REPUBLIC OF THE PHILIPPINES

MASTER PLAN STUDY
ON
THE INTEGRATED AGRICULTURAL DEVELOPMENT PROJECT
IN MARINDUQUE

APPENDIX I

JANUARY 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF THE PHILIPPINES

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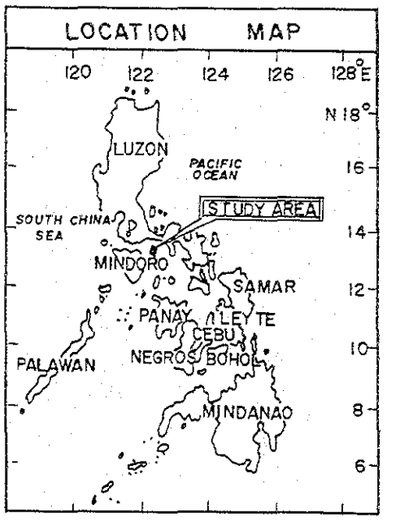
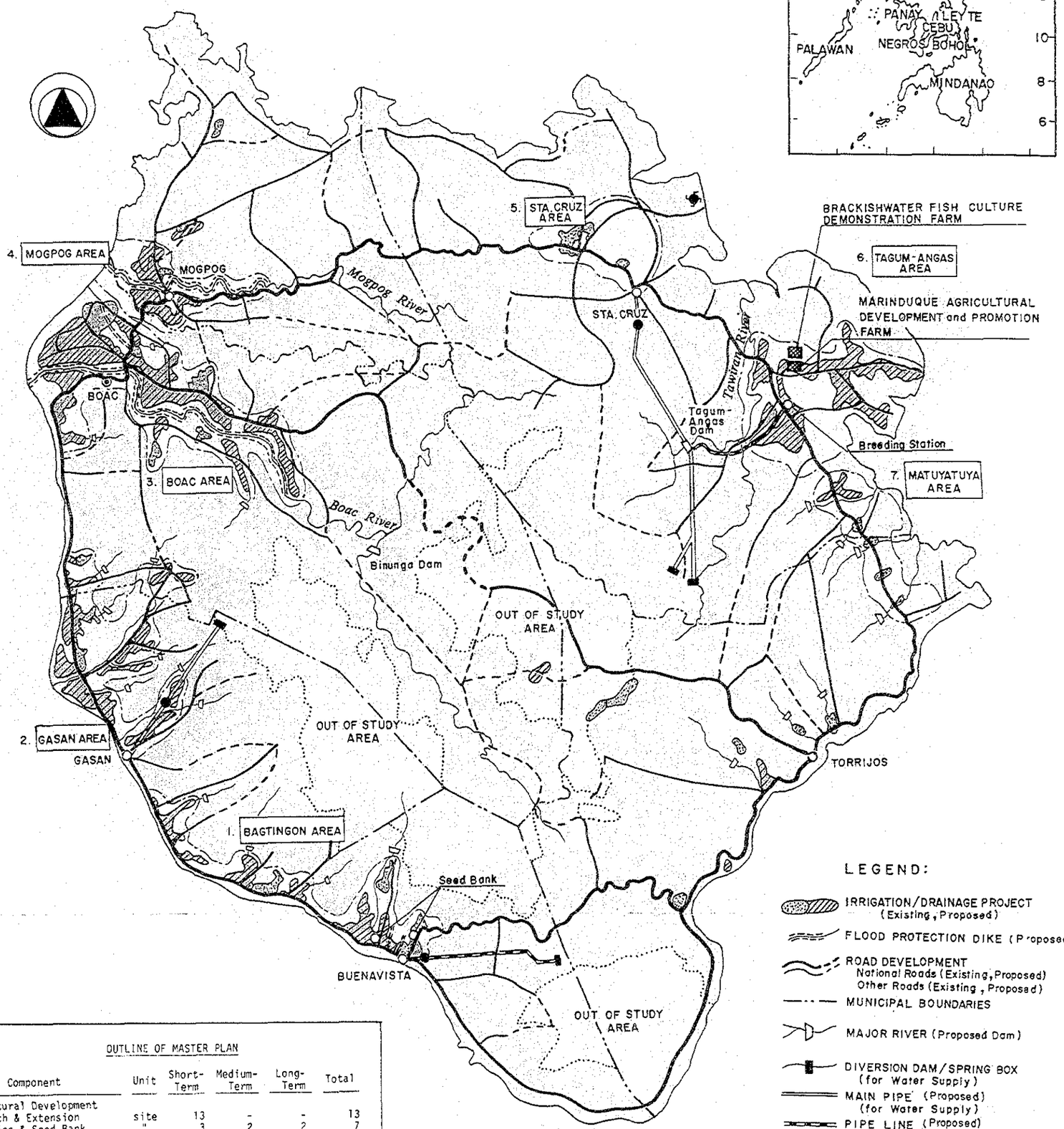
JAPAN INTERNATIONAL COOPERATION AGENCY

GENERAL PLAN

THE INTEGRATED AGRICULTURAL DEVELOPMENT PROJECT IN MARINDUQUE





LEGEND:

- IRRIGATION/DRAINAGE PROJECT (Existing, Proposed)
- FLOOD PROTECTION DIKE (Proposed)
- ROAD DEVELOPMENT
  - National Roads (Existing, Proposed)
  - Other Roads (Existing, Proposed)
- MUNICIPAL BOUNDARIES
- MAJOR RIVER (Proposed Dam)
- DIVERSION DAM/SPRING BOX (for Water Supply)
- MAIN PIPE (Proposed) (for Water Supply)
- PIPE LINE (Proposed) (for Village Water Supply)
- GENERATOR (Proposed)
- 1. PRIORITY DEVELOPMENT AREA

0 1 2 3 4 5 6 Km.

OUTLINE OF MASTER PLAN

Component	Unit	Short-Term	Medium-Term	Long-Term	Total
1. Agricultural Development					
1) Research & Extension	site	13	-	-	13
2) Nurseries & Seed Bank	"	3	2	2	7
3) Demonstration Farm	"	11	12	6	29
4) Post-Harvest	"	8	8	9	25
5) Livestock Development	"	15	11	3	29
6) Farmer's Organization	"	7	16	17	40
7) Marketting & Traiding	"	3	4	-	7
2. Agricultural Infrastructure Development					
1) Irrigation/Drainage	ha	1,650	680	1,340	3,670
2) Flood Protection	km	12	11	20	43
3) Rural Road	"	290	240	400	930
4) Village Water Supply	m^3/d	2,870	-	-	2,870
3. Rural Infrastructure Development					
1) Rural Water Supply	m^3/d	3,380	1,500	2,030	6,910
2) Hydro-Power & Generator	KW	9,000	300	600	9,900
3) Rural Electrification	km	490	150	210	850
4) Traffic System	place	245	215	400	860
5) Health & Medical Service	"	20	10	-	30
6) Education & Welfare	"	300	-	-	300
7) Communication	km	40	-	100	140
4. Aquaculture Development					2
5. MADPP	place	1	-	-	1

PRESENT AND PROPOSED LAND USE

Land Use	Present (ha)	Proposed (ha)
I. Agricultural Area		
Paddy Rice	5,400	5,650
Diversified Crops	4,020	4,300
Coconut Trees	32,470	29,550
Meadows and Others	2,810	4,000
Fruit	-	2,100
II. Forest Area		
Shrub/Grasses	24,370	7,300
Forest	5,530	21,500
III. Wetland and Others	5,900	6,100
Total	80,500	80,500

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ABBREVIATION/CONVERSION TABLE/GLOSSARY

ABBREVIATIONS

BAEcon	Bureau of Agricultural Economics
BAPA	Bureau of Power Association
BAS	Bureau of Agricultural Statistics
BAEx	Bureau of Agricultural Extension
BAT	Bureau of Air Transportation
BCGS	Bureau of Coast and Geodetic Survey
BDT	Bureau of Domestic Trade
BFT	Bureau of Foreign Trade
BIR	Bureau of Internal Revenue
BL	Bureau of Lands
BMG	Bureau of Mines and Geo-Sciences
BOI	Board of Investment
BOP	Bureau of Posts
BOS	Bureau of Soils
BSMI	Bureau of Small and Medium Scale Industries
BUTEL	Bureau of Telecommunications
CB/CBP	Central Bank of the Philippines
DA	Department of Agriculture
DAR	Department of Agrarian Reform
DBM	Department of Budget and Management
DECS	Department of Education, Culture and Sports
DENR	Department of Environmental and Natural Resources
DFA	Department of Foreign Affairs
DLG	Department of Local Government
DOF	Department of Finance
DOH	Department of Health
DOLE	Department of Labor and Employment
DOTC	Department of Transportation and Communication
DPWH	Department of Public Works and Highways
DSWD	Department of Social Welfare and Development
DTI	Department of Trade and Industry
IBRD	International Bank for Reconstruction and Development
IRRI	International Rice Research Institute
IMF	International Monetary Fund
JICA	Japan International Cooperation Agency
JSPS	Japan Society for the Promotion of Science
LBP	Land Bank of the Philippines
LWUA	Local Water Utilities Administration
MWSS	Metropolitan Waterworks and Sewerage Systems
NACIAD	National Council on Integrated Area Development

NACIDA	National Cottage Industries Development Authority
NDC	National Development Corporation
NCSO	National Census and Statistics Office
NEA	National Electrification Administration
NEDA	National Economic and Development Authority
NEPC	National Environmental Protection Council
NFA	National Food Authority
NHA	National Housing Authority
NIA	National Irrigation Administration
NIST	National Institute of Science and Technology
NLUC	National Land Use Committee
NMYC	National Manpower and Youth Council
NNC	National Nutrition Council
NPC	National Power Corporation
NPCC	National Pollution Control Commission
NRCP	National Research Council of the Philippines
NWRB	National Water Resources Board
OEA	Office of Energy Affairs
OECF	Overseas Economic Cooperation Fund
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PCA	Philippine Coconut Authority
PCARRD	Philippine Council for Agricultural Resources Research and Development
PCCI	Philippine Chamber of Commerce and Industry
PCIERD	Philippine Council for Industry and Energy Research Development
PCGG	Presidential Commission on Good Government
PCGR	Presidential Commission on Government Reorganization
PEO	Provincial Engineering Office
PNB	Philippine National Bank
PNOC	Philippine National Oil Corporation
PPA	Philippine Ports Authority
RDC	Regional Development Council
RWDC	Rural Waterworks Development Corporation
SSS	Social Security System
TBAC	Technical Board for Agricultural Credit
UN	United Nations
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
UNIDO	United Nations Industrial Development Organization
UP	University of the Philippines

CONVERSION TABLE

LENGTH

mm	:	millimeter(s)
cm	:	centimeter(s)
m	:	meter(s)
km	:	kilometer(s)
inch	:	inch(s) = 2.54 cm
mile	:	mile(s) = 1.6093 km

AREA

sq.mm	:	square millimeter(s)
sq.cm	:	square centimeter(s)
sq.m	:	square meter(s)
sq.km	:	square kilometer(s)
ha	:	hectare

WEIGHT

mm.gr	:	milli-gram(s)
gr	:	gram(s)
kg	:	kilo-gram(s)
ton	:	ton(s)
once	:	once(s) = 28.350 gr

CAPACITY

lit	:	liter(s)
cu.m	:	cubic meter(s)
gallon	:	gallon(s) = 3.785 lit.
MCM	:	million cubic meter(s)
cavan	:	cavan(s) = 50 kg of palay

DISCHARGE

lps	:	liter(s) per second
cms	:	cubic meter(s) per second (or m^3/sec, cu.m/sec)
cusec	:	cubic foot per second
lpd	:	liter(s) per day

VELOCITY

mm/sec	:	millimeter(s) per second
cm/sec	:	centimeter(s) per second
m/sec	:	meter(s) per second
km/hr	:	kilometer(s) per hour
knot	:	knot(s) = 1.86 km/hr

sec	:	second(s)
min	:	minute(s)
hr	:	hour(s)
Max. or max.	:	maximum
Min. or min.	:	minimum

%	:	percent(s)
No.	:	number
^oC	:	degree(s) centigrade
Hp	:	horse power
W	:	watt(s)

KW	:	kilowatt(s)
MW	:	megawatt(s)
WH	:	watt(s) hour
KWH	:	kilowatt(s) hour
MWH	:	megawatt(s) hour

EL	:	elevation
MSL	:	mean sea level
FWL	:	full water level
HWL	:	high water level
LWL	:	low water level

ET	:	evapotranspiration
ETcrop	:	evapotranspiration of crop
N	:	nitrogen
P	:	Phosphorus
K	:	Potassium
LV	:	local variety
LIV	:	local improved variety
HYV	:	high yielding variety
O & M	:	operation and maintenance cost
EIRR	:	economic internal rate of return
MT	:	metric ton(s)
B/C	:	benefit cost ratio
FY	:	Fiscal year (1st of January to 31st of December)
peso	:	peso(s) - US$ 0.04587 (as of June, 1989)
$	:	dollar(s) 21.80 pesos(as of June, 1989)

GLOSSARY

Study Area	:	Area of 805 sq.km covered by the Master Plan of the Integrated Agricultural Development Project in Marinduque
province	:	A political subdivision of a country comprising municipalities
	:	A political subdivision of province comprising Barangays
Barangay	:	A political subdivision of a municipality comprising villages
Poblacion	:	A political center of a town
Monsoon	:	Predict wind that blows from the sea to the continent and oppositely in Winter
Trade wind	:	One of three Philippines air currents, comprising from a generally easterly direction reaching the island during the period from February to April
Tropical cyclone	:	PAGASA classifies the tropical cyclone by the wind speed in center as follows: - Tropical depression; up to 17.1 m/sec (33 knot) - Tropical storm ; 17.2 (34 knot) to 32.6 m/sec (63 knot) - Typhoon ; over 32.7 m/sec (64 knot)
IR	:	High yielding variety of rice which bears varieties from IRRI
Cogon	:	A coarse grass which usually covers idle lands or abandoned clearing (Imperata cyclidrica)
Ganta	:	A common unit of volume for rice equivalent to 2.24 kg of milled rice
Nipa	:	Heave-leafed type of palm used in hatching huts
Share tenancy	:	A practice where operators rent the land they work and pay as rent a share of the cash or crops grown
Carabao	:	The animal that most farmers used for plowing and other farming works. It is about the size of an ox and its similar to the water buffalo in other countries.
Fiesta	:	Spanish term for feast, celebrated pompously once a year to honor the patron saint.
Kaingin	:	Deforestation by shifting cultivation with slashing and burning forest/brush
Survival	:	The number who graduate/the number who enroll

APPENDIX A GENERAL

APPENDIX A GENERAL

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APPENDIX A GENERAL

A-1 List of Personnel Contacted by the Study Team

NEDA:

Asst. Director General	: Mr. Harry S. Pasimio
Director, RDCS	: Mr. Ernesto S. Gorospe
Chief, Post Evaluation Div.	: Mr. Roland Tungpalan
Officer, Public Investment Staff	: Ms. Rachel Kapunan
Agriculture Staff	: Mr. J. Dominador Gomez Jr.
Regional Dev. Coordination Staff	: Mr. Pauline H. Luzano
Regional Director (Region - IV)	: Atty. Buenaventura C. Go-Soco
Asst. Regional Director	: Mr. Romeo S. Bacos
Chief, Eco. Dev. Div.	: Ms. Josefina U. Esguerra
Chief, Eco. Dev. Div. (former)	: Ms. Norma B. Tecson
Senior Economist, EDD	: Ms. Daisy Elena T. Ano
Chief, Social Dev. Div.	: Ms. Rebecca M. Noriega
Chief, Infra. Dev. Div.	: Mr. Edilberto R. Ramirez
Asst. Infra. Dev. Div.	: Mr. Bayani Tolibas
Chief, Infra. Sec. IDD	: Mr. Antonio Robeles
Chief, Macro-international Coordination and Assistance Div	: Mr. Oskar D. Balbastro
Chief, Operations Div.	: Mr. Rogelio Perena
Senior Engineer	: Mr. Alejandro C. Villrimo
Officer	: Mr. Alex Villarino
Officer	: Ms. Liberty Abellon
Aquaculture Specialist	: Mr. Virgilio B. Marzo
Officer	: Mr. Amador A. Remigio

JICA Philippines Office:

Resident Representative	: Mr. Moriya Miyamoto
Deputy Representative	: Mr. Katsuhiko Oshima
Asst. Resident Representative	: Mr. Noriaki Niwa
Asst. Resident Representative	: Mr. Katsuhiko Ozawa

Embassy of Japan:

First Secretary	: Mr. Naoki Hayashida

RDC:

Chairman, Governor of Occ. Mindoro	: Mr. Pedro O. Medalla Jr.

NACIAD:

Director, PPDD	: Ms. Pulcra M. Nietes
Office-in-charge	: Ms. Caridad Nasol
Project Officer, MIADP	: Mr. Renate Onte
Officer	: Ms. Raymunda Garcia
Management & Audit Analyst	: Ms. Marlene C. Fuentes
Senior Management & Audit Analyst	: Mr. Rafael Gonzalo G. Garcia

Note: NACIAD was abolished due to reorganization of governmental agencies.

NIA:

Administrator	: Mr. Jose del Rosario, Jr.
Administrator (former)	: Atty. Federico N. Alday, Jr.
Asst. Administrator	: Mr. Sebastian T. Julian
Manager, PDD	: Mr. Avelino S. Rivera
Manager, CID	: Mr. Jose M. Alcantara
Asst. Manager, CID	: Mr. Rogelio F. Gusilatar
Chief, Planning Formulation Div., PDD	: Mr. Isidro R. Digal
Chief, Project Investigation Div., PDD	: Mr. Rogelio P. Delarosa
Chief, F/S Div.	: Mr. Armentia
Chief, Irr. Work Sect. PDD	: Mr. Edilberto B. Punzal
Chief, Dams and Reservoirs Sect., PDD	: Mr. Clemente Alanano
Supervising Irrigation Engineer, PDD	: Mr. Arturo S. Samson
Engineer, Land Resources & Utilization Div., PDD	: Mr. Guillermo de Guzman
Engineer	: Mr. Roland M. Maloles
Engineer, DSD	: Mr. Marcelo Carreon
Supervising Planning Engineer	: Mr. Wilfredo D. Silva
Institutional Development Dept.	: Mr. Carmelo Cablayan
Sr. Irrigation & Drainage Eng'r, JICA	: Mr. Yasuhiko Mishima
Sr. Irrigation & Drainage Eng'r, JICA	: Mr. Sumio Oishi
Irrigation & Drainage Engineer, JICA	: Mr. Yukinori Ouchi
Team Leader of DCIEP, JICA	: Mr. Masao Morikawa
Irrigation Engineer of DCIEP, JICA	: Mr. Koji Yamasita
Pedologist of DCIEP, JICA	: Mr. Yutaka Tokunaga
Regional Director (Region - IV)	: Mr. Nicasio T. San Miguel
Asst. Regional Director	: Mr. Efren Vendiola
Prov'l Irrigation Eng'r (Marinduque)	: Mr. Marcial R. Dayot
Economist	: Ms. Emiliana Japos
Officer	: Mr. Alfredo R. Bumatay
Officer	: Mr. Tonny Manuba
Technical Staff	: Mr. Jorge Palomares

DPWH:

Project Director, PMO - ADB	: Mr. Erwin I. Pattugalan
Administrative Officer, PMO - ADB	: Mr. Dante D. Fernandez
Project Director, PMO - IBRD	: Mr. Nestor Abarka
Asst. Director, PMO - IBRD	: Mr. Felipe De Vera
Project Manager, PMO - MFCP	: Mr. Rogolio A. Flores
Project Manager, PMO - SWIM	: Mr. Antonio Alpasan
Project Manager, PMO - SWIM	: Mr. Tomas Buen
Project Manager, PMO - RWS	: Mr. Florencio F. Padernal
Chief, Planning Div.	: Mr. Romuldo Oba
Chief, Planning Standard Sect., PD	: Mr. Teodorico L. Fortes
Regional Director (Region IV - B)	: Mr. Alfred P. Torres
Chief, Construction Div.	: Mr. Salvador J. Asayes
Chief, Maintenance Div.	: Mr. Mannuel L. Villaverde
Supervising Civil Eng'r, Maint. Div.	: Mr. Gelacio M. Bamcoro
Supervising Economist, PMO - F/S	: Mr. Carmelino Tizon
District Engineer (Marinduque)	: Mr. Romeo Alcala
Chief, Const. Sect.	: Mr. Honorio Salazar
Chief, Water Supply Sect.	: Mr. Rizal J. Malapote
Chief, Planning Sect.	: Mr. Wilfred R. Monte
Chief, Maintenance Sect.	: Mr. Elmer Mayangitan
Chief, Monitoring Sect.	: Mr. Ildefonso Lauro M. Go
Asst. Maintenance Sect.	: Mr. Socimo Laynes
Senior Engineer	: Mr. Eflen Labay
Equipment Eng'r, Marinduque Area Shop	: Mr. Reynaldo T. Ricafoente
Training Officer	: Ms. Emadelyn Quinones
Engineer, Const. Sect.	: Ms. Maricel M. Lingon

DA:

Asst. Director, BACD	: Mr. Joseph H. Francia
Agricultural Expert, IADCCO, JICA	: Mr. Shigetaka Saburi
Asst. Regional Director (Region - IV)	: Mr. Lino A. Licuanan
Chief, Planning Officer	: Ms. Rosa Macas
Asst. Planning Officer	: Ms. Easter Y. Cid
Officer	: Ms. Pat Bulahagui
Officer	: Mr. Bayani D. Jimenez
Supervising Soil Technologist	: Mr. Bonifacio C. Queriijero
Prov'l Agricultural Officer(Marinduque)	:Mr. Felipe G. Sanchez
Prov'l Agri. Stat. Officer	: Mr. Librado L. Alilio
Chief, Planning Sect.	: Mr. George Mangaliman
Chief Crop Sect.	: Mr. Pablo M. Boter
Prov'l Engineer	: Mr. Galo G. Aragones
Soil Sect.	: Mr. G. C. Roque
Brackish-water Demonstration Fish Farm	: Mr. Pepe A. Abario

DLG:

Chief, SRRIP Div.	: Mr. Jymy Kapirap
Prov'l Govt. Operations Officer	: Mr. Ricardo Nudo
Asst. Prov'l Govt. Operations Officer	: Mr. Floro Magcamit
Sr. Local Govt. Operations Officer	: Ms. Teresita Garcia

DECS:

Division Superintendent	: Ms. Dolores Orlina
Division Statistician	: Ms. Lolita J. Natolla
Vocational Education Supervisor	: Mr. Miguel Malapad

NWRC:

Chief, Water Resources Specialist	: Mr. Melchor O. Baltazar

PAGASA:

Chief, Climate Data Section	: Mr. Rodlofo C. Felisarta
Chief, Climate Branch	: Mr. Ruben C. Acuna
Chief, Water Resources Specialist	: Mr. Melchor O. Baltazar
Weather Observer II	: Ms. Harriet R. Lafagnas

NSCO:

Computer system Specialist	: Mr. Yasusi Nagai
Domestic Trade Div.	: Ms. Vilma S. Malumay

BAS:

Agricultural Statistic Officer	: Mr. Celestirio Olalp
Prov'l Officer (Marinduque)	: Mr. Librado L. Alilio

BFAR:

Chief, Planning & Management Staff	: Ms. Natividad Macalincag-Lagua

PPA:

Officer	: Mr. Orland Ancheta

Congresswoman, Marinduque	: Hon. Calmencita O. Reyes

Marinduque Provincial Government:

Governor	: Atty. Luisito M. Reyes
Vice Governor	: Atty. Juan Max Lim
Member Sangguniang Panlalawigan	: Mr. Cesaria Zoleta
Member - SP	: Mr. Angel Regalia
Member - SP	: Mr. Francisco Preclaro
Prov'l Assessor, PAO	: Mr. Angel Palomares
Prov'l Planning & Development Coordinator (PPDC)	: Mr. Alexander D. Palmero
Prov'l Engineer, PEO	: Mr. Godofredo R. Sadiua
Administrative Officer, PAO	: Mr. Samuel D. Paraguya
Prov'l Budget Officer	: Mr. Enrique Saporna
Prov'l Agriculturalist	: Mr. Liberato Urgasan
Asst. Prov'l Agriculturalist	: Ms. Luz D. Pedernal
Superintendent, School Div.	: Ms. Dolores M. Orlina
Sr.Officer, Prov'l Governor's Office	: Mr. Rhodelio R. Bugarin
Asst. Prov'l Engineer, PEO	: Mr. Reynaldo M. Ringor
Mechanical Engineer, PEO	: Mr. Tomas Mondragon
Constr. & Maintenance Supervisor, PEO	: Mr. Rolando S. Josue
Dev't Proj. Analyst, PPDC	: Ms. Corazon Jasmin
Planning Officer, PPDC	: Ms. Cleofe Aguirre
Economist, PPDC	: Ms. Luz Lazares
Prov'l Dentist	: Dr. Urbito U. Marciano Jr.

DAR:

JICA Expert	: Mr. Toshio Hiroto
Prov'l Agrarian Reform Officer	: Ms. Maria Lucena
Prov'l Officer	: Mr. Edilberto R. Ardieta
Agrarian Reform Proj. Officer	: Mr. Constantino Manrique
Agrarian Reform Technician	: Mr. Pacifico Monteagudo
Prov'l Environment & Natural Resources Officer	: Mr. Vicente Cabrera

NFA:

Prov'l Manager	: Mr. Benedict P. Asi
Registration Licensing Officer	: Ms. Marilyn N. Bunoz
Prov'l Officer	: Mr. Absahun R. Cirjales

PCA:

Asst. Director (Region - IV)	: Mr. Natalio C. Bondad Jr.
Prov'l Coconut Dev. Officer	: Mr. Moises D. Mendoza

DOH:

Medical Doctor, Prov'l Health Office	: Dr. Efren J. Labay
Medical Specialist	: Dr. Virgilio M. Go
Prov'l Health Officer	: Ms. Anita Magcamit

DSWD:

Prov'l Social Welfare Officer	: Ms. Leticia L. Salvo

DENR:

Prov'l Environment & Natural Resources Officer	: Ms. Vicente Cabrera
Forestry Supervision II	: Mr. Isidro L. Mercado

DTI:

Prov'l Director	: Ms. Arsenia Rivamonte

Boac Municipality:

Mayor	: Mr. Dominador M. Leonida
Vice-Mayor	: Mr. Alejandro B. Solomon
Officer	: Mr. Dem Armiento
Municipal Planning & Dev. Coordinator	: Luna Evlogio R. Manrique

Santa Cruz Municipality:

Mayor	: Mr. Percival F. Marales
Municipal Planning & Dev. Coordinator	: Mr. Procopio Naya
Waterworks Supervisor, OIC	: Mr. George Preclaro
Planning & Survey Div., OIC	: Mr. Danny Rosal
Engineer	: Mr. Manny Pevidal

Gasan Municipality:

Mayor	: Ms. Lourdes V. Mendoza
Municipal Planning & Dev. Coordinator	: Mr. Estanislao Malagotnot Jr.

Buenavista Municipality:

Mayor	: Ms. Ofelia S. Madrigal
Vice-Mayor	: Mr. Luciano F. Sadim
Municipal Agriculturalist	: Mr. Ernesto N. Sotto
Municipal Planning & Dev. Coordinator	: Mr. Bert S. Fabrero

Mogpog Municipality:

Mayor	: Dr. Ruben M. Tan
Vice-Mayor	: Mr. Buenaventura Logdat
Municipal Administrator	: Mr. Benjo k. Buenviaje
Municipal Planning & Dev. Coordinator	: Mr. Roberto L. Delprado
Rural Health Unit	: Dr. Reynaldo R. Montegrejo

Torrijos Municipality:

Mayor	: Mr. Ben Cordero Lim
Vice-Mayor	: Mr. Tomas Pizzaro
Project Dev. Analyst	: Ms. Brenda Fatalla
Municipal Planning & Dev. Coordinator	: Mr. Valerio Grimaldo

MIST:

President	: Mr. Andres G. Malabed Jr.
College Dean	: Mr. Respicio A. Javier
Administrative Officer	: Ms. Prosefina M. Mabiog
Officer	: Mr. C. L. Reyes
Officer	: Mr. Cirilo Morilla

Marcopper Mining Corp.:

Manager, Geology Dept.	: Mr. Mario Pangan
Lubrication Engineer	: Mr. Beato R. Revilla

MARELCO:

Manager	: Mr. Rolando L. Banos
Electrical Engineer	: Mr. Carlito Mistal

BUTEL:

Prov'l Officer	: Mr. Edgardo M. Mirafuente

PIPAC:

Institute Director	: Dr. Modesto T. Chua

PNB. Boac Branch:

Manager	: Mr. Antonio O. Realuvit

ADB:

Fishery Economist	: Mr. Barry V. Lanier
Senior Project Economist	: Mr. Robert E. Hood

Others:

Fisheries Consultant	: Mr. John A. Maynard
Project Monitor, CIAD	: Mr. W. R. Bill Murdoch
Filipinas Aquaculture Cop.	: Mr. C. A. Martines

President, Primary Multipurpose Cooperative,	Sta. Cruz	: Mr. Paciano Rodelas
Barangay Captain,	Masalcot, Sta. Cruz	: Mr. Cecilio Ramos
- do -	, Baliis, Sta. Cruz	: Mr. Ernesto M. Ribleza
- do -	, Nangka, Torrijos	: Mr. Bernardo Anprade
- do -	, Banuyo, Gasan	: Mr. Domnador P. Sadiwa

A-2 Member List of the Study Team

Team Leader/Rural Planning	: Mr. Masahiro Iida
Co-Leader cum Group Leader/ Agro-Economy/Evaluation	: Mr. Shoji Masumura
Agriculture & Farmer's Organization	: Mr. Yasushi Goto
Aquaculture	: Mr. Iwao Mizuishi
Group Leader/Irrigation & Drainage	: Mr. Yoichiro Kuroda
Meteorology & Hydrology	: Mr. Hirofumi Tanaka
Geology & Hydrogeology	: Mr. Shun Watanabe
Group Leader/Agricultural Infrastructure	: Mr. Shun-ichi Hosono
Rural Infrastructure	: Mr. Masatoshi Higashide
Supervision of Topographic Surveying	: Mr. Hisashi Kato

A-3 Implementing Arrangement (I/A) for the Master Plan Study

IMPLEMENTING ARRANGEMENT ON THE TECHNICAL COOPERATION BETWEEN THE JAPAN INTERNATIONAL COOPERATION AGENCY AND NATIONAL COUNCIL ON INTEGRATED AREA DEVELOPMENT ON THE INTEGRATED AGRICULTURAL DEVELOPMENT PROJECT IN MARINDUQUE IN THE REPUBLIC OF THE PHILIPPINES

AGREED UPON
BETWEEN
THE JAPAN INTERNATIONAL COOPERATION AGENCY
AND
NATIONAL COUNCIL ON INTEGRATED AREA DEVELOPMENT

MANILA, JULY 15, 1988

J. ANDRES A. LIMCAOCO
Acting Executive Director
National Council on
Integrated Area Development
(NACIAD)

MORIYA MIYAMOTO
Resident Representative
Japan International
Cooperation Agency
(JICA)

I. INTRODUCTION

In response to the request of the Government of the Republic of the Philippines (hereinafter referred to as "GOP"), the Government of Japan (hereinafter referred to as "GOJ") had decided to conduct the Study on the Integrated Agricultural Development Project in Marinduque (hereinafter referred to as "the Study"), and exchanged the Note Verbales with GOP concerning the implementation of the Study.

The Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programmes of GOJ, will undertake the Study, in accordance with the relevant laws and regulations in force in Japan.

On the part of GOP, the National Council on Integrated Area Development Office (hereinafter referred to as "NACIAD") shall act as counterpart agency to the Japanese Study team and also as coordinating body in relation with other governmental and non-governmental organizations concerned for the smooth implementation of the Study.

The present document constitutes the implementing arrangement between JICA and NACIAD under the above-mentioned Notes Verbales exchanged between two governments.

II. OBJECTIVES OF THE STUDY

The objectives of the Study is to formulate the Plan for Integrated Agricultural Development in the province of Marinduque.

III. OUTLINE OF THE STUDY

III-1. STUDY AREA

The Study area covers about 81,000 ha. of the potential area of Integrated Agricultural Development in Marinduque.

III-2. OUTLINE OF THE STUDY

The Study consists of two stages. At the first stage, data collection and field survey will be conducted in order to obtain basic data necessary for formulation of Master Plan. The second stage will cover supplementary field survey mainly for selected project components and areas in the province to finalize the Plan.

1. First Stage

1-1. Data collection and field survey

To collect and review available data and information relevant to the Study and to carry out field survey on the following items:

(1) Natural condition
   a. Topography
   b. Meteorology
   c. Hydrology
   d. Geology
   e. Soil

(2) Social condition
   a. Population and habitation
   b. Social organization
   c. Industry and economy

(3) Agriculture
   a. Farming
   b. Land use
   c. Land holding
   d. Cropping
   e. Agriculture organization
   f. Storage facilities
   g. Processing of agricultural products

(4) Agricultural infrastructure
   a. Irrigation and drainage system
   b. Farm Land conservation
   c. Farm road and rural road

(5) Agro-economy
   a. Marketing system
   b. Farmer's income and productivity
   c. Agricultural credit
   d. Farmers organization
   e. Extension service
   f. Agro-industry

(6) Rural infrastructure
   a. Rural electrification
   b. Communication
   c. Rural water supply
   d. Welfare
   e. Education

(7) Aquaculture

(8) Flood damages

1-2. Topographical mapping of the high potential development areas (Scale: 1/10,000)

1-3. To select priority project components and areas in the Province based on the findings and discussions with authorities concerned of the Government of the Philippines.

1-4. Preliminary formulation of the Integrated Agricultural Development Plan.

2. Second Stage

On the basis of the results of the first stage, the following will be carried out.

2-1. Supplmentary survey and additional data collection.

2-2. Comprehensive studies and analysis.

(1) To formulate the Plan for Integrated Agricultural Development, taking into consideration such components as follows.

a. Development of irrigation and drainage system
b. Improvement of rural roads and farm roads
c. Development of agricultural support system including institutional development as well as physical development
d. Development of aquaculture

(2) To formulate priority project(s)

a. Preliminary design of the major structures
b. Approximate estimation of development cost

IV. STUDY SCHEDULE

The Study will be executed in accordance with the attached tentative work schedule.

V. REPORTS

JICA shall prepare and submit the following reports in English to GOP.

(1) Inception report
Thirty (30) copies at the commencement of the first stage field work.

(2) Field report (I)
Thirty (30) copies at the end of the first stage field work.

(3) Interim report
Thirty (30) copies at the commencement of the second stage field work.

(4) Field report (II)
Thirty (30) copies at the end of the second stage field work.

(5) Draft final report
Thirty (30) copies within one (1) month after the end of the second stage home office work.
GOP is requested to provide its comments on the draft final report within one (1) month after its receiving.

(6) Final report
Fifty (50) copies within two (2) months after receiving the comments on the Draft Final Report.

VI. UNDERTAKING OF GOP

In accordance with the Notes Verbales exchanged between GOJ and GOP, GOP shall accord privileges, immunities and other benefits to the Japanese study team and, through the authorities concerned, take necessary measures to facilitate smooth conduct of the Study.

1. GOP shall be responsible for dealing with claims which may be brought by the third parties against the members of Japanese study team and shall hold them harmless in respect of claims or liabilities arising in the course of, or otherwise connected with the discharge of their duties in the implementation of the Study, except when such claims or liabilities arise from gross negligence or willful misconduct of the above-mentioned members.

2. The National Economic and Development Authority (NEDA) Region IV shall provide counterpart personnel to ensure that the Study shall be in accordance with the regional development thrusts.

3. NACIAD shall, at its own expense, provide the Japanese study team with the following, if necessary, in cooperation with other agencies concerned:

   (1) Available data and information related to the Study;
   (2) Counterpart personnel;
   (3) Suitable office space with necesaary equipment in Manila and the Study area;

(4) Credentials or identification cards to the members of the Japanese study team;

(5) Appropriate number of vehicles with drivers.

4. NACIAD shall make necessary arrangements with other governmental and non-governmental organizations concerned for the following:

(1) to secure the safety of the Japanese study team;

(2) to permit the members of the Japanese study team to enter, leave and sojourn in the Philippines for the duration of their assignment therein ;

(3) to exempt the members of the Japanese study team from taxes, duties, fees and other charges on equipment, machinery and other materials brought into the Philippines for the conduct of the Study;

(4) to exempt the members of the Japanese study team from income tax and charges of any kind imposed on or in connection with any emolument or allowance paid to the members of the Japanese study team for their services in connection with the implementation of the Study;

(5) to provide necessary facilitate to the Japanese study team for remittance as well as utilization of the funds introduced into the Philippines from Japan in connection with the implementation of the Study;

(6) to secure permission for entry into private properties or restricted areas

for the conduct of the Study;

(7) to secure permission to take all data and documents (including photgraphs) related to the Study out of the Philippines to Japan by the Study team;

(8) to provide medical services as needed and its expenses will be chargeable on members of the Japanese study team.

VII. UNDERTAKING OF GOJ

In accordance with the Notes Verbales exchanged between GOJ and GOP, GOJ through JICA, shall take the following measures for the implementation the Study;

1. To dispatch, at its expense, study teams to the Philippines;

2. To pursue technology transfer to the Philippine counterpart personnel in the course of the Study;

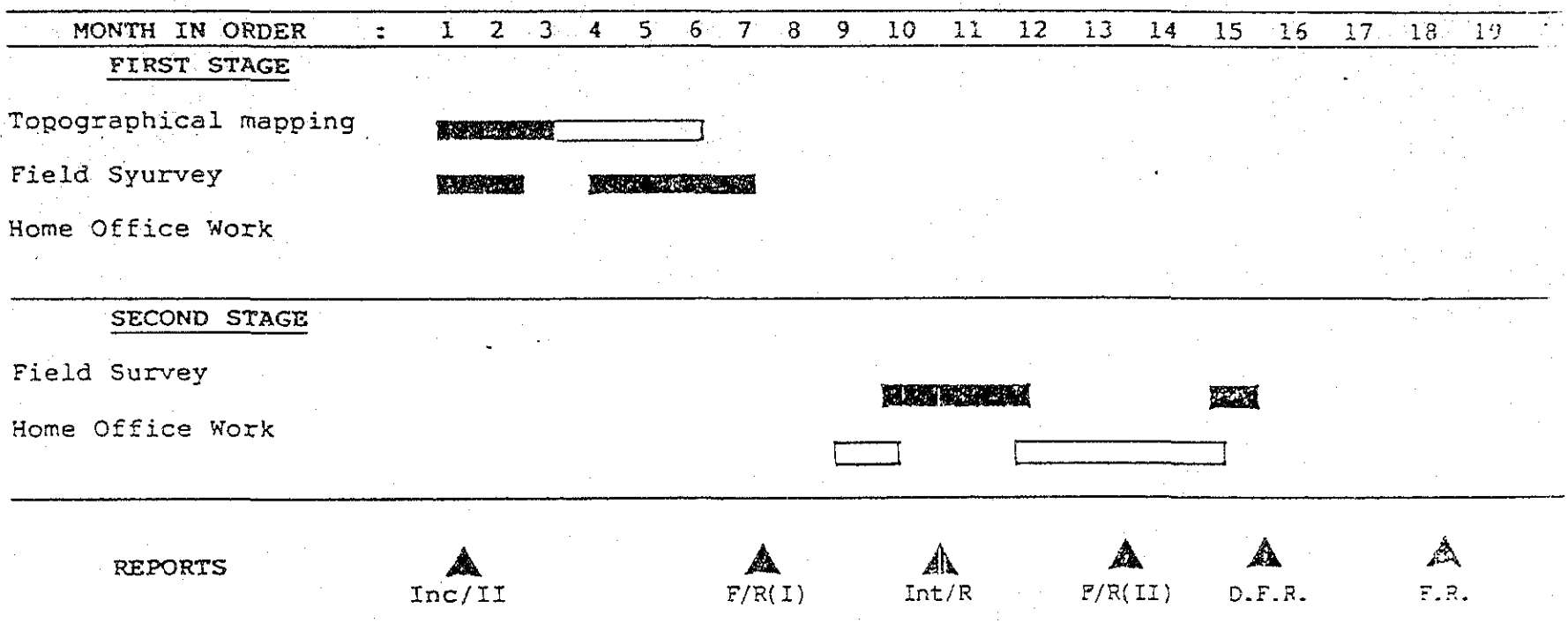
3. To provide the necessary equipment for the implementation of the Study, which will remain the property of JICA unless otherwise agreed.

VIII. CONSULTATION

JICA and NACIAD shall consult with each other in respect of any matter that may arise from or in connection with the Study.

A P P E N D I X

TENTATIVE WORK SCHEDULE



Remarks:

Inc/R	:	Inception Report
F/R(I)	:	Field Report (I)
Int/R	:	Interim Report
F/R(II)	:	Field Report (II)
D.F.R.	:	Draft Final Report
F.R.	:	Final Report

REPUBLIC OF THE PHILIPPINES
NATIONAL ECONOMIC AND DEVELOPMENT AUTHORITY
NEDA sa Pasig, Amber Avenue
Pasig, Metro Manila

Cable Address: NEDAPHIL
P.O. Box 419, Greenhills
Tels. 673-50-31 to 50

10 March 1988

Mr. Moriya Miyamoto
Resident Representative
Japan International Cooperation Agency
L.C. Bldg., 375 Gil J. Puyat Avenue
Makati, Metro Manila

Dear Mr. Miyamoto:

This has reference to the ongoing Study on the Marinduque Integrated Agricultural Development Project (MIADP) under the JICA Technical Assistance Program.

In view of the abolition of the National Council on Integrated Area Development (NACIAD), we wish to convey to your Office our concurrence of the designation by the Regional Development Council (RDC) of Region IV for the NEDA Regional Office IV (as the technical arm of the RDC) as coordinating agency for the TA on MIADP. The responsibilities of the Government and the NACIAD, as stipulated in the Implementing Arrangements (I/A) executed between JICA and NACIAD on 15 July 1988 with respect to the said study, shall therefore be assumed by the NEDA Regional Office.

We wish to point out, however, that the Office of the Provincial Governor of Marinduque shall take an active role in the overall coordination of the study; in the event that the MIADP itself shall be implemented, the Provincial Government of Marinduque shall serve as Executing Agency. This is in accordance with NEDA Board Resolution No. 68 (s. 1988) which assigns responsibility for overall coordination and supervision of Integrated Area Development (IAD) projects to the respective Offices of the Provincial Governor concerned, in the case of IADs covering a single province.

For your reference, attached herewith are copies of RDC IV Resolution No. IV-20-89 and NEDA Board Resolution No. 68 (s. 1988).

Best regards.

Very truly yours,

FLORIAN A. ALBURO
Deputy Director-General

cc: Hon. Luisito Reyes, Governor of Marinduque
Hon. Pedro Medalla, Jr., as RDC IV Chairman

APPENDIX B REGIONAL/RURAL DEVELOPMENT

APPENDIX B REGIONAL/RURAL DEVELOPMENT

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APPENDIX B REGIONAL/RURAL DEVELOPMENT

B-1 National Background

B-1-1 Philippine Economy

The Philippines experienced the worst economic and financial crisis in its postwar history starting in late 1983. Gross Domestic Product (GDP) at constant 1972 market prices showed negative growth in 1984 and 1985. Negative growth during this period was attributed to negative growth in industrial as well as service sectors. After contracting by an average annual rate of 4.3% during 1984-1985, GDP at constant 1972 market prices grew by 1.5% in 1986 and by 5.1% in 1987. (refer to Table B-1-1)

Notwithstanding the recovery of the growth process, the country's balance of payments continued to remain fragile during 1986-1987. The deficit in the balance of trade which amounted to $2.48 billion in 1983, declined to $0.48 billion in 1985 and $0.20 billion in 1986 and moved into $1.0 billion in 1987. In nominal US dollars, merchandise exports increased modestly from $4.6 billion in 1985 to $4.8 billion in 1986 and more substantially to $5.7 billion in 1987. After declining every year during 1981-1986, imports rose sharply from $5.0 billion in 1986 to $6.7 billion in 1987. Imports of capital goods, raw materials and fuels increased appreciably in 1987 over the previous year's levels. (refer to Table B-1-2)

In spite of the fact that long run sustainability of the Philippine economy is yet to be confirmed, there are a number of positive indications that the process of recovery has commenced. Such indications can be seen from several socio-economic indicators such as growth rate of Gross Domestic Product (GDP), decreased rate of consumer price indexes, and favorable trends in balance of payment.

B-1-2 Medium-Term Philippine Development Plan (MTPDP)

The MTPDP proclaimed in December 1986 (the original MTPDP) was updated by NEDA in July 1988, mainly to revise growth projections, in order to reflect the economic experience of 1987 and to address more comprehensively the priorities of the Government. The MTPDP which outlines the development strategy of the Philippine Government during 1987-1992, both in the original and updated versions, seeks to shift the focus of the development strategy from growth maximization to rural development, poverty alleviation and reduction in social inequity.

The updated MTPDP (1988-1992) envisages further strengthening of economic growth during the period 1988-1992, so that by the end of the Plan, a firm foundation for taking the economy to the next stage in its developmental aspirations of joining the ranks of the newly industrializing countries by the turn of this century, would have been laid. The updated MTPDP has revised the targets of the original MTPDP, taking account of the experience of 1987. The major macroeconomic targets and projections in the updated MTPDP (1988-1992) compared with the original MTPDP (1987-1992) and the actual achievements in 1987 are given in Table B-1-3.

The rate of growth of real GNP at 6.5% in the updated MTPDP is slightly less than the 6.8% originally planned and takes into account the underachievement of the planned rate of growth in 1987. A reduced rate of growth for agriculture value-added takes into account the considerably low rate of growth in 1987. A somewhat higher level of unemployment, particularly rural unemployment, reflects the lower growth rate in agriculture. The Plan aims at a substantial reduction in the incidence of poverty from about 59% in 1985 to 45.2% in 1992. In particular, the incidence of rural poverty will decline from 63.2% to 47.2% during this period.

B-1-3 Agricultural Sector

The Philippines is an archipelago comprising about 7,000 islands, with a total land area of about 30 million ha. Total harvest area in 1986 was 12.5 million ha with the total land area under cultivation for foodgrains (rice and corn) at 7.0 million ha, of which 17% was under irrigation. The remaining harvest area was planted to coconut (3.3 million ha), sugarcane (0.35 million ha), coffee (0.15 million ha), cacao (15,000 ha), and fruits and nuts (0.6 million ha). In 1986, the population of the Philippines was estimated at about 57.0 million, of which about 38.0 million (66%) lived in rural areas, largely dependent on agriculture for livelihood.

Although industrialization has been the main focus of the Philippine Government economic policy, the agricultural sector continues to be the mainstay of the economy, accounting for about 50% of total employment, 28% of GDP, and 31% of export earnings in 1987.

The growth of the agriculture sector in real terms decelerated from 3.7% in 1986 to 0.4% in 1987. (refer to Table B-1-1). The low growth in 1987 was mainly due to the generally poor harvests of both cash and foodcrops due to adverse weather conditions and contraction in forestry value-added. In crop subsector, almost the entire crops, except corn, experienced negative growth rates in 1987. There was a physical decline in the outputs of rice, coconuts, sugarcane, banana, coffee and abaca in 1987 compared with 1986. Some gains were however registered in the outputs of corn, peanuts and pineapples. In fisheries subsector, fish production in 1987 rose by 5.9% over 1986. This growth was mainly due to the growth of 8.2% in fishery output from commercial fishing and the growth of 19.1% in fishery output from aquaculture. Aquaculture has been the fastest growing field in fisheries and contributed to more than 30% of the growth in the value-added by fisheries. (refer to Table B-1-4)

Table B.1.1 Gross Domestic Product by Industrial Origin
(in million pesos at constant 1972 prices)

Industry	1983	1984	1985	1986	1987
1. Agriculture, Fishery and Forestry	24,845	25,409	26,252	27,233	27,331
Growth Rate (%)	-2.1	2.2	3.3	3.7	0.4
2. Industrial Sector	35,956	32,282	29,000	28,380	30,656
Growth Rate (%)	0.7	-11.3	-10.2	-0.2	8.0
3. Service Sector	39,120	36,236	34,652	35,674	37,961
Growth Raee (%)	3.2	-7.4	-4.4	2.9	6.4
Gross Domestic Product	99,921	93,927	89,904	91,287	95,948
Growth Rate (%)	0.9	-6.0	-4.3	1.5	5.1

Source: 1988 Philippine Statistical Yearbook, NSCB

Table B.1.2 Balance of Trade in the Philippines, 1983 to 1987
(F.O.B. value in million U.S. dollars)

Year	Total Trade	Exports	Imports	Balance
1983	12,491.92	5,005.29	7,486.63	-2,481.34
1984	11,460.26	5,390.65	6,069.61	-678.96
1985	9,739.62	4,628.95	5,110.67	-481.72
1986	9,885.38	4,841.78	5,043.60	-201.82
1987	12,457.21	5,720.24	6,736.97	-1,016.73

Source: 1988 Philippine Statistical Yearbook, NSCB

Table B.1.3 Aggregate Macroeconomic Targets, 1987-1992

Target Item	1987 Actual	Original Target	Updated Target
Gross National Product (in billion pesos at constant 1972 prices)	94.7	116.7	114.8
Growth Rate (%)	5.7	6.8	6.5
Gross National Product (in billion pesos at current prices)	706.3	1,101.2	1,058.3
Inflation Rate Projections (%)	3.8	8.1	7.2
Per Capita GNP (in pesos at current prices)	12,313	17,813	17,132

Source: Philippine Development, August 1988

Table B.1.4 Quantity and Value of Fish Production, 1983 to 1987

(Quantity in 1,000 metric tons and value in million pesos)

Year	Total		Commercial Fishing		Municipal Fishing		Aquaculture	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1983	2110.2	18981.5	519.3	4642.7	1145.8	9539.6	445.1	4799.2
1984	2080.4	25649.9	513.3	6521.2	1089.2	11862.8	477.9	7265.9
1985	2052.1	31897.3	512.0	7857.2	1045.4	14715.7	494.7	8724.4
1986	2089.5	37331.5	546.2	9247.9	1072.4	17251.5	470.9	10832.2
1987	2213.0	37241.9	591.2	9820.7	1060.9	16107.5	560.9	11313.6

Source: 1988 Philippine Statistical Yearbook, NSCB

B-2 Regional Level

B-2-1 Region IV - Southern Tagalog Region

The Southern Tagalog Region (Region IV) is considered the largest and prime region in the country. It is composed of eleven (11) provinces, of which six (6) are the mainland provinces of Aurora, Batangas, Cavite, Laguna, Quezon and Rizal while five (5) are island provinces to wit: Marinduque, Occidental Mindoro, Oriental Mindoro, Palawan and Romblon. It includes 8 cities, 213 municipalities, and 5,249 Barangays. (refer to Table B-2-1). The Region IV had a total population of about 6.1 million in 1980, which is estimated to reach about 7.9 million in 1989. The region accounts for large agricultural and fishery resources having a total farm area of 1.25 million ha or 13% of total national farm area.

B-2-2 Medium-Term Regional Development Plan (1987 - 1992)

The Medium-Term Development Plan of Region IV has been prepared to seek to achieve economic recovery in the short-run and sustainable growth in the long-run in line with the basic strategy formulated in the Medium-Term Development Plan of the Republic of the Philippines. The Plan's major projections and targets are described hereunder.

1) The regional population is expected to grow at an average annual rate of 2.64% to reach 8.5 million in 1992.

2) The Gross Regional Domestic Product (GRDP) will ;increase from an estimated P13,570 million at constant 1972 prices in 1987 to around P18,801 million in 1992, posting an average annual growth rate of 6.74%. Per capita GRDP will increase by annual average rate of 3.62% as against the population annual growth rate of 2.64%.

3) Regional employment is projected to reach from a total of 2.4 million in 1987 to around 3.3 million in 1992 at an average annual growth rate of 6.32%.

4) Structure of regional economy, in terms of share in GRDP, will be estimated as follows; i) agriculture sector with the share of 32.8%; ii) industry sector, 34.4%; and iii) services sector, 32.8%. Unemployment is expected to be reduced to 4.08% in 1992 from 10.33% in 1987.

B-2-3 Updated Agriculture Sectoral Plan (1989 - 1992)

Medium-Term Southern Tagalog Regional Development Plan (1987-1992) was updated taking into consideration the revised MTPDP. In line with the updated Regional Development Plan, agriculture sectoral plan has also been updated. Overall objective of the updated Plan is to lay the foundation for an equitable, efficient and ecologically sustainable growth for the agriculture sector. In particular, the target is set to increase the number of rural families above the poverty line by 20% at the end of 1992. The present indicative level of monthly income of 2,174 pesos (or annual income of 26,088 pesos) will be increased to 2,609 pesos (or annual income of 31,308 pesos) in 1992. Other objectives include: improvement and diversification of food production to meet nutritional requirements; attainment of self-sufficiency; equitable distribution of production; increase in agro-based employment opportunities; institutionalization of farmers' participation in agricultural development through cooperatives and other community-based organizations.

To maximize the use of land resources, agricultural diversification and integrated farming system are given emphasis. This may include fish-livestock-crops mix and multiple cropping system under coconut.

Table B.2.1 Outline of Southern Tagalog Region

Name of Province	Population (1980 in million)	Area (sq.km)	Cities	Municipal-ities	Barangays
Aurora	0.11	3239.5	-	8	151
Batangas	1.17	3165.8	2	32	1076
Cavite	0.77	1287.6	3	20	520
Laguna	0.97	1759.7	1	29	671
Marinduque	0.17	959.2	-	6	218
Occ. Mindoro	0.22	5879.8	-	11	158
Or. Mindoro	0.45	4364.7	-	15	419
Palawan	0.37	14896.3	1	21	414
Quezon	1.13	8706.7	1	40	1238
Rizal	0.56	1308.9	-	14	172
Romblon	0.19	1355.9	-	17	212
Southern Tagalog	6.11	46924.1	8	213	5249

Source: Philippine Yearbook, 1987

B-3 Socio-economic Conditions in Marinduque

B-3-1 Demographic Structure

1) Population Trends and Projections

Based on the population statistics between 1948 and 1980, average annual population growth in Marinduque for 32 years is enumerated at 2.2% which is lower than the national average of 2.9%. The population between 1975 and 1980 grew at an average annual rate of 1.3% in Marinduque. The low growth rate is considered to be due to outmigration of younger generation to Metro Manila and other provinces although definite data on exact number of outmigration are not available. For the formulation of the master plan, population projections have been undertaken on the assumption that population would have increased at an annual growth rate of 1.9% between 1980 and 1989 and it will increase at the same rate up to 2010. Adoption of annual growth rate of 1.9% is based on the estimated natural growth rate of 2.4% and outmigration rate of 0.5%. The same rate is also utilized in the Medium-Term Southern Tagalog Region Development Plan, 1987-1992 prepared by Regional Development Council, Southern Tagalog Region in 1986. Based on this assumption, the population of Marinduque is estimated to reach 205,781 in 1989 and will further increase to 305,536 in 2010. (refer to Table B-3-1)

2) Population Density

Average population density per physical area (959.2 sq.km) in Marinduque was 1.8 persons per ha(or 180 persons per sq.km) in 1980. Among six (6) municipalities, population density is highest in Mogpog with 3.0 persons per ha in terms of physical area, 4.6 persons in terms of agricultural land area and 38.4 persons in terms of cultivated area. Santa Cruz was the second most densely populated municipality in terms of physical and agricultural land areas, but ranked fifth in terms of cultivated area. Torrijos has the lowest density in terms of physical, agricultural and cultivated areas. (refer to Table B-3-2)

3) Labor Force and Employment

Labor force (or economically active population) is defined as all persons of 15 years old and over who work or are looking for work or who help any member of their family in agriculture, trade or any other profession. Excluded are housewives, students, pensioners, landlords, etc. Labor force comprises the employed and the unemployed. Based on the Integrated Survey of Households in 1988, employed persons in the labor force in Marinduque was recorded as 65,000 and unemployed persons as 11,000 with the unemployment rate of 14.5% which was the highest among the eleven provinces in Region IV. (refer to Table B-3-3). It is estimated that high rate of unemployment in Marinduque is due partly to adverse effects caused by typhoons in 1987.

B-3-2 Economic Structure

1) General

The main economic activity in the province is agriculture, with coconut as the primary crop, followed by palay and corn. Due mainly to its generally hilly and mountainous terrain, it is not self-sufficient in rice supply and other agricultural products. The province is dependent on its neighbors - Quezon and Oriental Mindoro - for its rice and some other food needs.

Fishery is one dominant source of livelihood in the province. In 1986, total fish production was recorded at 7,184 metric tons with 77% contributed by municipal fishing. Commercial fishing production shared 21% of the total production while inland fishery and aquaculture had an aggregate share of 2%. (refer to Table B-3-4)

The main industry is mining, producing about 13% of the nation's copper, 2% of its gold and 10% of its silver. (refer to Table B-3-5). Marcopper Mining Corporation operates producing copper, while another mining firm extracts lime.

The manufacturing operations in the province have been closely linked with the agriculture sector, consisting of grain milling, food preservation, woodcraft, etc. Commerce and trade in the province is facilitated through two major trade centers in the neighboring provinces, namely: Lucena City in Quezon and Pinamalayan in Oriental Mindoro.

2) Economic Structure by Employment

Marinduque's economy is basically agriculture, with 59% of its workers engaged in the primary industry sector, namely: agriculture, forestry and fisheries, in 1980. The secondary industry sector, comprising mining, manufacturing, construction and utility, employed a total of 7,036 workers or 15.4% of the total workers. The tertiary industry sector which includes transportation, commerce transportation, finance and services absorbed 10,741 workers representing 23.5% of the total workers. (refer to Table B-3-6)

B-3-3 Income Levels

1) 1985 Family Income

Based on the 1985 Family Income and Expenditures Survey, the estimated total income of Marinduque was 671,038 pesos against 36,608 families. Average household income in 1985 was estimated at 18,330 pesos. Income level of Marinduque contributed only about 1.7% to total regional income and had the second lowest share among the eleven (11) provinces of Region IV.

Income level of Marinduque is considered to be worsened after 1987 when two big typhoons, Herming in August and Sisang in November, attacked the island and caused considerable damages in agricultural production.

2) Income Distribution

The household income pattern in Marinduque showed that 48.9% of all families belonged to the income stratum with annual income below 10,000 pesos. The total income of this stratum shared only 19.2% of the total income. The middle income group (those receiving between 10,000 pesos and 40,000 pesos) comprised 41% and contributed 39.3% of the total income. The higher income group which accounted for 10.1% of all families earned 41.5% of the total income in 1985. (refer to Table B-3-7)

B-3-4 Administration

The provincial government of Marinduque is responsible for overall planning and development of Marinduque to improve socio-economic conditions in close collaboration with national line agencies and other institutions. Organizationally, the provincial government is composed of the office of the Provincial Governor, Vice-Governor, Sangguniang Panlalawigan (Board Members), and the offices of various divisions such as Civil Security Unit, Provincial Budget, Provincial Planning and Development, Provincial Treasurer, Provincial Engineer, Provincial Assessor, Provincial Agriculturist, and National Offices.

National line agencies have their provincial offices to extend their services at provincial level. Such offices include, among others, Department of Public Works and Highways, National Irrigation Administration, Department of Agriculture, Department of Agrarian Reform, Department of Education, Department of Health, Department of Trade and Industry, Department of Natural Resources, etc.

The province of Marinduque is divided into six (6) municipalities, namely; Boac, Buenavista, Gasan, Mogpog, Santa Cruz, and Torrijos. Each municipality is further subdivided into Barangays. The municipality of Boac, the capital town, ranks third inland area, but ranks first in terms of the number of Barangays with 61, followed by Santa Cruz with 55, Mogpog with 37, Gasan and Torrijos with 25 each, and Buenavista with 15.

B-3-5 Small Scale and Cottage Industries

Manufacturing operations in the province have been closely linked with the agriculture sector and have been largely carried out by small-scale operators in the areas of grain milling, food processing, woodcraft, weaving, etc.

Handicraft operation is one of the main manufacturing activities in the province. Although there are no exact data on the handicraft establishments, it is estimated that more than 30 establishments are operating for the manufacture of wooden birds, napkin rings, bamboo fans, nito baskets, etc. There exist only a few establishments which can employ more than 100 workers. A handicraft establishment in Gasan employs about 300 workers and produces 620,000 pcs. of wooden birds and other fashion accessories. Another establishment in Gasan employs about 140 workers to produce 740,000 pcs. of wooden birds and other decorative items. As tabulated in Table, most establishments of woodcraft operation are located in Gasan and some others are located in other municipalities. (refer to Table B-3-8)

One of the major problems in woodcraft manufacturing is the shortage of raw materials. Supply of wood logs suitable for handicraft is decreasing year by year. The manufacturers feel it imperative to make plantation of several species such as Santol, Dita, Lanete, Taloto and Bonliw to secure raw materials in the future.

Table B.3.1 Population Statistics in Marinduque
(1939 - 1989)

Province/ Municipality	1939 Jan.1	1948 Oct.1	1960 Feb.15	1970 Mar.6	1975 May 1	1980 May 1	1989 Estimate
Marinduque	81,768	85,828	114,586	144,109	162,804	173,715	205,781
Municipality of:							
Boac	20,977	19,687	26,712	32,402	35,649	37,005	43,836
Buenavista	4,354	5,040	7,303	10,463	11,787	13,025	15,429
Gasan	10,794	10,052	14,508	19,827	20,596	23,185	27,465
Mogpog	12,132	12,922	18,413	21,980	24,736	26,399	31,272
Santa Cruz	24,537	27,430	32,765	41,300	49,274	51,846	61,416
Torrijos	8,974	10,697	14,885	18,137	20,762	22,255	26,363

Source: 1980 Census of Population and Housing, Marinduque

Table B.3.2 Population Density, 1980
(Persons per ha)

Municipality	Density per Physical Area	Density per Agri. Land Area	Density per Cultivated Area
Boac	1.7	4.3	15.4
Buenavista	1.7	3.4	15.9
Gasan	1.9	4.2	19.9
Mogpog	3.0	4.6	38.4
Sta. Cruz	2.1	4.5	12.3
Torrijos	1.0	2.3	7.1
Marinduque	1.8	3.9	14.0

Source: 1980 Census of Agriculture, Vol 2

Table B.3.3 Employment Status in Marinduque, 1987

(Unit: 1,000 persons)

Province/ Urban-Rural	Working Population	Economically Active Population			Economically Inactive
		Employed	Unemployed	Total	
Marinduque	123	65	11	76	48
Urban	18	9	3	12	6
Rural	105	55	8	63	42

Note : Figures may not add up to totals due to rounding

Source: Integrated Survey of Households, NCSO, October 1988

Table B.3.4 Fisheries and Aquatic Production in Marinduque

(Unit: metric ton)

Classification	1983	1984	1985	1986
Municipal	7543	8122	8935	5530
Commercial	57	291	1289	1502
Fishpond (Brackishwater)	783	163	126	152
Bangus	768	150	116	151
Sugpo	2	1	1	1
Others	13	12	9	-
Total	8383	8576	10350	7184

Source: Bureau of Fisheries and Aquatic Resources, 1988

Table B.3.5 Comparative Summary of Production and Value

	Philippines		Marcopper		Share of Marcopper	
	Quantity (MT)	Value (million ₱)	Quantity (MT)	Value (million ₱)	Quantity (%)	Value (%)
Copper						
1984	233,160	4,970.07	32,733	516.747		
1985	222,190	5,629.95	33,148	614.531		
1986	217,020	5,460.59	28,851	568.627		
1987	214,100	6,141.17	23,933	628.544		
Total	886,470	22,201.78	118,665	2,328.449	13.39	10.49
	Quantity (kg)	Value (million ₱)	Quantity (kg)	Value (million ₱)		
Gold						
1984	25,730	4,772.59	789	141.420		
1985	33,060	6,087.88	803	139.382		
1986	35,430	8,394.77	584	123.932		
1987	32,600	9,290.35	594	162.249		
Total	126,820	28,545.59	2,770	566.083	2.18	1.99
	Quantity (kg)	Value (million ₱)	Quantity (kg)	Value (million ₱)		
Silver						
1984	48,960	199.12	5,831	21.913		
1985	52,420	186.24	6,864	20.678		
1986	51.530	174.56	4,879	14.218		
1987	50.820	218.17	3,232	12.649		
Total	203,730	778.09	20,806	69.458	10.21	8.93
Grand Total		51,525.46		2,963.99		5.8

Table B.3.6 Sectoral Distribution of Labor Force
(1980)

Sector	Gainful Workers	Share (%)
Primary		
Agriculture	26,935	59.0
(Crop production)	(22,074)	(48.4)
(Fishery)	(4,700)	(10.3)
(Others)	(161)	(0.3)
Secondary		
Mining	3,060	6.7
Manufacturing	2,364	5.2
Utilities 1/	178	0.4
Construction	1,434	3.1
Sub-Total	7,036	15.4
Tertiary		
Commerce	2,520	5.5
(Wholesale)	(302)	(0.7)
(Retail)	(2,218)	(4.8)
Transportation	1,517	3.3
Services	6,704	14.7
Sub-Total	10,741	23.5
Others 2/	942	2.1
Total	45,654	100.0

Source: 1980 Census of Population and Housing, Marinduque.

Notes : 1/ Utilities include electricity, gas and water.
2/ Others signify activities not adequately defined.

Table B.3.7 Family Income Distribution in Marinduque, 1985

Income Class	No. of Families	Share (%)	Total Income (10^3 pesos)	Share (%)	Average Income (pesos)
Under ₱10,000	17,913	48.9	128,825	19.2	7,192
10,000-14,999	7,752	21.2	47,271	14.5	12,548
15,000-19,999	3,648	10.0	62,424	9.3	17,112
20,000-29,999	1,889	5.2	44,614	6.6	23,618
30,000-39,999	1,694	4.6	59,548	8.9	35,152
40,000-59,999	1,694	4.6	75,360	11.2	44,486
60,000 and over	2,019	5.5	202,996	30.3	100,533
Total	36,608	100.0	671,038	100.0	18,330

Source: 1985 Family Income and Expenditures.

Note : Some minor calculation errors are found in the original data.

Table B.3.8 Small Scale and Cottage Industries in Marinduque

Name of Firm	Product Line	Employment	Prod. Capacity	Location
Golden Forest Handicraft	Wooden birds, napkin rings, baskets	30	35,000-40,000/mo.	Gasan
LMDU's Handicraft	Wooden birds, decorative items	100	8,400 pcs/year	Gasan
Lilibeth Handicrafts	Wooden birds	140	117,000 pcs/year	Gasan
Eomulo del Mundo	Wooden birds, ballpen cases, Christmas decor	41	25,000-50,000/mo (Christmas Decor)	Torrijos
Ten Fingers Woodcraft	Wooden birds, fashion accessories	300	620,000 pcs/year	Gasan
UNI Handicraft	Wooden birds, decorative items	140	740,000 pcs/year	Gasan
Emilio Dimailig's Handicraft	Attache cases, peanut, tray, wall decor, lamp	11	1,000 pcs/year	Gasan
Rosa's Handicraft	Bamboo Fans	6	7,600 pcs/year	Gasan
Coring J. Motol's Trading	Baskets made of vines	6	2,000-3,000/mo	Mogpog
MI Craft	Baskets	35	2,000 sets/mo	Buenavista
D'Homemakers	Nito plates/trays		200-300 doz.	Boac
Torrijos Loomweaver's Asso.	Placemats	14	50 placemats/day	Torrijos
Gabisan Decorative Jars	Decorative/functional jars	3	100 pcs/week	Torrijos

Source: Department of Trade and Industry, Marinduque

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APPENDIX C METEOROLOGY AND HYDROLOGY

C-1 Climate

C-1-1 Observatories in and around Marinduque

The Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) utilizes the Coronas climate classification system which a weather condition of a particular area in the Philippines is classified into the following four types based on the monthly rainfall pattern. The Coronas classification system has four climate categories, namely, Type I, II, III and IV. The Type I has two pronounced seasons, dry season from November to April and wet season during the rest of the year. This categorized areas are mainly distributed at western Luzon, western Mindro, western Panay, western Palawan and western Negros islands. The Type II mainly covers the areas of eastern Luzon, eastern Samar, eastern Lyte, eastern Mindanao islands, which has no dry season with a very pronounced, much rainfall from November to January. The Type III areas mainly occupied the parts of eastern Palawan, eastern Panay, eastern Negros, and southern Cebu islands, and the eastern part of Mindanao island. This type has a feature that the seasons are not pronounced, relatively dry from November to April and wet during the rest of the year. The climate of Marinduque is categorized on Type IV having a rainfall more and less evenly distributed throughout the year and no clear boundary between dry and wet seasons. (refer to Figure C-1-1)

In the Marinduque island, there were three rainfall stations at Boac, Gasan and Sta. Cruz since 1955. The observation works at the Sta. Cruz station were discontinued in 1965. The Boac and Gasan stations are in operational now. The Gasan station was operated in 1980 and has some lack of data. The Boac station is in operation since 1970, which can provided almost enough volume of rainfall data for various analysis. Various climatological data excepting rainfall, such as temperature,

humidity, wind speed and direction, etc., are not available in Marinduque. The Calapan station in the Mindro island is applied as synoptic station due to same climate type of Marinduque. (refer to Figures C-1-2 to C-1-4 and Tables C-1-1 to C-1-3)

During the Study period since the end of 1988, the JICA Study Team established two rainfall stations at Boac, Boac Municipality and Tawiran, Sta. Cruz Municipality. The observation works were started from December, 1988 and the data are observed by an automatic recorder at each station. The stations are operated and maintained by the PEO, the Provincial Government of Marinduque. The Team also established one observatory of temperature and humidity in Boac. The station also began the observation works from December, 1988 and PEO is also in charge of operation and maintenance and data collection. (refer to Figure C-1-2)

C-1-2 Rainfall

1) Isohyetal Annual Rainfall

The isohyetal map of annual rainfall was presented based on the existing data and the height of the land in Marinduque. The sea shore area of the island has about 2,000 mm of annual rainfall, however, the amount of about 3,500 mm will be estimated at the interior areas in the island. The average amount of annual rainfall is calculated at 2,800 mm. (refer to Figure C-1-5)

2) Monthly Rainfall Distribution

The annual rainfall at the Boac station is calculated at 2,034.6 mm on an average for ten years from 1877 to 1896. Since the amount of the monthly rainfall in Marinduque is affected by the monsoon. The more amount of rainfall during the period from June to December is recorded than that of the remaining period. The minimum mean monthly rainfall of 70.9 mm in March was observed and the maximum of 273.6 mm in October.

During the period from January to May, the monthly mean rainfall amounted at less than 150 mm, and during the rest period more than 150 mm. Those monthly rainfall, however, were not uniformly observed. The amount of rainfall is always fluctuated year by year. The total amount of rainfall during the wet season from June to December occupies 75% of the annual rainfall. (refer to Figures C-1-6, C-1-7 and Tables C-1-4, C-1-5)

3) Rainy Days

A number of the monthly rainy day of effective rainfall which is calculated based on the effective ratio of 80% of rainfall between five and 80 mm of daily rainfall, is about ten days during the period from June to November. The annual mean effective rainfall days is 80. (refer to Table C-1-4)

4) Probable Rainfall

The provable analysis of daily, consecutive two and three days rainfall are carried out by using the Iwai method and 16 years completed data out of 17 years from 1970 to 1986 at the Boac station. The results are summarized as follows. (refer to Table C-1-6)

Return Period	Rainfall in mm		
	Daily	2-day	3-day
2 years	66.5	99.6	120.6
5 "	89.5	139.3	175.9
10 "	104.5	165.9	214.0
30 "	127.1	206.7	273.6
50 "	137.4	225.6	301.6
100 "	151.3	251.5	340.4

5) Probable Ten Day Effective Rainfall

The probable ten (10) day effective rainfall with return periods of two, five and ten years are studied. Based on the results of the analysis, during the period from February to April less rainfall would be expected on the two years probability, however, on the five and ten years return period, February and April would not be expected any effective rainfall. (refer to Table C-1-7)

6) Probable Continuous Drought Days

On the other hand, the continuous drought days is one of the important factors of the agricultural development. Those analyses also were made by the Team. According to the results of analysis, during the period from February to April, frequency of appearance with more than five times for 17 years was appeared. The probability analysis of the continuous drought days are also carried out by the Team. The results are summarized as follows. (refer to Tables C-1-6 and C-1-8)

Return Period	Continuous Drought Days
2 years	17.9
5 "	22.2
10 "	24.4
30 "	27.4
50 "	28.6
100 "	30.0

C-1-3 Temperature

There are no data available in Marinduque as mentioned before. The synoptic Calapan station in Mindro was used for the study because of the same climatic classification of Marinduque and neighboring location.

The annual mean, maximum and minimum temperatures were calculated at 27.0, 32.9 and 22.3 centigrade degrees, respectively. The differences between the monthly mean maximum and minimum temperatures are between six to eight centigrade degrees through the year while the difference of the monthly mean temperature is only 3.3 centigrade degrees. At areas with a high elevation of abut 400 to 700 m above the mean sea level (MSL) which are located at central and southern part of Marinduque, the temperature of two to four centigrade degrees are cooler and lower than that of low-lying areas near a sea shore. (refer to Table C-1-4)

C-1-4 Relative Humidity

The annual mean relative humidity of 83%, the minimum of 78% in April and the maximum of 86% in September to November were calculated by using the data at the Calapan station due to no available data in Marinduque. Based on the analysis, the values of relative humidity from March to May are ranging less than 80%, in other remaining period, humidity values show more than 80%. Those values are matched up to the amount of monthly rainfall. (refer to Table C-1-4)

C-1-5 Wind Direction and Velocity

The mean wind velocity is 2.4 m/sec and the velocity is almost same throughout the year excepting a typhoon period. The main wind direction during the less rainfall season or the dry season is southwest while during the period of wet season the direction varied from northwest to northeast. (refer to Table C-1-4)

C-1-6 Cloudiness

The recorded annual mean cloudiness in Okta is 5.1 with the minimum cloudiness of 3.7 in March and the maximum cloudiness of 6.0 in August. Based on the results, it is said that the weather of Marinduque is mainly cloudy. The cloudiness of the period from March and April are less than 4 in Okta, which means dry period. (refer to Table C-1-4)

C-1-7 Evaporation and Evapotranspiration

There is no data available in Marinduque and in the synoptic stations such as Calapan, etc. Only at the Los Banous station, evaporation data are available. Based on the data, the total amount of evaporation is calculated at 1,604.4 mm per annum. In order to convert from the data by an open pan equipment to the actual one, the conversion factor of 0.7 is applied. Consequently, the actual amount of evaporation is calculated at 1,120 mm per annum. (refer to Table C-1-4)

C-1-8 Tropical Cyclone

The tropical cyclone to pass on and near the Marinduque island within a range of 200 km which may give various influences to the island are considered in this analysis. The definitions of the tropical cyclone between the World Meteorological Organization (WMO) classification and PAGASA are as follow.

Standard		Center wind speed	
WMO	PAGASA	in m/sec	(in knot)
Tropical depression	Tropical depression	less than 17.1	(less 33)
Tropical storm	Tropical storm	17.2 to 24.4	(34 to 47)
Severe tropical storm	- do -	24.5 to 32.6	(48 to 63)
Typhoon/Hurricane	Typhoon	more than 32.7	(more 64)

The number of tropical cyclones which passed within a range of 200 km from the island, was 114 for 37 years from 1951 to 1987. The frequency of the cyclone, therefore, is 3.3 times a year. The frequency of cyclone for every ten years is ranging from 27 to 38. On the other hand, typhoon affected the island once a year. As a seasonal distribution, in June, October to December, the frequency of typhoon is more than eight times during the period of 37 years from 1951 to 1987. Especially, in 1987, three big typhoon, "Herming", "Sisang" and "Trining", attached the island and inflicted much damages to the island.

The typhoon "Herming", which passed the island in August 8 to 14, hit many agricultural products and social facilities. The Office of Civil Defense reported the damage of 187.8 million pesos of crops and 160.8 million pesos of others by typhoon "Herming". (refer to Figures C-1-8 and C-1-9, and Table C-1-9)

Table C-1-1 Observation Items by Station

Item	Temperature (°C)						Relative Humidity	Rainfall (mm)	Clouds (Oktas)	Wind	
	Max	Min	Mean	Dry	Wet	DP				DIR	SPD
Calapan; Ori. Mindro	o	o	o	o	o	o	o	o	o	o	o
Romblon; Romblon Isd.	o	o	o	o	o	o	o	o	o	o	o
Tayabas; Lucena City	o	o	o	o	o	o	o	o	o	o	o
Sta. Cruz;											
Boac;						o					
Gasan;						o					

Period of Record

Table C-1-2 Data Records of Temperature, Relative Humidity, Clouds and Wind

Name of Sta.		Location		Elevation	Observation Period	Remark
Calapan	PAGASA	14°38N	121°101E	72 m	1977 and 1979 to 1987	Daily data
Romblon	do	12°35N	122°16E	47	1977 to 1982 and 1983 to 1987	
Tayabas	do	14°02N	121°35E	157.1	1977 and 1980 to 1987	

Table C-1-3 Rainfall Observatories and Observation Period

Name of Sta.		Location		Elevation	Observation Period	Remark
Calapan	PAGASA	14°38N	121°01E	72 m	1977 to 1978 and 1979 to 1987	
Romblon	do	12°35N	122°16E	47	1977 to 1981 and 1983 to 1987	Daily data
Tayabas	do	14°02N	121°35E	157.1	1977 and 1980 to 1987	
Sta. Cruz	do	-	-	-	1955 to 1965	
Boac	do	-	-	-	1970 to 1987	
Gasan	do	-	-	-	1980 to 1987	

Table C-1-4 Summary of Climatological Conditions of Marinduque

Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Monthly Rainfall 1/													
Mean (mm)	136.2	80.0	70.9	73.8	128.2	226.8	222.6	155.5	201.3	273.6	247.0	218.8	2,034.6
Max. (mm)	298.2	262.7	129.9	227.8	283.9	323.9	315.1	458.6	352.5	621.0	433.9	538.3	-
Min. (mm)	36.6	10.4	19.3	0.0	19.6	116.1	70.1	35.6	37.4	104.0	119.2	56.8	-
Daily Rainfall													
Max. (mm)	50.5	37.8	43.0	67.0	40.3	52.5	55.6	43.7	51.0	61.2	52.8	52.8	
Number of Rainy Days	6	4	4	4	5	8	9	6	8	10	9	6	80
Temperature 2/													
Max. (°C)	28.3	29.1	30.5	31.8	32.9	32.2	31.6	31.6	31.3	30.7	30.0	28.6	
Min. (°C)	22.3	22.7	23.4	24.3	24.4	24.1	23.9	23.9	23.8	23.7	23.6	22.6	
Mean (°C)	25.3	25.8	26.7	28.0	28.6	28.2	27.7	27.1	27.1	27.5	27.2	26.9	27.0
Relative Humidity 3/													
(%)	84	82	79	78	79	82	85	84	86	86	86	84	83
Cloudiness 4/													
(okta)	5.7	4.5	3.7	3.4	4.4	5.6	5.6	6.0	5.9	5.7	5.5	4.9	5.1
Prevailing Wind													
Direction 5/	NE	NE	E	SE	SE	SE	NW	NW	NE	NE	NE	NE	
Velocity (m/s)	2	2	3	3	2	3	2	2	2	2	2	3	2.4
Open Pan Evap. 6/													
mm/day	3.2	4.7	6.1	6.6	5.6	4.7	4.1	4.0	3.7	3.5	3.3	3.3	1,604.4
Number of Typhoons 7/	1	1	1	2	5	8	4	1	1	10	10	8	1.4

Note: Period of Record and Source

1/ 1970 - 1986, (at Boac, PAGASA)
2/ 1977 - 1986, (at Calapan, PAGASA)
3/ - do -
4/ - do -
5/ 1970 - 1986, (at Calapan, PAGASA)
6/ 1977 - 1986, (at Los Banos, PAGASA)
7/ 1951 - 1987, (in Marinduque, PAGASA)

Table C-1-5 Monthly and Annual Rainfall at Boac

(Unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Amount
1970	129.9	10.4	50.4	21.0	89.1	323.9	117.9	61.0	148.1	621.0	433.9	56.8	2,063.4
1971	36.6	111.2	69.2	20.3	174.9	257.8	216.4	35.6	37.4	248.7	279.6	210.3	1,698.0
1972	139.4	51.1	48.7	110.6	140.4	264.1	252.8	275.8	319.8	229.0	244.5	187.6	2,263.8
1973	139.8	57.7	51.8	25.9	109.7	329.8	458.8	171.9	352.5	274.7	270.3	538.3	2,781.2
1974	164.7	184.0	60.7	89.9	82.0	175.1	188.2	458.1	170.9	357.7	244.6	169.8	2,345.7
1975	84.0	59.1	15.8	99.8	177.9	286.8	329.7	137.2	250.6	155.2	314.3	496.8	2,407.2
1976	109.5	69.9	78.5	0.0	283.9	274.2	70.1	171.1	108.3	262.0	198.7	553.5	2,179.7
1977	298.2	262.7	124.0	59.1	116.1	283.6	315.1	130.1	100.3	172.2	290.6	125.3	2,277.3
1978	131.9	58.2	38.8	54.6	136.3	215.0	130.0	188.9	305.4	333.7	308.9	179.3	2,082.0
1979	80.3	21.3	19.3	166.8	58.7	175.6	120.7	87.2	174.0	104.1	242.8	195.3	1,446.1
1980	125.5	101.8	119.6	38.9	19.6	202.8	220.6	198.9	102.7	284.0	-	63.2	(1,477.6)
1981	150.0	76.9	78.2	62.7	95.7	198.9	239.5	80.0	167.9	262.9	181.4	155.1	1,749.2
1982	120.0	79.9	126.9	39.1	221.8	197.5	121.9	137.6	109.8	243.1	119.2	142.7	1,659.5
1983	159.5	55.6	37.8	59.2	58.7	116.1	270.2	202.3	212.1	207.0	212.9	160.7	1,752.1
1984	149.1	39.3	129.9	79.9	176.6	201.3	222.4	269.4	272.7	331.0	275.4	116.8	2,263.6
1985	115.3	83.1	95.0	227.8	161.5	214.3	229.0	37.8	269.5	250.2	269.6	224.1	2,177.2
1986	181.5	37.9	59.4	99.0	77.2	138.5	281.7	-	320.2	314.0	311.6	144.0	(1,965.0)
Mean	136.2	80.0	70.9	73.8	128.2	226.8	222.6	155.5	201.3	273.6	247.0	218.8	2,034.6

Note: 1. The figure in ( ) show the total amount of rainfall in omitting the days without records.
2. The monthly mean rainfall are bared on complete records only.

Table C-1-6 Hydrological Probability at Boac

Return Period	Annual Rainfall (Jan-Dec) (mm)	Annual Rainfall (June-May) (mm)	Annual Effective Rainfall (mm) 1/	Annual Consecutive Drought Days 2/	Irrigation Period of Second Rice Rainfall (mm)	Irrigation Period of Second Rice Effective Rainfall (mm) 1/	Irrigation Period of Second Rice Consecutive Drought Days 2/	Maximum Rainfall Daily (mm)	Maximum Rainfall Consecutive 2 days (mm)	Maximum Rainfall Consecutive 3 days (mm)
2	2,042.5	2,030.3	1,591.6	29.2	607.1	487.8	17.9	66.5	99.6	120.6
5	1,772.0	1,860.9	1,357.4	39.1	511.7	410.8	22.2	89.5	139.3	175.9
7	1,705.7	1,636.1	1,300.7	42.4	494.8	397.1	23.3	96.9	152.4	194.5
10	1,645.1	1,566.1	1,249.0	45.8	481.1	385.9	24.4	104.5	165.9	214.0
15	1,585.2	1,498.6	1,198.2	49.7	469.2	376.2	25.6	113.0	181.1	236.0
20	1,547.2	1,455.7	1,166.1	52.4	454.4	370.6	26.4	118.9	191.7	251.5
30	1,498.6	1,401.1	1,125.1	56.2	454.4	364.0	27.4	127.1	206.7	273.6
50	1,444.0	1,340.2	1,079.3	61.1	446.5	357.5	28.6	137.4	225.6	301.6
80	1,398.9	1,290.2	1,041.6	65.6	440.7	352.7	29.6	146.8	243.1	327.8
100	1,322.1	1,268.2	1,025.1	67.7	438.3	350.7	30.0	151.3	251.5	340.4

Note: 1/ The amount of 80% of daily rainfall more than 5 mm and less than 80 mm is effective for paddy cropping.
2/ Daily rainfall of less than 5 mm is considered as drought.

Table C-1-7 Probable 10 Days Rainfall at Boac

(Unit: mm)

Return Period	10 days	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
2	1st	39.6	19.6	19.6	0	21.3	59.7	104.1	40.9	57.2	70.4	85.1	49.8	567.3
	2nd	43.9	37.9	20.6	39.1	39.9	80.7	49.0	34.6	78.4	107.1	82.9	60.6	674.7
	3rd	37.6	0	19.3	20.6	52.3	84.3	62.3	48.8	49.0	81.5	80.5	40.4	576.6
	Total	121.1	57.5	59.5	59.7	113.5	224.7	215.4	124.3	184.6	259.0	248.5	150.8	1,818.6
5	1st	23.1	0	0	0	0	37.9	39.1	18.5	21.6	59.0	54.4	21.1	274.7
	2nd	24.6	0	15.8	0	23.8	40.4	39.1	18.5	40.4	60.0	58.9	39.6	361.1
	3rd	19.3	0	0	0	18.8	43.8	19.8	13.0	23.1	48.5	62.3	19.6	268.2
	Total	67.0	0	15.8	0	42.6	122.1	98.0	50.0	85.1	167.5	175.6	80.3	904.0
10	1st	0	0	0	0	0	35.1	33.6	0	21.1	58.4	53.0	19.6	220.8
	2nd	18.5	0	8.4	0	20.6	23.6	21.6	12.2	39.4	57.9	57.6	35.8	295.6
	3rd	16.3	0	0	0	18.0	38.1	18.8	0	20.6	38.4	42.0	19.3	211.5
	Total	34.8	0	8.4	0	38.6	96.8	74.0	12.2	81.1	154.7	152.6	74.7	727.9

Table C-1-8 Continuous Drought Days

	Max. Centinous drought days	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1970	37	Jan. 18 - Feb. 3	******											
1971	43	March 15 - April 6			******									
1972	25	Jan. 27 - Feb. 20	******											
1973	47	Feb. 8 - March 26		********										
1974	19	March 28 - April 15			*****									
1976	63	March 23 - May 24			**********									
1977	21	April 21 - May 11				******								
1978	31	March 19 - April 18			******									
1979	30	March 16 - April 14			******									
1980	32	May 2 - June 2					******							
1981	31	March 23 - April 22			*******									
1982	18	April 18 - May 5				******								
1983	33	Feb. 13 - March 17		********										
1984	22	Feb. 11 - March 3		*******										
1985	26	July 23 - Aug. 17							**********					
1986	21	March 21 - April 10			******									
Mean	31	Frequency	2	5	11	8	4	1	1	1	0	0	0	0

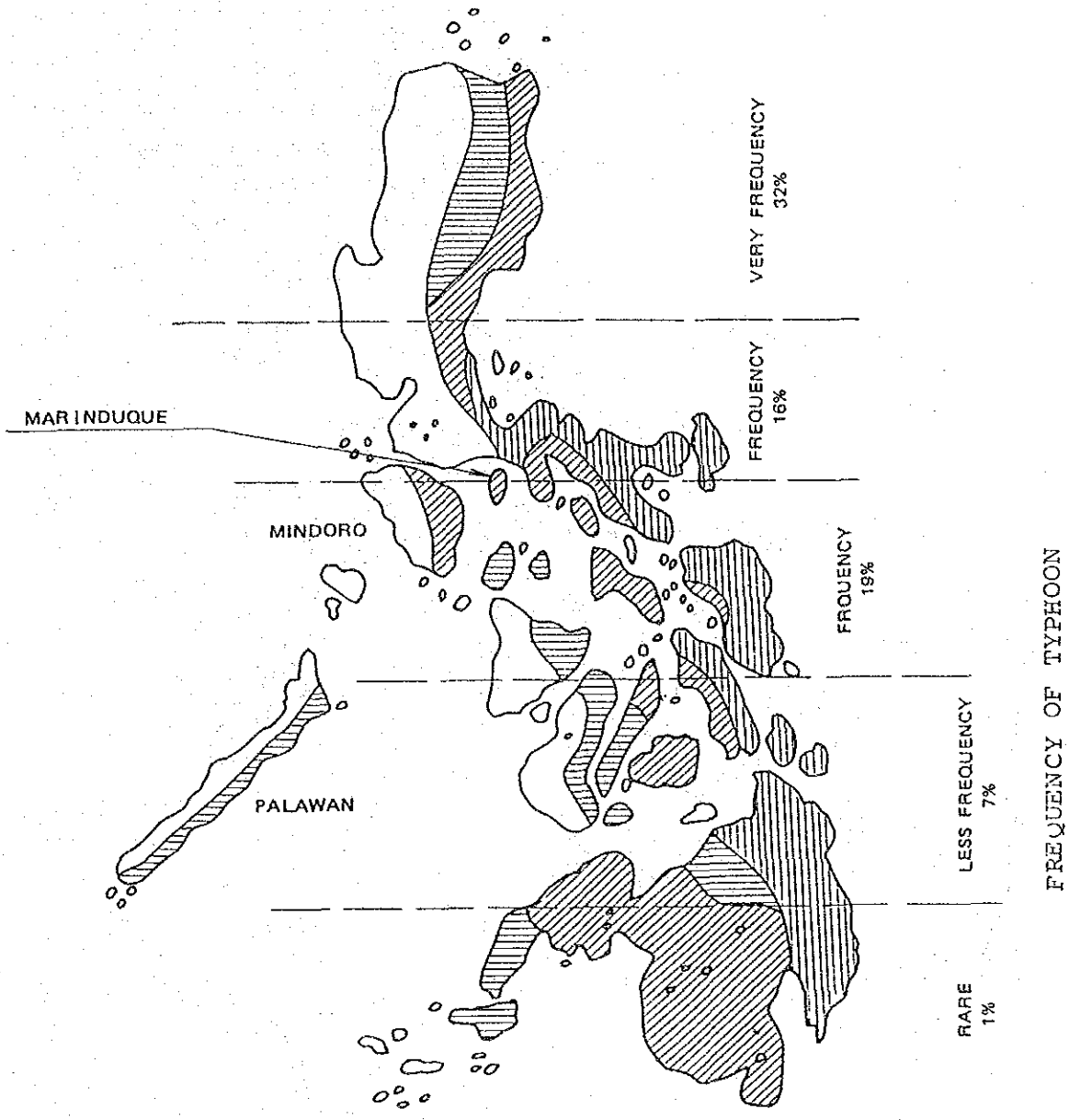
Source: PAGASA Boac
Rainfall gauge station

Table C-1-9 Damages by Major Typhoons to Marinduque

Year	Name of Typhoons	Date	Meteorological Data Rainfall (mm)	Max. Wind (kph)	Casualties Dead	Damages (Million ₱) Crop	Others	Total
1978	Welling	Sep. 24 - 28	116.6	200-V	-	7.0	3.0	10.0
1979	Bebeng	Apr. 12 - 20	166.8	165-R	-	5.0	3.0	8.0
1981	Daling	June 28- July 2	129.6	100-C	6	1.0	3.9	4.9
	Yeyeng	Nov. 16 - 21	84.4	130-C	no damage report			
	Dinang	Dec. 23 - 27	52.5	150-C	-	2.5	4.3	6.8
1983	Auring	July 9 - 11	85.8	65-C	-	0.1	1.2	1.3
1987	Herming	Aug. 8 - 14	75.4	165-C	6	187.8*1	160.8	348.6
	Sisang	Nov. 23 - 27	70.6	240-L	6	1.0	17.3	18.3
	Trining	Dec. 16 - 18	138.6	139-C	no damage report			

Source: office of Civil Devense
Meteorological Data (PAGASA) Rainfall-Tanza (Boac)
Max. Wind V = Virac Radar, R = Romblon, C = Calapan, L = Legaspi
*1 - Coconut (80%), Rice and Others (20%)

Figure C-1-1 Coronas Climatic Classification Map



LEGEND: TYPES OF CLIMATE

CORONAS CLASSIFICATION

1st Type: Two pronounced seasons; dry from November to April; wet during the rest of the year.

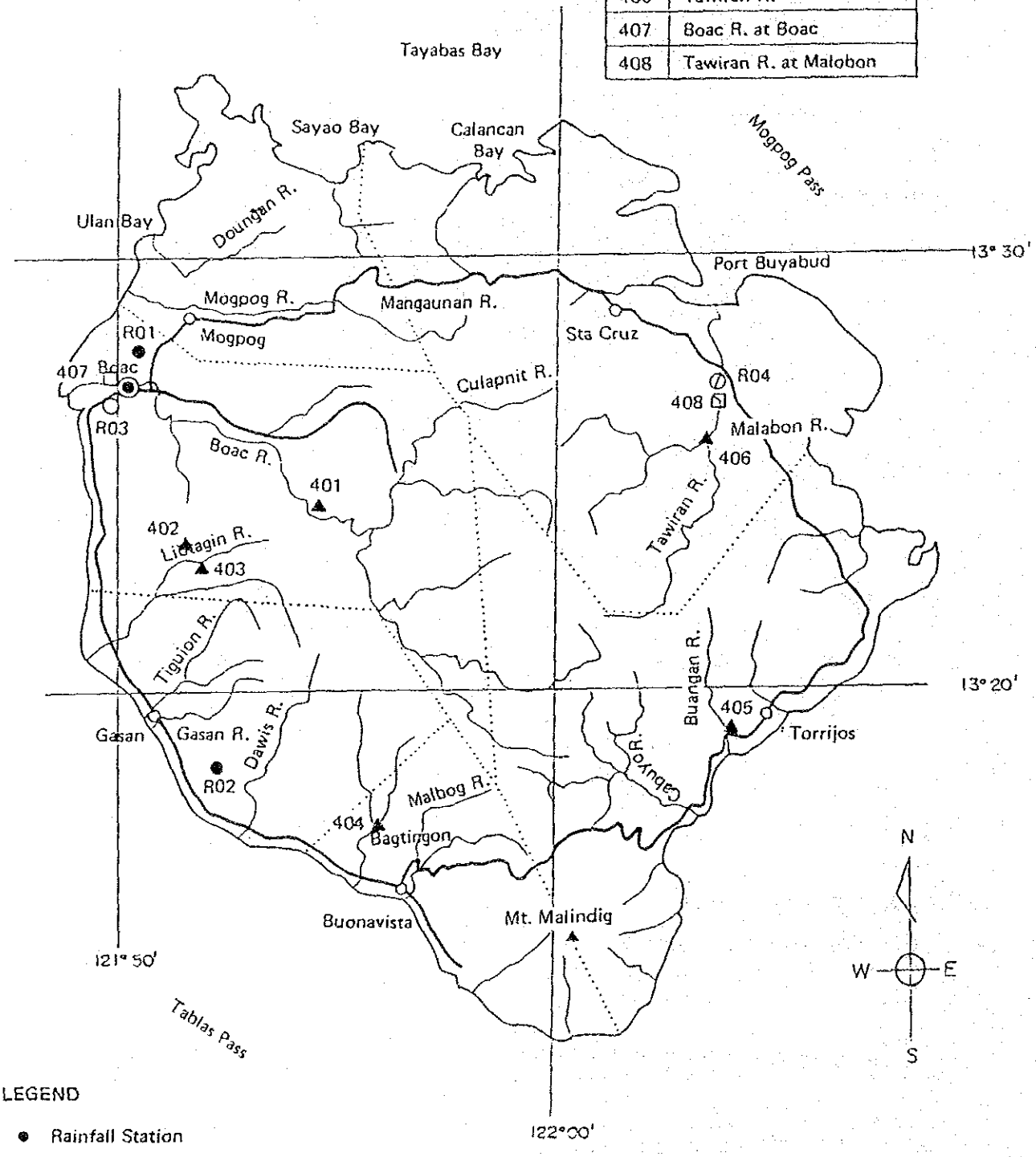
2nd Type: No dry season with a very pronounced, maximum rainfall from November to January.

3rd Type: Seasons not very pronounced, relatively dry from November to April and wet during the rest of the year.

4th Type: Rainfall more or less evenly distributed throughout the year.

Figure C-1-2 Location Map of Observatories in Marinduque

Rainfall Stations		Stream Gaging Station	
R01	Tanza (Boac)	401	Boac R. at Binunga
R02	Gasan	402	Tugos N.R. at Tugos
R03	Capital in Boac	403	Tugos E.R. at Tugos
R04	Tawiran E. School	404	Bagtingon R. at Bagtingon
		405	Buangan R. at Buangan
		406	Tawiran R.
		407	Boac R. at Boac
		408	Tawiran R. at Malobon



LEGEND

- ● Rainfall Station
- ▲ Stream Gaging Station
- □○ JICA Station (Water Level and Rainfall Gaging Station)

0 5 10 km

Figure C-1-3 Location Map of Observatories

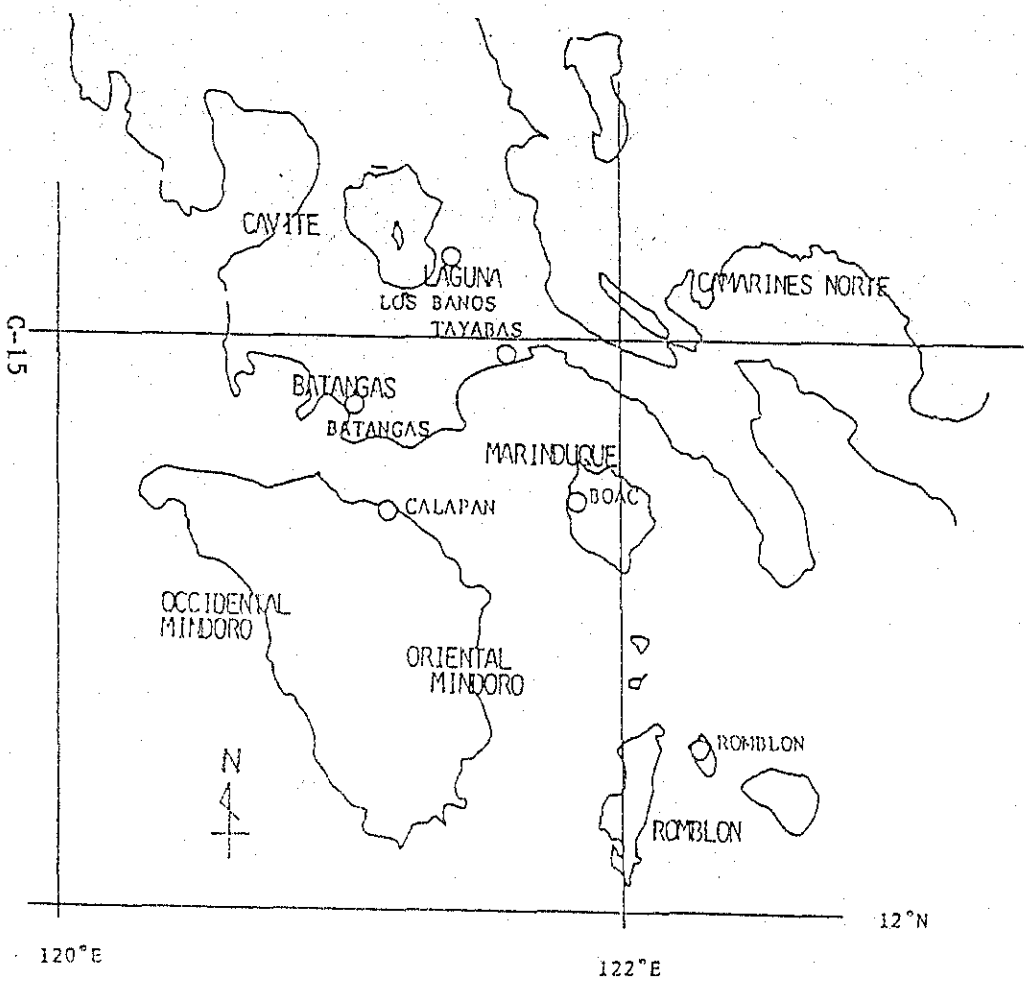


Figure C-1-4 Monthly Rainfall Distribution

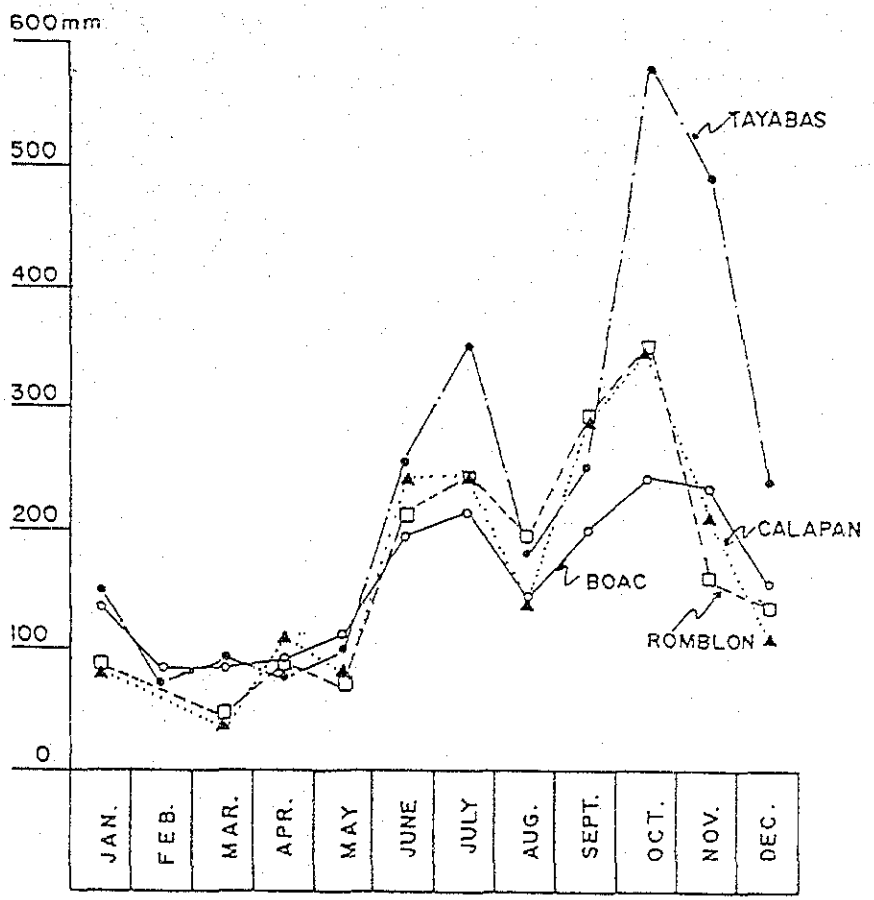


Figure C-1-5 Isohyetal Map of Annual Rainfall

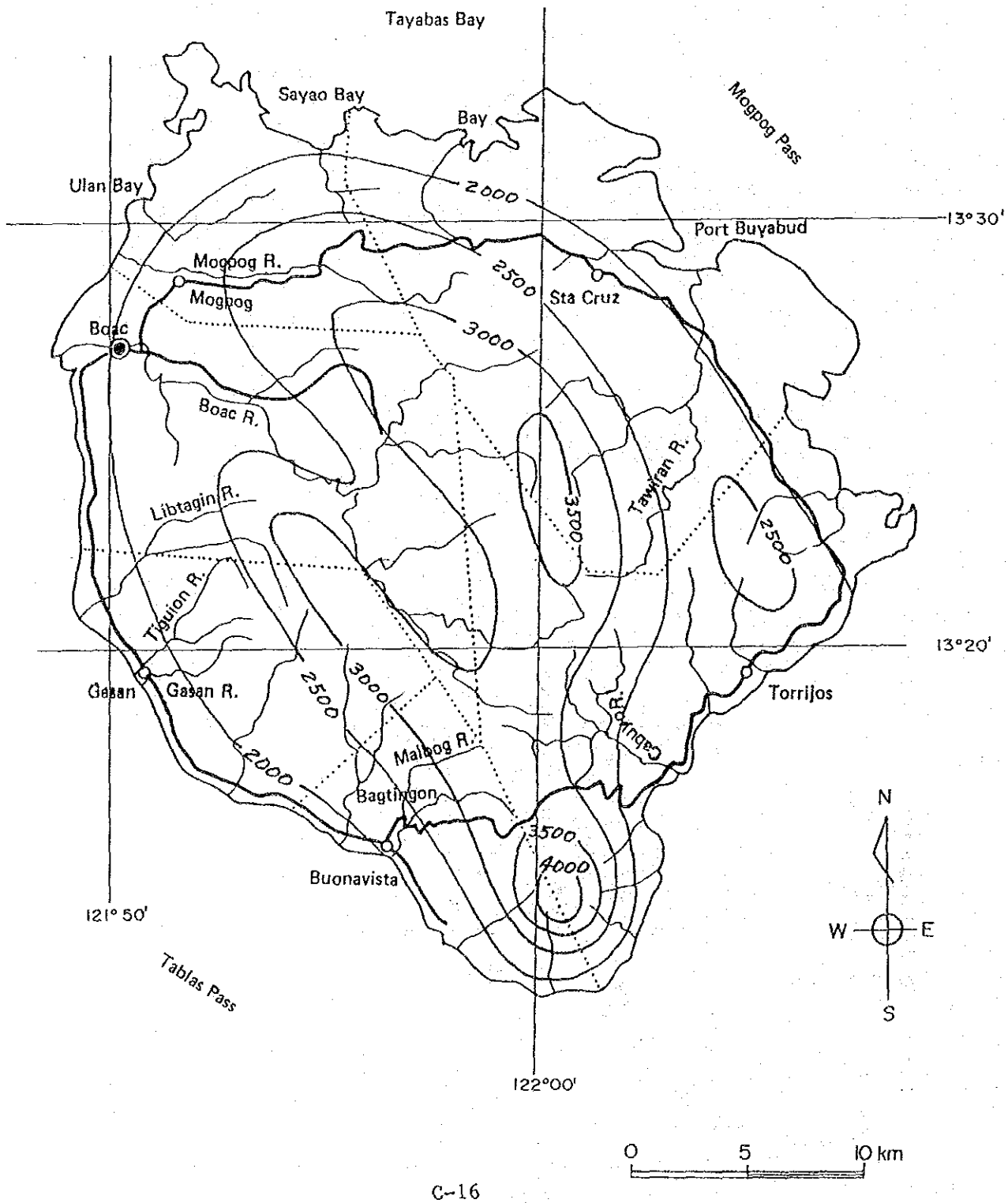
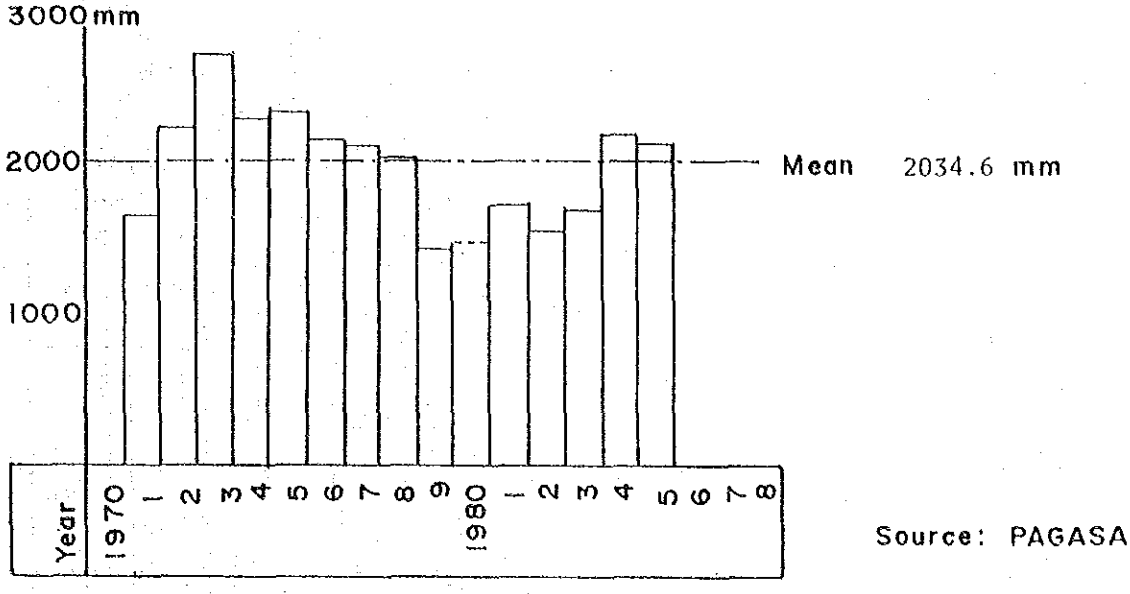


Figure C-1-6 Annual Rainfall (BOAC)



Source: PAGASA

Figure C-1-7 General Climatic Conditions (CALAPAN)

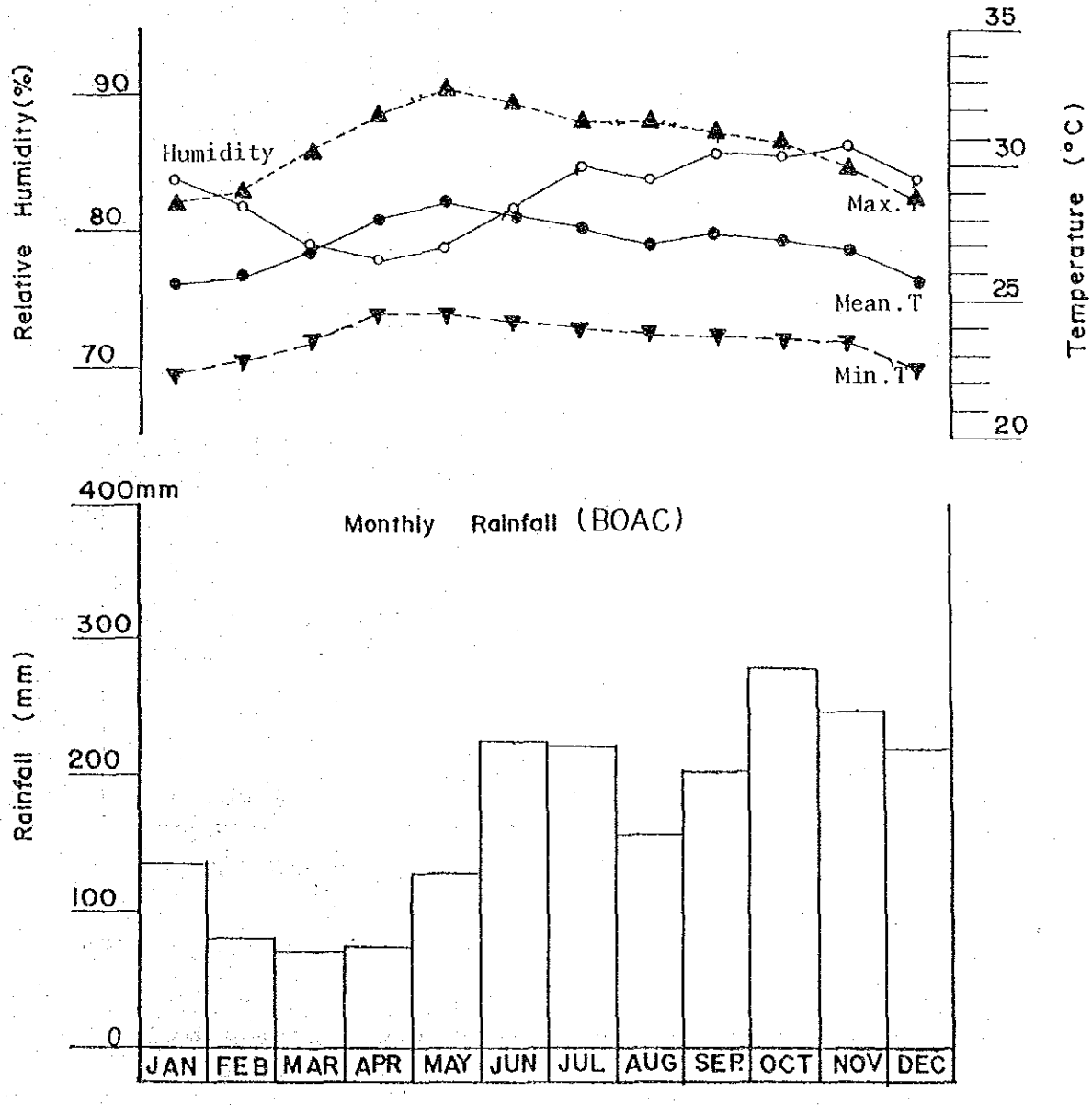
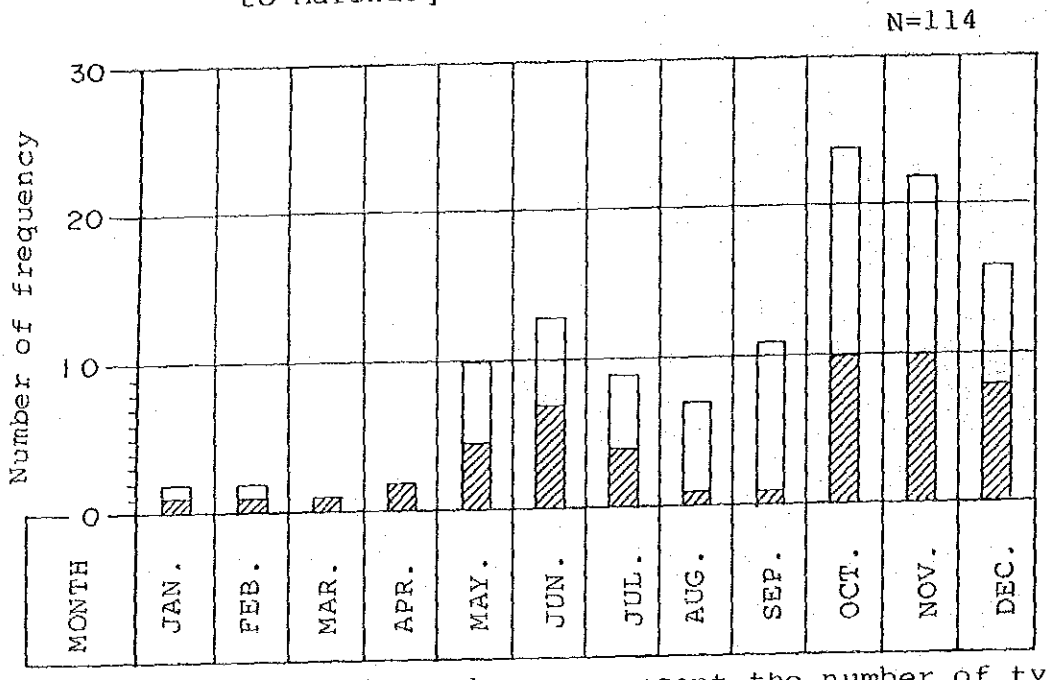


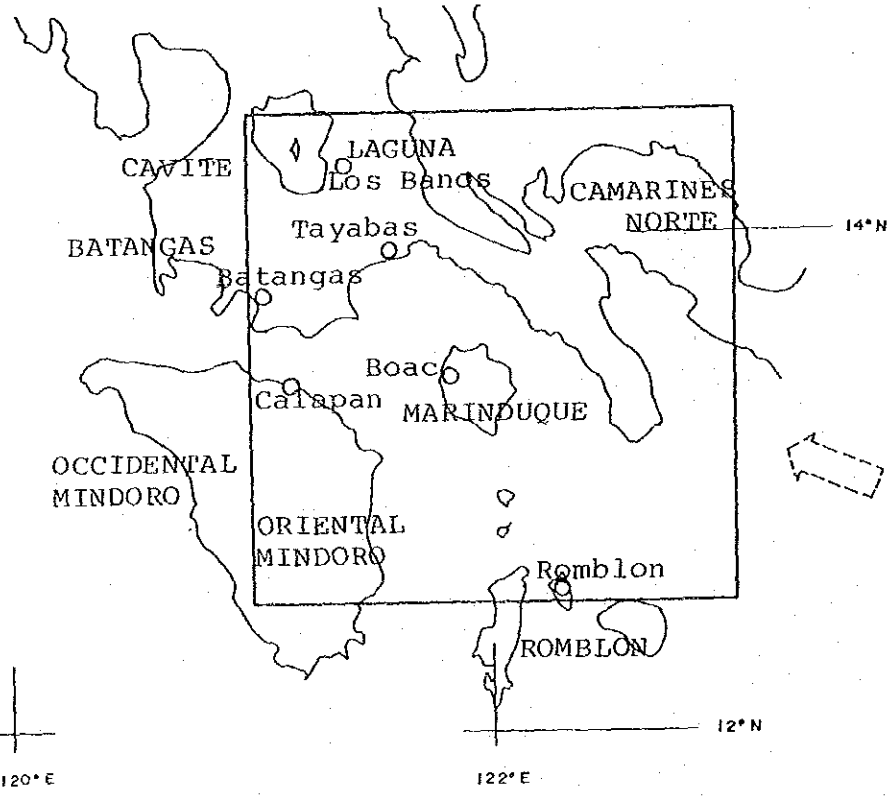
Figure C-1-8 Frequency of Tropical Cyclones affected to Marinduque



Note: The oblique lines above represent the number of typhoons

Period	E.of T.C.
1951 to 1960	30
1961 to 1970	27
1971 to 1980	38
1981 to 1987	19
Total	114 (4.22)

Note: ( ) figure is a mean value of Tropical Cyclones



Note: The above shows the area from 121°E to 123°E and 12°30N to 14°30N.

Figure C-1-9 Number of Tropical Cyclones Passed within a Range of 200 Km.

C-2 Rivers and Streams

C-2-1 River Basin

1) Scale of River Basin

The Marinduque province having 17 islets occupied the area of 959 sq.km. The main island of Marinduque having an acreage of 935 sq.km, is divided into 32 river basins. Of which only three river basins occupy about 40% of the total drainage area, that is, the Boac river basin of 227 sq.km, the Mogpog river basin of 58 sq.km and the Tawiran river basin of 99 sq.km. The acreage of other river basins is only about 20 sq.km on an average. (refer to Figure C-2-1)

2) Vegetation of River Basin

The vegetation of river basins located at the western part of Marinduque is better than other parts. Most river basins located at northern and western parts of the island, are covered by coconut. At the upper reach of the Boac river, a natural forest is still observed. Even a river having a small drainage area in the western part, which originated from the same forest area, has discharge thought a year. The good vegetation is the most important factor to maintain water resources.

However, at the eastern part of the island is devastated by "Kaingin" and/or logging. Therefore, at the rivers in the western part of the island, the discharge is observed throughout a year. Therefore, no discharge in many rivers observed at dry season. Most river basins area in the eastern part was converted to the wild grass areas such as cogon and left as there were.

C-2-2 River Conditions

In generally, a river bed slope of a river in Marinduque is steep. Only three rivers, the Boac, Mogpog and Tawiran rivers, have gentle slope or flat portions at the lower reach of the river, which are

usually tidal and meandering. Other rivers forming the 29 river basins have steep slope gradient of less than 1:100 without any tidal section. At most sections of those rivers, river improvement works such as flood protection and flood control works, are not fully carried out yet due to lack of budget. Therefore, many calamities such as river slope sliding at the meandering portions are occurred. The road destruction was caused by high flood during typhoon with heavy rain or heavy rainfall by monsoon, where the road is running along the river. The many farm lands at the lower reach of the river are suffered from over-topping flood during the period of heavy rainfall.

C-2-3 Hydrological Observatories

1) Automatic Recorder

There are eight operational observatories of water level in the Marinduque island, which were operated by NIA and PEO. Of which two observatories, that is, Boac and Tawiran stations were constructed by the JICA Study Team in the end of 1988. Since the stations are equipped by the automatic water level recorder, they will be able to obtain variable hydrological data. The observation should be continued as long as possible or at least 30 years together with the aforesaid rainfall stations. The discharge measurement should be done by various water levels, even in flood. (refer to Figure C-1-2 in former Chapter and Figure C-2-2)

2) Staff Gauge

The staff gauge to obtain hydrological data at several rivers, are also newly constructed by NIA in 1988 and equipped with staff gauge only. The observation works should be continued as same as the above stations. The discharge measurement should be done by various water levels, even in flood. (refer to Table C-2-1 and Figure C-1-2 in the former Chapter)

3) Available Hydrological Data

There were three gauging stations, namely the Boac station, at Tampus, the Boac municipality, with the drainage area of 218 sq.km at the Boac river, the Malabon station, at Sta. Cruz, with the drainage area of 63 sq.km at the Malabon river and the Mangaunan station, at Butansapa, Mogpog, with the drainage area of 28 sq.km, from 1959 to 1970 under the former National Water Resources Council (NWRC) which was established in 1979 and re-organized recently to DENR (Department of Environment and Natural Resources). Those stations were constructed by BPW (Bureau of Public Works) and the observation works were carried out by WRSD and WRD (Water Resources Division), DPW. During this period, discharge data are available for various analysis. However, the observation works at those three stations were already terminated. (refer to Table C-2-2)

C-2-4 Annual Run-off

1) Calculation Method

The annual run-off of the Boac river is calculated by using the series Tank model method. The Tank model method, which is one of run-off analysis methods, can estimate various discharge such as drought, flood, etc. based on rainfall. For verifying analyzed results actual discharge and rainfall data are used. After determination of parameters and height of outlets of tanks, various discharges are calculated by rainfall data. (refer to Figures C-2-3 and C-2-4)

2) Annual Run-off

According to the actual observed data from 1959 to 1969, the annual run-off of the Boac river is about 271.9 MCM (= 10.49 cu.m/sec x 30 days x 86,400). On the other hand, the estimated run-off discharge for 17 years from 1970 to 1986, amounts at 321.7 MCM (= 3,723.67 cu.m/sec x 86,400). The other rivers of Malabon and Mangaunan, which

have drainage areas of 63 and 28 sq.km, respectively, are also calculated at 4.2 MCM (= 1.62 cu.m/sec x 30 days x 86,400) and 2.5 MCM (= 0.97 cu.m/sec x 30 days x 86,400), respectively. The specific discharge of the Boac, Malabon and Mangaunan rivers are 1.25, 0.067 and 0.089 MCM/sq.km, respectively. On other rivers which has an average drainage area of abut 20 sq.km, the annual discharge of 37.5 MCM (= 20 sq.km x 2,500 mm x 0.5 run-off coefficient mentioned after) is estimated. (refer to Tables C-2-3 to C-2-8)

3) Run-off Coefficient

Assuming the average amount of annual rainfall of 2,500 mm in the Boac river basin, the total amount of water resources in the drainage area of 218 sq.km is calculated at 545 MCM (= 2,500 mm x 218 sq.km). The run-off coefficient is about 0.5 (= 271.9 MCM / 545 MCM).

C-2-5 Flood Discharge

The flood discharge of the rivers in the Study Area could not be obtained due to lack of that kind of data. During the field survey period, the peak flood discharge of 6.0 cu.m/sec/sq.km at the Boac river was estimated based on the flood marks at the river. The maximum amount of flood discharge is calculated at 1,308 cu.m/sec. For estimating flood discharge of the other rivers, the nomograph prepared by NIA is utilized. This graph shows the probable flood discharge by a acreage of the drainage area in Marinduque. The river having a small drainage area of 20 sq.km has the following flood discharge. (refer to Figure C-2-5)

Return Period	Probable Discharge (cu.m/sec)	Specific Discharge (cu.m/sec/sq.km)
2 years	84	4.2
5 "	180	9.0
10 "	265	13.3
20 "	350	17.5
50 "	500	25.0

C-2-6 Drought Discharge

The average drought discharge was usually occurred in March and April. At the Boac river, 2.92 cu.m/sec (or 1.34 cu.m/sec/100 sq.km) of the mean drought discharge was calculated based on the mean value of 355 day discharge calculated during the period from 1970 to 1986 by the Tank model method. The minimum mean and mean discharge are 2.77 and 4.68 cu.m/sec, respectively. (refer to Tables C-2-6 to C-2-7)

The probable drought discharge of the Boac river is also calculated and summarized as follows. (refer to Table C-2-8)

Return Period	Probable Discharge (cu.m/sec)	Specific Discharge (cu.m/sec/100 sq.km)
2 years	2.8	1.28
5 "	2.2	1.01
10 "	1.9	0.87
30 "	1.6	0.73
50 "	1.5	0.69

Table C-2-1 Water Level Gauging Stations in Marinduque

No.	Name of River	Location	Coordinates		Catchment Area (sq.km)	Remarks
			Latitude	Longitude		
1	Boac	Binunga (Boac)	13°24'00"	121°55'00"	149	Staff gauge read two times a day from 1988 August by NIA
2	Tugos (North)	Tugos (Boac)	13°23'45"	121°51'32"	3	- do -
3	Tugos (East)	Tugos (Boac)	13°23'45"	121°51'32"	7	- do -
4	Bagtingon	Bagtingon (Buenavista)	13°17'47"	121°56'27"	10	- do -
5	Buangan	Buangan (Torrijos)	13°19'06"	122°04'05"	16	- do -
6	Tawinan	(Sta. Cruz)				- do -
7	Boac	1 km from the Capital of Boac 1 km downstream from the Nepomuceno Bridge	13°27'05"	121°50'30"	218	Newly established (Automatic Gauge) by JICA
8	Tawinan	Malabon (Sta. Cruz)	13°26'30"	122°03'50"	63	Newly established (Automatic Gauge) by JICA

Table C-2-2 Collected Data of Daily Discharge in Marinduque

Sta. Cruz: Tawiran River

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1959	-	-	-	-	-	-	**	**	**	**	**	**
1960	-	**	**	**	**	**	**	**	**	**	**	**
1961	**	**	**	**	**	**	**	**	**	**	**	**
1962	**	**	**	**	**	**	**	**	**	**	**	**
1963	**	**	**	**	**	**	**	**	**	**	**	**
1964	**	**	**	**	**	**	**	**	**	**	**	**
1965	**	**	**	**	**	**	**	**	**	**	**	**
1966	**	**	**	**	**	**	**	**	**	**	**	**
1967	**	**	**	**	**	**	**	**	**	**	**	**
1968	**	**	**	**	**	**	**	**	**	**	**	**
1969	**	**	-	-	-	-	-	-	-	-	-	-

Boac: Boac River

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1959	**	**	**	**	**	-	-	**	**	**	**	**
1960	**	**	**	**	**	**	**	**	**	**	**	**
1961	**	**	**	**	**	**	**	**	**	**	**	**
1962	**	**	**	**	**	**	**	**	**	**	**	**
1963	**	**	**	**	**	**	**	**	**	**	**	**
1964	**	**	**	**	**	**	**	**	**	**	**	**
1965	**	**	**	**	**	**	**	**	**	**	**	**
1966	**	**	**	**	**	**	**	**	**	**	**	**
1967	**	**	**	**	**	**	**	**	**	**	**	**
1968	**	**	**	**	**	**	**	**	**	**	**	**
1969	**	**	-	-	-	-	-	-	-	-	-	-

Mogpog: Mangamnan River

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1959												
1960	**	**	**	**	**	**	**	**	**	**	**	**
1961	**	**	**	**	**	**	**	**	**	**	**	**
1962	**	**	**	**	**	**	**	**	**	**	**	**
1963	**	**	**	**	**	**	**	**	**	**	**	**
1964	**	**	**	**	**	**	**	**	**	**	**	**
1965	**	**	**	**	**	**	**	**	**	**	**	**
1966	**	**	**	**	**	**	**	**	**	**	**	**
1967	**	**	**	**	**	**	**	**	**	**	**	**
1968	**	**	**	**	**	**	**	**	**	**	**	**
1969	**	**	-	-	-	-	-	-	-	-	-	-

Legend: ** : Discharge *: Water level and discharge - : No observation

Table C.2.3 Monthly Runoff

Name of station : BOAC RIVER
Station location: TAMPUS, BOAC, MARINDUQUE
Drainage Area : 218 sq.km.

(Unit: cu.m/s)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1959	****	****	****	****	****	****	4.66	7.05	2.46	6.07	55.76	7.60	*****
1960	55.31	7.53	2.80	11.31	15.12	****	4.66	7.05	2.46	6.07	5.91	7.60	*****
1961	2.73	2.06	1.92	2.28	2.28	7.25	4.67	7.76	5.63	17.83	61.03	12.03	10.62
1962	6.46	5.83	5.26	4.14	4.30	6.46	17.63	10.47	12.51	7.57	56.57	9.08	12.19
1963	5.51	13.00	10.03	9.72	9.03	8.52	11.16	11.31	5.73	6.35	3.78	3.81	8.16
1964	2.91	1.88	2.00	1.83	7.04	18.30	8.92	3.93	3.98	4.22	7.17	4.54	5.56
1965	2.95	3.90	3.64	2.55	2.33	3.16	4.07	3.70	5.15	6.23	3.54	2.55	3.65
1966	3.36	1.91	1.56	1.31	2.86	3.19	5.53	3.96	2.00	2.38	5.06	55.49	7.39
1967	49.68	6.51	4.45	2.63	1.85	2.15	1.85	1.77	2.15	11.90	47.30	20.14	21.03
1968	28.34	10.70	2.86	2.17	3.18	15.42	33.59	60.32	22.13	4.71	0.42	0.41	15.35
1969	0.37	0.32	****	****	****	****	****	****	****	****	****	****	*****
MEAN	15.76	5.36	3.84	4.22	5.33	8.06	9.67	11.73	6.42	7.33	39.64	12.33	10.49

Table C.2.4 Monthly Runoff

Name of station : MALABON RIVER
Station location: STA. CRUZ, MARINDUQUE
Drainage Area : 63 sq.km.

(Unit: cu.m/s)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1960	****	1.02	1.44	1.61	2.54	3.30	1.65	1.11	1.26	12.09	0.98	0.78	*****
1961	0.38	0.30	0.25	0.23	0.45	0.48	0.75	0.59	0.78	3.46	9.74	1.38	1.57
1962	0.54	0.47	0.37	0.27	0.47	0.90	5.64	2.07	3.76	1.39	4.67	1.41	1.83
1963	0.49	0.36	0.18	0.12	0.13	0.24	0.42	2.48	3.79	1.08	1.19	1.48	1.00
1964	1.07	0.47	0.57	0.28	0.29	5.57	1.93	0.58	10.54	1.94	7.24	3.41	2.82
1965	1.12	1.22	0.77	0.51	0.31	0.50	1.59	4.76	2.24	1.90	0.97	0.75	1.39
1966	0.93	0.20	0.15	0.09	2.55	0.96	1.32	0.93	0.33	0.27	2.99	11.14	1.82
1967	3.59	0.44	0.18	0.12	0.17	0.13	0.13	0.12	0.59	0.68	12.90	1.16	1.68
1968	1.85	0.65	0.31	0.23	0.31	0.34	0.59	1.89	0.79	2.10	0.51	0.36	0.93
1969	0.23	0.13	****	****	****	****	****	****	****	****	****	****	*****
MEAN	1.13	0.53	0.47	0.38	0.80	1.38	1.56	1.61	2.68	2.77	4.58	2.43	1.62

Table C.2.5 Monthly Runoff

Name of station : MANGAUNAN RIVER
Station location: BUTINSAPA, MOGPOG, MARINDUQUE
Drainage Area : 28 sq.km.

(Unit: cu.m/s)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1959	****	****	****	****	****	****	1.41	0.70	0.29	0.38	7.71	2.76	*****
1960	5.29	0.79	0.38	0.88	0.60	3.01	0.92	0.83	0.59	3.67	0.67	0.48	1.51
1961	0.36	0.33	0.32	0.29	0.46	0.98	0.42	0.36	0.42	0.73	5.74	0.90	0.94
1962	0.90	0.37	0.34	0.34	0.79	0.62	1.13	0.82	1.91	1.32	2.61	1.36	1.04
1963	0.40	0.32	0.17	0.20	0.18	0.22	0.90	2.44	0.32	1.25	1.30	0.99	0.72
1964	0.41	0.32	0.21	0.14	0.12	0.31	0.15	0.09	0.28	0.24	3.65	1.34	0.61
1965	0.86	0.77	0.62	0.60	0.63	0.60	0.56	0.79	0.58	0.62	0.56	0.60	0.65
1966	0.08	0.01	0.01	0.01	0.99	0.30	2.16	1.21	0.30	1.48	4.29	4.53	1.29
1967	4.99	1.25	0.54	0.57	0.35	0.44	0.39	0.51	0.37	1.49	4.03	0.54	1.29
1968	0.71	0.40	0.21	0.38	0.20	0.56	0.95	1.01	0.70	1.41	1.54	0.22	0.69
1969	0.13	0.06	****	****	****	****	****	****	****	****	****	****	*****
MEAN	1.41	0.46	0.31	0.38	0.48	0.78	0.90	0.88	0.58	1.26	3.21	1.37	0.97

Table C-2-6 Summary of Calculated Daily Discharge of Boac River

C.A. = 218.0 sq.km (cum/s)
(Unit: cu.m/sec)

Year	Max-Q	95 Day Q	185 Day Q	275 Day Q	355 Day Q	Min-Q	Mean-Q	Total-Q
1970	406.59	9.41	4.65	3.08	1.84	1.81	10.67	3,895.80
1971	56.48	9.74	4.63	3.34	2.41	2.38	7.58	2,767.25
1972	49.93	14.88	9.76	4.17	2.52	2.47	11.03	4,036.80
1973	71.33	19.20	11.41	5.36	2.76	2.64	14.56	5,313.95
1974	60.60	18.07	11.01	6.33	4.28	4.12	13.77	5,026.48
1975	101.27	15.14	8.16	5.15	3.31	3.21	12.19	4,449.90
1976	90.52	13.31	7.20	4.91	3.22	2.79	12.05	4,409.18
1977	64.73	16.63	10.66	6.45	4.84	4.64	12.70	4,634.09
1978	53.96	14.67	7.70	4.42	2.64	2.50	10.14	3,700.70
1979	71.54	7.27	4.63	2.92	2.49	2.25	6.36	2,319.98
1980	36.88	8.91	5.70	3.76	1.99	1.79	7.33	2,681.71
1981	35.07	9.64	4.96	3.35	2.15	2.08	7.29	2,660.40
1982	51.69	8.38	5.84	3.88	3.03	2.75	6.98	2,548.37
1983	22.95	10.69	7.41	3.07	1.59	1.58	7.54	2,752.98
1984	33.63	15.24	9.35	4.86	3.26	3.04	10.96	4,010.32
1985	75.45	14.38	8.31	5.47	4.40	4.23	11.01	4,019.80
1986	37.28	16.07	9.61	4.80	2.98	2.77	11.16	4,074.68
Max-Q	406.59	19.20	11.41	6.45	4.84	4.64	14.56	-
Min-Q	22.95	7.21	4.63	2.92	1.59	1.58	6.36	-
Mean	77.64	13.03	7.71	4.43	2.92	2.77	10.20	3,723.67
Specific Discharge	35.61	5.98	3.54	2.03	1.34	1.27	4.68	-

Table C-2-7 Calculated 10 Days Discharge

(Unit: cu.m/sec)

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1970	1	29.76	20.99	16.71	12.99	9.02	18.93	56.03	19.50	13.56	34.11	114.88	70.94
	2	39.00	19.37	15.01	11.57	8.89	48.82	33.17	19.83	19.51	464.46	137.84	31.88
	3	31.11	14.32	17.15	10.09	13.09	110.68	24.76	15.67	23.92	103.67	127.95	27.26
	Total	99.87	54.68	48.87	34.65	31.31	178.43	113.96	55.00	56.99	602.24	380.67	130.08
1971	1	23.40	19.93	18.52	15.13	21.62	45.92	90.62	16.82	13.63	23.46	61.04	54.67
	2	22.32	33.05	27.01	13.17	11.16	40.08	66.79	16.05	12.59	61.31	51.30	43.85
	3	23.06	18.82	18.77	11.66	37.81	76.05	36.26	16.61	12.31	68.51	66.48	79.64
	Total	68.78	71.80	64.30	39.96	70.59	162.05	193.67	49.48	38.53	153.28	178.82	178.16
1972	1	64.37	19.82	16.70	15.14	15.57	59.49	104.36	44.96	125.14	72.91	79.02	87.04
	2	52.22	18.42	16.53	17.30	13.13	34.49	51.33	56.02	112.64	53.63	69.09	76.28
	3	23.06	18.82	18.37	11.66	37.81	76.05	36.26	16.61	12.31	68.51	66.48	79.64
	Total	153.27	58.74	51.60	46.13	48.72	149.66	210.75	181.08	311.37	203.54	221.35	215.52
1973	1	32.89	50.58	22.90	17.79	15.05	38.73	133.68	92.72	55.40	101.66	70.12	69.49
	2	38.50	29.90	20.58	15.98	15.62	51.11	102.77	51.13	101.07	88.27	92.43	160.59
	3	45.84	19.82	23.61	15.74	17.13	70.56	168.41	60.16	111.24	95.44	118.41	222.31
	Total	117.23	100.30	67.09	49.51	47.80	160.40	404.86	204.01	267.71	285.37	280.96	452.39
1974	1	140.38	42.48	53.23	28.34	25.00	64.17	21.10	126.65	62.25	112.26	96.96	51.53
	2	96.59	49.04	34.32	30.99	25.28	44.15	20.12	137.23	44.78	143.92	66.86	60.59
	3	65.43	52.68	34.00	28.46	24.99	25.72	62.93	136.31	71.36	97.19	59.47	69.05
	Total	302.40	144.20	121.55	87.79	75.27	134.04	104.15	400.19	178.39	353.37	223.29	181.17

(Cont'd)

Table C-2-7

(Unit: cu.m/sec)

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
	1	41.32	26.71	23.03	18.32	19.69	12.47	99.35	57.93	93.34	37.54	74.52	76.90
1975	2	35.72	29.29	21.25	16.71	25.61	47.51	118.10	32.02	81.72	41.03	65.84	91.93
	3	36.72	20.31	20.98	17.58	30.96	108.26	96.85	32.21	49.74	47.61	103.18	279.05
	Total	113.76	76.31	65.26	52.61	76.26	178.24	314.29	122.16	224.80	126.18	243.54	447.88
	1	96.00	30.61	30.48	21.50	15.04	46.16	38.55	20.40	24.32	37.05	56.78	246.10
1976	2	104.54	31.82	25.24	19.19	28.67	36.16	20.69	31.88	19.66	65.28	53.51	135.87
	3	46.21	25.23	27.20	17.00	167.43	140.88	24.19	45.24	29.09	77.19	55.59	130.93
	Total	246.75	87.66	82.92	57.69	211.14	223.20	83.43	97.52	73.07	179.52	165.88	512.90
	1	103.04	47.23	71.66	28.91	23.76	35.74	106.09	46.07	33.39	30.89	51.77	113.05
1977	2	115.57	72.96	54.72	31.15	29.51	72.94	91.64	57.41	44.94	40.46	71.88	46.07
	3	120.31	79.44	55.24	26.21	35.25	76.04	97.75	44.12	24.45	41.88	68.17	36.10
	Total	338.92	199.63	181.62	86.27	88.52	184.72	295.48	147.60	102.78	113.23	191.82	195.22
	1	38.41	24.08	20.27	15.37	12.95	35.49	29.33	18.04	35.41	87.59	74.22	74.29
1978	2	43.48	24.01	20.26	19.06	23.62	53.55	42.89	45.35	75.97	100.70	103.09	86.55
	3	36.74	17.32	19.09	14.41	22.13	42.09	23.72	47.06	95.34	102.05	112.05	61.63
	Total	118.63	65.41	59.62	48.84	58.70	131.13	95.94	110.45	206.72	290.34	289.36	222.47
	1	27.41	25.25	19.63	14.03	13.82	12.21	15.47	19.01	15.11	25.78	27.02	68.71
1979	2	31.40	23.10	18.48	91.91	14.34	58.83	14.21	14.55	33.95	39.39	42.75	57.27
	3	32.83	17.25	17.71	25.07	13.16	28.46	20.23	15.06	35.99	18.49	61.44	54.91
	Total	91.64	65.60	55.82	131.01	41.32	99.50	49.91	48.62	85.05	83.66	131.21	180.89

(Cont'd)

Table C-2-7

(Unit: cu.m/sec)

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
	1	22.88	24.96	19.74	16.72	13.24	12.15	29.22	28.83	31.99	25.15	59.99	26.76
1980	2	28.67	40.23	18.03	14.89	10.98	22.75	42.57	26.13	28.07	58.99	75.89	33.15
	3	43.66	20.05	24.62	14.10	10.24	36.33	72.71	80.43	30.13	96.91	66.54	22.46
	Total	95.21	85.24	62.39	45.71	34.46	71.23	144.50	135.39	90.19	181.05	202.42	82.37
	1	18.83	28.65	18.92	14.45	13.85	11.06	106.92	19.12	19.27	39.79	55.56	31.46
1981	2	18.21	21.92	17.18	12.51	10.95	29.99	61.32	16.93	50.71	46.20	66.37	36.36
	3	62.92	20.27	17.99	20.64	17.18	53.82	33.21	16.96	31.56	72.39	55.31	51.63
	Total	99.96	70.85	54.09	47.60	41.98	94.87	201.45	53.01	101.54	158.38	177.24	119.45
	1	32.72	28.42	19.34	16.75	15.05	31.96	36.13	17.12	28.11	27.09	39.85	25.33
1982	2	32.25	26.06	20.97	17.32	43.79	54.96	41.29	16.50	34.11	49.10	35.93	38.30
	3	36.48	16.32	25.02	14.60	56.17	43.84	23.73	56.43	21.66	70.48	28.51	47.31
	Total	101.45	70.80	65.33	48.67	115.01	130.76	101.15	90.05	83.88	148.67	104.29	110.94
	1	28.28	22.66	16.95	12.48	10.40	9.30	25.96	39.92	46.65	54.92	54.52	45.34
1983	2	36.29	28.07	15.64	11.45	9.81	8.39	59.24	39.46	42.63	50.67	58.78	67.34
	3	47.91	14.56	16.22	12.03	10.37	12.22	68.58	58.60	58.23	66.82	54.35	47.69
	Total	112.48	65.29	48.81	35.96	30.59	29.91	153.78	137.98	147.51	172.41	167.65	160.37
	1	28.41	28.56	25.99	17.99	18.31	39.59	71.58	29.51	53.02	99.73	86.60	58.87
1984	2	38.00	24.02	23.81	20.19	18.34	49.83	62.72	64.64	61.78	98.34	89.33	58.40
	3	42.30	18.11	20.92	16.67	34.95	42.31	49.22	95.09	90.41	120.34	96.06	45.74
	Total	108.71	70.69	70.72	54.85	71.60	131.75	183.52	189.14	205.21	318.41	271.99	163.01

(Cont'd)

Table C-2-7

(Unit: cu.m/sec)

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1985	1	32.57	26.60	25.72	24.60	50.94	24.75	147.96	23.02	35.88	63.70	41.34	100.71
	2	39.07	26.01	30.43	31.84	45.61	27.79	68.82	22.24	74.04	89.51	83.24	93.10
	3	38.02	25.42	24.92	60.02	42.58	65.91	46.33	23.66	71.29	72.55	85.19	58.59
	Total	109.66	78.03	81.07	116.46	139.46	118.45	263.11	68.92	181.21	225.76	209.77	252.40
1986	1	35.79	36.19	23.81	18.31	15.98	13.55	41.32	53.62	67.66	83.51	99.06	48.97
	2	38.94	28.91	24.61	28.54	20.35	28.63	61.31	56.89	94.38	115.57	104.70	46.43
	3	66.69	19.54	22.80	19.22	16.72	28.95	75.27	75.22	98.89	105.07	92.92	60.86
	Total	141.42	84.64	71.22	66.07	53.05	71.13	177.90	185.73	260.93	304.15	296.68	156.26

Table C-2-8 Probability of Exceedance (Boac River)

(Unit: cum/s)

R.P.	Max-Q	95 Day Q	185 day Q	275 day Q	355 day Q	Min-Q	Mean-Q	Total-Q
1/2	66.	12.7	7.4	4.1	2.8	2.6	10.0	3,637
1/5	112	9.8	5.6	3.4	2.2	2.0	7.9	2,906
1/10	144	8.5	4.9	3.1	1.9	1.8	7.0	2,570
1/20	177	7.5	4.3	2.8	1.7	1.7	6.3	2,314
1/30	196	6.9	4.0	2.7	1.6	1.6	6.0	2,187
1/50	221	6.3	3.6	2.6	1.5	1.5	5.6	2,046

Figure C-2-1 River Basin

River Basin	Drainage Area (sq.km)
7. Mogpog	58
8. Boac	227
9. Tawiran	99
16. Buangan	19
21. Malbog	23
22. Caigangan	27
24. Dawis	24
26. Gasan	9
27. Tiguion	14
28. Libtagin	40
Others (22)	422
Total	935

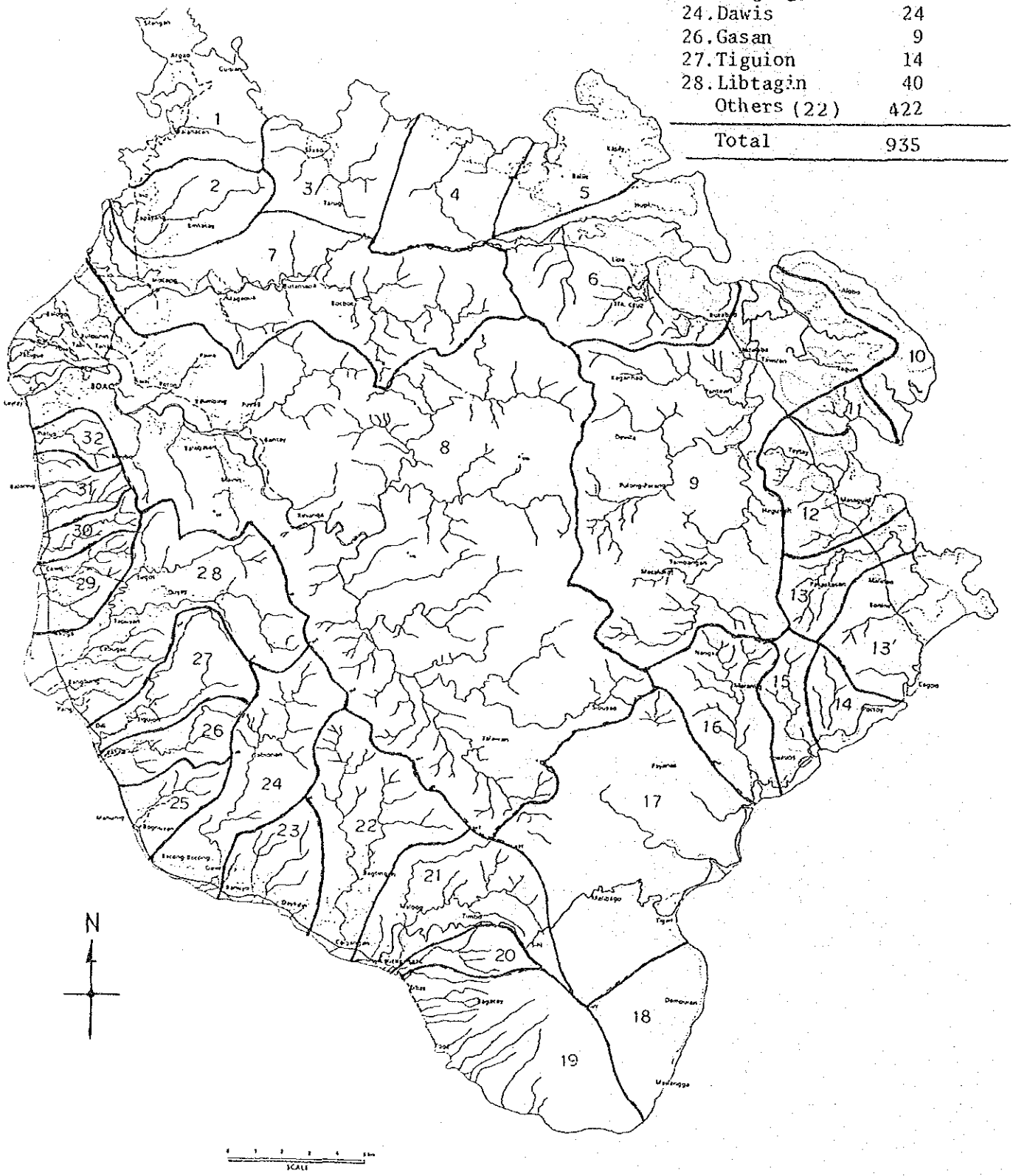
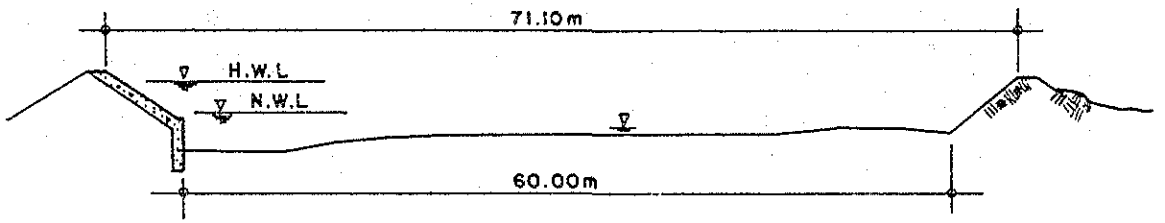


Figure C-2-2 Cross Section of Rivers at Water Level Gauge Stations

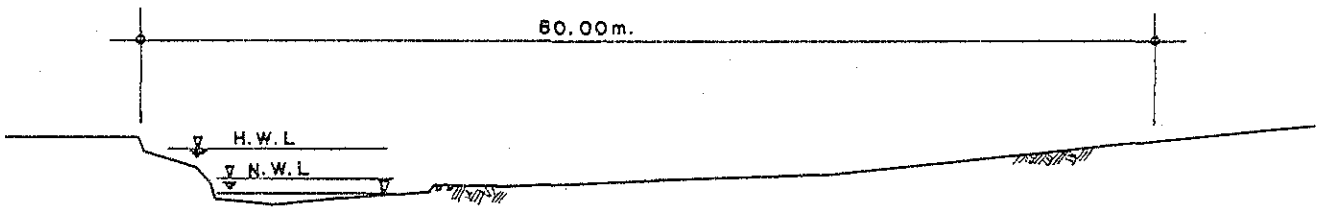
Newly installed By JICA STUDY TEAM

No. 7 BOAC RIVER AUTOMATIC WATER LEVEL GAUGE STATIONS

SCALE 1:50M.



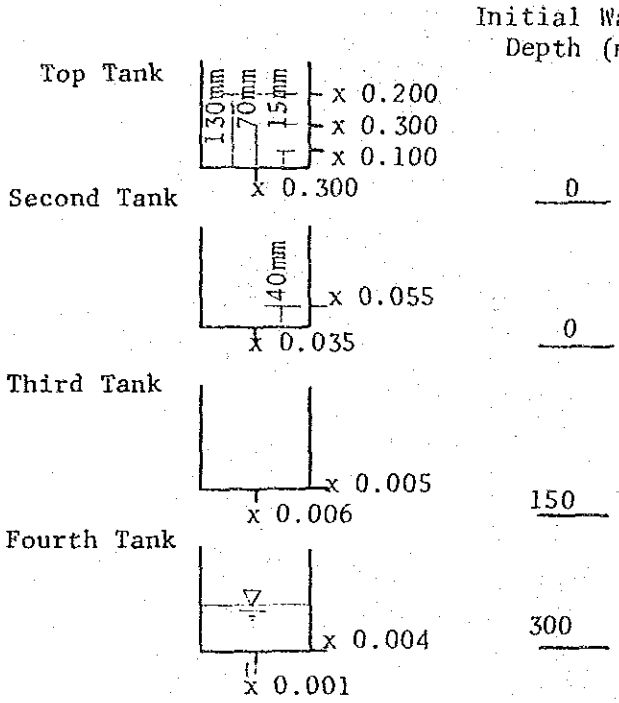
No. 8 TAWIRAN RIVER AUTOMATIC WATER LEVEL GAUGE STATIONS



LOCATION: Boac (Boac River)

DRAINAGE AREA: 218 sq.km.

STUDY PERIOD: 1961-68



Evapotranspiration

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Evapotraspiration (mm/day)	2.2	2.8	3.8	4.1	3.6	3.2	3.1	2.8	2.8	2.7	2.7	2.5	1,101.1

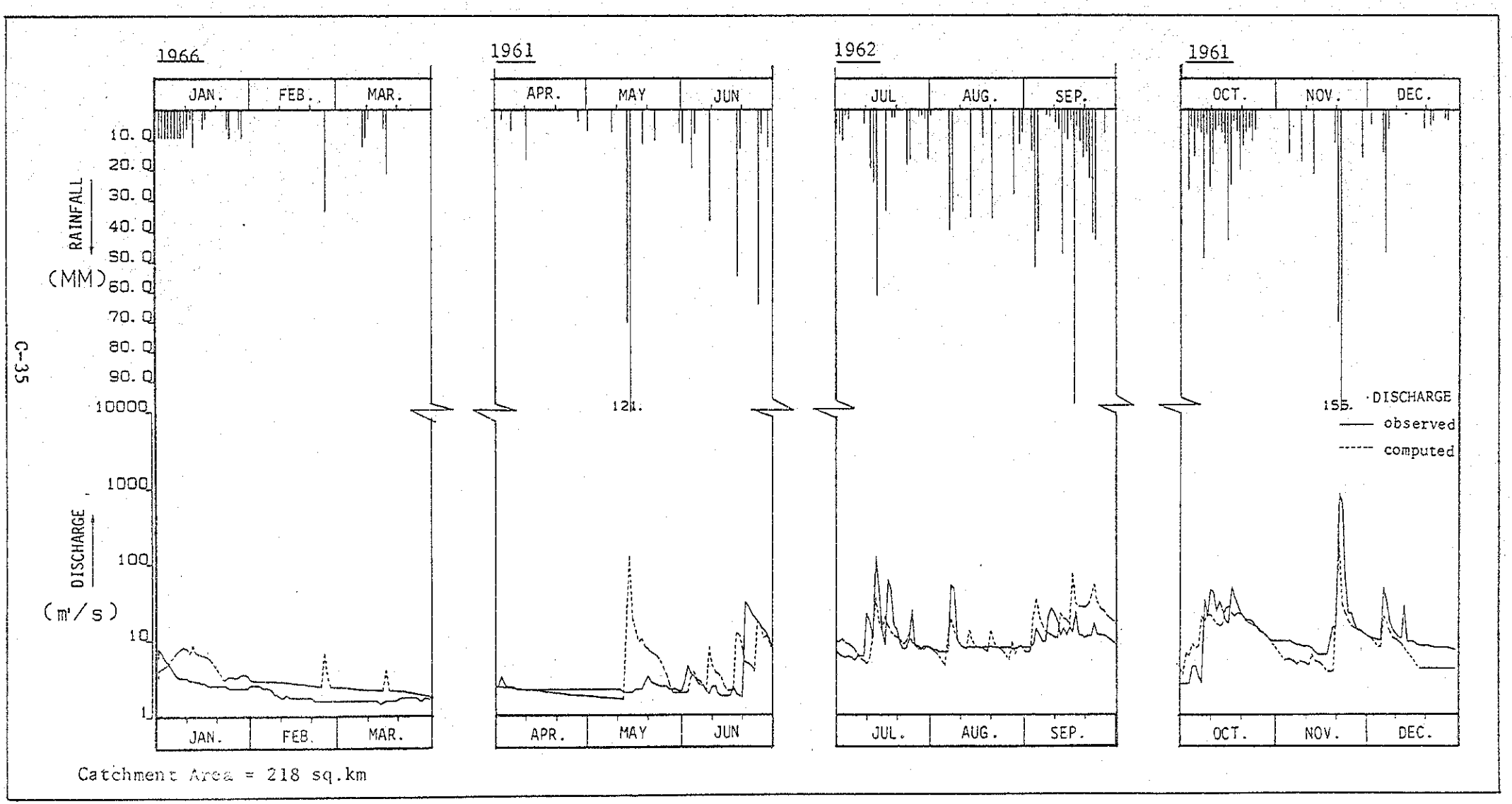
Note: Evapotranspiration = Potential Evapotranspiration x 0.7

Operation 1: Evapotranspiration subtracted from top to third tanks, from top tank when water in top tank, from second tank when no water in top tank, and so on.

Operation 2: Evapotranspiration reduced to 70% when rainy day.

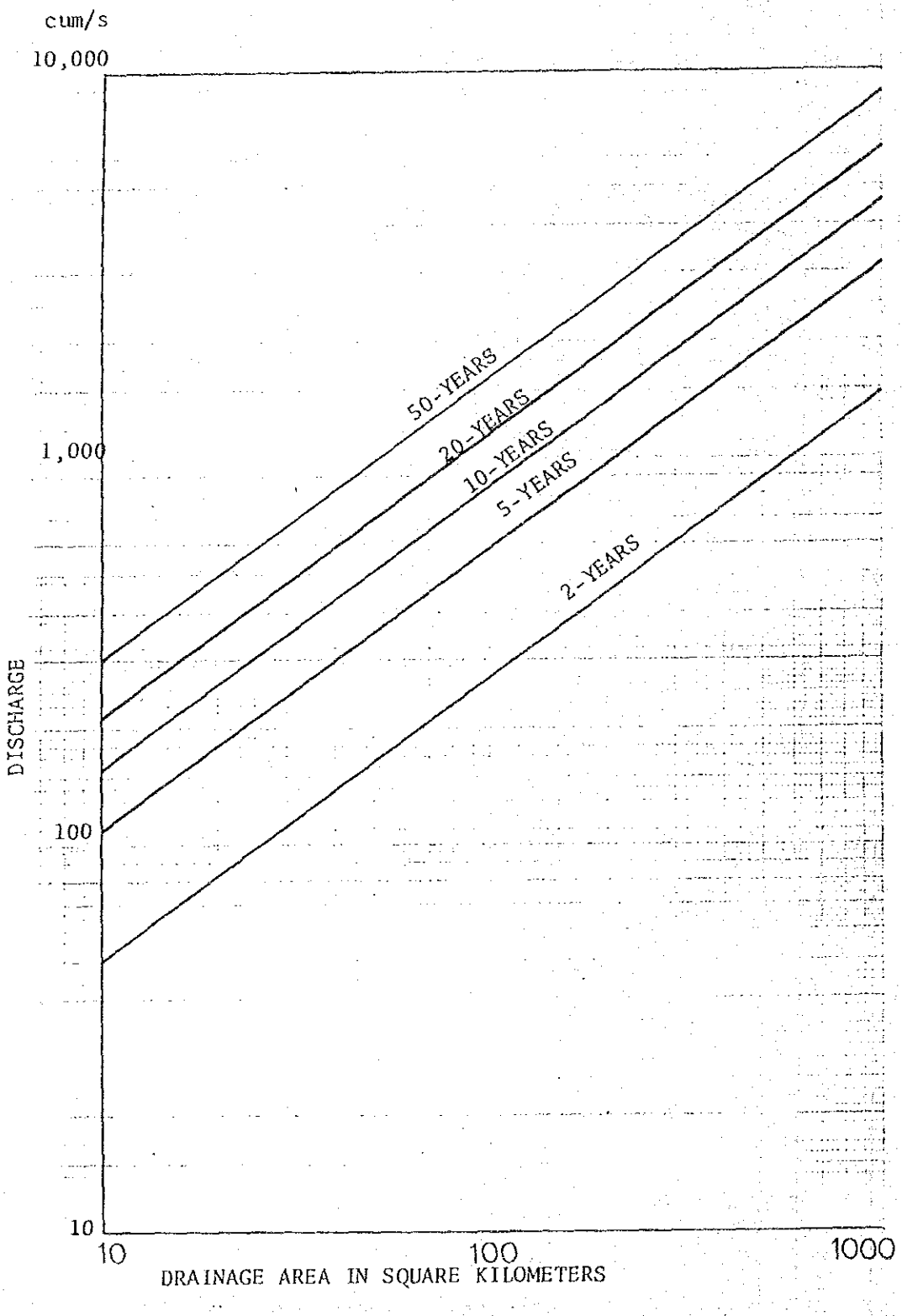
Figure C-2-3 Tank Model of the Boac River

Figure C-2-4 Results of Analysis by Tank Model Method



Catchment Area = 218 sq.km

Figure C-2-5 Nomograph of Probable Flood Discharge



Source: NIA

C-3 Water Resources Development

C-3-1 Available Water Resources in Marinduque Island

The total water resources of the Marinduque island having 935 sq.km is calculated at 2,620 MCM based on the average annual rainfall of 2,800 mm. On the other hand, the total amount of evapotranspiration from the whole island is also estimated at 1,100 mm or 1,030 MCM based on the Los Banous data. The total amount of percolation is assumed at 280 mm or ten percent of rainfall of 2,800 mm, which is equivalent to 260 MCM. Therefore, the total amount of surface run-off is calculated at 1,420 mm or 1,330 MCM. The surface run-off is divided into two categories such as flood discharge and normal discharge. The total annual amount of flood and normal discharges are assumed at 1,140 mm or 1,070 MCM and 280 mm or 260 MCM, respectively. The flood discharge is estimated by the ratio of 80% due to lack of data. (refer to Figure C-3-1)

C-3-2 Present Water Utilization

There are 900 ha of the irrigated paddy fields in the island at present. On the fields, the two cropping faming is carried out by farmers. Therefore, the total amount of water used for paddy cultivation is 17 MCM (= 900 ha x 1,900 mm). The total amount of drinking water is about 1.0 MCM (= 206,000 presons x 10 lit/day/person x 365 days). The water utilization ratio, therefore, is able to calculate at less than 1.0% only (= 18 MCM / 1,330 MCM) at present, that is to say, about 99% of water resources are flowed out to the sea without any utilization.

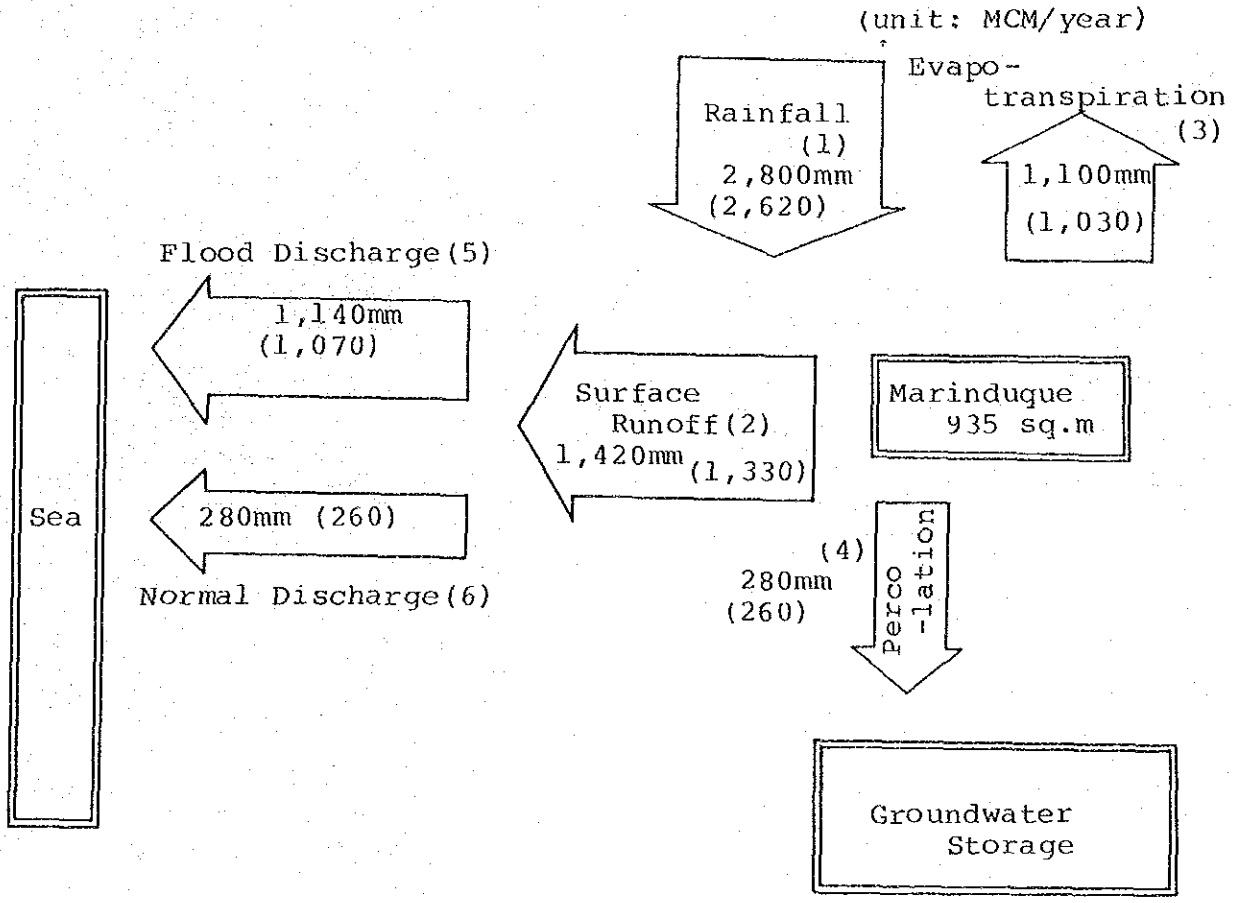
C-3-3 Proposed Water Utilization

After completion of the various projects and increase of the number of inhabitants, the following water utilization is considered.

Irrigation water	3,910 ha x 1,900 mm	= 74 MCM
Water supply	306,000 x 60 lit/day/person x 365 days	= 7 MCM
Others	20% of above total	= 19 MCM
	Total	100 MCM

The water utilization rate will be improved up to about eight percent in the future. (100 MCM / 1,330 MCM x 100 = 8%)

Figure C-3-1 Water Balance in Marinduque



Legend;

(1) Annual Rainfall: based on isohyetal map of annual rainfall
(2) Surface Runoff : (1) x 50%
(3) Evapo-transpiration: 1,600mm (open pan evaporation) x 70%
(4) Percolation : (1)-(2)-(3)
(5) Flood Discharge: assumed at 80% of annual discharge
(6) Normal Discharge: (2)-(5)

APPENDIX D GEOLOGY AND HYDROGEOLOGY

APPENDIX D GEOLOGY AND HYDROGEOLOGY

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APPENDIX D GEOLOGY AND HYDROGEOLOGY

D-1 Geology

D-1-1 Regional Geology

The general geologic setting of Marinduque is fairly complex with serpentinites and altered volcanics as basement rocks. These older rocks are overlain unconformably by a thick sequence of pyroclastic rock with intercalated clastic rock, volcanic flow and limestone ranging in age from Eocene to Miocene which are in turn overlain unconformably by younger pyroclastic and tuffaceous sedimentary rocks. Middle Tertiary adjustments accompanied by the intrusion of diorite caused the block movements, folding and faulting in the area.

Geologically, Marinduque is divided into two blocks by the Boac river fault which traverses the island from the northeastern slopes of Mt. Malindig in Torrijos to Mogpog. The northeastern block is underlain mostly by diorite and pre-Miocene rocks while the southwestern block consists mainly of Pliocene and younger formations. (refer to Figure D-1-1)

D-1-2 Geologic Structures

The regional structural feature of Marinduque is dominated by the northwest trending Boac river fault which is clearly expressed by topography. The fault is steeply dipping to the southwest and appears to have controlled the course of the middle to upper reaches of the Boac river.

West of the Boac river fault is another similarly northwest trending fault that marks the western edge of the wedge-shaped horst block near the center of the island. These two faults are apparently deep-seated and could have probably influenced the emplacement of the intrusive rocks contributing appreciable copper sulphide and gold metallization.

Other important regional structure is the thrust fault along the western flank where small bodies of serpentinite were thrusted into the Gasan formation.

D-1-3 Geology at Major Selected Sites

A geological reconnaisance survey of potential sites for dams and appurtenant structures was undertaken to have a preliminary evaluation of the geotechnical conditions obtaining in these areas. Selection of the sites investigated was based mainly on the underlying rock types to provide a general impression on the engineering geological conditions that may be expected in five of the major rock formations encountered in the Study Area.

1) Binunga Site

The site is underlain by limestone with intercalated volcanic rocks. Outcrop faces which rise steeply on both banks show a slightly weathered limestone with moderate to steep dips upstream. Solution cavities are conspicuously absent and dissolution appears to have affected only the outer portion of bedding planes. Upstream on the right bank, fresh andesite was observed to overlie the limestone. Fractures are mainly bedding joints and are generally tight. No major faults were found in the immediate vicinity but the Boac river fault as indicated in the regional map exists some 800 m upstream of the site. In the river bed, the water way is about 60 m becoming wider upstream. It is covered with alluvial sediments which may reach a thickness of more than ten meters above the rock level. At the left side of the river bed towards the left abutment, a relatively flat to gently inclined surface runs for about 90 m. It is covered with thick vegetation and appears to be underlain by older alluvial deposit.

Geotechnically, the site considered is favorable for the location of dam and its appurtenances as these will be effectively anchored and rested on solid rock foundation, aside from having a big reservoir area.

The major fault is found existing at a considerable distance from the site and therefore will not pose major instability in the structure. The foundation problem so far identified will be related to geologic condition of the rock in the river bed and the overlying alluvial deposit. This involves the assessment of the sub-surface features of both materials to define the type of protective treatment needed to make the foundation tight and free from possible uplift pressure underneath the dam and the depth to cut-off. This can be accomplished by conducting core drilling and seismic survey in the river bed. For further studies, detailed geologic mapping and core drilling should also be carried out on both abutments to confirm the absence of solution cavities in limestone.

2) Devilla River Sites

Two sites are being considered along the Devilla river: the site-A located some 1.6 km upstream of its confluence with the Tambangan river where the water starts to flow as the Tawiran river and site-B which is about 1.5 km upstream of the site-A. No sub-surface investigation has been undertaken at the site-A while the site-B was explored by four drillholes along the dam axis with a total length of 120 m.

The river bed at the site-A has an approximate elevation of 22 m and a width of about 40 m. The slope on the right abutment varies from 15 to 20 degrees. The left abutment is steeper with slopes of about 40 to 45 degrees. The main rock types in the area are agglomerate and andesite of the Oligocene San Antonio formation. The fresh and massive agglomerate is widely exposed on the left abutment. It is well indurated and the near absence of fracturing was noted. A few meters downstream of the potential dam axis on the left abutment, a moderately to highly fractured andesite is exposed in this area, there is a marked contrast in topography with that of the area underlain by agglomerate. Apparently, the more gentle slopes and thicker overburden in this area are due in part to the fractured nature of andesite. The same condition

seems to prevail on the right abutment where small outcrops of fractured andesite is limited to its southern slopes. Alluvial deposit overlying the bedrock at the river section is estimated to be in the order of three to six meters thick and consists predominantly of gravels and boulders of volcanic rocks and chert.

The site-B has a river section width of about 30 m at an elevation of approximately 37 m. It is generally rocky especially on the downstream side. Inclination of the abutments averages about 30 to 40 degrees at the left and right abutments, respectively. The rocks at and around the damsite area are essentially andesitic to basaltic volcanic flows belonging to the San Antonio formation. These rocks are classified petrographically into several rock types including andesite, andesite porphyry, porphyritic andesite, porphyritic basalt, basalt porphyry and dacite. However, since each rock type does not exhibit peculiar engineering properties, these volcanic rocks should be considered as one mass in regard to bedrock for the construction of a dam. Fresh volcanic rocks in the area are generally dense and hard. Jointings and shearing, particularly those trending prominently to the northwest with steep dips to the northeast, are rendered tight by quartz and calcite veins.

The results of previous drilling exploration at the site-B were evaluated and the different grades of bedrock were determined based on a standard classification of rock quality in the dam foundations(Tanaka). In general, bedrocks within the C_L-C_M class are adequate for the foundation of a fill dam type. Accordingly, the rock excavation line has been delineated and the average depth of excavation would be apporoximately seven meters.

In regard to engineering geological considerations, the site-B appears to be better than the site-A. For one, the average depth of excavation at the site-A would be more than seven meters although less excavation would probably be required at the left abutment along the dam axis. Also, the more intense fracturing of the andesite at the site-A,

which apparently influenced the gentle slopes and deeper weathering of the bedrock, would require more extensive consolidation grouting and deeper grout curtain to reduce permeability and improve its strength as foundation materials. Further, the higher elevation and narrower river section plus the steeper slopes on the right abutment at the site-B makes it more advantageous than the site-A.

3) Tambangan River Sites

The Tambangan river flows through rocks belonging to the same Oligocene San Antonio formation as at the Devilla river. The formation consists essentially of andesitic to basaltic volcanic flows with minor intercalated agglomerates. The major difference will probably be related to the intensity of fracturing, depth of weathering and thickness of overburden. Moreover, the river section in both sites are generally wider than those at the Devilla river. The stretch of the Tambangan river from the site-A which is about 2.7 km upstream from its junction with the Devilla river to the site-B located some 2.5 km farther upstream, showed only few outcrops of the underlying formation and most of the riverbed are covered with alluvial deposit. Accordingly, the final selection of the site will be guided chiefly on the basis of economy and depth of excavation that will be involved.

4) Cabugao Site

The site is underlain by the siltstone member of the Boac formation. The siltstone is grayish brown to brown in color when weathered and is poorly compacted and loosely cemented. Fresh outcrops as seen in nearby areas showed a gray-colored rock but is similarly friable as the weathered siltstone. Both abutments are covered with clayey silt overburden with thickness averaging about two meters.

Due to the poor consolidation of siltstone, future studies should include sub-surface exploration by core drilling and standard penetration test to ascertain the engineering properties of the foundation materials.

5) Antipolo Site

The local geologic setting at the site is fairly similar to the geology of Cabugao area, both being underlain by siltstone. However, soil overburden is expected to be thicker due to a flatter slope on the left abutment.

Considering the size of the structures, exploratory work such as core drilling, standard penetration test and laboratory testing of core samples are necessary to determine in detail the bearing capacity of the foundation rock.

6) Bangbang Site

Bangbang site is located within the silt/siltstone member of the Boac formation and is about one kilometer south-southwest of Cabugao site which has a similar geologic setting. The nature of the underlying rock formation at the site, however, can not be ascertained at this stage due to the absence of rock exposures.

As noted on outcrops in areas underlain by the same formation, there is somewhat a variation in the induration of siltstone. The more indurated type indicates the presence of calcareous cementing materials while the soft and friable types, which sometimes assume the characteristics of silt when exposed, owe their consolidation to pressure exerted by the overlying materials and without any cementation. Consequently, one of the major foundation problems that may be encountered at the site is differential settlement and in view of this, exploration by core drilling and standard penetration test should be undertaken to establish the foundation conditions prevailing at the site.

There are two proposed sites, about 500 m apart, for the Bangbang area which are located in the middle reaches of the creek. While geologically, both sites are similar, there is a marked difference in the width of the valley, abutment slopes and thickness of the overburden.

7) Bagtingon Site

The width of the river bed is about 40 m while the slope on both abutments is about 35 degrees. However, the slope on the right abutment becomes more gentle near the top where inclination is about ten degrees. A flat portion also runs at the river bed to about elevation 80 m. Slightly weathered to fresh outcrops of diorite can be seen on the left bank. The rock is dense and hard and is traversed by moderately spaced joints which are generally tight. No outcrops were found on the right abutment as the soil cover is relatively thick. However, at about 200 m upstream of the dam axis, a small outcrop of sheared diorite was observed. The rock is soft and appears to have been affected by the northwest trending regional fault that passes thru the right abutment.

In view of the adverse geologic condition on the right abutment, detailed geologic mapping and sub-surface exploration by core drilling should be undertaken to fully comprehend the foundation conditions prevailing at the site.

8) Masaguisi Site

The Masaguisi site has narrow waterways and steep abutments. A soil cover on both abutments is relatively thin probably averaging one meter in thickness. The main rock type encountered around the site is andesite. Fresh outcrops as noted upstream of the dam axis revealed a well indurated and sound rock. Aside from the sound physical condition of the foundation materials, there were no major geologic discontinuities found in the area and as such the proposed site is considered suitable for the location of the proposed structures.

9) Cabuyo River Sites

The three potential sites are located in the middle reaches of the southeast-flowing Cabuyo river which has carved out its southern course on the clastic member of the Eocene formation. This formation consists mainly of volcanic wackes and shale with intercalated flows and

agglomerates. In places, these rocks appear to have been affected by the regional northwest-southeast trending faults which are presumably splays of the major Boac river fault. A considerable portion of the Cabuyo river, especially on its middle to upper reaches, were probably controlled by these geologic structures.

The lowest site-A is located some 3.5 km upstream from the mouth of the Cabuyo river. It is underlain by basaltic volcanic rocks which are generally hard and dense. The soundness of this rock, however, may be affected by the intense fracturing as a result probably of faulting which has been manifested by a fault scarp in the upper slopes of the left abutment. On the other hand, the right abutment exhibits tight, moderately spaced and steeply to vertically dipping joints on the same rock type. Topographically, the site-A offers the best condition in terms of steepness of abutment slopes and width of the river bed section among the three sites. However, the topographic condition on the upper slopes of the right abutment where a low saddle may exist, should be verified in future studies.

At about 350 m upstream of the site-A and just a few meters downstream of the confluence of Cabuyo and Payanas rivers is the site-B. The main rock type at the site is well indurated andesitic volcanic rocks with intercalated agglomerate which has a limited exposure on the right bank. Although the northwest trending fault at the site-A is inferred to pass through the upper slopes of the left abutment, its probable effects on the rocks at the site is not clearly manifested because of soil and vegetable cover.

Farther upstream at approximately 700 m from the site-B, the rocks underlying the area where the site-C is located, consists of siltstone on the left abutment and andesite porphyry on the right abutment. The siltstone is generally massive, greenish gray to black in color, hard and is slightly metamorphosed. The prominent joints trend to the northeast and dip steeply to the southeast and probably mark the bedding in siltstone which is not clearly defined. The andesite porphyry, on the other hand, is slightly altered hydrothermally and is brownish gray

in color. It is moderately hard and is travered by some open joints. Topographically, the siltstone area has steeper abutment slopes (40°) than the andesite porphyry area (30°). While no major faults were observed within the immediate vicinity of the site, an intensely brecciated zone with a width of a few meters were found along the ridge trail on the left side of Cabuyo river between the sites-B and -C.

From the foregoing, since the three sites seem to be affected, though in varying degrees, by the major regional geologic structures in the area, further investigation of the extent and nature of these structures by conducting detailed geological mapping and sub-surface exploration is necessary to fully understand the geotechnical conditions prevailing in the area.

10) Dawis River Site

The site is located along the approximately 200 m gorge section of the Dawis river, some four kilometers upstream from its mouth. It has a riverbed width of 15 to 20 m at about elevation 40 m with both banks rising steeply (75 to 80°) to almost vertically up to elevation 70 m.

Both banks are occupied by limestone which is white to buff in color and generally hard when fresh. It strikes to the northwest with dips of 40° to the southwest in a downstream direction and forms part of the southwestern limb of the northwest plunging anticline. Joints in the rock are randomly oriented and are conspicuously affected by dissolution. A number of joints have been widened to as much as 0.10 m and dissolution appears to have penetrated the inner joint planes in some cases.

Owing to the steepness of slopes on both bank, overburden is expected to be thin about one meter or less, but is probably thicker from elevation 70 m upwards, where slopes are about 40°. At the river section, alluvium consisting mainly of gravel and boulders, is estimated to be approximately five to ten meters thick.

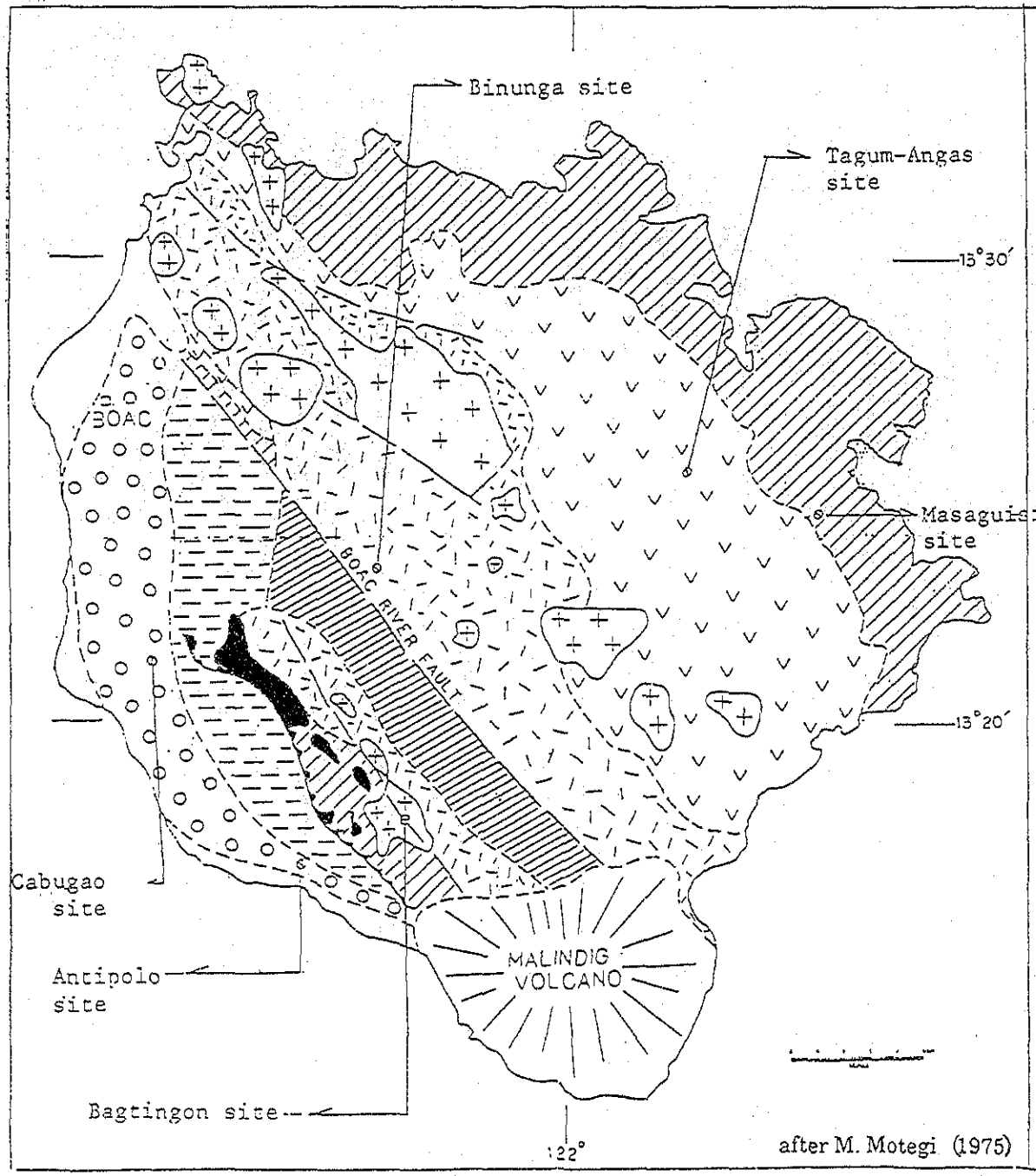
The susceptibility to dissolution of limestone, the thick overburden at the river section and the unfavorable downstream dip of rocks on both abutments which may cause sliding failure, constitute the weak features of the foundation materials at the site. As such, further exploration by detailed mapping, core drilling, standard penetration test, etc. are deemed essential in the proper evaluation of the foundation conditions obtaining at the site.

D-1-4 Construction Materials

Impervious core materials are available in large quantities in practically all the sites investigated. As for the other types of materials, the followings are its potential sources:

- Concrete aggregates and filters : The floodplains of Boac and Libtanging rivers and its tributaries.
- Riprap : areas underlain by volcanic rocks and diorite.

The field and laboratory tests, however, should be undertaken to determine its actual engineering properties thus ascertaining its suitability as construction materials. The selection of the source area for potential dam sites will be guided principally by economic considerations.



EXPLANATION

Lithology

Age	Symbol	Formation/ Rock Unit	Description
RECENT		Alluvium	Fluvial sand & gravel, flood-plain, delta & beach deposits
PLEISTOCENE	volc	Malindig Volcanics	Andesite, tuff and agglomerate
		Boac F.	Terrace gravel member: essentially elevated deltaic sand & gravel: Silt member: Largely reworked tuff of tuffaceous clastics
PLIOCENE		Gasan F.	Largely tuff or tuffaceous clastics
UPPER MIOCENE		Porvado F.	Molasse deposit: essentially conglomerate, sandstone and shale
MIDDLE MIOCENE		Diorite & related porphyries	
LOWER MIOCENE		Torrijos F.	Andesite to basalt flows and agglomerate with minor intercalated clastics; includes reefal lenses intercalated with the volcanics
OLIGOCENE		San Antonio F.	Essentially andesitic flows with minor intercalated wackes
EOCENE		Talantunan-Tumicob F.	Volcanic wackes, shale and fine turbidites with intercalated limestone and minor dacite/ andesite flows
CRITTACEOUS		Serpentinite	

Geologic Structures

- High Angle Fault
- Thrust Fault
- Selected site

THE INTEGRATED AGRICULTURAL DEVELOPMENT PROJECT IN MARINDUQUE

Figure D-1-1
Geological Map

D-2 Seismicity

The historical seismic data of Southern Luzon indicates that Marinduque is located within an area of a low level of seismic activity as no significant earthquake with a magnitude greater than five (5) has been recorded within a 50 km radius from the island.

D-3 Hydrogeology

D-3-1 Classification of Groundwater Areas

For planning purposes, Marinduque is divided into three groundwater zones: shallow well areas, where wells with depths not greater than 20 m are recommended and the static water levels are generally within six meters below ground surface; deep well areas, where wells with depths greater than 20 m are recommended and the static water levels usually exceeding six meters below ground surface; and, difficult areas, where groundwater depths vary considerably and about 25% of such areas may yield non-productive wells.

In terms of aerial extent, deep well areas comprise the largest, occupying about 50% of the total land area followed by difficult areas which occupy about 40% of the total land area. The remainings constitute the shallow well areas. (refer to Figure D-3-1)

D-3-2 Hydrogeological Conditions

The Quaternary alluvium is the major hydrologic unit in the shallow well areas. It consists of the unconsolidated deposit of clay, silt, sand and gravel and underlies the floodplains and coastal plains in the western and northeastern parts of the island. Lithologic logs of wells drilled into the alluvium indicate the preponderance of clay materials at or near the surface overlying sand/gravel layers at

different levels. Shallow aquifers consisting of sand, gravel or its admixtures of varying proportions, generally occur at depths of ten meters or more with thickness ranging from two to ten meters. In places where the thickness of alluvium exceeds 50 m as in Boac and Mogpog, there exist deepwater aquifers at depths of more than 20 m with thickness varying from 10 to about 30 m. Some of the wells drilled into these aquifers are weakly to moderately flowing at the rate of 0.75 to 2.2 lit/sec which indicate that semi-confined to weak artesian conditions exist where clay layers are thicker and more extensive. Although deep aquifers occur at the shallow well areas, the development of shallow wells deserves higher priority due to its less susceptibility to salt water intrusion.

Deep well areas are underlain mainly by sedimentary rock formations. These are usually located in areas with slopes reaching up to 10% and commonly at elevations of more than 50 m above mean sea level. Rock types that are included in this zone belong to formations ranging in age from Eocene to Pleistocene with better aquifers probably occurring in the Pleistocene Boac formation and the Upper Miocene Porvado formation.

Except for the Boac formation, very few wells, if any, have been drilled into the other rock formations. Examination of the lithologic logs of wells revealed that sandstone and conglomerate are the major sources of water drilled in to the Boac formation. These rocks are poorly consolidated and loosely cemented; occurs generally at depths of more than 40 m; and, underlie the alluvium in the coastal and floodplains of the western part of Marinduque. A number of wells have been bottomed in the conglomerate which has usually been partially penetrated for more than 10 m. The Bureau of Mines and Geosciences has estimated the thickness of Boac formation to be about 400 m.

Difficult areas have varying slopes, elevations and water depths. These areas are underlain by rock formations consisting essentially of well indurated volcanic rocks which have almost zero permeabilities or