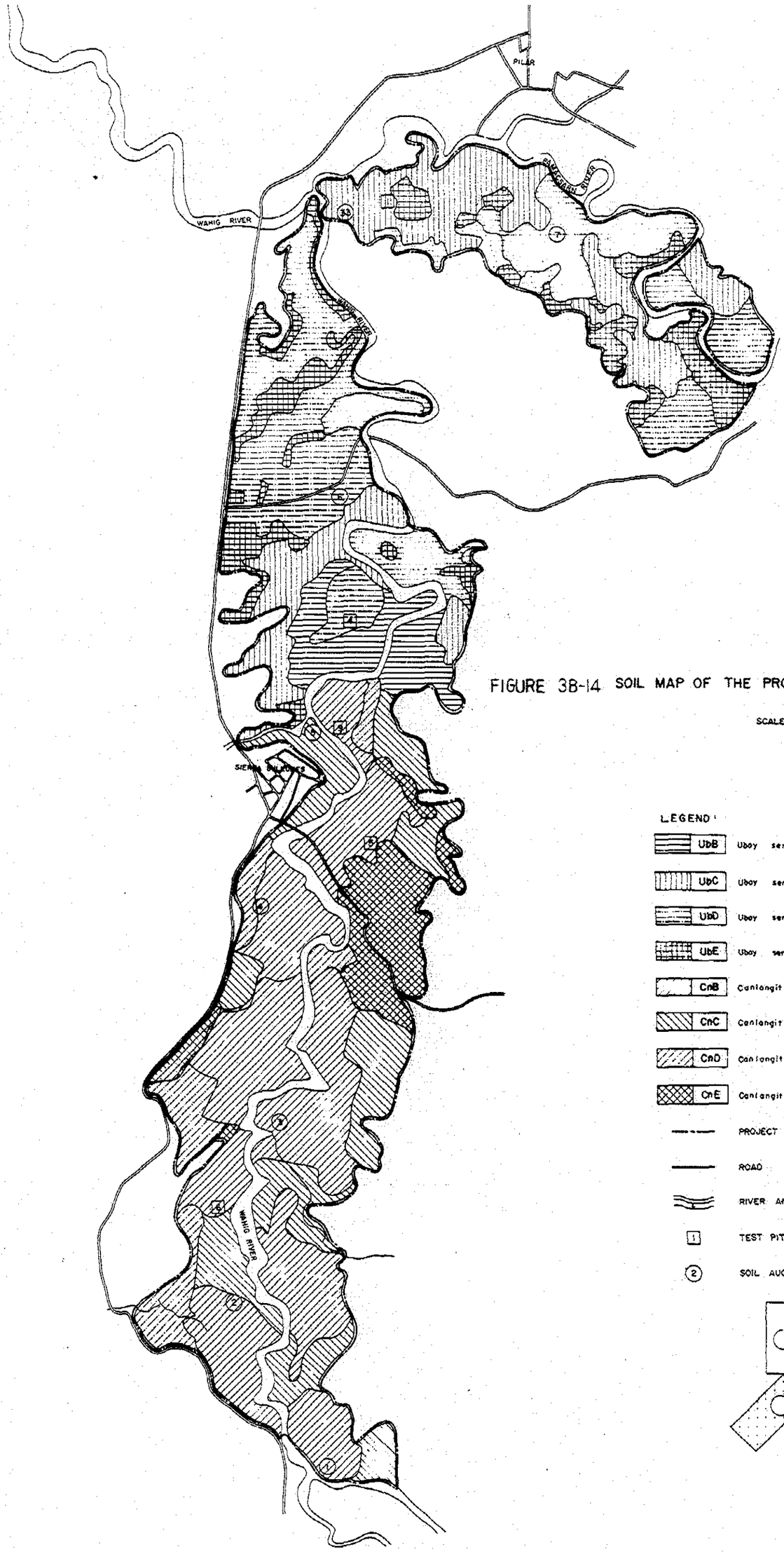


FIGURE 38-14 SOIL MAP OF THE PROJECT AREA

SCALE : 1 : 10,000

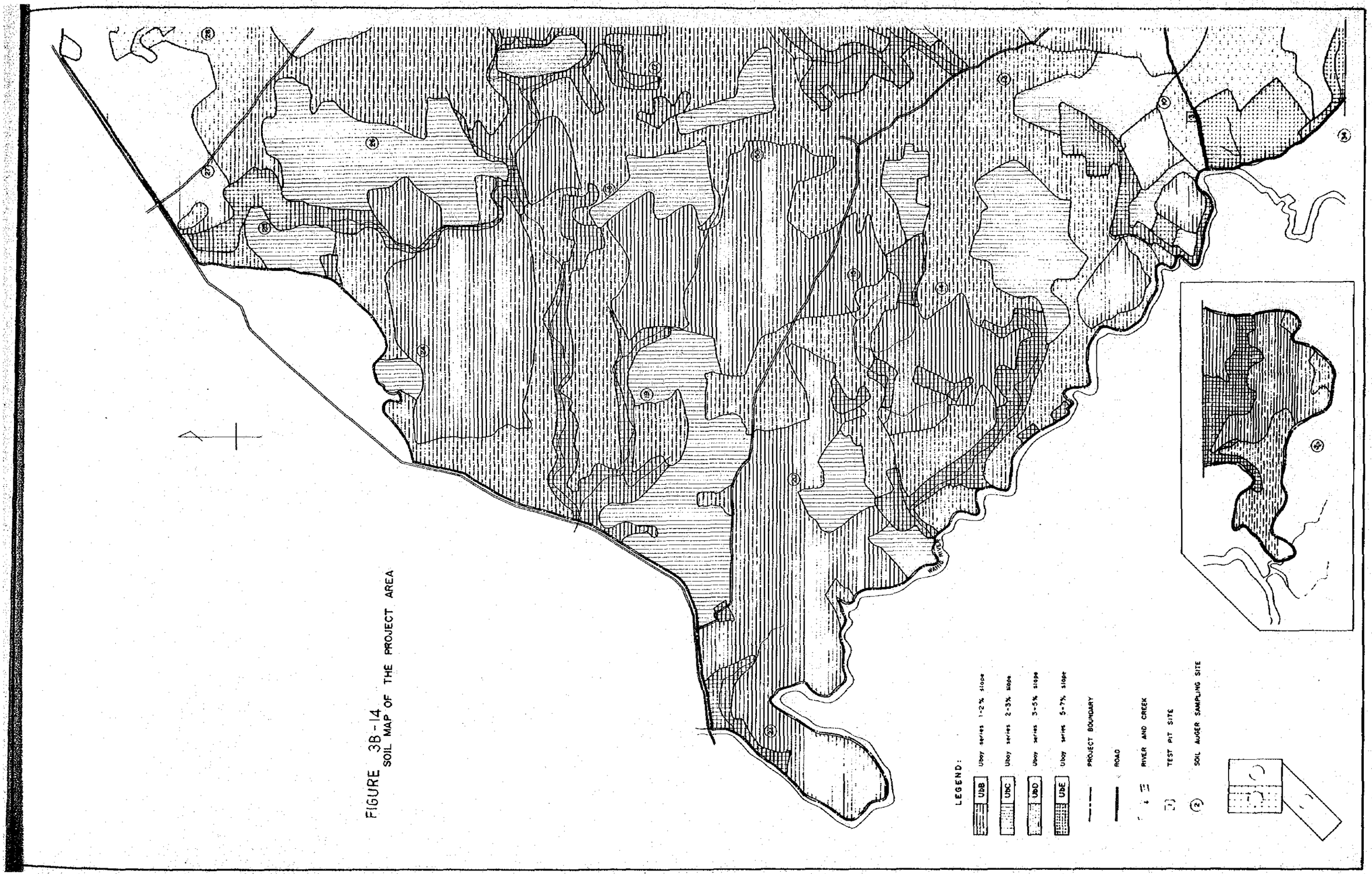


FIGURE 3B-14
SOIL MAP OF THE PROJECT AREA

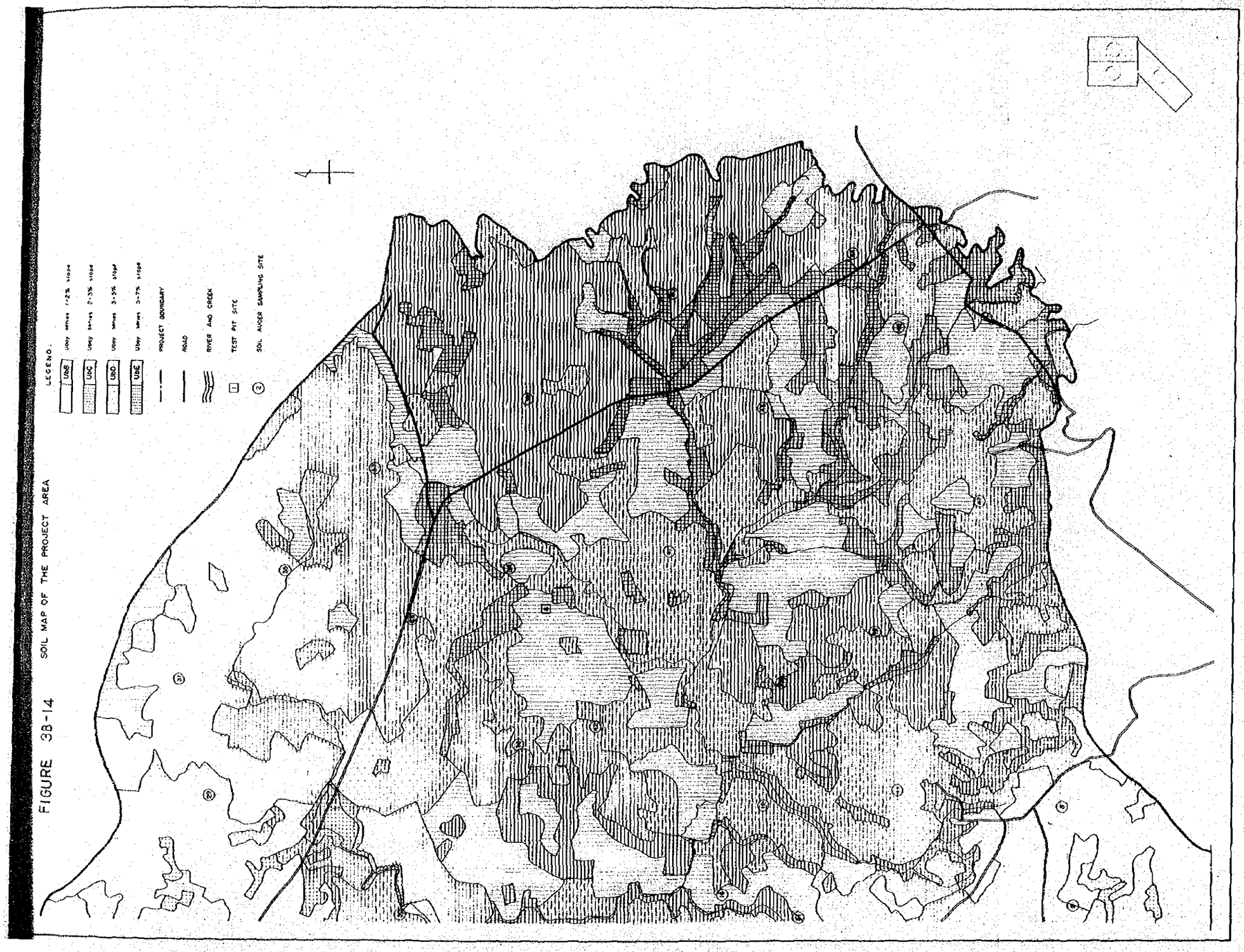


FIGURE 38-14 SOIL MAP OF THE PROJECT AREA

The prosedures of soil classification and soil map making were based on the criteria which established in the previous soil survey of this project conducted by B.S and NIA.

2. Canlangit series

This series is a member of the fine clayey moderately deep and somewhat poorly drained soils. A-horizones are dominantly gray, dark gray or grayish brown clay loam or clay with few to common yellowish brown, readish brown or dark brown mottles. B-horizones are dark yellowish brown or grayish brown clay with yellowish brown or gray mottles. C-horizones, on the other hard, are stratified dark greenish brown, olive gray or yellowish brown, sandy clay loam, silty clay or clay with few Fe concretions and gravels.

Canlangit soils are strongly effected by weathered limestone materials and many very fine white limestone particles are found throughout the horizons. Therefore, these soils are recognized from Ubay soils by their effervescence with 10 per cent hydro chronic acid solution (Hcl).

The relief is nearly flat on the river terrace to slopping on undulating portions. These soils covers the southern parts of Upper area. They are mainly used for paddy field under the communal irrigation system except for limited portions planted with coconut and other crops.

Four mapping units are adopted in this soil according to the soil survey Report (NIA, July, 1975). They are CnB (Canlangit clay loam 1.0 to 2.0 % slopes), CnC (Canlangit light clay 2.0 to 3.0 % slopes), CnD (Canlangit clay 3.0 to 5.0 % slopes), and CnE (Canlangit clay 5.0 to 7.0 % slopes).

CnB: These soils occur on nearly level to gently sloping, moderately dissected terraces. They are situated on a strip along the Wahig River. Most portions have profiles

similar to that described for the series. They are mainly used for irrigated paddy field.

CnC: These soils occur on gently sloping, moderately dissected low to medium terraces. They are found along Wahig River and its tributaries. They are also mainly used for irrigated paddy field.

CnD: These soils occur on gently sloping, undulating moderately dissected medium to higher terraces. They are found in the southern tip of the Upper area. Most of these soils are used for irrigated paddy field.

CnE: These soils occur on gently undulating, undulating moderately dissected medium to higher terraces. They are found mainly on adjacent areas to the project boundary and ridge of dissected terraces. Usually they are under grassland.

Diagramatic representations of the typical profiles are shown in Figure 3B-15 to 3B-17. The representative soil profile is shown as follows:

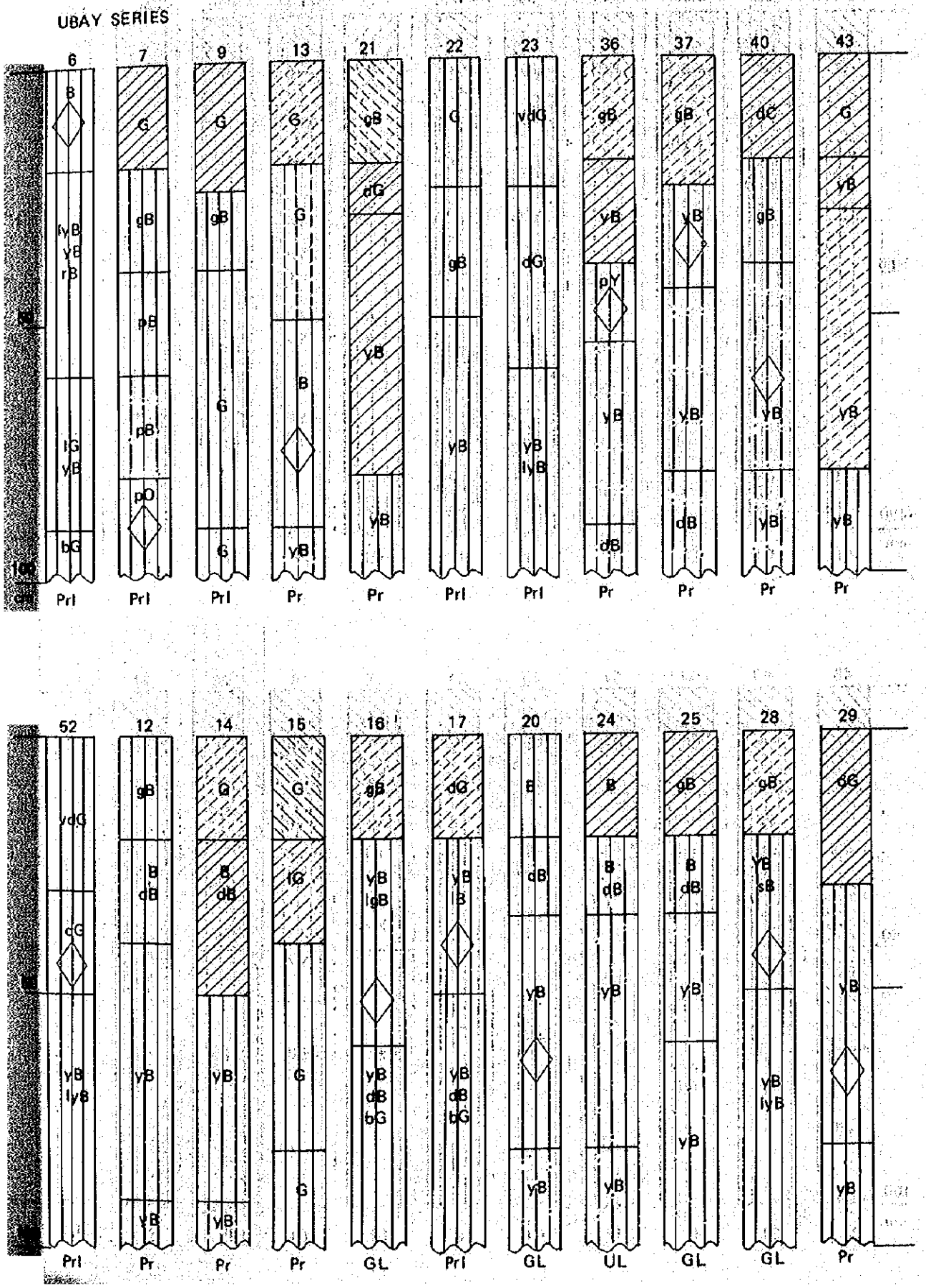
TEST PIT No.6

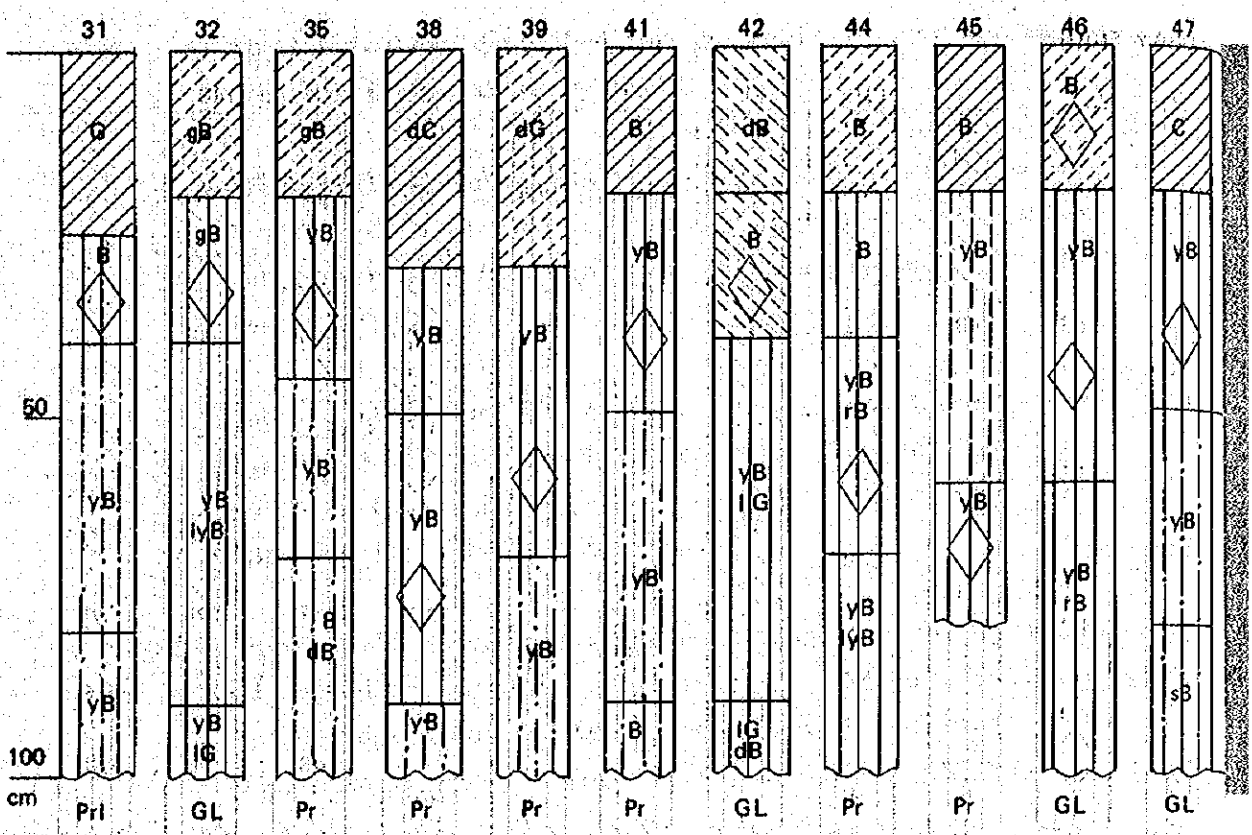
Location: San Jose, Sierra Bullones
Land use: Paddy field (irrigated)
Soil series: Canlangit

Profile description:

APg: 0 - 16 cm dark gray (10 YR4/1) moist, light clay, gleyed layer; weak medium angular brocky structure; very sticky, very plastic and friable; common fine to medium distinct red (2.5 YR4/5) filmy and tubular mottles; few shales and few gravels; common fine root; effervescence; abrupt smoth boundary; hardness 17 mm; pH: 7.8

FIGURE 3B-15 DIAGRAMATIC REPRESENTATIVE SOIL PROFILES BY SOIL AUGER TEST

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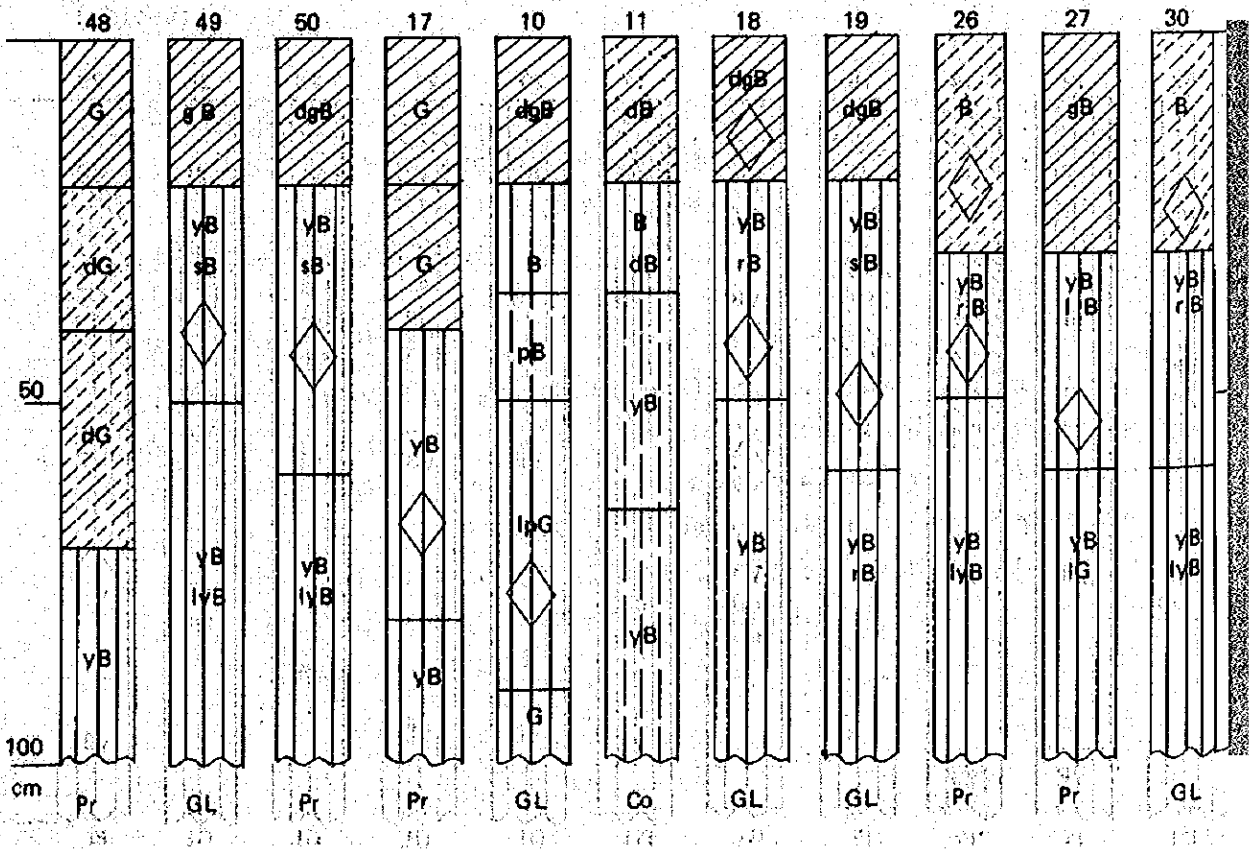
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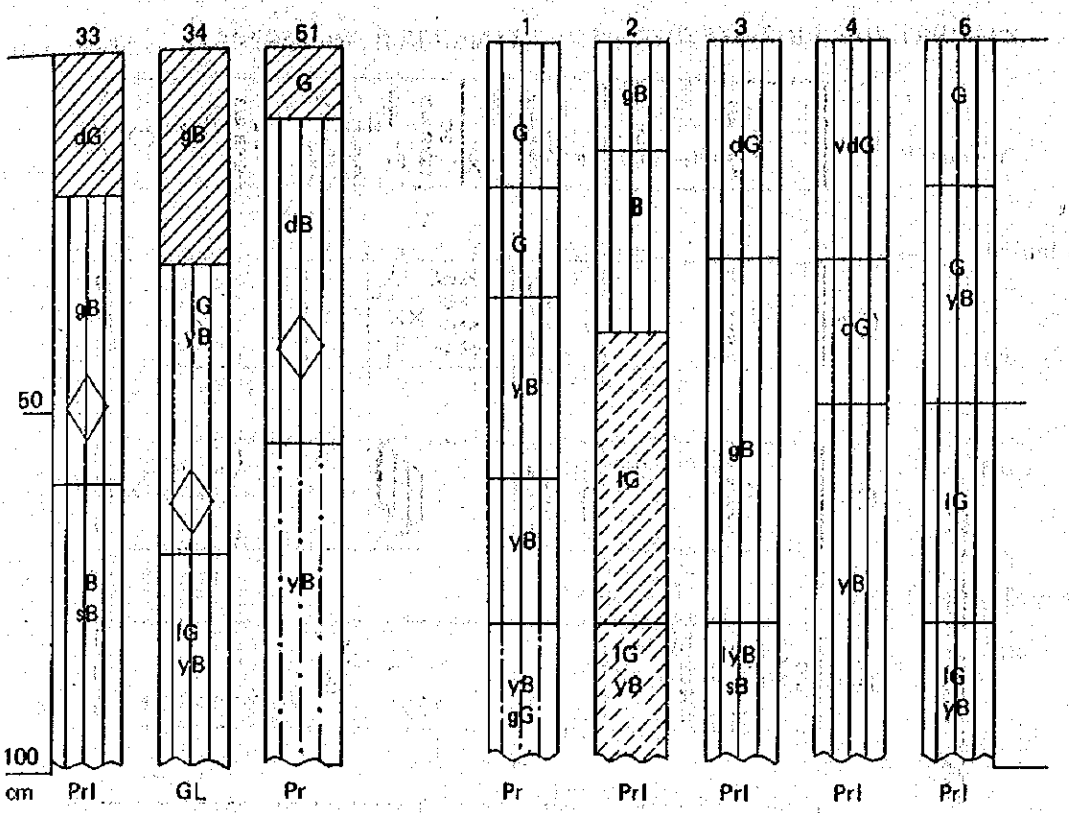
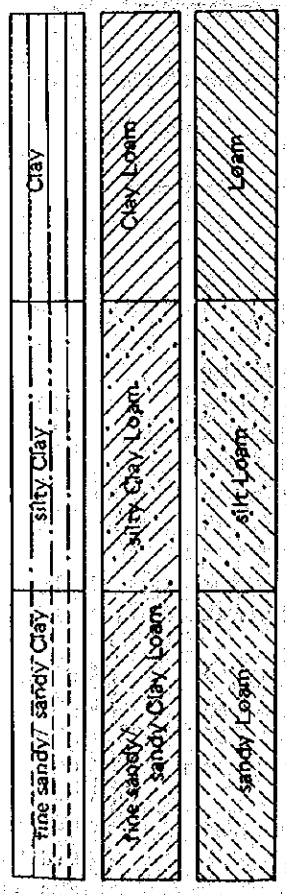
GL

CANLAGIT SERIES





LEGEND

PrI	:	irrigated paddy field
Pr	:	rainfed paddy field
UL	:	upland field
GL	:	grassland
Co	:	coconut field
◇	:	gravelly soils (mainly laterite concretions — 3 - 6 mm in length)
rB, dB	:	stratified layer
B	:	Brown
sB	:	strong Brown
dB	:	dark Brown
pB	:	pale Brown
lyB	:	light yellowish Brown
yB	:	yellowish Brown
rB	:	reddish Brown
gB	:	grayish Brown
dgB	:	dark grayish Brown
G	:	Gray
dG	:	dark Gray
vdG	:	very dark Gray
lG	:	light Gray
lbG	:	light brownish Gray
bG	:	blownish Gray
gG	:	Greenish Gray
pY	:	pale Yellow
Bl	:	Black

FIGURE 3B-16 DIAGRAMATIC REPRESENTATIVE SOIL PROFILES IN TEST PITS

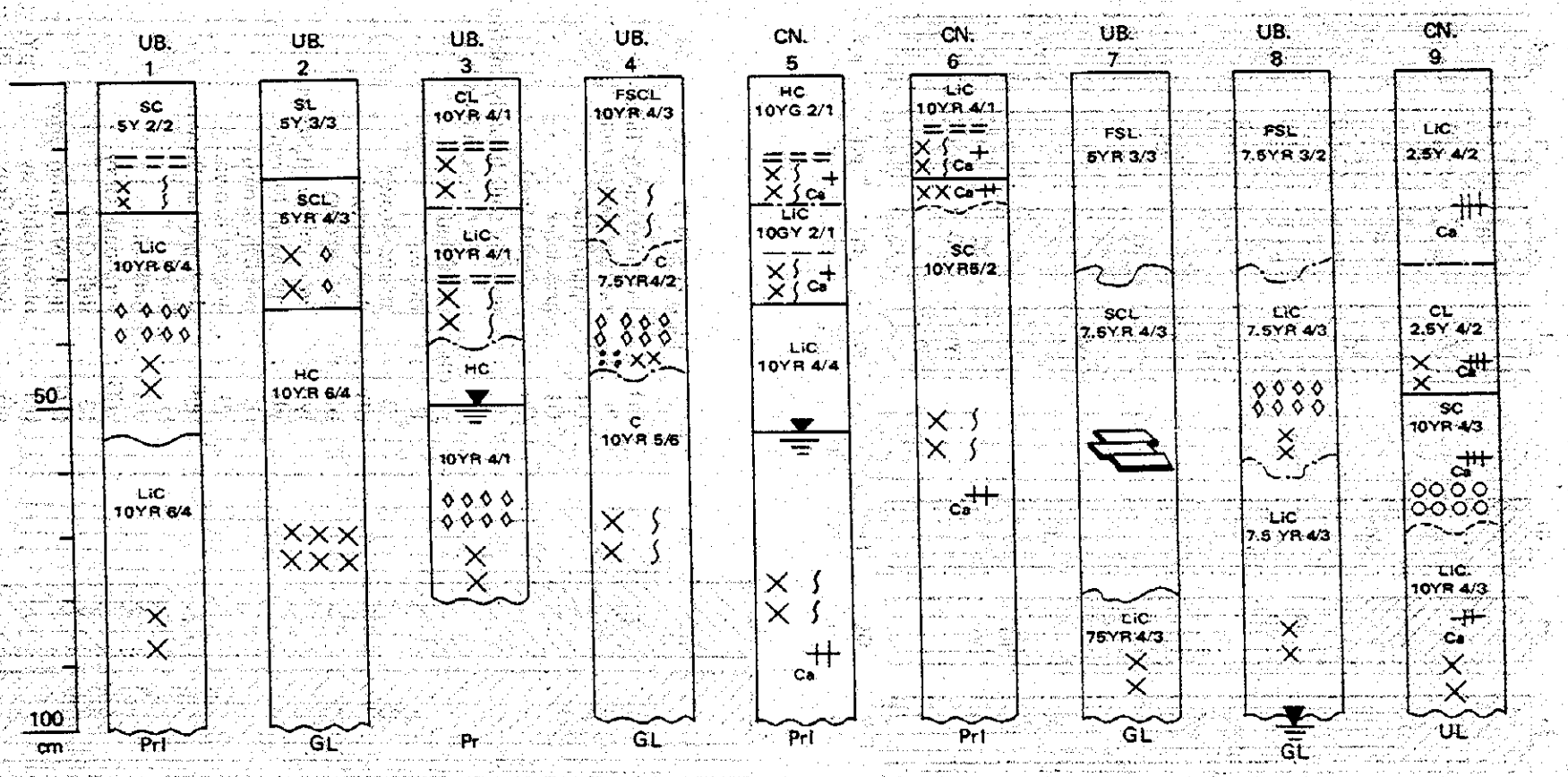
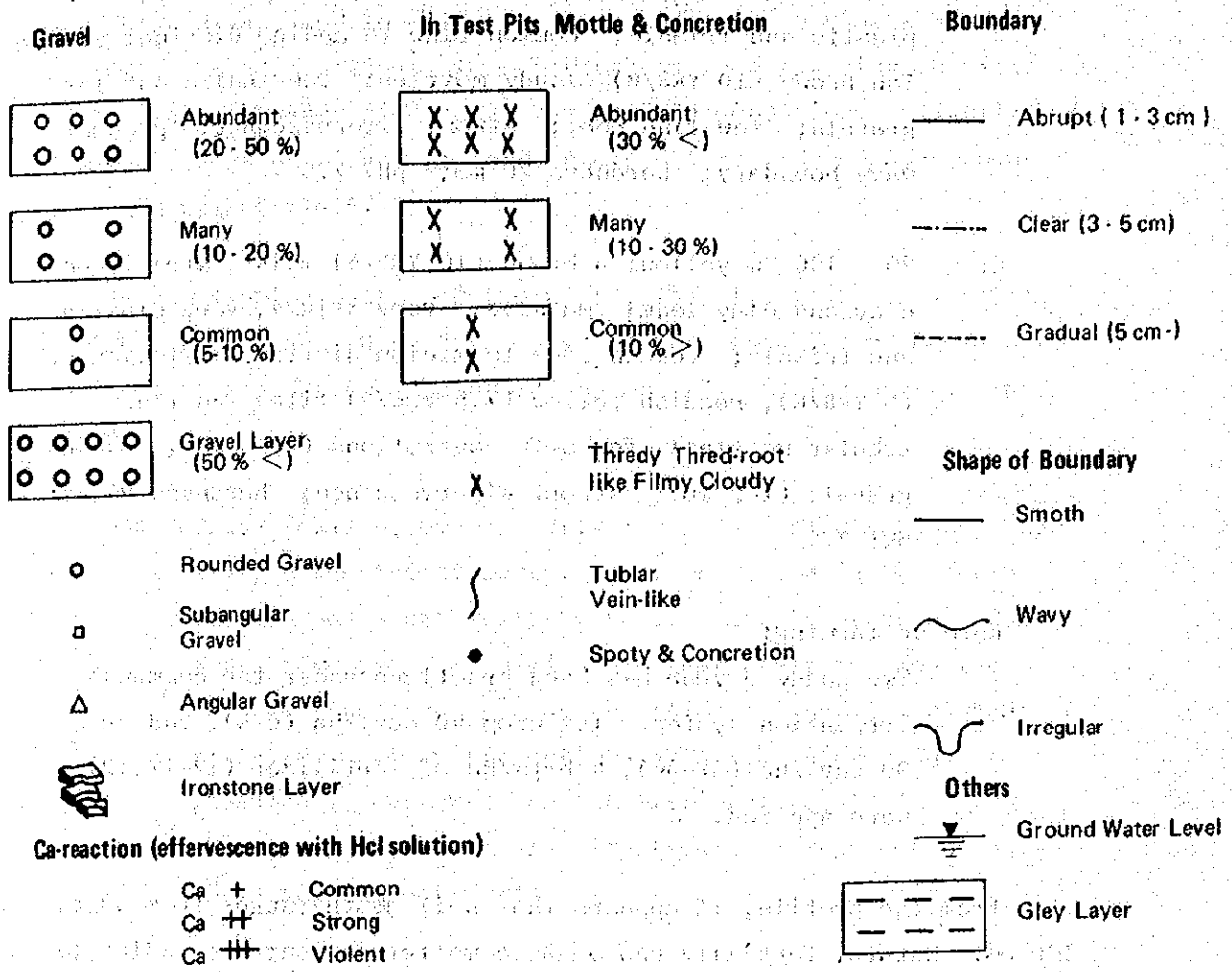


FIGURE 3B-17 LEGENDS OF DIAGRAMATIC REPRESENTATIVE OF SOIL PROFILES



C	:	Clay
HC	:	heavy Clay
SC	:	sandy Clay
LiC	:	light Clay
SCL	:	sandy Clay Loam
FSCL	:	fine sandy Clay Loam
CL	:	Clay Loam
SL	:	sandy Loam
FSL	:	fine sandy Loam

5YR4/3	:	reddish Brown
5YR3/3	:	dark reddish Brown
7.5YR5/8	:	strong Brown
7.5YR4/2	:	dark Brown
7.5YR4/3	:	dark Brown
7.5YR3/2	:	dark Brown
10YR6/4	:	light yellowish Brown
10YR5/2	:	grayish Brown
10YR5/6	:	yellowish Brown
10YR4/1	:	dark Gray
10YR4/3	:	Brown
10YR4/4	:	dark yellowish Brown
2.5Y4/2	:	dark grayish Brown
5Y2/2	:	olive Black
10GY2/1	:	greenish Black

B1: 16 - 20 cm. grayish brown (10 YR5/2) moist, sandy clay; weak medium angular brocky structure; very sticky, very plastic and friable; common fine to medium distinct yellowish brown (10 YR5/8) cloudy mottles; few shalls and few gravels; few fine root; strong effervescenct; gradual wavy boundary; hardness 20 mm; pH: 7.9

C: 20 - 100 cm yellowish brown (10 YR5/6) moist, stratified clay and clay loam; massive; very sticky, very plastic and friable; common fine to medium distinct yellowish red (5 YR5/8), reddish yellow (7.5 YR6/8) filmy and fine tubular mottles; few soft concretions (2-10 mm), common gravels (1-2 mm); strong effervescence; hardness 22 mm; pH: 7.3

note on farming:

Two paddy a year has been practiced under the communal irrigation system. 1st crop 40 cav./ha (C-4), 2nd crop 30 cav./ha (IR-36), 4 bags/ha of fertilizer (12-12-12) were applied.

From the profile, it appears that soil depth ranges from 50 to 100 cm. Natural fertility and organic matter content are medium to low but the cation exchange capacity and the base saturation are high.

3. Ubay series

Ubay series is a member of the fine clayey family, moderately deep, well drained soils. A-horizons are gray, grayish brown, dark grayish brown or brown to dark brown clay loam, silty clay loam, sandy clay loam, sandy loam or clay. B-horizons are chiefly yellowish brown, brown to dark brown, bright brown gravelly clay or clay loam with Fe concretions. C-horizons are stratified yellowish brown, brown to dark brown, bright brown, greenish gray or gray silty clay, clay or sandy clay with few Fe concretions and gravels. Where used for paddy fields, A-horizons are deminantly gray or dark gray.

The Lower are is occupied by Ubay soils and occupied hectarage is 6,600 ha. The relief is linked with undulating, almost flat and depression areas; and locally, surface gradients vary between 2 to 7 per cent. The depressions, formerly creeks, and lowlying portions are mainly used for paddy rice under the rainfed condition. Slightly higher portions or ridges of terrace are mainly grassland, coconut field and upland field.

As the mapping unit, UbB (Ubay clay loam 1.0 to 2.0 % slopes), UbC (Ubay clay loam 2.0 to 3.0 % slopes), UbC (Ubay clay loam 3.0 to 5.0 % slope) and UbE (Ubay clay loam 5.0 to 7.0 %) are adopted in the soil map.

UbB: These soils occur on nearly level to gently sloping moderately dissected terraces. They are found in the north eastern and south western areas of the Lower area. Most areas have profiles similar to that described for the series. They are used as the rainfed paddy field where situated on lowlying portions, and remaining areas are grassland, scattered coconut field and upland field. These landuse status are almost same in the case of other three mapping unit area.

UbC: These soils occur on gently sloping, moderate dissected low and medium terraces. They are mostly found on central and boundary area of the Lower area. Land use situation is same as UbB.

UbD: These soils occur on gently sloping and undualting moderately dissected low and medium terraces. They are found on a strip in the central, northern and southern areas of the Lower area. Most area have profile similar to that described for the series. The landuse situation is same as in UbB and UbC.

UbE: These soils occur on gently undulating, undulating moderately dissected medium to higher terraces. Usually these lands occur on side slope of creeks which is natural drainage channels of run-off water throughout the Lower area. And also they are found on the edge of southern parts of the Lower area. Some of them are used for non-irrigated paddy fields but most of them are left under grassland and waste land.

Soil profiels of these soils are shown as diagramatic representation in Figure 3B-15 to 3B-17. The representative soil profile is shown as follows;

TEST PIT No.8

Location: San Isidro, Pilar
Land use: Grassland
Soil series: Ubay

Profile description:

A1: 0 - 30 cm dark brown (7.5 YR3/2) most, fine sandy loam; medium angular brocky structure; sticky, plastic and friable; few fine distince strong brown (7.5 YR5/8) fine tubular mottles; few gravels and concretions; many fine root; clear irregular boundary; hardness 20 mm; pH: 5.3

B2: 30 - 60 cm dark brown (7.5 YR4/3) moist, stratified gravelly clay loam and fine sandy clay loam; common fine to medium distinct light brownish gray (10 YR6/2) filmy mottles; few concretions; common fine root; clear irregular boundary; hardness 20 mm; pH: 5.7

C: 60 - 100 cm strong brown (7.5 YR5/8) moist, light clay; massive; sticky, plastic and friable; common fine distinct reddish yellow (7.5 YR6/8) cloudy mottles; few concretions; few fine root; hardness 19 mm; pH: 6.2

G. Physical and Chemical Characteristics

The summarized physical and chemical characteristics are as follows: (refer to Table 3B-22)

1. Soil Texture

Generally speaking, most of the soils in the Project Area belong to medium moderately fine textured soils. The distribution of surface and subsoils texture among different textural classes based on Figure 3B-16 is shown as follows;

Soil Series	Layer	Soil Texture							Gravelly			
		C	SC	CL	SiCL	SCL	SiL	SL	C	FSCL	CL	Total
Canlangit	Surface	5	0	0	0	0	0	0	0	0	0	5
	Sub-s.	5	0	0	0	0	0	0	0	0	0	5
Ubay	Surface	5	0	21	1	11	1	2	1	3	2	47
	Sub-s.	10	2	4	1	1	0	0	22	1	0	47

Above table shows general distribution of the soil textural classes is the Project Area. Figure 3B-18 shows the particle size distribution of surface and subsoils of representative soils collected from soil auger holes and test pits. From these data on soil texture, it can be summarized as follows;

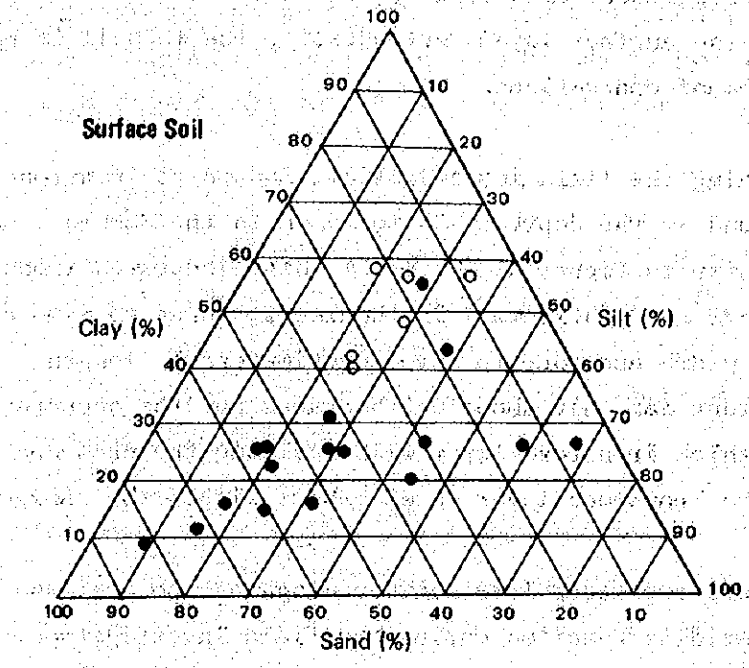
a) texture of surface soils of Canlangit series belong to fine clayey to fine loamy textured soils.
b) texture of subsoils of both soil series are fine clayey to fine loamy textured soils.
c) there is quite different characteristic between Canlangit and Ubay series. That is the presence of lateritic gravelly concretions in Ubay soils. At a depth of less than 80 cm, mostly between 20 to 60 cm, lateritic gravels are found in a layer of varying thickness from 20 to 40 cm. These gravelly concretions are amorphous shape and three to five millimeters in length. It looks like plinthite originated from lateritic material. Usually, these concretions are embeded in clay loam

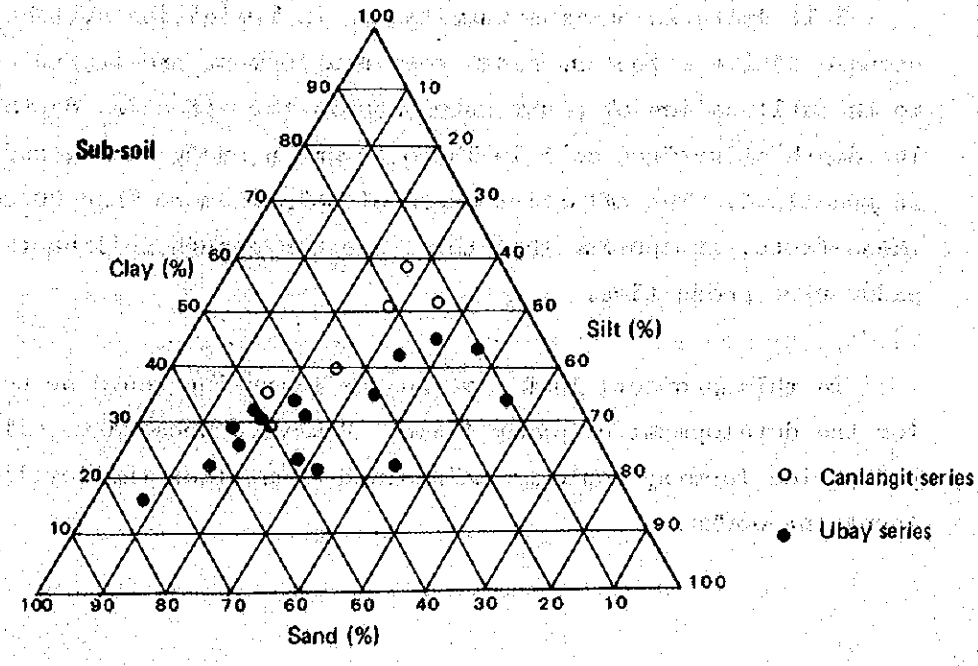
Table 3B-22 Physical and Chemical Properties of Soils in the Project Area

Sample No.	Moisture (%)	Particle Size Distribution: Coarse Sand (%)	Fine Sand (%)	Total Sand (%)	Silt (%)	Clay (%)	Texture	Humas (%)	PH H_2O	PH KCl	Exch. Acidity Y_1	Exchangeable Cation (me/100g): Ca	Mg	K	Na	CEC (me/100g)	Base Sant (%)	P-absorption Coefficient	Total N (%)	Available P_2O_5 (mg/100g)	Free Fe_2O_3 (%)	Free MnO (mg/100g)	T-Ca CaO (%)	T-Mg MgO (mg/100g)	T-Mn MnO (mg/100g)
1	6.3	20.72	36.49	57.21	17.02	25.77	SC	2.71	7.7	7.1	0.5 >	34.31	1.54	0.10	0.30	14.8	>100	250	203	1 >	2.03	90	2.13	0.53	128
2	6.9	20.03	31.96	51.99	13.43	34.58	Lic	0.49	7.7	6.5	0.5 >	16.69	1.69	0.08	0.17	16.4	>100	410	94	1 >	2.27	99	0.48	0.55	142
3	10.8	17.42	20.03	37.45	19.30	43.25	Lic	0.52	7.4	6.2	0.5 >	25.29	3.71	0.25	0.34	27.7	>100	650	78	1 >	3.52	96	0.69	1.01	166
4	2.8	22.38	44.33	66.71	18.74	14.55	SL	1.52	5.1	3.8	5.7	1.93	1.29	0.12	0.15	7.5	46.5	240	124	1 >	1.62	47	0.14	0.34	80
5	9.4	32.42	31.66	64.08	13.44	22.48	SCL	1.05	5.2	3.8	12.7	2.88	2.08	0.15	0.26	10.8	49.5	340	127	1 >	2.24	139	0.14	0.57	238
6	10.0	11.76	16.24	28.00	25.46	46.54	HC	0.60	5.7	3.8	21.0	13.63	10.39	0.17	0.46	29.5	76.7	650	77	1 >	4.61	44	0.33	1.64	72
7	2.4	3.63	57.04	60.67	23.13	16.20	CL	1.69	4.8	3.9	8.2	1.67	1.14	0.08	0.19	7.6	40.3	280	142	1 >	1.26	18	0.10	0.30	33
8	4.3	6.25	44.27	50.52	18.49	30.99	Lic	1.25	5.3	3.9	15.7	4.06	4.12	0.13	0.26	14.3	59.8	320	128	1 >	1.90	7	0.17	0.64	27
9	8.4	17.10	11.16	28.26	26.44	45.30	HC	0.62	6.0	4.7	0.5 >	14.55	15.02	0.23	0.30	28.1	>100	560	73	1 >	5.06	120	0.45	1.85	267
10	6.1	37.40	15.54	52.94	12.72	34.34	Lic	0.74	5.7	4.2	3.5	7.34	7.81	0.18	0.34	19.0	82.2	480	93	1 >	2.37	561	0.21	0.90	1,129
11	11.7	2.35	20.75	23.10	18.74	58.16	HC	3.46	7.4	6.6	0.5 >	52.02	4.69	0.19	0.32	40.9	>100	590	251	1.42	2.84	51	2.37	1.85	91
12	9.2	7.12	26.91	36.73	23.49	39.78	Lic	1.20	8.0	6.8	0.5 >	48.99	3.80	0.27	0.42	30.3	>100	340	130	6.88	2.77	107	9.04	1.72	146
13	6.6	6.00	42.24	48.24	22.95	28.81	Lic	0.61	8.1	6.9	0.5 >	42.05	2.77	0.16	0.27	22.5	>100	410	83	6.70	2.48	59	16.17	1.40	86
14	7.9	9.43	27.26	36.69	23.00	40.31	Lic	2.18	7.8	7.0	0.5 >	43.92	3.09	0.11	0.24	25.0	>100	410	191	3.05	3.63	103	5.57	1.05	190
15	7.3	14.45	33.96	48.41	17.19	34.40	SC	1.40	7.9	7.0	0.5 >	40.96	2.87	0.13	0.25	22.7	>100	410	135	3.03	3.81	113	5.78	1.10	202
16	12.6	5.81	12.78	18.59	18.05	63.36	HC	0.79	7.3	6.3	0.5 >	31.27	5.30	0.21	0.30	34.3	>100	810	86	1.07	5.15	11	0.83	1.19	30
17	1.3	37.38	44.41	81.79	9.13	9.08	FSL	2.31	4.8	4.0	6.9	0.63	0.23	0.07	0.15	4.7	23.0	70	87	2.85	0.88	33	0.02	0.11	42
18	2.6	43.13	33.21	76.34	7.78	15.88	SCL	0.29	5.5	4.3	2.1	2.31	2.25	0.06	0.16	6.5	73.1	70	61	4.17	1.68	139	0.05	0.26	150
19	7.3	29.15	13.32	42.47	18.00	39.53	Lic	0.32	6.1	4.8	0.5 >	9.97	12.44	0.19	0.40	22.6	>100	330	53	3.50	4.15	36	0.25	1.00	87
20	5.8	9.82	63.60	73.42	15.65	10.93	FSL	1.43	5.3	4.1	4.4	1.19	0.54	0.06	0.17	4.7	40.9	110	108	15.60	0.56	9	0.20	0.11	17
21	7.3	21.89	29.03	50.92	17.57	31.51	Lic	0.64	5.7	4.1	9.7	6.06	5.11	0.06	0.27	15.6	73.4	330	79	3.03	2.04	121	0.26	0.67	296
22	4.17	16.15	26.33	42.48	19.52	38.00	Lic	0.34	6.2	4.9	0.5 >	9.47	9.84	0.18	0.35	19.2	>100	390	42	1 >	4.67	14	0.31	0.81	34
23	5.7	5.56	30.10	35.66	21.72	42.62	Lic	1.63	8.0	6.8	0.5 >	47.21	3.77	0.47	0.25	29.8	>100	200	138	12.60	2.39	73	8.68	1.62	99
24	5.4	10.83	39.02	49.85	20.82	29.33	CL	1.09	8.1	6.9	0.5 >	41.52	3.07	0.29	0.25	23.4	>100	240	91	14.22	2.31	62	11.98	1.45	89
25	4.1	22.65	34.50	57.15	17.57	25.28	SC	0.99	8.1	6.9	0.5 >	38.40	2.63	0.27	0.24	19.3	>100	240	92	15.33	1.90	31	13.71	1.32	64
26	5.2	4.10	42.99	47.09	22.13	30.78	Lic	1.30	8.0	6.8	0.5 >	42.05	3.00	0.30	0.24	22.9	>100	160	97	16.49	2.44	81	10.06	1.51	102

Note: The soil analysis was conducted by Soil Laboratory, Tokyo Agricultural University

FIGURE 3B-18 PARTICLE SIZE DISTRIBUTION OF SOILS





or clay which is brown to yellowish brown and generally shows a strong multicolored mottling. The presence of lateritic gravels at the depth of less than 80 cm is a diagonostics of this series. Occasionally, the lateritic gravels may occur in the surface layers but usually, the topsoil is relatively free of concretions.

d) During the field investigation, indurated ironstone layer was found at the depth of 30 to 85 cm in the Sample area IV-II. (refer to Figure 3B-16, No.7) These indurated ironstone are one to two centimeters in thickness, three to five centimeters in width and four to seven centimeters in length. That extent was only about 0.2 hectares but the occurrence of such a thick ironstone layer will indicate the presence of extensive ironstone layer in elsewhere within the Lower area.

e) There are recognized neither manganess concretions nor benzidine reaction during the field investigation.

2. Soil depth

Soil dpeth is an important factor in irrigation suitability becuase of its effect on plant root development and its relationship to the utilization of plant nutrients in the effective depth of soil. The depth of surface soil is 15 to 20 cm in paddy field, and 15 to 30 in grassland. The effective depth of soil is more than 50 cm. From these facts, it appears that this area has enough soil depth for paddy rice production.

In this project, land leveling or terracing would be necessary for the development of paddy field. However, necessary soil depth for paddy rice farming would be maintained even after the levelling or terracing works.

3. Soil Structure

In general, paddy fields have massive structure except field situated on higher portions. These fields have weak developed structure, mostly angular blocky structure. On the other hand, grassland or upland field have weak developed angular blocky or granular structure in shalower stratum and massive in deeper stratum.

4. Permeability under flooding

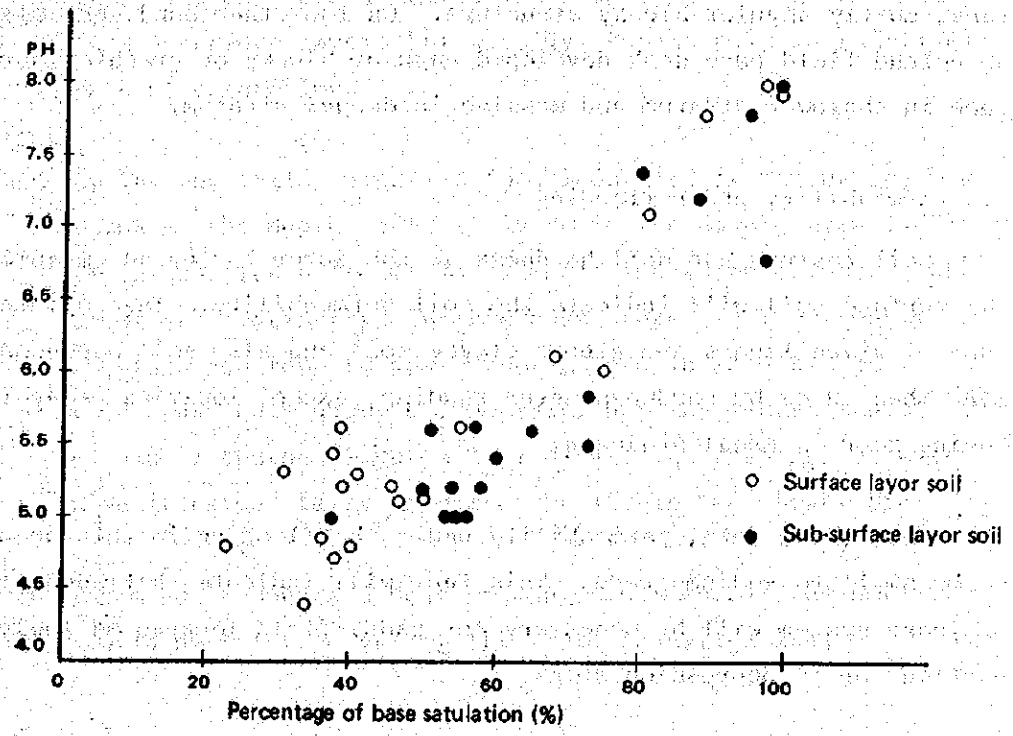
Soil texture and soil hardness at the layer laying 50 cm below the surface soil will indicate the soil permeability. The soil texture of given layers are almost clayey soil and also soil hardness are more than 19 cm by hardness meter reading, except lowlying paddy field having poor internal drainage.

From these data, permeability under the flooding in this area seems small to medium grade. This fact will indicate that adequate drainage system will be necessary for paddy field located on lowlying portions or in depression areas.

5. Soil Reaction

Soil reaction of this area has quite different reaction between Canlangit and Ubay soils. The Canlangit soil has been effected by limestone, therefore pH in this soil ranges from 7.1 to 8.0. On the other hand, Ubay soil has moderately to strong acid reaction. As a rule, grassland and rainfed paddy fields have lower values in pH and deeper stratum has higher pH than surface soil. This mainly seems due to the bases reaching by rainfall. The pH and percentage of base saturation are correlated as shown in Figure 3B-19. The percentage of base saturation is a very useful criterian in depicting the fertility conditions in the soil colloid-root environment.

FIGURE 3B-19 RELATIONSHIP BETWEEN PH AND PERCENTAGE OF BASE SATURATION



6. Cation Exchange Capacity (CEC)

CEC varies with the content of clay. It ranges from 4.7 of Ubay surface soil to 46.9 of Canlnagit surface soil. On the Canlangit soil, CEC is generally in the range 20.2 - 46.9 me/100 g of surface soil and 22.7 - 52.8 me/100 g of subsoil. In the Ubay soil, it is lower than Canlangit soil. It is 4.7 - 32.1 in the surface soil and 6.5 - 23.2 in the subsoil. The soils having higher CEC values have higher clay content than soils of lower CEC values, and also deeper stratum has slightly more CEC than the surface soil, this being related to clay accumulation in the deeper stratum.

The base saturation of Canlangit soil appears to be over 80 percent, often more than 100 percent, indicating that these soils are hardly reached out and rich in exchangeable bases. On the contrary,

the base saturation of Ubay soils are below 60 percent in grassland. This may be mainly due to low bases contents and higher leaching under rainfed condition and natural vegetation.

Of the exchangeable cations, calcium and magnesium are high and these bases contents in Canlangit soils are higher than Ubay soils. The exchangeable potassium content is medium in Canlangit soil and low in Ubay soil and it appears that irrigated paddy field has rather higher potassium content than rainfed paddy field.

7. Organic matter

The organic matter contents in the Canlangit soil is medium to moderatly high while the Ubay soil is moderatly low to medium. The surface soils have higher contents than the subsoils and also the surface soils of irrigated paddy field have rather higher contents than rainfed paddy field.

8. Phosphorous

Generally speaking, available phosphate is low to very low except for few sample collected field where it is medium to high. The phosphorous absorption coefficient of this area is low.

9. Nitrogen

In general, nitrogen content is low to very low.

10. Iron and Manganese

Free Fe_2O_3 contents ranges from 0.56 to 5.15 percent and mostly from 2.0 to 4.0 percent. It appears that relatively high iron contents are found in the deeper horizons. These phenomena may be accumulation in deeper portion due to iron reaching from the upper horizons. Usually, manganese contents are less than 0.14 percent. It is concluded that the soils of this area contain relatively high amount of active iron or manganese.

H. Land Classification for Irrigated Paddy Rice

1. Basic Specification

The specification for land classification which were adapted to the study on irrigation project conducted by NIA, were modified according to the additional data and the results of field investigation, as shown in Table 3B-23. The major change is that the specification on salinity of soil was delated from the formerly adapted specification according to previous soil survey report which indicated the soil salinity less than 1.4 millimhos per centimeter (at 25°C) in the project area. Usually, soil salinity less than 4.0 millimhos per centimeter is considered as tolerable salinity for rice plant.

The arability classification of the land was accomplished during field investigation. The landformers, land use, soils, topography and drainage conditions of land were examined during the field investigation. Detailed description of soil profiles and other land features were made and soil samples were collected for laboratory analysis from test pits.

2. Mapping Symbols

The land classification mapping symbols which were used by BS were adapted to the project study. A typical example used to describe a paddy rice field is

$$\frac{2Rs}{Pr21BY} - y$$

The numerator of the above symbole (2Rs) shows that it is moderately suited for paddy rice production with a Class 2 rating because of soil deficiency. The first digit of the denominator (Pr) shows that present land use is rainfed paddy field; the second digit shows the land has class 2 productivity; the third digit, it has class 1 land development cost; the last two digits (B & Y) show it will have a medium (B) water requirement and that it has moderate (Y) drainability. y at the right of the symbol defines the soil fertility deficiency.

Table 3B-23 Feasibility Grade Land Classification Specification for the Project Area

Land Characteristics	Paddy Field	
	Class 2R -- Arable	Class 3R -- Arable
Soils (dominant texture of surface layer 0 - 30 cm)	fine sandy loam to clay	fine sandy loam to clay
Soil Depth	> 45 cm	> 30 cm
Cation Exchange Capacity (CEC-surface layer soil 0 - 30 cm)	>4 me/100 g soil	>4 me/100 g soil
pH (anaerobic)	> 5.5	> 5.0
Reduction Products in Soil Solution after Prolonged flooding	Low	Low
Topography		
Slope in General Gradient	< 3 %	< 7 %
Land Levelling	< ₱ 1,800/ha	< ₱ 3,000/ha
Land Clearing	< ₱ 1,800/ha	< ₱ 3,000/ha
Land Terracing	< ₱ 1,800/ha	< ₱33,000/ha
Internal Drainage	Slow	Slow

The followings are the mapping symbols used in this project study.

a) Land class symbols
   2R : moderate suitability for irrigated paddy rice
   3R : marginal suitability for irrigated paddy rice

b) Deficiency symboles
   s : soil deficiency
   t : topography deficiency

c) Present land use symboles
   Pr : rainfed paddy field
   PrI: irrigated paddy field
   UL : upland crop field
   GL : grassland

d) Drainability symbole
   Y : restricted subsurface drainage but drainable at moderate cost

e) Water requirement symboles
   B : medium irrigation water requirement

f) Special deficiency symbole
   y : soil fertility problems
   g : general slope exceeding three(3) per cent
   j : irregular size and shape
   u : undulating surface with moderate or high leveling requirement

3. Description of land classes and subclasses

A total of 7,300 ha of land was classified, consisting of about 300 ha of land found to be nonarable, not suited for irrigation and about 7,000 ha of arable lands, suited for irrigation. The nonarable lands consist mostly of residential areas, road, creek and proposed project facilities. About 55 percent of arable lands consist of

moderately suitable land for irrigated paddy rice production (2R) and remainder is classified as the marginally suitable land for irrigated paddy rice production (3R).

Class 2R: - Arable Paddy field

The lands are considered to be of moderate suitability for paddy rice production under irrigation. The class 2R lands comprise about 55 percent of the total arable land. The subclasses delineated were 2Rs and 2Rst which reflect deficiencies in soil, topography, drainage or conbination of these deficiencies, but are capable of producing good production, when provided with reasonable irrigation and surface drainage facilities and if proper high yielding rice varieties, soil and water management, and improved farming practices are used.

Subclass 2Rs:

This subclass consists of moderately productive lands having low land development cost, medium water requirement and restricted drainability. It has a soil limitation with low fertility level. About 2,400 ha were mapped in this subclass. These lands have a gradient of one to two percent (soil mapping unit--CnB and UbB soils) and situated on nearly level to gently sloping areas. About 1,500 ha of grassland, 610 ha of paddy field and 220 ha of upland fields belong to this subclass.

The 2Rs lands on Canlangit series (mapping unit CnB) are distributed in the Upper area. The textural class of the surface soils and the subsoils are clay in general. The reaction of the root-zone layer is alkaline and the pH meatured in H_2O ranges from about 7.0 to 8.0. The CEC ranges from about 20 to 47 me/100 g in surface soils and from 23 to 53 me/100 g in subsoil. These higher values of CEC associated with high base saturation. These higher values in pH and CEC are mainly due to the influence of weathered limestone.

The 2Rs lands on Ubay series (mapping unit UbB) are found in the northern part of the Upper area and the Lower area. The textural class of surface soils varies from sandy loam to clay, but is usually in sandy clay loam to clay. The subsoils contain usually high portions of gravelly ironstone concretions at the depth of 20 to 80 cm. This lateritic fine gravel is found in a layer of varying thickness. Usually, these gravels are embedded in clay loam or clay which is yellowish brown to brown and generally shows a strong multicolored mottling. These soils either have horizons that are medium permeable to water or occupy portions that are conductive to water control as related to paddy rice cultivation. The reaction of root-zone layer varies from moderately to strongly acid. The pH measured in H_2O ranges from about 5.0 to 6.0. The CEC ranges from about 5.0 to 17 me/100 g in surface soil and from 10 to 29 me/100 g in subsoil. These lower values of CEC associated with lower base saturation.

Test pit No.5, 6, 7 and No.9 represent soil profiels of subclass 2Rs land. In generally, this subclass one have topography deficiency. Since they occupy the land having a gradient less than two percent, they can be developed at a low cost. The land which have been developed into paddy field, would not develope except some irrigation and drainage construction areas. The target yield estimates 76 cavans in the wet season and 88 cavans in the dry season. This subclass is shown as I-a/f($\frac{2Rs}{21BY}$ - y) on the land classification map. (refer to Figure 3B-20)

Subclass 2Rst:

This subclass consists of moderately productive land having low land development cost, medium water requirement and restricted drainability as same as subclass 2Rs. It has a soil-topography deficiency which include field size and shape. The soils of 2Rst land are similar to those of 2Rs lands as mentioned above. The gradient of 2Rst land ranges from two to three percent. The microrelife varies from slightly uneven to hummoky. The soils of

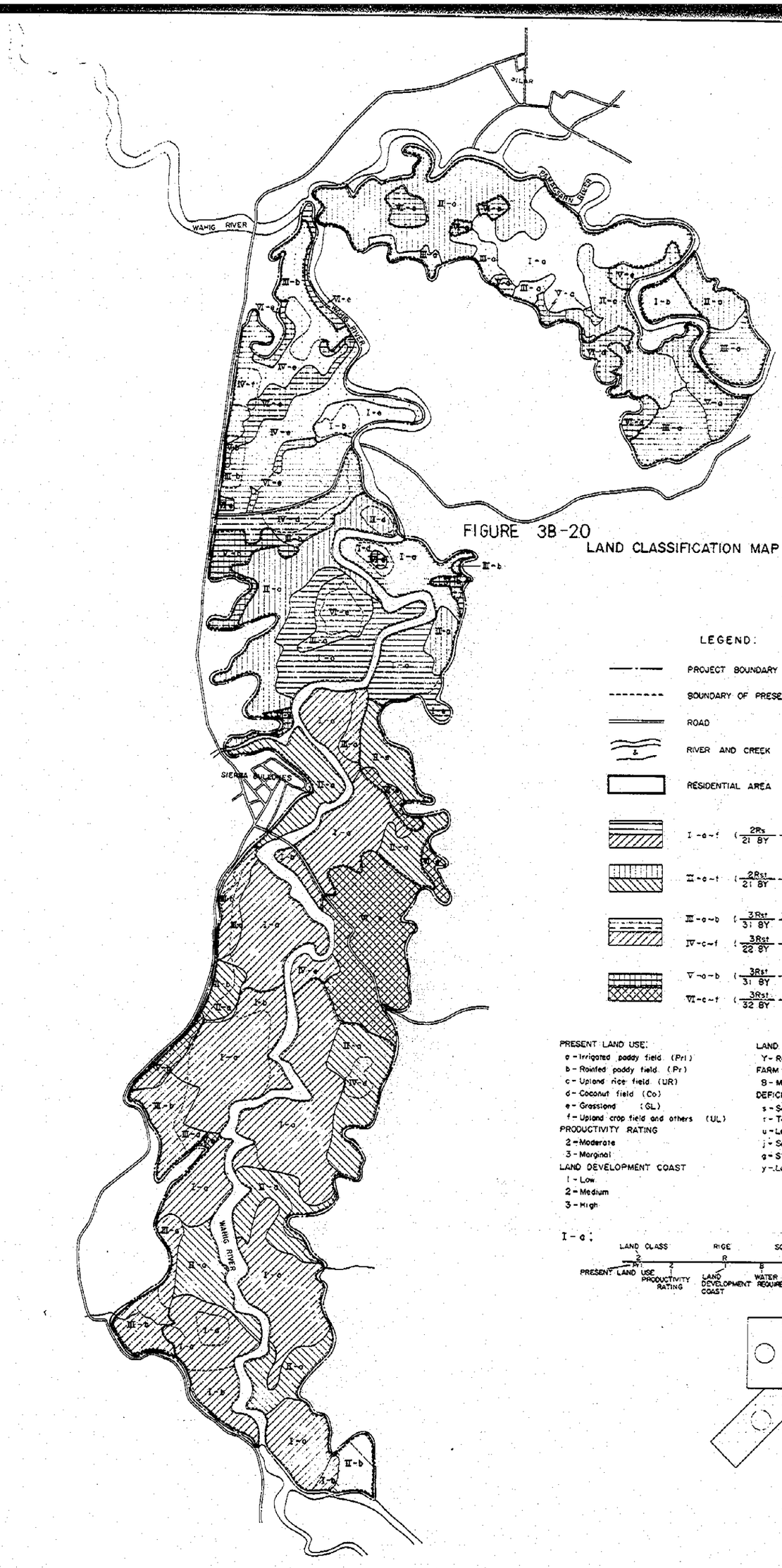
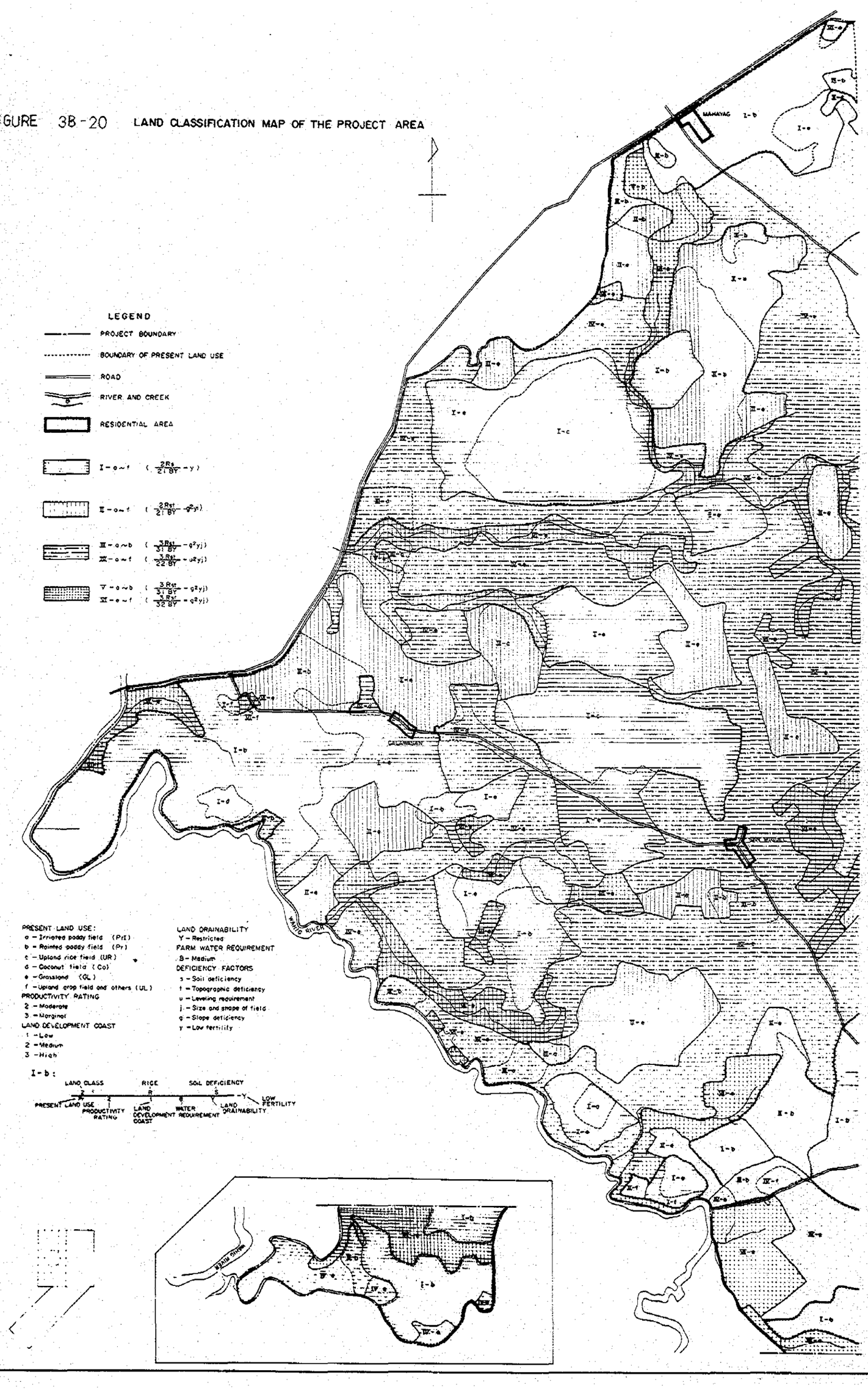
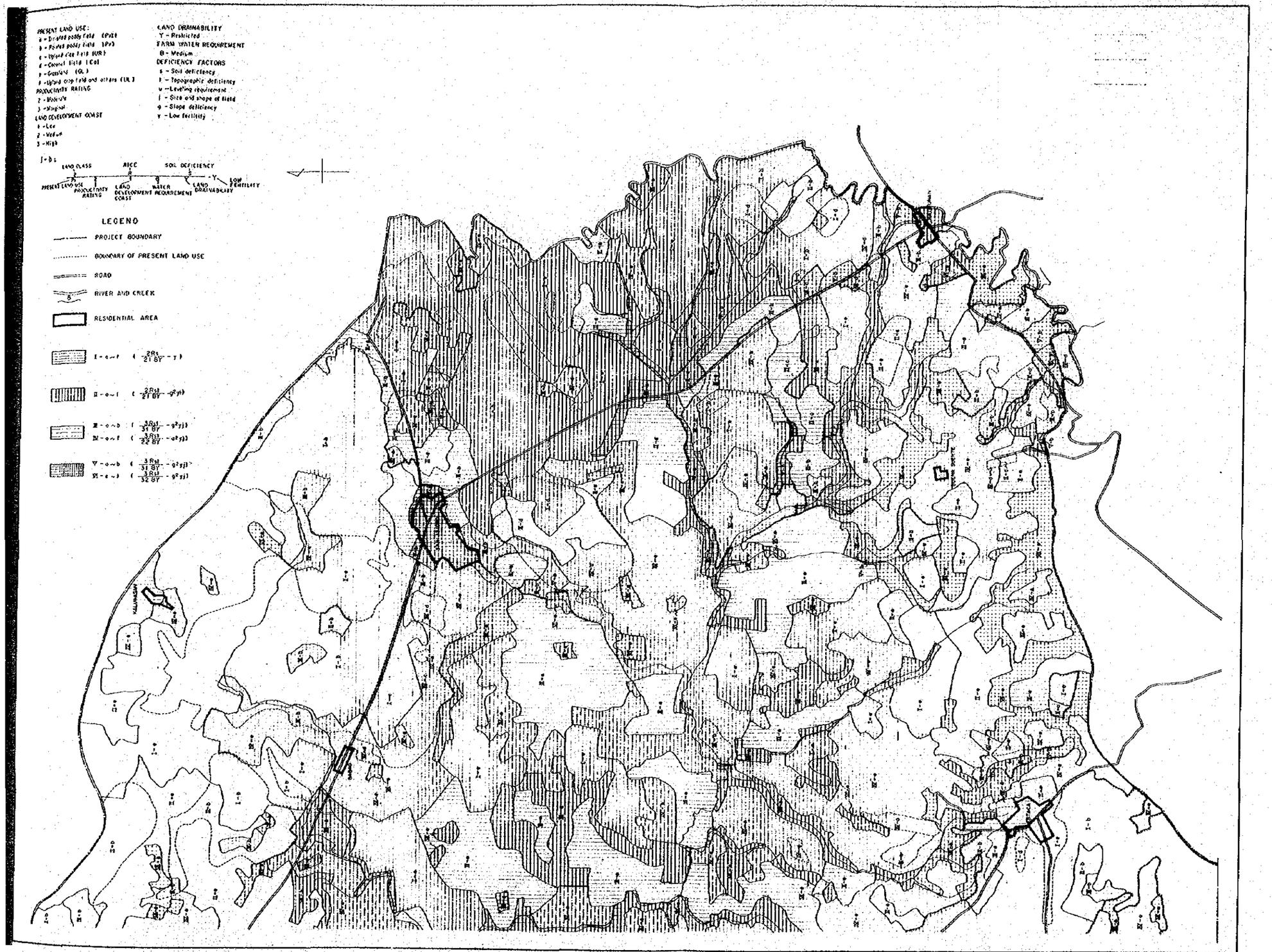


FIGURE 3B-20
LAND CLASSIFICATION MAP OF THE PROJECT AREA

FIGURE 3B-20 LAND CLASSIFICATION MAP OF THE PROJECT AREA




PRESENT LAND USE:
a - Irrigated paddy field (PAI)
b - Rained paddy field (PR)
c - Upland rice field (UR)
d - Coconut field (Col)
e - Grassland (GL)
f - Upland crop field and others (ULC)
PRODUCTIVITY RATING
2 - Moderate
3 - Marginal
LAND DEVELOPMENT COAST
1 - Low
2 - Medium
3 - High
LAND DRAINABILITY
Y - Restricted
FARM WATER REQUIREMENT
B - Medium
DEFICIENCY FACTORS
s - Soil deficiency
t - Topographic deficiency
w - Leveling requirement
l - Size and shape of field
g - Slope deficiency
y - Low fertility
LAND CLASS
ALCC
SOIL DEFICIENCY
PRESENT LAND USE
PRODUCTIVITY RATING
LAND DEVELOPMENT COAST
WATER REQUIREMENT
LAND DRAINABILITY
LOW FERTILITY
LEGEND
PROJECT BOUNDARY
BOUNDARY OF PRESENT LAND USE
ROAD
RIVER AND CREEK
RESIDENTIAL AREA

this subclass belong to CnC and UbC soil mapping unit and test pit No.1 and No.8 represent soil profile of subclass 2Rst land.

About 1,400 ha of lands belong to this subclass. 760 ha of this subclass land still have native grass cover. These lands can be contour terraced and developed into adequate sized, well shaped paddy fields at resonable cost. Terracing will result in exposing subsoils on each developed paddy field. This exposing subsoil will affect the productivity for few years. However, it is expected that production of paddy rice will be obtained the target yield within five to seven years after the completion of the project under the recommended management and practicies.

The remaining about 600 ha have been developed into paddy field and about 470 ha of which have been left under the rainfed condition. In generally, these paddy fields are small and not well shaped owing to their irregular topography. Under the project, these fields will not be consolidated except some portions where irrigation and drainage facilities will be constructed. Consequently, they would obtain the target yield within few years after completion of the project. Proper land development and careful management will be required for successful irrigation of these lands similar to that required for 2Rs land. The target yield estimates 76 cavans in the wet season and 88 cavans in the dry season per hectare. This subclass is shown as II-a/f($\frac{2Rst}{21BY}$ - yj) on the land classification map.

Class 3R: - Arable paddy field

The lands are considered to be limited suitability for paddy rice production due to their physical deficiencies which seriously affect its suitability for rice production. Consequently, they require medium land development cost and special management practices.

In spite of these deficiencies, this class land will be capable of

profitable rice production under adequate irrigation farming. Most of this class lands have undulating topography. The principal subclass is 3Rst.

Subclass 3Rst:

This subclass totals about 3,150 ha of land with a combination soil-topography deficiency. It is located on CnD, CnE, UbD and UbE soils with slope over three percent but not exceed seven percent. Test pit No.2, 3 and 4 represent soil profile of subclass 3Rst land. Soils and drainage conditions are both similar to class 2R land. In generally, terracing or leveling will be needed for underdeveloped lands. After terracing or leveling, the subsoils would be exposed and those soils may be low in organic matter and also low in fertility. Consequently, adequate green manure or organic matter and fertilizers should be applied in order to improve and stabilize the surface soils as in the developed paddy fields. About 2,690 ha of this subclass land are left under grassland and only about 320 ha of land have been developed into paddy field but their field size are small and shape is irregular. 68 percent of existing paddy field are left under the rainfed condition. This subclass is divided into three mapping units according to different productivity rating and land development cost.

The first mapping unit consists of marginally productive lands having low land development cost, medium water requirement and restricted drainability. The areas covered is about 320 ha and it has been developed into paddy field but 68 percent of them are left under the rainfed condition. This subclass is located on CnD, CnE, UbD and UbE soils. Under the proposed planning, it is expected that these lands would be irrigated without much additional land development such as terracing except some portions. This subclass is shown as III-a/b($\frac{3Rst}{31BY}$ - g^2yj) for existing paddy fields on 3-5 % sloping land and as V-a/b($\frac{3Rst}{31BY}$ - g^2yj) for existing paddy fields on 5-7 % sloping land on the land classification map.

The second mapping unit consists of moderately productive lands having medium land development cost, medium water requirement and restricted drainability. It has a topographic deficiency and located on CnD and UbD soils having three to five percent slope. This subclass covers about 2,000 ha of land and most of lands are left under grassland. 1,840 ha of grassland probably would be leveled and developed into adequate size and well shaped paddy field under the project. This subclass is shown as IV-c/f($\frac{3Rst}{22BY}$ - u^2yj) on the land classification map.

The third mapping unit consists of marginal productive lands having medium land development cost, medium water requirement and restricted drainability. It has a topographic limitation and located on CnE and UbE soils having five to seven percent slope. The areas consist of about 860 ha and most of them are left under grassland. The soils under this subclass are marginally suited to paddy rice production due to the topographic limitation which requires terracing works. This terracing would be done at reasonable cost, depending on their location and sloping situation. When land development is done, it is expected that these lands would have productivity similar to subclass 2Rst land. This subclass is shown as VI-c/f($\frac{3Rst}{32BY}$ - g^2yj) on the land classification map.

After class 3R lands have been developed into paddy field, it is expected that these lands would have productivity similar to subclass 2Rst land. The target yield is 66 cavans in the wet season and 80 cavans in the dry season per hectare.

Table 3B-24 and 3B-25 show the hectareage of classified lands by soil mapping unit and land subclass and also predominant characteristics of each subclass and recommended management practices are shown in Table 3B-26.

Table 3B-24 Hectarage of Land Class by Soil Unit in the Project Area

(unit: ha)

Land Class	Upper Area											Lower Area					
	CnB	CnC	CnD	CnE	Sub-Total	UbB	UbC	UbD	UbE	Sub-Total	Total	UbB	UbC	UbD	UbE	Sub-Total	Total
$\frac{2Rs}{21BY}$ - y	164				164	96				96	260	2,271				2,271	2,531
$\frac{2Rst}{21BY}$ - yj		54			54		102			102	156		1,313			1,313	1,469
$\frac{3Rst}{31BY}$ - g^2yj			53	10	63			43	27	70	133			62	122	184	317
$\frac{3Rst}{22BY}$ - u^2j			9		9			61		61	70			1,997		1,997	2,067
$\frac{3Rst}{32BY}$ - g^2j				44	44				37	37	81				835	835	916
Total	164	54	62	54	334	96	102	104	64	366	700	2,271	1,313	2,059	957	6,600	7,300

Table 3B-25 Hectarage of Land Class by Soil Unit in Available Land for the Project

(unit: ha)

Land Class		Paddy Field			Upland Field			Coconut Field	Grassland	Total
		PrI	Pr	Total	Rice	Other	Total			
$\frac{2Rs}{21By} - y$	U.A	207	15	222	-	-	-	5	4	231
	L.A	29	361	390	213	4	217	64	1,525	2,196
	Total	236	376	612	213	4	217	69	1,529	2,427
$\frac{2Rst}{21BY} - yj$	U.A	119	12	131	-	-	-	2	-	133
	L.A	12	456	468	33	2	35	30	760	1,293
	Total	131	468	599	33	2	35	32	760	1,426
$\frac{3Rst}{31BY} - g^2yj$	U.A	68	65	133	-	-	-	-	-	133
	L.A	33	151	184	-	-	-	-	-	184
	Total	101	216	317	-	-	-	-	-	317
$\frac{3Rst}{22BY} - u^2yj$	U.A	-	-	-	-	3	3	9	23	35
	L.A	-	-	-	41	3	44	74	1,817	1,935
	Total	-	-	-	41	6	47	83	1,840	1,970
$\frac{3Rst}{32BY} - g^2yj$	U.A	-	-	-	-	-	-	1	61	62
	L.A	-	-	-	-	-	-	9	790	799
	Total	-	-	-	-	-	-	10	851	861
Upper Area		394	92	486	-	3	3	17	88	594
Lower Area		74	968	1,042	287	9	296	177	4,892	6,407
Total		468	1,060	1,528	287	12	299	194	4,980	7,001

Note: 1) U.A ..... Upper Area; L.A ..... Lower Area
2) Other ..... Upland crops (mainly corn and cassava etc.)
3) Grassland .. Scattered minor field of upland crops are included.

Table 3B-26 Principal Subclass and Recommended Management Practices

Subclass	Predominant Characteristics	Recommended Management Practices
2Rs 2,427 ha (34.7 %)	nearly level to gently sloping moderately dissected terraces. (1-2 % slope); lowlying portions, where excess water from surrounding areas would collect and cause drainage problems; clay textured soil (Canlangit soils), sandy clay loam, clay underlaid by clay laom, clay with fine ironstone concretion (Ubay soils); medium drainage;	develop farm surface drainage system; use recomended rice varieties and farming practices; more fertilizers and organic matters inputs require; reasonable water management;
2Rst 1,426 ha (20.4 %)	gently sloping, moderately dissected low to medium terraces; (2-3 % slope); soil condition similar to 2Rs; existing paddy fields are poorly shaped and relatively small size;	if undeveloped, would be leveled terraced; after leveling/terracing incorporate green manure/organic matter into soil where subsoil has been exposed; otherwise manage same as above;
3Rst 3,148 ha (44.9 %)	gently sloping, to undulating moderately dissected medium to higher terraces, (3-7 % slope); soil condition similar to 2Rs; consists mostly undulating, rolling undeveloped lands which could be terraced; developed paddy fields are poorly shaped and relativelly small size;	after terracing, incorporate green manure/organic matter into soil where subsoil has been exposed; otherwise manage same as above;
Total 7,001 ha		

I. Future Soil Investigation

The completion of this survey does not means that soil studies, or even soil survey, are concluded. On the contrary, as farming becomes more intensive increasingly, the detailed soil investigation will be required. This survey provides the basic information for the feasibility study of irrigation agricultural project. More detailed survey will be needed on pilot farm and for canal alignment and drainage installation and also for terrace making.

The many soil smaples were taken from the Project Area for determination of soil fertility status by chemical analysis by the NIA in order to recommend the rational fertilizer application by soil type to the farmer concerned. This activity is good idea for the project execution. When agriculture becomes more intensive after the completion of irrigation system, more detailed investigation and soil maps may be required, and in order to make the most economic use of fertilizers intensive sampling of the topsoils for investigate the soil fertility status may be collected for and also field trial will be needed.

In the case of development, certain problem portions are sure to be encountered, especially where much land leveling or terracing have been done. Minor element deficiencies and luck of response to fertilizers will need to be investigated. This requirement for continued soil investigation and survey implies the staff must be made available for enough time to deal with the needs of the project area, if the development scheme is to be a success.

The field survey must be supported by adequate laboratory facilities to provided necessary analysis is good time. When intensive farming develops, the laboratory will be called on to provided analysis to help in making rational decisions on fertilizers application for individual farms.

J. Summary of Conclusions and Recommendations

1) Of the 7,300 ha surveyed, about 1,500 ha are under paddy rice, 300 ha upland crops, 200 ha coconut, 5,000 ha grassland, and 300 ha are creeks, road, residential areas and others.

2) Canlangit and Ubay soil series were found in the Project Area. Canlangit soil occurs in the southern part of Upper area and Ubay soil distributes in the northern part of Upper area and the Lower area.

3) Canlangit soil is clayey textured soil having slightly slow drainage, mainly used for paddy field. Ubay soil is clay loam to clay soil with fine gravelly ironstone concretions at the depth of less than 80 cm and having somewhat good drainage.

4) Canlangit soil has alkaline reaction and high CEC values mainly due to their high contents of weathered limestone. On the contrary, Ubay soil has acid reaction and low CEC values mainly due to the leaching of bases. Both of soils are poor in natural nutrients of soils.

5) The land classification for irrigated paddy rice cultivation is as follows;

Description	Moderately Suitable Land (2R)	Marginally Suitable land (3R)	Total (ha)
Upper Area			
Arable land	364	230	594
Project area	348	172	520
Whole area			700
Lower Area			
Arable land	3,489	2,918	6,407
Project area	2,970	1,830	4,800
Whole area			6,600
Whole Project Area			
Arable land	3,853	3,148	7,001
Project area	3,318	2,002	5,320
Whole area			7,300

As shown above figures, almost the Project Area is able to develop into paddy field except some portions having topographic limitation in class 3R lands. Those lands will be needed leveling or terracing.

6) In the Upper area, 96.9 percent of class 2R and 57.8 percent of class 3R land have been developed into paddy field with poorly shaped and relatively small size plots. On the other hand, only 24.6 percent of class 2R and 6.3 percent of class 3R lands have been used for paddy field in the Lower area. Consequently, remaining about 4,900 ha of existing grassland, 2,300 ha in class 2R and 2,600 ha in class 3R can be developed into paddy fields, depending on their location and sloping.

7) It is recommended that surface drainage system would be installed throughout the area especially for lowlying portions.

8) It is recommended that priority in next stage soil investigations would be given to studies the more detailed survey.

TABLE 3C-1 Present Irrigation Area

Description	Area (ha)	Remarks		
A. Communal Irrigation System				
Pamacsalan area				
1. Pamacsalan, Pilar	130			
Wahig area				
2. Bogsoc, S. Bullones	53			
3. Villagracia, S. Bullones	14			
4. Sta. Cruz, S. Bullones	17			
5. Salvador, S. Bullones	52			
6. San Jose, S. Bullones	42			
7. Canlangit, S. Bullones	47			
8. Sawang, S. Bullones	19			
Sub-total	374			
B. Pump Irrigation		Depth (mm)	Height (m)	Quantity (ℓ/s)
1. Katipunan, Alicia	6	150	10.7	56.8
2. "	6	125	13.7	37.9
3. Babag, Dagohoy	7	125	19.8	37.9
4. Caluwasan, Dagohoy	12	125	13.7	37.9
5. "	10	150	10.7	37.9
6. "	4	100	13.7	18.9
7. "	5	100	10.7	18.9
8. "	5	100	24.4	18.9
9. Malitbog, Dagohoy	5	100	10.7	37.9
10. "	3	100	15.2	18.9
11. Canlangit, S. Bullones	6	125	10.7	37.9
12. Poblacion, S. Bullones	5	100	15.2	18.9
13. "	4	100	10.7	18.9
14. "	5	100	10.7	18.9
15. Estaca, Pilar	5	125	10.7	37.9
16. Buenasuerte, Pilar	6	125	19.8	37.9
Sub-total	94			
C. Farm Systems Development Corporation				
1. Landing irrigator's service Association, Dagohoy 1/	103	200	30HP	13,627.0
Total	571			

Source: A,B : Provincial Irrigation Office, Bohol
C : FSDC, Provincial Office, Bohol
1/ : Under construction (to be completed until the end of November, 1977)

Table 3C-2. Available Irrigation Water for Communal Irrigation Area

(unit: 1,000 cu.m)

Year	Wahig Basin		Pamacsalan Basin	
	Run-off Discharge	Intake Water for Communal	Run-off Discharge	Intake Water for Communal
1956-1957	40,035.7	2,010.8	48,528.2	1,071.3
1957-1958	23,052.6	2,837.3	27,942.5	1,511.7
1958-1959	27,377.1	2,440.7	33,184.4	1,300.3
1959-1960	28,152.7	2,415.1	34,124.5	1,286.7
1960-1961	30,342.4	2,196.5	36,778.7	1,197.1
1961-1962	38,247.3	1,551.0	46,360.4	826.4
1962-1963	40,858.3	2,561.9	49,525.3	1,365.0
1963-1964	32,706.8	4,015.6	39,644.6	2,139.4
1964-1965	51,193.9	2,469.5	62,053.3	1,315.7
1965-1966	27,312.3	4,048.8	33,105.8	2,157.2
1966-1967	33,850.1	2,893.7	41,030.4	1,541.7
1967-1968	28,799.2	4,080.6	34,908.1	2,177.4
1968-1969	24,557.3	3,671.2	29.766.4	1,977.0
1969-1970	28,484.1	2,658.5	34,526.2	1,416.4
1970-1971	42,236.2	1,225.7	51,195.4	653.1
1971-1972	37.988.6	2,701.2	46,046.8	1,439.2
1972-1973	34,353.5	3,303.2	29.519.3	1,844.4
1973-1974	38,228.8	2,396.8	46,337.9	1,277.0
1974-1975	37,716.3	2,212.8	45,716.7	1,178.9
1975-1976	32,227.0	2,266.1	39,063.1	1,207.4
Ave.('000 cu.m)	33,886.0	2,697.9	40,467.9	1,444.2
		7.96%		3.57%
(mm)	1,467.9	1,105.7	1,445.3	1,110.9

Note: Catchment Area

Wahig basin : 23.1 sq.km
Pamacsalan basin: 28.0 sq.km

Communal irrigation area

Wahig area : 244 ha
Pamacsalan area : 130 ha

Present Production

Table 3D-1 Present Paddy Production

Year	Philippines			Central Visayas 1/			Bohol			Benefited Five Municipalities 2/		
	Area (ha)	Yield (ton/ha)	Production (ton)	Area (ha)	Yield (ton/ha)	Production (ton)	Area (ha)	Yield (ton/ha)	Production (ton)	Area (ha)	Yield (ton/ha)	Production (ton)
1968	3,303,660	1.37	4,560,697	157,030	0.57	89,443						
1969	3,332,150	1.33	4,444,656	127,450	0.58	73,572						
1970	3,113,440	1.68	5,233,408	61,380	1.30	80,076						
1971	3,112,630	1.71	5,342,916	95,540	1.12	106,713	51,306	1.37	70,461	9,227	1.54	14,259
1972	3,246,380	1.57	5,100,084	96,050	1.13	108,416						
1973	3,111,800	1.42	4,414,630	70,150	1.25	87,292						
1974	3,436,800	1.63	5,594,134	79,620	1.50	119,280						
1975	3,538,840	1.78	5,660,046	84,820	1.35	114,140						
1976	3,579,320	1.72	6,159,472	89,600	1.43	128,256						
1977	3,547,500	1.82	6,456,076	88,000	1.50	132,431						
Average	3,332,225	1.59	5,296,612	83,145	1.32	109,576						

Note: 1/ Central Visayas: Bohol, Cebu, Negros Oriental, Siquijor

2/ Benefited Five Municipalities: Sierra Bullones, Pilar, Dagohoy, San Miguel, Alicia.

Data Source: Philippines: BAE con

Central Visayas: BAE con

Bohol: National Census and Statistics Office, 1971 Census of Agriculture, Bohol

Benefited five municipalities: - do -

Table 3D-2 Present Paddy Yield in the Project Area

Crop	Number of Sample Farmer	Area Planted (ha)	Average Yield divided by A.P.[1/] (cavan)	(ton)	Area Harvested (ha)	Average Yield divided by A.H.[2/] (cavan)	(ton)
Irrigated							
1st Crop	12	8.58	51	2.550	8.58	51	2.550
2nd Crop	12	8.58	44	2.200	8.58	44	2.200
Rainfed							
1st Crop	47	61.25	27	1.350	54.40	30	1.500
2nd Crop	47	62.38	25	1.250	55.18	29	1.450
Upland	7	6.25	15	0.750	6.25	15	0.750

Note: One cavan is 50 kg

1/ A.P.: Area Planted

2/ A.H.: Area Harvested

Source: Farm Management Survey of BIADP, NIA Aug., 1977

Table 3D-3 Average Normal Yield and Unit Price of Palay in the Project Area

Item	Normal Yield (ton/ha)	Normal Yield (Cavan/ha)	Average Price (₱) per Cavan (50 kg)	Average Price (₱) per Kilo
Irrigated				
1st Crop	2.4	(47.5)	50.83	1.02
2nd Crop	2.1	(42.1)	51.25	1.02
Rainfed				
1st Crop	1.6	(32.0)	47.90	0.96
2nd Crop	1.5	(29.0)	50.0	1.00
Upland	0.8	(15.0)	51.00	1.02

Note: Normal Yield is average of last 5-years excluding abnormal years.

Source: Farm Management Survey of BIADP, NIA, Aug., 1977

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Table 3D-4 Yield of Upland Crops in the Project Area

Crop	Nov. of Sample Farmer	Area Planted (ha)	Area Harvested (ha)	Total Annual Production (kg)	Average Yield 1/ (kg/ha)
Corn: 1st	11	7.65	7.60	4,014.4	528
2nd	2	2.65	2.65	1,700.0	641
3rd	1	2.50	2.50	1,500.0	600
Cassava	8	5.25	5.25	5,815.0	1,108
Sweet Potato	1	0.50	0.50	300.0	600
Coconut (Copra)	23	16.05	16.00	11,684.5	728

Note: 1/ Yield based on the planted area

Source: Farm Management Survey of BIADP, NIA, Aug., 1977

Table 3D-5 Present Crop Production

Crop	Planted Area (ha)	Harvested Area (ha)	Yield (ton/ha)	Production (ton)
(1) Paddy				
- Irrigated, Wet	468	468	2.4	1,123
- Irrigated, Dry	468	468	2.1	983
- Rainfed, Wet	1,060	954	1.6	1,526
- Rainfed, Dry	1,060	901	1.5	1,352
- Unland Rice	287	287	0.8	230
	3,343	3,078	1.7	5,214
(2) Corn	173	173	0.5	87
(3) Cassava	63	63	1.1	69
(4) Sweet Potato	120	120	0.6	72
(5) Coconut, etc.	194	83	0.6	50
Total	3,893	3,517		5,492

Note: (1) Yield of each crop exclusive of coconut; Farm Management Survey of BIADP, NIA, 1977

(2) Yield of coconut; Agricultural Census, 1971

(3) The harvested areas by crop are estimated from the data of Farm Management Survey of BIADP, NIA, 1977, BAE con Barrio Screening Survey, 1976 and others.

Table 3D-6 Paddy Production with Masagana 99 by Municipality

Municipality	Phase	Irrigated			Rainfed		
		Harvested Area (ha)	Yield (cavans/ha)	Production (cavans)	Harvested Area (ha)	Yield (cavans/ha)	Production (cavans)
Sierra Bullones	IV	427	78	33,364	-	-	-
	V	257	74	19,030	135	60	8,166
	VI	353	76	26,755	-	-	-
	VII	439	75	32,929	47	73	3,458
	VIII	517	82	42,412	65	70	4,550
	Ave.	399	77	30,898	82	66	5,391
Dauis	IV	494	76	37,686	50	36	1,800
	V	308	77	23,815	14	59	825
	VI	217	80	17,280	150	70	10,000
	VII	292	65	19,076	35	68	2,393
	VIII	135	90	12,150	40	70	2,800
	Ave.	289	76	22,001	58	61	3,564
Dagohoy	IV	398	79	26,880	212	40	8,480
	V	244	86	20,984	75	68	5,100
	VI	242	65	15,822	50	60	3,000
	VII	150	101	15,136	25	60	1,500
	VIII	157	76	11,060	50	65	3,250
	Ave.	238	76	17,976	82	52	4,266
San Miguel	IV	102	68	7,000	282	49	13,725
	V	25	80	2,000	159	60	9,540
	VI	43	88	3,792	160	40	6,400
	VII	50	90	4,500	158	53	8,325
	VIII	50	85	4,250	75	60	4,485
	Ave.	54	80	4,308	167	51	8,495
Alicia	IV	231	80	18,398	4	50	200
	V	384	77	29,672	-	-	-
	VI	138	79	10,862	-	-	-
	VII	232	66	15,314	25	62	4,278
	VIII	195	68	13,350	60	37	2,230
	Ave.	236	74	17,519	30	75	2,236
Total	IV	1,652	75	123,328	548	44	24,205
	V	1,218	78	95,501	383	62	23,631
	VI	993	75	74,511	360	54	19,400
	VII	1,163	75	86,955	290	54	15,676
	VIII	1,054	79	83,222	290	60	17,315
	Ave.	1,216	76	92,703	374	54	20,045

Source: BPI, Bohol

Note: (1) IV: 1974/Nov. - 1975/Apr. (Dry Season)
V: 1975/May - 1975/Oct. (Wet Season)
VI: 1975/Nov. - 1976/Apr. (Dry Season)
VII: 1976/May - 1976/Oct. (Wet Season)
VIII: 1976/Nov. - 1977/Apr. (Dry Season)

(2) One cavan is estimated at 42 kg

Table 3D-7 Attained Paddy Yield in the Project Area and its Vicinity

Item	Season	Farmers A	Farmers B	Farmers C	San Jose Compact Farm	Seed Farmers	A.T. Seed Farm	DAR Katipunan Demo. Farm	DAR Bicao Demo. Farm	BPI Marcos Corn Expt. Farm
(a) Location		Pilar, Rizal	Pilar, Rizal	Dagohoy, Malitbaog	S-Bullones, San Jose & Bugsoc	7 municipalities within & near to the Project Area	Ubay, Lumanancog	Alicia, Katipunan	Carmen, Bicao	Ubay, Gabi
(b) Planted Area (ha)	Wet	1.25	3.0	8.0	25.0	10.5	34.0	2.0	1.0	1.5
	Dry	1.25	3.0	8.0	25.0	9.7	34.0	2.0	1.0	1.5
(c) Average Yield (ton/ha)	Wet	2.7	2.9	2.1	2.9	3.6	4.4	3.7	4.0	4.8
	Dry	2.9	3.2	1.7	3.4	4.5	4.7	4.0	4.2	4.7
(d) Variety		IR-30, 36	IR-20, 28, 36	IR-30, 1561 MRC 348	IR-26, 36	IR-20, 28, 30, 36, 38	IR-36, 40	IR-36	IR-36 MRC-348	N.A.
(e) Planting Distance	Wet	35cm x 5cm	35cm x 5cm	20cm x 20cm	At random	N.A.	25cm x 25cm	40cm x 5cm	40cm x 5cm	N.A.
	Dry			18cm x 18cm			20cm x 20cm			
(f) Input material per hectare										
- Fertilizer	Wet	50-30-30	80-40-40	85-30-30	47-14-14	N.A.	60-35-35	80-55-0	70-70-70	90-40-40
	Dry	60-30-30	80-40-40	90-30-30	47-14-14		80-35-35	80-60-0	70-70-70	94-50-50
- Insecticides (Ave. of wet & dry)		Thiodan-2 qts. Brodan-16 fl.oz Sevidol-10 kg	Thiodan-3 qts Mipcin-2 kg Hytox-3 bags	Thiodan-16 fl.oz Endrin-8 fl.oz Folidol-8 fl.oz	Brodan-1 ℓ Linden-32 kg Endrin-1 ℓ	N.A.	Brodan-2 qts Hytox-104 kg	Parapest-16 fl.oz Hytox-15 kg	Brodan-2 qts Hytox-100 kg Hinosan-1 qts	Sevidor-2 kg Parapest-1 qts
- Herbicides (Ave. of wet & dry)		No use (by hand)	No use (by hand)	No use (by hand)	No use (by hand)	N.A.	Agroxone-1 qts 2, 4-D-1 qts	2, 4-D-Amine -1 qts Agroxon-1 qts	No use (by hand)	Agroxone-620 kg
(g) Remarks		Ave. yield for latest 3 years (1974 - 1976)	Ave. yield for latest 3 years (1974 - 1976)	Paddy field was developed newly (1976)	Ave. yield for latest 2 years (1975 - 1976) Nos. of member: 41 Communal Irrigation Area	Ave. yield of latest 3 croppings	Ave. yield for latest 5 years (1973 - 1977)		Ave. yield for latest 3 years (1975 - 1976)	

Table 3D-8 Input Material for Each Crop per Hectare (At Present)

Materials	Unit	Irrigated Paddy (H.Y.V.) Wet	Irrigated Paddy (H.Y.V.) Dry	Rainfed Paddy (H.Y.V.) Wet	Rainfed Paddy (H.Y.V.) Dry	Rainfed Paddy (T.V.) Wet	Rainfed Paddy (T.V.) Dry	Upland Rice	Corn	Cassava	Sweet Potato
1. Seed	kg	60.0	55.0	58.0	50.0	42.5	50.0	52.5	16.7	2,928 1/	4,965 1/
2. Fertilizer											
- 45-0-0	kg	17.5	29.0	1.5	1.5	-	-	-	-	-	-
- 12-12-12	kg	175.0	180.5	87.5	86.0	-	-	54.0	15.0	-	25.0
- 14-14-14	kg	5.5	5.5	18.0	22.0	-	-	-	10.0	-	-
Total	kg	198.0	215.0	107.0	109.5	-	-	54.0	25.0	-	25.0
3. Pesticides											
- Liquid	Qt.	1.1	1.4	0.4	0.38	-	-	-	-	-	-
- Granular	kg	-	-	0.02	-	-	-	-	0.13	-	-
4. Herbicides											
- Liquid	Qt.	-	-	0.08	0.06	-	-	-	-	-	-

Remarks 1/: Unit is pieces

Table 3D-9 Total Input Material for Each Crop (At Present)

Materials	Unit	Irrigated Paddy(H.Y.V.) Wet	Irrigated Paddy(H.Y.V.) Dry	Rainfed Paddy (H.Y.V.) Wet	Rainfed Paddy (H.Y.V.) Dry	Rainfed Paddy(T.V.) Wet	Rainfed Paddy(T.V.) Dry	Upland Rice	Corn	Cassava	Sweet Potato	Total
Planted Area	ha	468	468	954	954	106	106	287	173	63	120	
1. Seed	kg	28,080	25,740	61,480	5,300	4,505	5,300	15,068	2,889	184 1/	596 1/	145,473 2/
2. Fertilizer												
- 45-0-0	kg	8,190	13,572	1,590	1,590	-	-	-	-	-	-	24,942
- 12-12-12	kg	81,900	84,474	92,750	91,160	-	-	15,498	2,595	-	3,000	371,377
- 14-14-14	kg	2,574	2,574	19,080	23,320	-	-	-	1,730	-		49,278
Total		92,664	100,620	113,420	116,070	-	-	15,498	4,325	-	3,000	445,597
3. Pesticides												
- Liquid	Qt.	515	655	424	403	-	-	-	-	-	-	1,997
- Granular	kg	-	-	21	-	-	-	-	22	-	-	43
4. Herbicides												
- Liquid	Qt.	-	-	88	64	-	-	-	-	-	-	152

1/ : Unit is thousand pieces
2/ : Total seed of paddy and upland rice

Remarks: Paddy seed
H.Y.V.: 121 ton
T.V.: 10 ton
Upland rice: 15 ton

Table 3D-10 Quantity of Inputs in Paddy Production with Masagana 99

Municipality	Phase	Irrigated								Rainfed							
		Harvested Area	Fertilizer			Insecticides		Herbicides		Harvested Area	Fertilizer			Insecticides		Herbicides	
			45-0-0	21-0-0	NPK	Liquid	Granular	Liquid	Granular		45-0-0	21-0-0	NPK	Liquid	Granular	Liquid	Granular
		(ha)	(bag)	(bag)	(bag)	(ℓ)	(kg)	(ℓ)	(kg)	(ha)	(bag)	(bag)	(bag)	(ℓ)	(kg)	(ℓ)	(kg)
Sierra Bullones	IV	427	250	400	1,600	875	7,125	850	7,000	-	-	-	-	-	-	-	-
	V	257	125	250	800	514	4,290	500	4,000	135	135	270	600	270	2,254	270	2,254
	VI	353	200	350	1,300	706	5,895	700	5,800	-	-	-	-	-	-	-	-
	VII	439	240	380	1,750	878	4,331	850	4,150	47	47	90	160	94	784	94	784
	VIII	517	275	425	1,900	1,034	8,633	1,000	8,500	65	65	130	260	130	1,085	130	1,085
	Ave. Qty. per ha		0.5	0.9	3.7	2.0	15.2	2.0	14.8		1.0	2.0	4.1	2.0	16.7	2.0	16.7
Pilar	IV	494	500	500	1,800	988	8,200	900	7,000	50	50	100	200	100	835	100	835
	V	308	150	375	1,500	616	5,000	550	4,000	14	14	28	56	28	467	28	467
	VI	217	120	275	900	434	3,623	330	3,600	150	150	300	600	300	5,000	300	5,000
	VII	292	225	300	1,100	620	5,000	600	4,200	35	35	70	140	70	5,845	70	5,845
	VIII	135	240	450	1,400	270	2,250	250	2,000	40	40	80	120	80	1,336	80	1,336
	Ave. Qty. per ha		0.9	1.3	4.6	2.0	16.6	1.8	14.4		1.0	2.0	3.9	2.0	48.7	2.0	46.7
Dagohoy	IV	398	200	450	1,700	800	6,680	650	5,550	212	200	180	750	424	3,540	424	3,540
	V	244	100	250	950	500	4,175	450	4,000	75	75	150	600	150	1,152	150	1,152
	VI	242	100	275	850	500	4,160	450	4,160	50	50	100	200	100	835	100	835
	VII	150	125	300	900	300	2,500	300	2,000	25	25	50	100	50	417	50	417
	VIII	157	50	250	750	314	2,505	300	2,250	50	50	100	200	100	835	100	835
	Ave. Qty. per ha		0.5	1.3	4.3	2.0	16.8	1.8	15.1		1.0	1.4	4.5	2.0	16.5	2.0	16.5
San Miguel	IV	102	50	150	350	204	1,703	180	1,700	282	200	560	1,128	564	9,418	564	9,418
	V	25	10	100	120	50	417	50	400	159	159	318	636	318	5,310	318	5,310
	VI	43	20	80	200	86	1,436	80	1,350	160	160	320	640	320	5,344	320	5,344
	VII	50	25	120	175	100	1,670	100	1,550	158	158	316	632	316	5,277	316	5,277
	VIII	50	15	100	200	100	1,670	90	1,500	75	75	150	300	150	1,152	150	1,152
	Ave. Qty. per ha		0.4	2.0	3.9	2.0	25.5	1.9	24.1		0.9	2.0	4.0	2.0	31.8	2.0	31.8
Alicia	IV	231	150	320	650	462	3,857	450	3,800	4	4	8	16	8	668	8	668
	V	384	175	300	950	768	6,412	740	6,350	-	-	-	-	-	-	-	-
	VI	138	50	150	600	276	1,304	276	1,250	-	-	-	-	-	-	-	-
	VII	232	100	400	850	464	3,874	464	3,550	25	25	50	100	50	835	50	835
	VIII	195	80	375	700	390	6,513	390	6,450	60	60	120	240	120	2,000	120	2,000
	Ave. Qty. per ha		0.5	1.3	3.7	2.0	18.6	2.0	18.1		1.0	2.0	4.0	2.0	39.4	2.0	39.4
Total	IV	1,652	1,150	1,820	6,100	3,329	27,565	3,030	25,050	548	454	848	2,094	1,096	14,461	1,096	14,461
	V	1,218	560	1,275	4,320	2,448	20,294	2,290	18,750	383	383	766	1,892	766	9,138	766	9,138
	VI	993	490	1,130	3,850	2,002	16,418	1,836	16,160	360	360	720	1,440	720	11,179	720	11,963
	VII	1,163	715	1,500	4,775	2,362	17,375	2,314	15,450	290	290	576	1,132	580	13,158	510	13,459
	VIII	1,054	660	1,350	4,950	2,108	21,571	2,030	20,700	290	355	580	1,120	580	6,408	580	6,408
	Ave. Qty. per ha		0.6	1.2	3.9	2.0	17.0	1.9	15.8		1.0	1.9	4.1	2.0	29.0	2.0	29.0

Table 3D-11 Distribution of Labor for Irrigated Paddy

(unit: man-day/ha)

Description	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1st Crop													
Seedbeding					0.70	1.92							2.62
Land preparation					0.93	15.38	2.91						19.22
Repair of dikes					0.23	3.38	0.58						4.19
Transplanting						1.17	18.07						19.24
Handweeding							10.61	6.99					17.60
Weeding													
Fertilizing						0.47	0.82	2.68					3.97
Spraying							0.47	0.93	0.35				1.75
Water Management						0.52	0.47	0.41	0.70				2.10
Harvesting										5.36	11.29		16.65
Threshing										3.09	5.94		9.03
Hauling										1.81	2.10		3.91
Drying										1.86	2.10		3.96
Total					1.86	22.84	33.93	11.01	1.05	12.12	21.43		104.24
2nd Crop													
Seedbeding											0.70	1.69	2.39
Land preparation	2.10										1.98	15.03	19.11
Repair of dikes	1.52										0.23	2.33	4.08
Transplanting	14.92											4.20	19.12
Handweeding	13.99	2.21											16.20
Weeding													9.21
Fertilizing	2.68	0.82										0.12	3.62
Spraying	0.93	0.58										0.12	1.63
Water Management	0.76	0.41	0.29									0.64	2.10
Harvesting			2.10	14.92									17.02
Threshing			1.86	7.40									9.21
Hauling			0.06	1.75	0.88								2.74
Drying			0.47	2.45									2.92
Total	36.90	4.02	4.78	26.52	0.88						2.91	24.13	100.14

Source: Farm Management Survey of BIADP, NIA, Aug., 1977

Table 3D-12. Distribution of Labor for Rainfed Paddy

(unit: man-day/ha)

Description	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1st Crop													
Seedbeding					0.29	1.33	0.03						1.65
Land Preparaton					1.61	11.07	0.85						13.53
Repair of dikes					0.36	2.02	0.42	0.03					2.83
Transplanting						5.31	13.09	0.78	0.41				19.59
Handweeding						0.16	2.92	1.84	0.16	0.13			5.21
Weeding							0.05	0.10	0.03				0.18
Fertilizing						0.42	1.11	0.47	0.14				2.14
Spraying							0.20	0.47	0.08	0.05			0.80
Water Management						-	-	-	-	-			-
Harvesting									0.24	3.67	8.36	0.24	12.51
Threshing									0.08	2.89	5.78	0.21	1.65
Hauling										0.49	1.14	0.02	1.65
Drying									0.07	0.98	0.93	0.02	2.00
Total					2.26	20.31	18.67	3.69	1.21	8.21	16.21	0.49	71.05
2nd Crop													
Seedbeding	0.11										0.42	0.99	1.52
Land preparation	1.91										2.76	8.54	13.21
Repair of dikes	0.55										0.59	1.78	2.92
Transplanting	8.46	1.59									0.80	6.93	17.78
Handweeding	2.29	1.72	0.26									0.46	4.73
Weeding	0.03	0.21											0.24
Fertilizing	0.63	0.85	0.02									0.30	1.80
Spraying	0.24	0.44	0.03									0.18	0.89
Water Management	-	-	-									-	-
Harvesting			1.31	8.22	3.03	0.16							12.82
Threshing			0.73	5.89	2.48	0.32							9.42
Hauling			0.22	1.28	0.56	0.02							2.08
Drying			0.22	1.09	0.38	0.15							1.84
Total	14.22	4.81	2.79	16.58	6.45	0.65					4.57	19.18	69.25

Table 3D-13 Distribution of Labor for Upland Palay

(unit: man-day/ha)

Description	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Seedbeding													
Land preparation			4.96	3.68	2.72	2.24							13.60
Repair of dikes													
Transplanting						6.88	1.60						8.48
Handweeding						1.44							1.44
Weeding by weedicide													
Fertilizing						0.80	0.24	0.48					1.52
Spraying													
Water Management													
Harvesting										6.56	4.48		11.04
Threshing										3.84	3.28		7.12
Hauling										0.48	0.67		1.15
Drying										0.96	0.96		1.92
Total			4.96	3.68	2.72	11.36	1.84	0.48		11.84	9.39		46.27

Table 3D-14 Calculation of Labor Use for All Products (At Present)

(Unit: man-day)

Items	Area	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1. Labor Requirement per ha.														
a. Paddy 1/														
- Irrigated, Wet	1 ha	-	-	-	-	1.9	22.8	33.9	11.0	1.1	12.1	21.4	-	104.2
- Irrigated, Dry	-do-	36.9	4.0	4.8	26.5	0.9	-	-	-	-	-	2.9	24.1	100.1
- Rainfed, Wet	-do-	-	-	-	-	2.3	20.3	18.7	3.7	1.2	8.2	16.2	0.5	71.1
- Rainfed, Dry	-do-	14.2	4.8	2.8	16.6	6.5	0.6	-	-	-	-	4.6	19.2	69.3
b. Upland Rice 1/	-do-	-	-	5.0	3.7	2.7	11.4	1.8	0.5	-	11.8	9.4	-	46.3
c. Corn 2/														
- 1st Crop	-do-	-	-	-	26.6	15.8	3.0	-	9.9	-	-	-	-	55.3
- 2nd Crop	-do-	-	-	-	-	-	-	-	60.3	10.1	-	12.0	-	82.4
- 3rd Crop	-do-	12.2	-	-	11.0	-	-	-	-	-	-	-	58.0	81.2
d. Cassava 2/	-do-	-	-	-	-	-	11.9	15.4	11.4	4.0	-	-	-	42.7
e. Sweet Potato 2/														
- 1st Crop	-do-	-	-	-	-	-	7.1	33.4	9.9	-	-	21.8	-	72.2
- 2nd Crop	-do-	33.4	9.9	-	-	-	21.8	-	-	-	-	-	7.1	72.2
f. Coconut, etc. 1/	-do-	-	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	14.4
2. Total Labor Requirement														
a. Paddy														
- Irrigated, Wet	468	-	-	-	-	889.2	10,670.4	15,865.2	5,148.0	514.8	5,662.8	10,015.2	-	48,765.6
- Irrigated, Dry	468	17,269.2	1,872.0	2,246.4	12,402.0	421.2	-	-	-	-	-	1,357.2	11,278.8	46,846.8
- Rainfed, Wet	1,060	-	-	-	-	2,438.0	21,518.0	19,822.0	3,922.0	1,272.0	8,692.0	17,172.0	530.0	75,366.0
- Rainfed, Dry	1,060	15,052.0	5,088.0	2,968.0	17,596.0	6,890.0	636.0	-	-	-	-	4,876.0	20,352.0	73,458.0
b. Upland Rice	287	-	-	1,435.0	1,061.9	774.9	3,271.8	516.6	143.5	-	3,386.6	2,697.8	-	13,288.1
c. Corn														
- 1st Crop	100	-	-	-	2,660.0	1,580.0	300.0	-	990.0	-	-	-	-	5,530.0
- 2nd Crop	66	-	-	-	-	-	-	-	3,979.8	666.6	-	792.0	-	5,438.4
- 3rd Crop	7	85.4	-	-	77.0	-	-	-	-	-	-	-	406.0	568.4
d. Cassava	63	-	-	-	-	-	749.7	970.2	718.2	252.0	-	-	-	2,690.1
e. Sweet Potato														
- 1st Crop	60	-	-	-	-	-	426.0	2,004.0	594.0	-	-	1,308.0	-	4,332.0
-2nd Crop	60	2,004.0	594.0	-	-	-	1,308.0	-	-	-	-	-	426.0	4,332.0
f. Coconut, etc.	194	232.8	232.8	232.8	232.8	232.8	232.8	232.8	232.8	232.8	232.8	232.8	232.8	2,793.6
Total	3,893	34,643.4	7,786.8	6,882.1	34,029.7	13,226.1	39,112.7	39,410.8	15,728.3	2,938.2	17,974.2	38,451.0	33,225.6	283,408.9
3. Available Farm Labor Force	-	118,967.5	103,450.0	118,967.5	113,795.0	118,967.5	113,795.0	118,967.5	118,967.5	113,795.0	118,967.5	113,795.0	118,967.5	1,391,402.5
4. Balance (3-2)	-	84,324.1	95,663.2	112,085.3	79,765.3	105,741.4	74,682.3	79,556.7	103,239.2	110,856.8	100,993.3	75,344.0	85,741.9	1,107,993.4

Remarks: 1/ Surveyed by "Farm Management Survey, NIA, 1977"
2/ Based on the data of "Cost and Returns of Palay, Corn and other selected Commodities," BAE Con, Research Report No.7 1975.

FIGURE 3D-1 LABOR USE FOR ALL PRODUCTS (AT PRESENT)

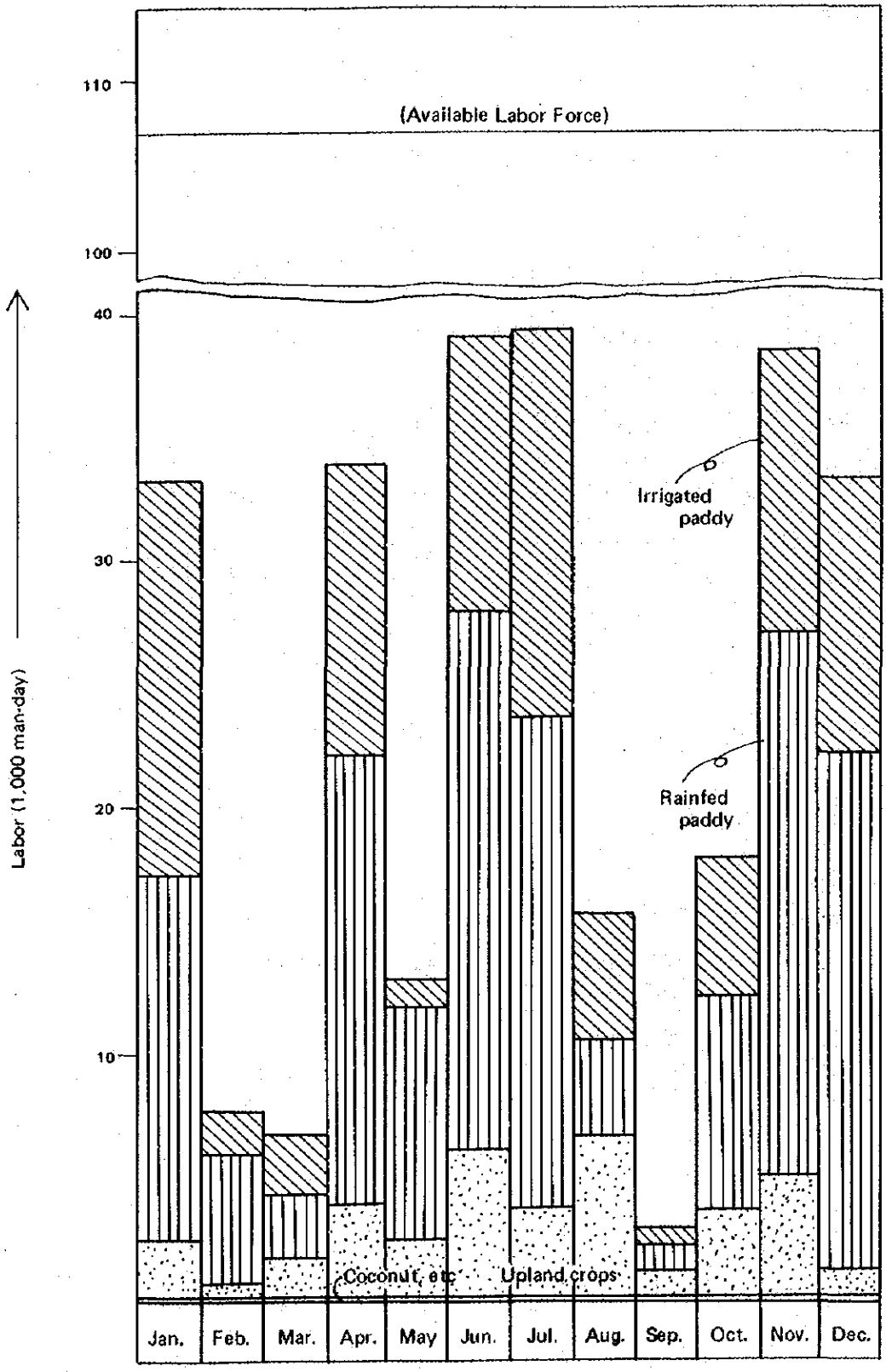


Table 3D-15 Population of Livestock and Poultry by Municipality

(Unit: Farm, Head, ₱ '000)

Animal	Sierra-Bullones			Pilar			Dagohoy			San Miguel			Alicia			Total		
	Farm	Nos.	Value	Farm	Nos.	Value	Farm	Nos.	Value	Farm	Nos.	Value	Farm	Nos.	Value	Farm	Nos.	Value
Carabao	1,256	2,282	834	1,200	2,326	821	823	1,425	502	1,315	2,538	817	1,311	2,105	631	5,905	10,676	3,605
Cattle	105	581	154	254	637	162	350	950	257	371	972	231	146	383	85	1,226	3,523	889
Hogs	1,310	3,991	309	1,285	4,650	399	857	2,798	199	1,285	3,319	252	1,421	4,271	324	6,158	19,029	1,483
Horses	39	41	9	44	60	14	12	20	4	16	24	6	-	-	-	111	145	33
Goats	31	112	2	83	252	6	151	478	9	195	546	9	54	147	2	514	1,535	28
Chickens	1,344	16,704	45	1,316	21,300	56	908	15,566	28	1,455	23,673	47	1,500	28,655	45	6,523	105,898	221
Ducks	5	15	-	6	12	-	-	-	-	17	123	-	5	15	-	33	165	-
Total	4,090	23,726	1,353	4,188	29,237	1,458	3,101	21,237	999	4,654	31,195	1,362	4,437	35,576	1,087	20,470	140,971	6,259

Source: Agricultural Census, 1971

(Excluding the population and value of the livestocks and poultry owned by non-farm households.)

Table 3D-16 Number of Carabao by Municipality

Municipality	Nos. by Age Group					Proportion to All Age Carabao (%)			
	All Ages	Under 3 years	3 years and Over	Work Carabao	Females 3 years and Over	Under 3 years	3 years and Over	Work Carabao	Females 3 years and Over
Sierra-Bullones	2,282	590	1,692	1,200	901	26	74	53	39
Pilar	2,326	658	1,668	1,326	716	28	72	57	31
Dagohoy	1,425	402	1,023	910	231	28	72	64	16
San Miguel	2,538	806	1,732	1,380	640	32	68	54	25
Alicia	2,105	515	1,590	1,137	541	24	76	54	26
Total	10,676	2,971	7,705	5,953	3,029	28	72	56	28

Source: Agricultural Census, 1971

Farm Economy - Summary of Farm Management Survey
Conducted by LRED, NIA, 1977

Table 3D-17 Farm Economy per one Farm

Tnure System	Average No. of Sample	Average Farm Size	Irrigated	Rainfed	No. of Family	Palay Production	Gross Farm Income: Palay	Other Crops	Other Works etc.	Sub-total	Non Farm Income	Gross Income
	farms	ha	ha	ha	person	cav.	peso	peso	peso	peso	peso	peso
Full Owner	23	2.22	0.14	1.33	5.3	87.6	4,380	250	8	4,638	635	5,273
Part Owner	12	1.70	0.17	0.71	5.6	62.2	3,110	442	54	3,606	355	3,961
Share Tenant	22	1.41	0.08	0.97	6.5	54.6	2,730	368	133	3,231	199	3,430
Lease	3	0.83	0.17	0.66	5.0	44.3	2,215	-	27	2,242	40	2,282
Average	60	1.75	0.14	1.04	5.8	69.0	3,450	285	64	3,799	423	4,222

Table 3D-18 Farm Economy per one Farm (Continue)

(Unit: Peso)

Tenure System	Production Cost: Crops	Feed	Harvester Thresher	Total	Farm Income	Rent	Net Income	Living Allowance	Surplus Income
Full Owner	734	12	621	1,367	3,906	-	3,906	3,698	208
Part Owner	449	4	547	1,000	2,961	677	2,284	2,157	127
Share Tenant	463	8	89	560	2,870	800	2,070	1,482	588
Lease	571	-	320	891	1,391	452	939	1,261	(-)322
Average	570	8	396	974	3,248	452	2,796	2,445	351

Table 3D-19 Production Cost (exclude labor) per Farm

(unit: Peso)

Tenure System	Palay				Other Crops			Sub Total	Harvester		
	Seeds	Fertilizer	Pesticide	Herbicide	Seeds	Fertilizers	Pesticides		Feed	and Thresher	Total
Full Owner	180	476	65	5	-	8	-	734	12	621	1,367
Part Owner	113	296	38	2	-	-	-	449	4	547	1,000
Share Tenant	133	279	33	3	9	3	3	463	8	89	560
Lease	117	444	10	-	-	-	-	571	-	320	891
Average	147	366	45	4	3	4	1	570	8	396	974

Table 3D-20 Income From Others Source

(unit: Peso)

Tenure System	Working on others farm	Hire of work animals to others	Hire of farm machines to others	Interes earned on money loaned to others	Receipt of gifts from relative and others	Rent from lands	Total
Full Owner	8	-	-	-	-	54	62
Part Owner	20	20	14	-	38	-	92
Share Tenant	120	13	-	-	8	-	141
Lease	27	-	-	-	-	-	27
Average	52	9	3	-	11	21	96

Table 3D-21 Annual Income from Non-Farm Occupation per Farm

(unit: Peso)

	Full Owner	Part Owner	Share Tenant	Lease	Average
Government Employee	4	100	-	40	24
Private Employee	150	-	24	-	66
Teachers	146	-	-	-	56
Carpenter	37	105	36	-	48
Dressmaker	7	-	4	-	4
National Hot Weaver	-	100	108	-	59
Business Man/Woman	185	12	1	-	107
Bus Operator	52	-	-	-	20
Tuba Making	-	-	18	-	7
Total	581	317	191	40	391

Table 3D-22 Beginning and Ending Inventory of Farm Equipment per one Farm

Equipment	Beginning	Ending	Deduction
Barn	230	306	76
Shed of Animal	34	31	- 3
Irrig. Pump Set	302	254	-48
Other Machines	37	34	- 3
Native Plow	49	78	29
Native Harrow	19	18	- 1
Sprayer	40	36	- 4
Potable Thresher	38	56	18
Bull Cart	9	20	11
Shovel	4	4	0
Total	762	837	75

Table 3D-23 Disposal of Palay Products by Tenure Systems

— Farm Management Survey, LRED in NIA, 1977

(unit: %)

Tenure System	Total Production	Rent to Land Lord		Harvester/ Thresher (Manual)	Threshers (Machinery)	Operators Shares				
		Share	Lease			Be Sold	Home Use	Seeds	Feeds	Creditor
Full Owner	100	-	-	11.4	2.8	45.9	33.4	3.5	0.3	2.7
Part Owner	100	18.5	3.3	14.3	3.3	20.5	33.7	3.0	0.1	3.3
Share Tenant	100	31.8	1.9	1.1	2.6	15.8	40.6	3.4	0.3	2.5
Lease	100	-	20.4	14.3	0.2	20.3	40.7	4.1	-	-
Average	100	11.7	1.7	11.6	2.7	31.3	34.8	3.4	0.2	2.6

LRED: Land Resources and Economic Division

Table 3D-24 Cost of Living Allowance per Farm

(unit: Peso, %)

Items	Full Owner	Part Owner	Share Tenant	Lease	Average
Rice and other cereals	592 (16.0)	142 (6.6)	240 (16.2)	215 (17.0)	354 (14.5)
Fish, meat, other viands	740 (20.0)	520 (24.2)	445 (30.0)	542 (43.0)	586 (23.7)
Softdrinks, beverages etc.	160 (4.3)	70 (3.2)	78 (5.3)	145 (11.6)	121 (4.6)
Food ingredients	54 (1.5)	90 (4.2)	40 (2.7)	38 (3.0)	58 (2.3)
Tobacco/Cigaretts	370 (10.0)	100 (4.6)	100 (6.7)	57 (4.5)	203 (8.2)
Housing	142 (3.8)	25 (1.2)	80 (5.4)	- -	75 (3.1)
Clothing	235 (6.4)	225 (10.4)	163 (11.0)	83 (6.6)	199 (8.2)
Fuel, light and water	118 (3.2)	52 (2.4)	60 (4.0)	47 (3.7)	81 (3.3)
Household furnishing and equipment	456 (12.4)	45 (2.1)	4 (0.3)	26 (2.1)	187 (7.6)
Household operation	208 (5.6)	14 (0.6)	43 (2.9)	38 (3.1)	103 (4.1)
Personal and medical care	217 (5.9)	108 (5.0)	66 (4.5)	22 (1.7)	130 (5.3)
Transportation and communication	120 (3.3)	75 (3.5)	42 (2.8)	32 (2.5)	78 (3.2)
Recreation	64 (1.7)	20 (0.9)	15 (1.0)	7 (0.5)	35 (1.4)
Education	220 (5.9)	671 (31.1)	106 (7.2)	9 (0.7)	258 (10.5)
Total	3,696(100.0)	2,157(100.0)	1,482(100.0)	1,261(100.0)	2,445(100.0)
Average cost per one person	698	385	228	252	421

Table 3D-25 Marketing of Agricultural Crops

Description	No. of Farmers	Types of Buyer: Marchant	Miller	NGA	Local Store	Place of Sale: Barrio	Poblacion	Other Poblacion	Transport: Distance to selling Place	Cost per unit	Milling Cost per unit	Comman Month Sold	Possible Destination: Cebu	Cagayan del Norte	Tagbilaran
Irrigated															
Rough rice															
Full-owner	4	3				2	1		1.50	1.00	5.00	Jun., Dec.	2		1
Part-owner	4	3			1	2	1	1	2.50	0.50		Apr., Oct.	1		2
Sharetenant	3	2				1	1					Apr., Dec.			2
Lease	1														
Sub-total	12	8			1	5	3	1					3		5
Corn															
Full-owner	1														
Part-owner															
Sharetenant	2	1				1						Sep., Dec.			1
Lease															
Sub-total	3	1				1									1
Coconut															
Full-owner	2	2				2			1.50	1.00		May, Dec.			2
Part-owner	1	1				1						May, Aug.			1
Sharetenant	2	1				1						Apr., Dec.			1
Lease															
Sub-total	5	4				4									4
Rainfed															
Rough rice															
Full-owner	19	14				10	4		4.0	0.50	4.00	May, Dec.	9	1	4
Part-owner	8	3		1	1	3	1	1	15.0		5.00	Nov., Dec.			5
Sharetenant	18	13			3	11	2	3	5.0	0.75	5.00	May, Dec.	3		13
Lease	1	1						1				Feb.			1
Sub-total	46	31		1	4	24	7	5	24.0	1.25	14.00		12	1	23
Casava															
Full-owner	3	2				1	1		0.5			Feb., May			2
Part-owner															
Sharetenant	4	2			1	2		1	0.15			Aug., Sep.	1		2
Lease															
Sub-total	7	4			1	3	1	1					1		4
Coconut															
Full-owner	9	6				4	2		15.0	1.00		Apr., Jun., Aug., Dec.	1		5
Part-owner	4	2				1	1		1.50			Jan., Mar., Jun., Sep.			2
Sheretenant	6	5			1	5		3	3.0	0.75		Apr., Jul., Oct., Dec.			6
Lease															
Sub-total	19	13			1	8	3	3					1		13

Source: Farm Management Survey conducted by LRED in NIA, 1977.

Table 3D-26 Number of Rice Mill, Warehouse and Truck
(as of September 1977)

1. Rice Mills

Municipality	Number of Rice Mills	Total Capacity (ton/day)1/
1. Sierra Bullones	8	31.8 (635 cav)
2. Pilar	3	8.0 (160 cav)
3. Dagohoy	2	6.0 (120 cav)
4. San Miguel	4	8.8 (175 cav)
5. Ubay	5	21.8 (435 cav)
6. Alicia	3	12.5 (250 cav)
Total	25	88.9(1,775 cav)

Note: 12 hours operation
detail figures are given in Table A

2. Warehouses

Municipality	Number of Warehouses	Total Capacity (ton)
1. Sierra Bullones	5	170.0
2. Pilar	-	-
3. Dagohoy	-	-
4. San Miguel	-	-
5. Ubay	2	525.0
6. Alicia	2	525.0
Total	9	1,220.0

3. Trucking Facilities

Municipality	Number of Trucks	Total Capacity (ton)
1. Sierra Bullones	5	13.5
2. Pilar	1	3.5
3. Dagohoy	-	
4. San Miguel	-	
5. Ubay		
6. Alicia	7	31.5
Total	13	48.5

Source: National Grain Authority (NGA)

Table 3D-27 Consumption Requirement of Rice and Corngrits per year

Municipality	Rice (ton)	Corngrits (ton)
1. Sierra Bullones	1,508.3	450.5
2. Pilar	1,394.6	416.6
3. Dagohoy	864.1	258.1
4. San Miguel	1,121.8	335.1
5. Ubay	3,387.9	1,012.0
6. Alicia	1,485.6	443.7
Total	9,762.3	2,916.0

Note: Based on NGA data on food consumption requirement of the province at 0.274875 kg per person per day for rice and 0.0821 kg per person per day for corngrits.

Table 3D-28 Number of Retail and Wholesale Persons

Municipality	Retail		Whole sale only		Whole sale/Retail	
	Persons	Only Units	Persons	Units	Persons	Units
1. Sierra Bullones	4	6	23	23	9	9
2. Pilar	2	2	24	24	6	6
3. Dagohoy	2	2	7	7	3	3
4. San Miguel	8	8	3	4	4	4
5. Ubay	34	40	7	8	21	21
6. Alicia	8	9	10	10	8	9
Total	58	67	74	76	51	52

Source: National Grain Authority

Table 3D-29 Credit Conditions in the Vicinity of Project Area

Description	Values
1. No. of fieldmen (Appraisers/Investigators)	8
2. Total number of Agri-Paddy Borrowers	140
3. Total area financed (ha)	1,237
4. Total loan exposure (₱ '000)	1,717
5. Outstanding principal balance (₱ '000)	1,414

Source: Development bank of Philippines, Tagbilaran City

Table 3D-30 Credit Conditions in the Vicinity of Project Area

Description	Values
1. Credit Officers	7
2. Number of farmers with credit	12
Amount credited (₱ '000)	48
3. Number of farmers without credit	unknown
4. Total area financed	-
5. Amount paid (₱ '000)	0.6
Amount unpaid (₱ '000)	47

Source: Rural Bank of Tagbilaran, Inc.

Table 3D-31 Credit Conditions in the Vicinity of Project Area

Description	Sierra Bullones	Pilar	Dagohoy	San Miguel	Ubay	Alicia	Total
1. Credit Officers	3	3	3	3	3	3	18
2. No. of farmers with credit	19	710	1,300	12	81	22	2,144
Amount credited (₱ '000)	34	500	890	17	95	35	1,571
3. No. of farmers without credit	-	-	-	-	-	-	-
4. Total area financed (ha)	49	6,350	5,050	17	140	60	11,666
5. Amount paid (₱ '000)	20	250	450	10	50	20	800
Amount unpaid (₱ '000)	14	250	440	7	45	15	771

Source: Philippines National Bank, Tagbilaran Branch

FIGURE 3D–2 ORGANIZATION CHART (BUREAU OF AGRICULTURAL EXTENSION)

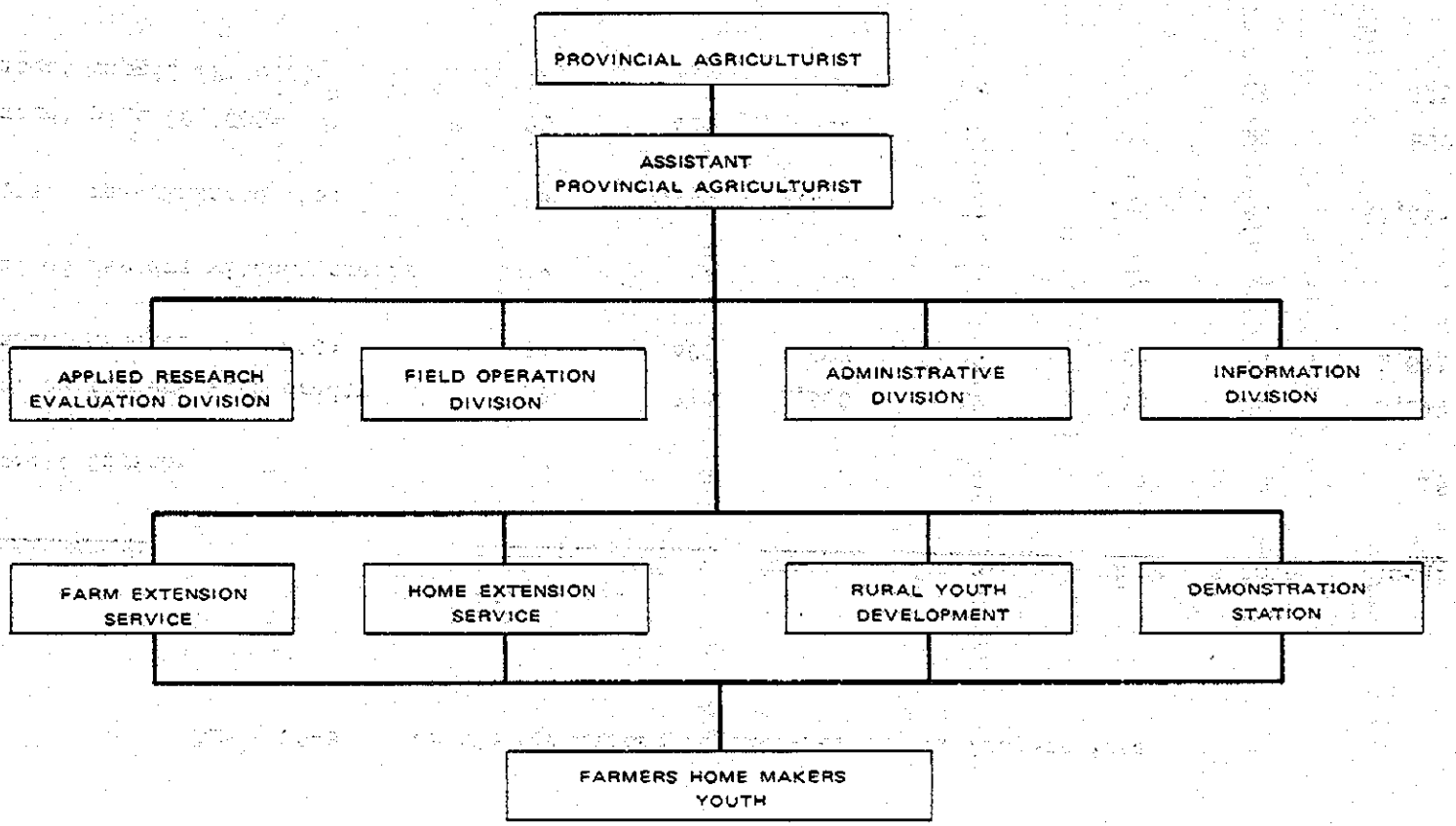


Table 3D-32 Technicians Assigned and Area

Municipality	Name	Area	
		Hectare	No. of Farmers
1. Sierra Bullones	Constancia Dolotina	60	50
2. Pilar	Ursulo Doria	250	200
	Marcos Cabahgbang	3,067	500
3. Dagohoy	Teodulo Yecyec	250	200
	Arsenia Namit	250	200
4. San Miguel	Ester Decasa	250	200
5. Alicia	Deogracias Autentico	155	250

Source: Bureau of Agricultural Extensions

Table 3D-33 Farmers Organization for Communal and Pump Irrigation Areas

Municipality	Barrio	Area (ha)	Member
1. Communal Irrigation Area			
Sierra Bullones	Bogsoc	53	86
	Villa Garcia	14	13
	Santa Cruz	17	20
	Salvadar	52	52
	San Jose	42	42
	Canlangit	47	41
	Sawang	19	15
	Sub-total	244	269
Pilar	Pamacsalan	130	127
	Sub-total	130	127
	Total	374	396
2. Pump Irrigation Area			
Sierra Bullones	Canlangit	6	
	Poblacion	5	
	"	4	
	"	5	
	Sub-total	20	
Pilar	Estaca	5	
	Buenasuerte	6	
	Sub-total	11	
Dagohoy	Caluwasan	12	
	"	10	
	"	4	
	"	5	
	"	5	
	Malitbog	5	
	"	3	
	Sub-total	44	
San Miguel	Babag	7	
	Sub-total	7	
Alicia	Katipunun	6	
	"	6	
	Sub-total	12	
	Total	94	

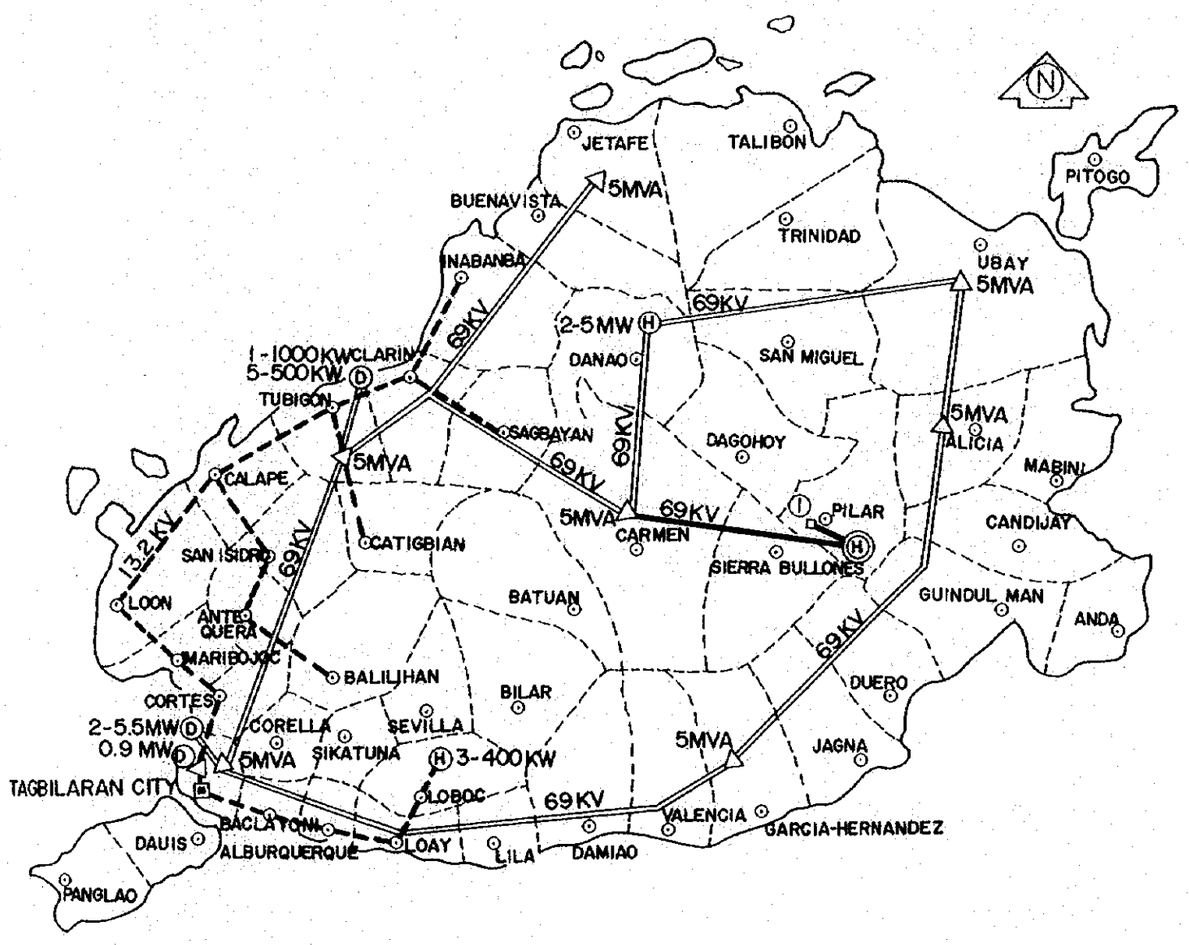
Table 3D-34 Establishment of Samahang Nayon and Kilusang Bayan

	Date Organized	Date Registered	Nos. of Samahang Nayon Organized	Nos. of Samahang Nayon Registered	Nos. of Member	Amount of Membership Fee	Barrio Saving Fund	Barrio Guarantee Fund	Kilusang Bayon
1. Sierra Bullones									None
a. Anibongan	7-28-74	10-15-75	1	1	60	600.00	1,005.15	1,660.00	
b. Bagsoc	8-19-73	1- 2-74	1	1	130	1,300.00	100.75	2,791.00	
c. Canlangit		8-12-74	1	1	48	480.00	506.85	870.00	
d. Poblacion	3-19-74	8-26-74	1	1	76	760.00	2,388.20	1,631.00	
e. San Jose	8-19-73	3-18-74	1	1	40	₱ 400.00	₱ 1,575.00	₱ 1,392.00	
f. Santa Cruz	3-28-74	7- 7-75	1	1	48	480.00	348.35	862.00	
g. Villa Garcia	8-26-73	11-27-73	1	1	29	290.00	874.00		
2. Pilar									None
a. Aurora	8-29-73	4-29-74	1	1	30	300.00	-		
b. Buenasuerte	9- 9-73	6-24-74	1	1	50	500.00	540.00	6,600.00	
c. Del Pilar	Not Registered				24	250.00	-		
d. Estaca	9- 1-73	2-18-75	1	1	45	450.00	-	807.90	
e. Cagawasan	5-1-74	11-17-76	1	1	62	620.00	305.00	1,300.00	
f. Lumbay	9- 3-73	10-18-74	1	1	36	360.00	343.00	790.00	
g. Poblacion		6-18-74	1	1	88	880.00	611.00	1,100.00	
h. Pamacsalan	Not Registered				25	250.00			
i. San Isidro	9- 9-73	6-17-74	1	1	61	610.00	60.00	800.00	
j. San Miguel	Not Organized								
3. Dagohoy									None
a. Caluwasan	8-18-73	6-17-74	1	1	45	₱ 450.00		₱ 1,359.00	
b. Malitbog	8-13-73	4-29-74	1	1	60	600.00		1,695.00	
c. Mahayag	8-25-73	4-29-74	1	1	30	300.00	-	3,350.00	
4. San Miguel									
a. Babag	Not Organized								
b. Camanaga	8-18-73	4- 3-74	1	1	50	500.00	1,700.00	1,800.00	
c. Cambangay Norte	8-19-73	11-27-73	1	1	37	370.00	700.00	730.00	
d. Mahayag	8-18-73	1-24-74	1	1	62	620.00	2,000.00	2,000.00	
5. Alicia									None
a. San Isidro	Not Organized								
b. Katipunan	Not Organized								

Table 3D-35 Present Status of Completed Cadastral Area

Municipality	Barrio	Beneficial Area (ha)	Completed Area	Non-Completed Area
Sierra Bullones	Poblacion	130	130	
	Anibogan	22		22
	Santa Cluz	36		36
	Villagarucia	112		112
	Salvador	52		52
	San Jose	47	47	
	Bogsoc	25	25	
	Canlangit	96	-	96
	Sub-total	520	202	318
Pilar	Delpilar	18	18	
	Lumboy	108		108
	Cagawasan	110	65	45
	Estaca	377	187	190
	Buenasuerte	535	183	352
	San Isidro	318		318
	Lasuerte	134		134
	Sub-total	1,600	453	1,147
San Miguel	Mahayag	277		277
	San Pascuel	110		110
	Katipunan	704	241	463
	Sub-total	1,091	241	850
Dagohoy	Poblacion	97	97	
	San Miguel	379	185	194
	Malitbog	633	200	433
	Caluwasan	406	179	227
	Mahayag	253	63	190
	Babag	341	141	200
	Sub-total	2,109	865	1,244
	Total	5,320	1,761	3,559
		(100%)	(33%)	(67%)

FIGURE 3E - 1 PRESENT ELECTRIFIED AREA AND ELECTRIC POWER PLAN



LEGEND :

- ▣ PROVINCIAL CAPITAL AND CITY
- ⊙ MUNICIPALITY
- △ PRIMARY SUBSTATION
- (H) PROPOSED HYDRO-POWER STATION
- (H) EXISTING HYDRO-POWER STATION
- (D) DIESEL POWER STATION
- ═══ EXISTING AND PLANNED 69KV TRANSMISSION LINE
- ━━━ PROPOSED 69KV TRANSMISSION LINE IN THE PROJECT
- - - - EXISTING DISTRIBUTION LINE 13.2KV
- (I) PROPOSED 3.45KV DISTRIBUTION LINE

Table 3E-1 Demand and Energy Growth

Year	Demand estimated by NPC (KW) (1)	Estimated Demand by the Rate of Growth as 15% by the Factor of Agricultural Development (KW) (2)	Demand of Agriculture Facility or Project Facility (KW) (3)	Revised Demand (KW) (4)=(1)or(2)+(3)	Energy Growth estimated by NPC (MWH) (5)	Revised Energy Growth (MWH) (6)=(5)x(4)/(1)
1979	65	-	-	65	40	40
1980	70	-	-	70	164	165
1981	80	-	30	110	190	261
1982	90	-	30	120	220	293
1983	100	-	40	140	250	350
1984	110	-	40	150	280	382
1985	120	-	60	180	310	465
1986	130	-	60	190	345	504
1987	140	-	60	200	375	536
1988	150	-	80	230	415	637
1989	160	-	80	240	450	675
1990	175	201	80	281	505	807
1991	190	219	90	309	560	909
1992	205	236	90	326	615	977
1993	220	253	90	343	670	1,046
1994	240	276	90	366	745	1,135
1995	260	299	100	399	825	1,265
1996	285	328	100	428	915	1,376
1997	310	357	100	457	1,015	1,497
1998	335	385	100	485	1,105	1,597
1999	360	414	100	514	1,225	1,743
2000	385	443	100	543	1,325	1,869