JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

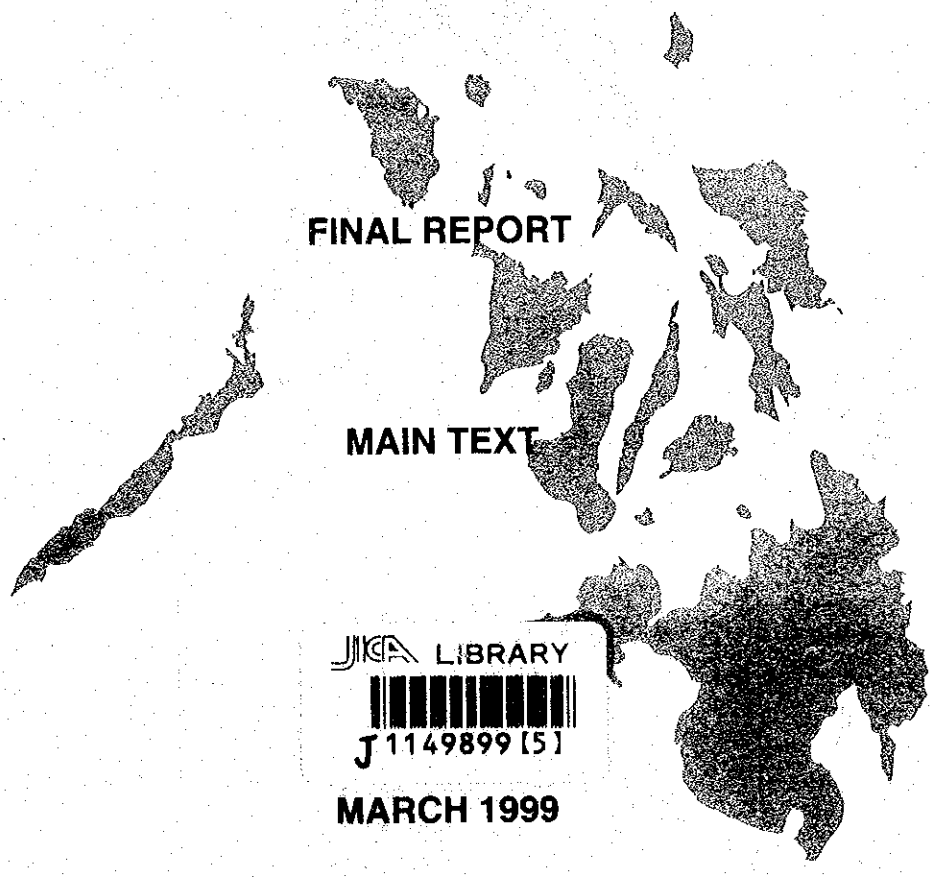
REPUBLIC OF THE PHILIPPINES

社会開発調査部報告書

MASTER PLAN STUDY

ON

VISAYAS AND MINDANAO ISLANDS STRATEGIC ROAD NETWORK DEVELOPMENT PROJECT



FINAL REPORT

MAIN TEXT

MARCH 1999

KATAHIRA & ENGINEERS INTERNATIONAL

YACHIYO ENGINEERING CO., LTD.

EXCHANGE RATE

October 30, 1998
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PREFACE

In response to a request from the Government of the Republic of the Philippines, the Government of Japan decided to conduct the Master Plan Study on Visayas and Mindanao Islands Strategic Road Network Development Project and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Kunihiko Sawano of Katahira & Engineers International, and consisting of Katahira & Engineers International and Yachiyo Engineering Co., Ltd. to the Philippines, three times between February 1997 and February 1999.

The team held discussions with the officials concerned of the Government of the Philippines and conducted field surveys in the study area. Upon returning to Japan, the team conducted further studies and prepared the present report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Philippines for their close cooperation extended to the study team.

March 1999

Kimio Fujita
President
Japan International Cooperation Agency

March 1999

Mr. Kimio Fujita
President,
Japan International Cooperation Agency

Letter of Transmittal

Dear Sir,

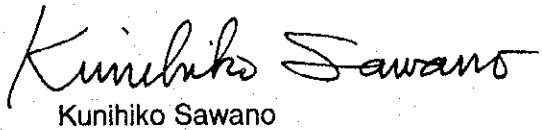
We are pleased to submit to you the Final Report of the Master Plan Study on Visayas and Mindanao Islands Strategic Road Network Development Project in the Republic of the Philippines. The report reflects the advice and suggestions of the authorities concerned of the Government of Japan and your Agency.

This report presents a master plan for major roads network development in Visayas and Mindanao Islands to support the balanced regional development in the islands. The master plan consists of 109 road projects. Taking into account the priority of the projects and the possible investment amount, the implementation schedule was developed for three six-year programs and recommendations to facilitate the implementation were made.

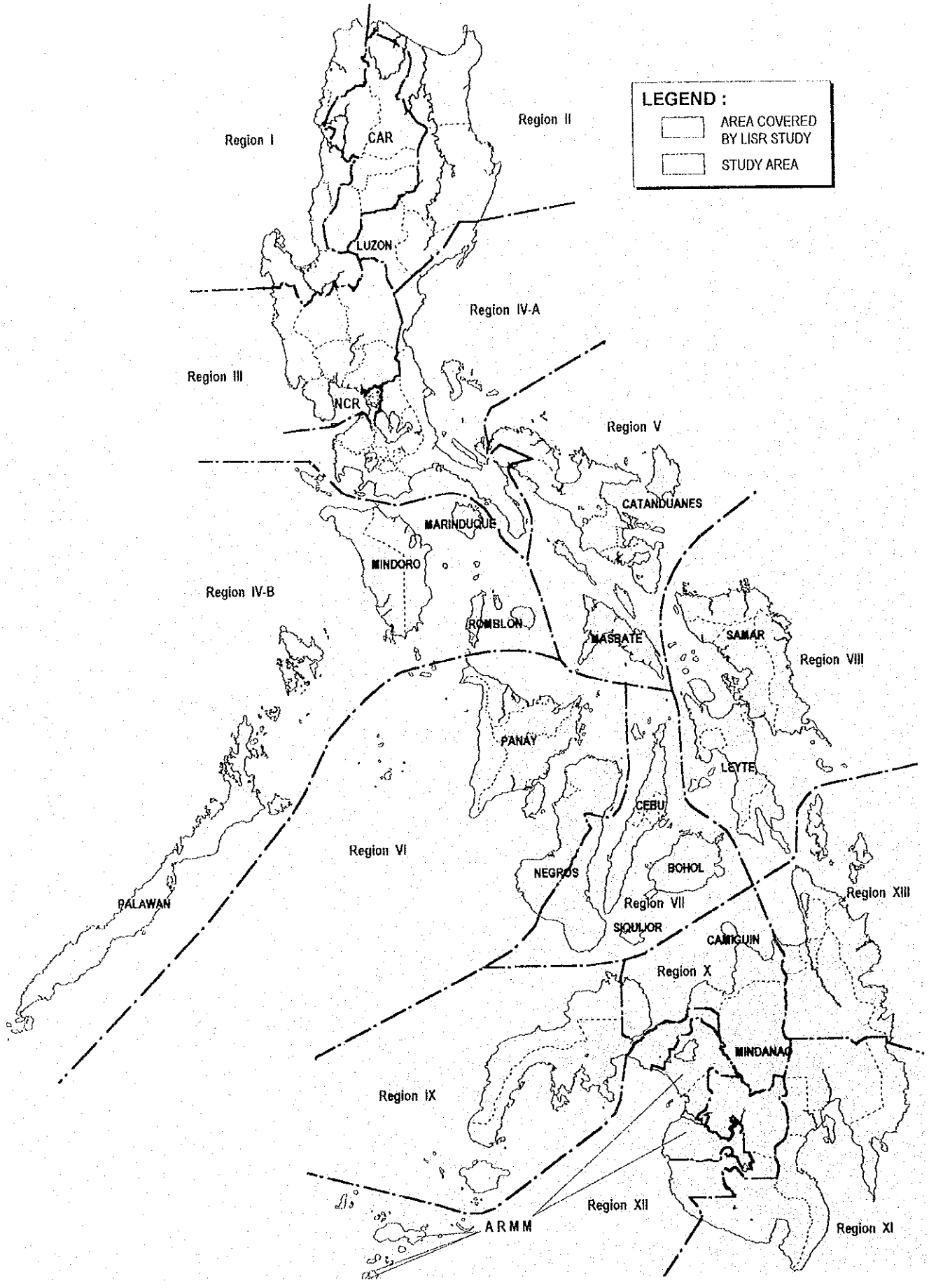
In view of the urgency of developing the strategic road network and the need for socio-economic development in Visayas and Mindanao Islands, we recommend that the Government of the Philippines realize this plan with high priority.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs and the Ministry of Construction of Japan. We also wish to express our deep gratitude to the Department of Public Works and Highways and other authorities concerned of the Government of the Philippines for the close cooperation and assistance extended to us during the course of the Study.

Very truly yours,

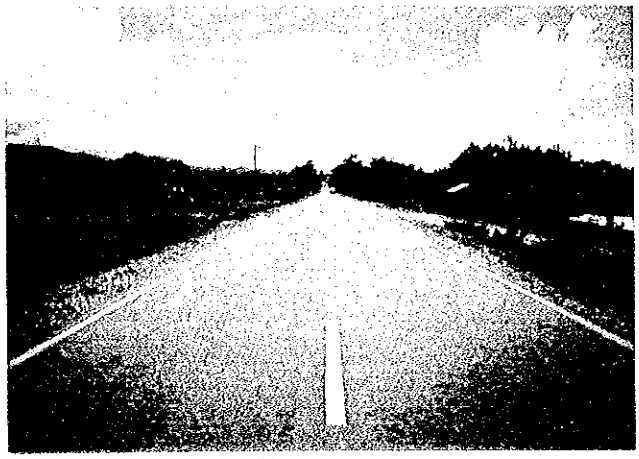


Kunihiko Sawano
Team Leader,
The Study Team for Master Plan Study
on Visayas and Mindanao Islands
Strategic Road Network Development Project



LOCATION MAP OF STUDY AREA

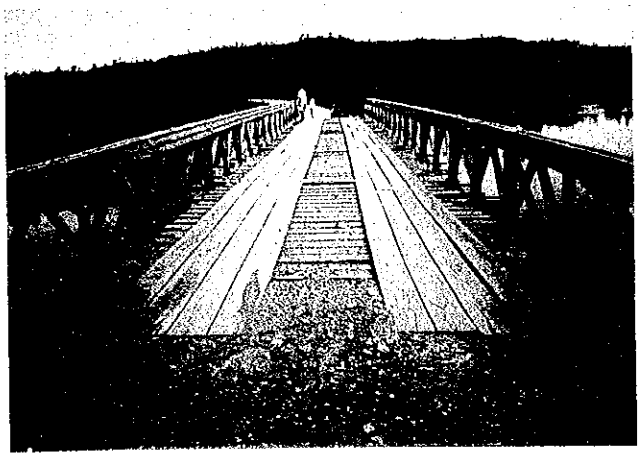
PCC Pavement in good condition
Bontoc – Sogod Road, Southern Leyte



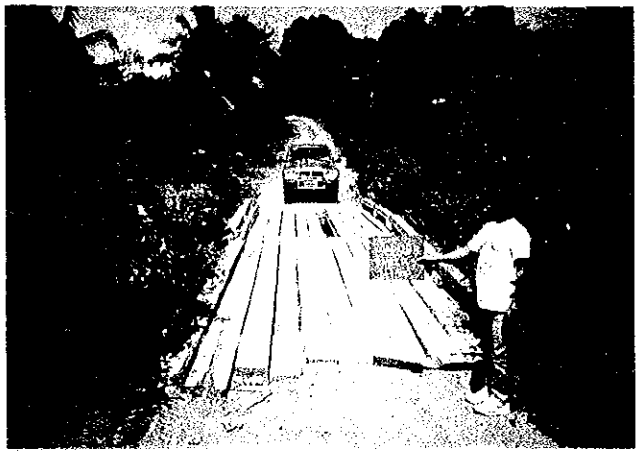
AC Pavement in good condition
Sindagan - Leon Postigo(Bacungan) Road, Zamboanga del Sur

Gravel road in fair condition
Surallah – Lake Sebu – Matium Road, South Cotabato

Earth road in bad condition
Leon - Bucari Road, Iloilo



Bailey Bridge
Surigao Davao Coastal Road, Surigao del Sur



Timber Bridge
Quezon - J.P. Rizal Road, Palawan

RC Bridge
Midsayap – Dulawan –Tacurong Road, Maguindanao

Spillway
Sagay - Balea Road, Negros Occidental

FINAL REPORT

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ABBREVIATIONS

AADT	:	Annual Average Daily Traffic
AASHTO	:	American Association of State Highway and Transportation Officials
AC	:	Asphalt Concrete
ACEL	:	Associated Construction Equipment Lessors, Inc.
ADB	:	Asian Development Bank
ADT	:	Average Daily Traffic
ALMED	:	Agricultural Land Management and Evaluation Division
ARMM	:	Autonomous Region for Muslim Mindanao
AWP	:	Annual Work Program
BAS	:	Bureau of Agricultural Statistics
B/C	:	Benefit/Cost Ratio
BOE	:	Bureau of Equipment
BOM	:	Bureau of Maintenance
BRP	:	Better Roads Philippines
BSWM	:	Bureau of Soils and Water Management
CARP	:	Comprehensive Agrarian Reform Program
CDSCF	:	Crop Development and Soil Conservation Framework
CEO	:	City Engineering Office
DEO	:	District Engineering Office
DENR	:	Department of Environment and Natural Resources
DPWH	:	Department of Public Works and Highways
ECA	:	Environmentally Critical Area
ECC	:	Environmental Compliance Certificate
ECP	:	Environmentally Critical Project
EIA	:	Environmental Impact Assessment
EIRR	:	Economic Internal Rate of Return
EIS	:	Environmental Impact Statement
EMB	:	Environmental Management Bureau
EMK	:	Equivalent Maintenance Kilometer
EO	:	Executive Order
FIRR	:	Financial Internal Rate of Return
GDP	:	Gross Domestic Product
GNP	:	Gross National Product
GOJ	:	Government of Japan
GOP	:	Government of the Philippines
GRDP	:	Gross Regional Domestic Product
GVA	:	Gross Value Added
HCM	:	Highway Capacity Manual
IACEP	:	Inter-Agency Committee on Environmental Protection
IBRD	:	International Bank for Reconstruction and Development
IEE	:	Initial Environmental Examination
IRI	:	International Roughness Index
IRF	:	Immediate Response Fund
JICA	:	Japan International Cooperation Agency
LOI	:	Letter of Instruction
LTO	:	Land Transportation Office
MBA	:	Maintenance by Administration

MBC	:	Maintenance by Contract
MEDCO	:	Mindanao Economic and Development Council
MIMAROPA	:	Mindro, Marinduque, Romblon and Palawan
MTPDP	:	Medium Term Philippine Development Plan
MTPIP	:	Medium Term Public Investment Program
NCR	:	National Capital Region
NCSO	:	National Census and Statistical Office
NEDA	:	National Economic and Development Authority
NEPC	:	National Environmental Protection Council
NIA	:	National Irrigation Administration
NPAA	:	Network of Protected Areas for Agriculture
NPV	:	Net Present Value
NSCB	:	National Statistical Coordination Board
NSO	:	National Statistics Office
NTCP	:	National Traffic Count Program
OD	:	Origin-Destination
OECF	:	Overseas Economic Cooperation Fund
PAGASA	:	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PAR	:	Philippine Area of Responsibility
PB	:	Performance Budget
PCC	:	Portland Cement Concrete
PCU	:	Passenger Car Unit
P.D.	:	Presidential Decree
PHIVOLCS	:	Philippine Institute of Volcanology and Seismology
PHMMS	:	Philippine Highway Maintenance Management System
PMO	:	Project Management Office
PMO-BOT	:	Project Management Office – Build-Operate-Transfer
PMO-F/S	:	Project Management Office – Feasibility Studies
PPA	:	Philippine Port Authority
PPP	:	Philippine Population Projection
RAIC	:	Regional Agro-Industrial Center
RDC	:	Regional Development Council
RIC	:	Regional Industrial Center
RIMSS	:	Road Information and Management Support System
ROW	:	Right-of-Way
SPCPD	:	Southern Philippines Council for Peace and Development
VOC	:	Vehicle Operating Cost

INTRODUCTION

INTRODUCTION

BACKGROUND OF THE STUDY

The Government of the Republic of the Philippines (GOP) has set the road development program in its Medium Term Development Plan (1993 – 1998) that includes the upgrading of 3,096 km of national roads to all-weather roads and paving of 5,187 km of national roads. However, the development level of major road network in the country is still far behind its targeted level. The development level in terms of road density and paved road ratio of major road network in Visayas and Mindanao area is further lag behind the road network in Luzon island.

The long term systematic road development plan has been studied only in late 1960s under the Philippine Transport Survey (PTS). No other master plan studies have been carried out except the Master Plan Study on Luzon Island Strategic Road Network Development Project in 1993 by Japan International Cooperation Agency (JICA).

With this view, GOP through the Development of Public Works and Highways (DPWH) sought a technical assistance from the Government of Japan (GOJ) for the conduct of the Study. In response to the request of GOP, GOJ has decided to conduct the Master Plan Study on Visayas and Mindanao Islands Strategic Road Network Development Project (hereinafter referred to as "the Study"). JICA, which is the official agency responsible for the implementation of GOJ technical cooperation programs, has organized and dispatched a Study Team for the Study in accordance with the Implementing Arrangement signed on September 4, 1996 between DPWH and the JICA Preparatory Study Team.

The JICA Study Team in close collaboration with the DPWH Counterpart Team commenced the Study in January 1997 and completed it in March 1999.

With completion of the Study, the strategic road network development plan covering the entire Philippine archipelago will be all set for implementation to achieve the promotion of regional economy and industrialization of the country.

OBJECTIVES OF THE STUDY

The objectives of the Study are:

- To formulate a master plan for Visayas and Mindanao Island Strategic Road Network Development
- To prepare short, medium and long term implementation programs consistent with said master plan

STUDY AREA

The Study area covers the following islands:

Mindoro, Palawan, Romblon, Marinduque, Catanduanes, Masbate, Panay, Guimaras, Negros, Cebu, Bohol, Siquijor, Samar, Leyte, Biliran, Camiguin and Mindanao Islands.

SCOPE OF THE STUDY

In order to achieve the objectives mentioned in 1.3 above, the Study shall cover the following items:

- Pre-study in Japan
- Discussion on Inception Report
- Collection and review of relevant information
- Road condition survey
- Traffic survey
- Preparation of present OD matrix
- Transport facilities survey
- Road disaster survey
- Environmental survey
- Road maintenance system survey
- Socio-economic survey
- Forecast of socio-economic framework
- Preparation of base map
- Preparation of Progress Report
- Evaluation of the present road network
- Traffic demand forecast
- Estimation of possible investment amount
- Establishment of basic concept for road network development
- Formulation of strategic road network
- Preparation of Interim Report
- Workshop in Interim Report
- Preparation of project list
- Standard design
- Estimation of project cost
- Initial environmental impact assessment
- Economic and financial analysis
- Project Evaluation
- Establishment of strategic road network development plan
- Evaluation of strategic road network development plan
- Recommendation on road maintenance system
- Recommendation on fund sources
- Preparation of master plan map
- Development of database and its operation manual
- Overall evaluation and recommendation
- Preparation of Draft Final Report
- Workshop on Draft Final Report
- Preparation of Final Report

STUDY SCHEDULE

Table-1 presents the work schedule of the Study, which commenced in January 1997 and completed in March 1999. The study flow diagram is presented in Figure-1.

ORGANIZATION FOR EXECUTING THE STUDY

JICA organized a Study Team to carry out the Study and an Advisory Committee to review the findings of the Study, while DPWH organized a Counterpart Team to collaborate with the JICA Study Team in carrying out the Study and a Steering Committee and the DPWH Technical Working Committee to ensure smooth conduct of the Study and to review and oversee the progress of the Study. The organization chart is shown in Figure-2.

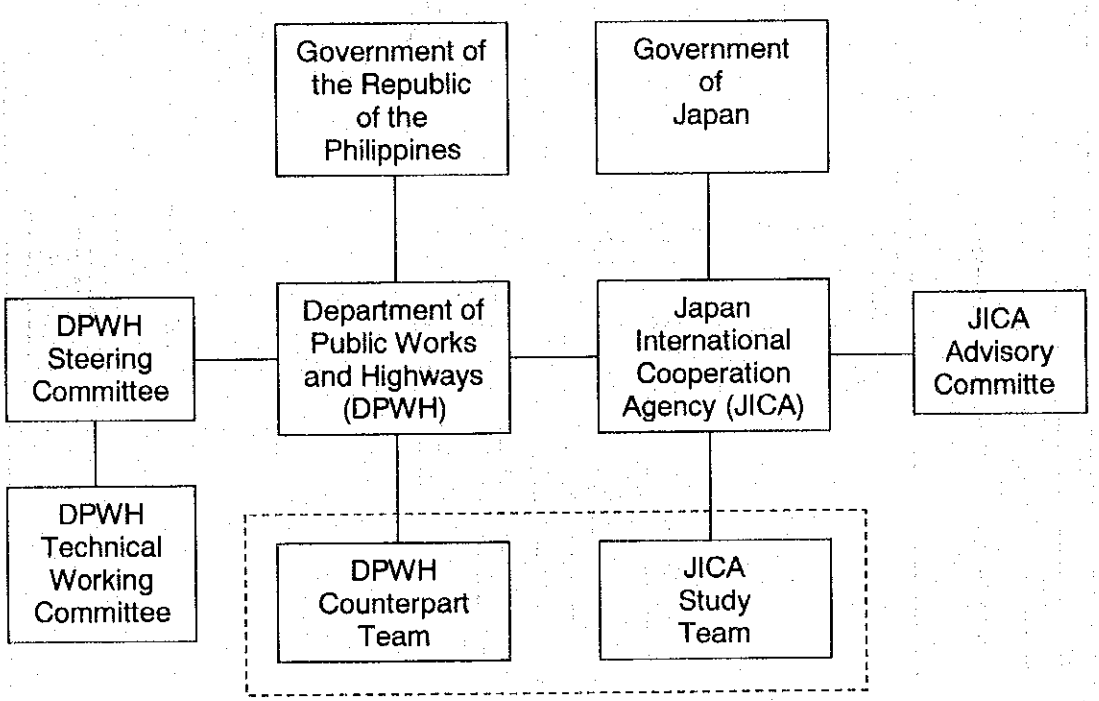
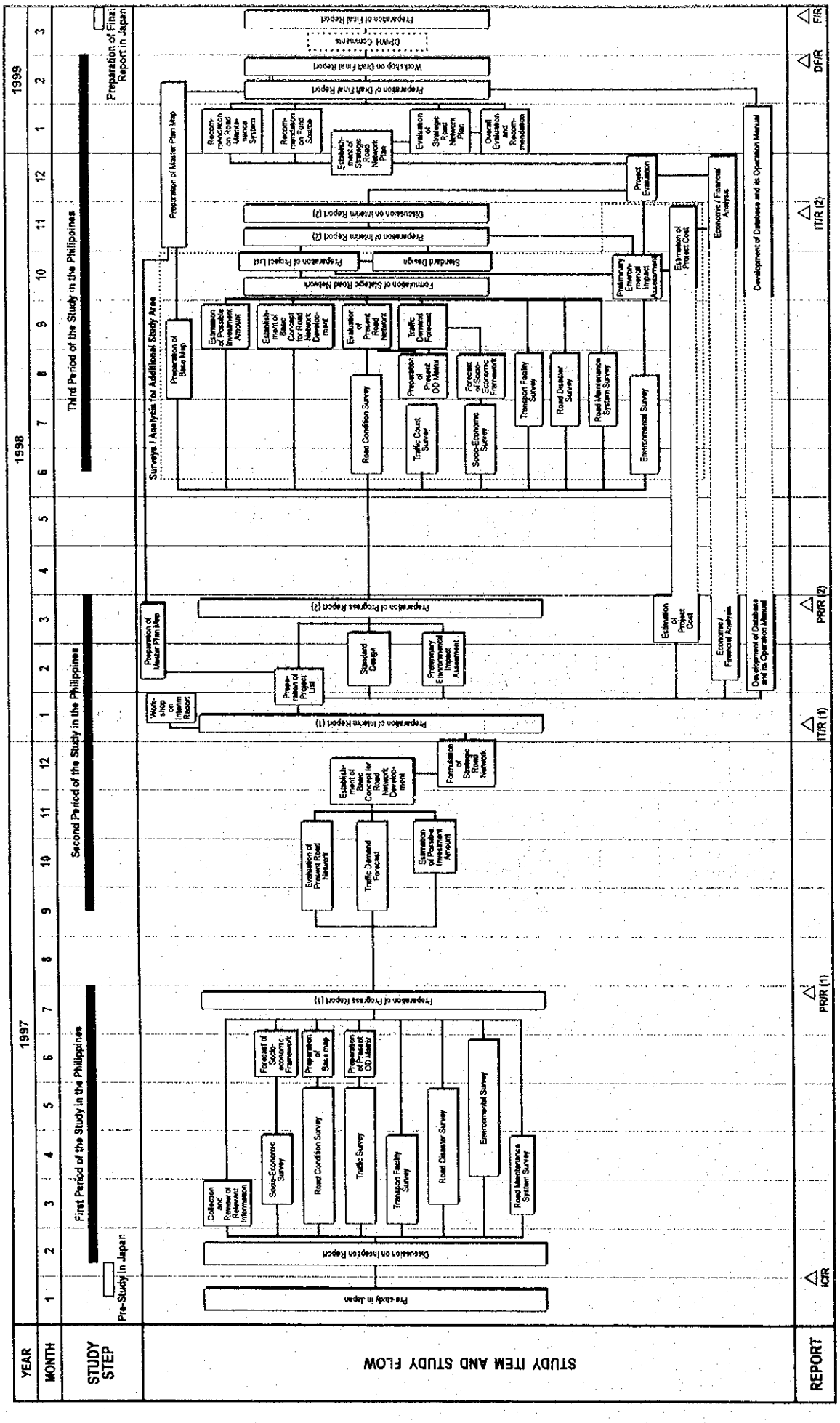


FIGURE – 2 ORGANIZATION CHART

FIGURE - 1 STUDY FLOW DIAGRAM



Members are as follows:

DPWH Steering Committee

Chairman	:	TEODORO T. ENCARNACION Undersecretary
Member	:	MANUEL M. BONOAN JESUS P. CAMMAYO Assistant Secretary
Member	:	LINDA TEMPLO Director, Planning Service
Member	:	JOSE P. GLORIA (January 1997 – April 1997) GERONIMO S. ALONZO (May 1997 – February 1999) Project Manager, PMO-FS
Member	:	TAKAAKI KUSAKABE (January 1997 – June 1998) SEIICHI ONODERA (July 1998 – February 1999) JICA Highway Adviser

DPWH Technical Working Committee

Chairperson	:	LINDA TEMPLO Director, Planning Service
Vice-Chairman	:	JOSE P. GLORIA GERONIMO S. ALONZO Project Manager, PMO-FS
Member	:	REBECCA T. GARSUTA Chief, DPD, Planning Service
Member	:	FAUSTINO STA. MARIA, JR. PMO-FS
Member	:	MERLINDA ALCARAZ DPD, Planning Service
Member	:	SOLITA V. GENOTA IPRSD, Planning Service
Member	:	TAKAAKI KUSAKABE SEIICHI ONODERA JICA Highway Adviser
Secretariat	:	MARITES V. REYES IPRSD, Planning Service CRISTY GAA DPD, Planning Service

JICA Advisory Committee

Chairman	:	MINOBU MORIKAWA (January 1997 – August 1998) KOZO FUJISHITA (September 1998 – February 1999)
Road Planning	:	KIYOHISA KONDO
Coordinator	:	HIROYUKI KANZAKI (January 1997 – April 1997) KOICHI KITO (May 1997 – February 1999)

DPWH Counterpart Team

Project Coordinator/Sr. Traffic Engineer	FAUSTINO STA. MARIA, JR.
Highway Planner	EPHRAIM CAPUCAO
	CARMELINO TIZON
Regional Planner	VICTORIA CORPUZ
Highway Engineer	MARIETTA VELASCO
Structural Engineer	MARINO AMORES
Maintenance Engineer	MAXIMO MONTANA II
Disaster Prevention Engineer	EDMUNDO MANGAOIL
Traffic Engineer	CESARIO VICENTE
General Economist	BELLA RESURRECCION
Systems Analyst	ALVIN MADRID
Environmental Specialist	ROMEO LESCANO
Highway Engineer	ELIZABETH LLANERA
Highway Engineer	SHIRLEY CASTRO
Highway Engineer	GILES MIRANDA
Highway Engineer	ANGELITA LUZ
Economist	REBECCA TENIOZO
Economist	JOEL VILORIA
Economist	GLORIA MALINIT
Economist Researcher	JOSEPHINE GUMBOC
Economist Researcher	LILIA NAUNGAYAN
Data Controller	ANICETA CABANOS
Statistician	MARILYN SAGALA
GIS Operator	RENE TENIOZO
AUTO-CADD Operator	AGUSTIN TALAY, JR.
Administrative Assistant	ELENITA DELOS SANTOS
Budget Officer	MA. LOURDES SANTOS
Secretary/Word Processor	ADELAIDA GALAGATA
Secretary	CLEOFE DAVID
Word Processor	JASMIN FIGUERAS
Draftsman	ELIZABETH ASUNCION
Draftsman	VALENTINO BUENABAJO
Duplicating Machine Operator	JUANITO MANZANO

JICA Study Team

Team Leader/Highway Planner	KUNIHIKO SAWANO
Regional Planner	NAOYUKI MINAMI
Transport Planner	TAKAO MITSUISHI
Deputy Team Leader/ Highway & Structural Engineer	MITSUO HATAKEYAMA
Disaster Prevention Engineer	KOUZOU FUJII
Traffic Engineer	KEIJI AOKI
Transport Economist	TETSUO WAKUI
System Analyst	SHUICHI YASHIRO
Environmental Engineer	KANJI WATANABE
Construction Engineer/ Cost Estimator	KAZUFUMI HOMA

REPORTS

Following reports were prepared during the study:

- Inception Report (January 1997)
- Progress Report I (July 1997)
- Interim Report I (January 1998)
- Progress Report II (March 1998)
- Interim Report II (November 1998)
- Draft Final Report (February 1999)

The Final Report is organized with the following:

- EXECUTIVE SUMMARY
- MAIN TEXT
- APPENDIX
- DATABASE MANUAL
- MASTER PLAN MAPS

PART I

PRESENT CONDITION OF THE STUDY AREA

CHAPTER 1

PHYSICAL PROFILE OF STUDY AREA

1.1 TOPOGRAPHY

The Philippines is an archipelago of 7,100 islands with a total land area of 300,000 square kilometers. It lies 966 kilometers off the southern coast of Asia, between latitude 4°23'N to 21°25'N and between longitude 116°E to 127°E. The archipelago is divided into three (3) major island groups: Luzon, with an area of 138,703 square kilometers; Visayas, with an area of 56,607 square kilometers and Mindanao, with an area of 102,003 square kilometers. The study area includes 19 islands and their land areas are shown in Table 1.1-1.

TABLE 1.1-1 LAND AREA BY ISLAND IN THE STUDY AREA

Region	Name of Island	Land Area (sq.km)
IV-B	Marinduque	959.2
	Mindoro	10,244.7
	Palawan	14,896.3
	Romblon (including Tablas and Sibuyan)	1,355.9
V	Masbate	4,047.7
	Catanduanes	1,511.5
VI	Panay	11,692.5
	Guimaras	604.6
VI/VII	Negros	13,328.4
VII	Bohol	4,117.3
	Cebu	5,088.4
	Siquijor	343.5
VIII	Biliran	523.8
	Leyte	7,479.3
	Samar	13,428.7
X	Camiguin	229.8
IX, X, XI, XII, XIII, ARMM	Mindanao (Study Area)	97,758.1
Study Area Total		187,609.7
Outside Study Area		
	Luzon	105,687.5
	Mindanao (Basilan, Sulu, Tawi-Tawi)	4,015.0
Total		**300,000.0**

Source: National Statistics Office

The geographical and topographical map is presented in Figure 1.1-1. Topographic features of the islands are as follows:

Marinduque Island is a round shape island. Most areas are mountainous with an elevation ranging from 100 to 800 meters from the sea level. The island has a few flat areas.

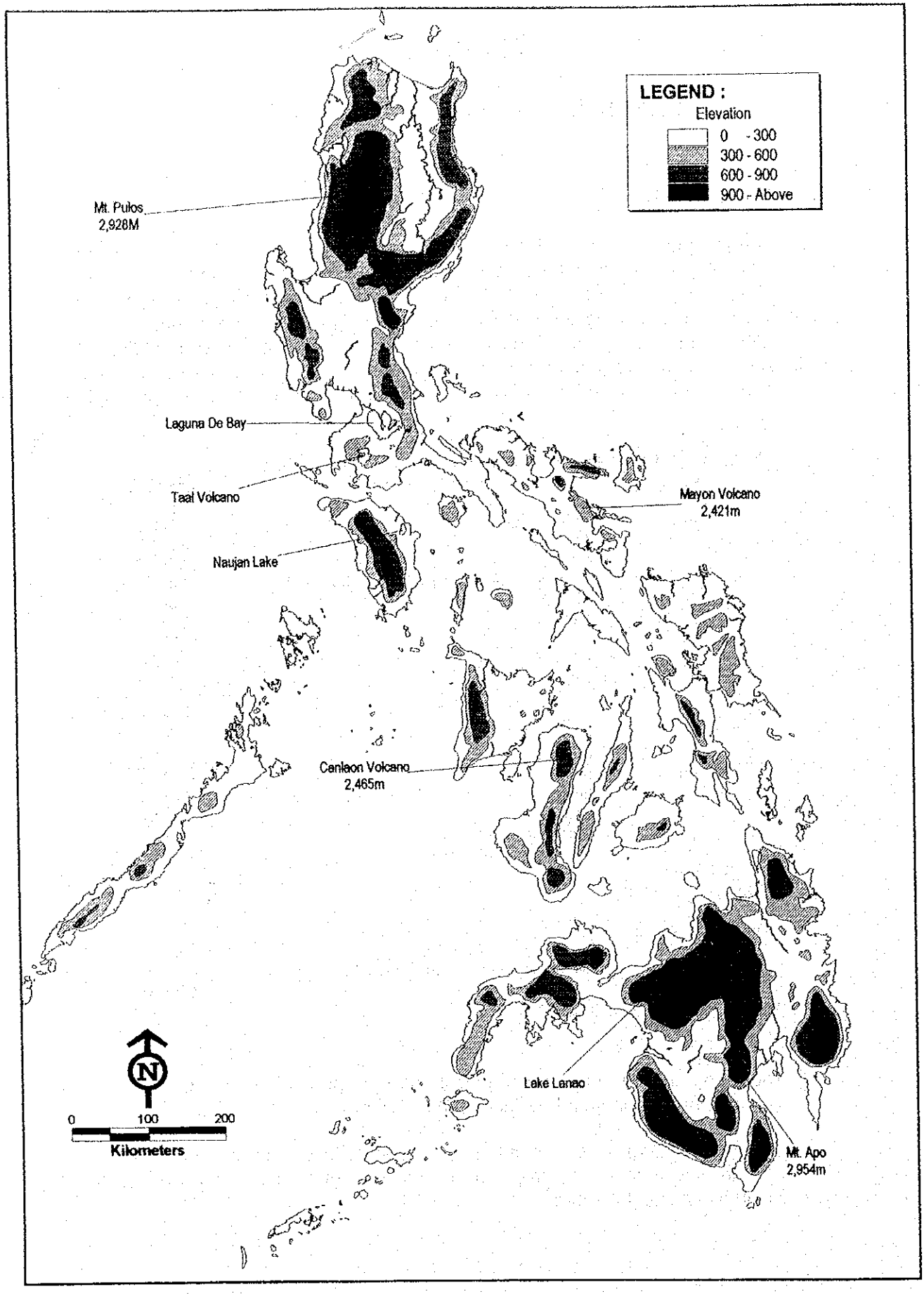


FIGURE 1.1-1 GEOGRAPHICAL AND TOPOGRAPHICAL MAP

Mindoro Island is topographically divided into two areas by mountain ranges running north-south direction at the center of the Island. Mt. Halcon (elevation is 2,505 meters) and Mt. Baco (elevation is 2,488 meters) are the two high mountains in the range.

There are wide flat plains in the east and the west areas of the island where some soft ground areas and swampy areas exist. In the western areas, rivers have been changing their courses and old traces of previous river courses are observed at various locations.

Tablas Island is a small island and extends in the north-south direction with narrow width. Along the eastern coast, a mountain range runs from the north to the south. Flat plains exist only in the western area.

Romblon Island is a small round shaped island. A mountain range running north to south at the center divides the island into two areas. Few flat plain is observed in the Island.

Sibuyan Island is a round shaped island and extensively mountainous. Few flat area is observed in the Island.

Palawan Island is a long and narrow island extending in the northeast-southwest direction. A mountain range at the center of island extends in the same direction as the Island with high mountain peaks of Mt. Gantung (1,780m) and Mt. Mantalingajan (2,085m). Flat lands developed mostly along the east coast, particularly at around the municipality town of Roxas, Puerto Princesa City, the municipality towns of Nara, Aboabo and Rio Tuba.

Masbate Island is like an inverse V shaped island and composed of mainly flat lands. At the central portion of the Island, there are mountainous areas, of which the highest peak is at the elevation of 769 meters.

Catanduanes Island is separated from the Luzon mainland by shallow Maqueda Channel and Lagonoy Gulf, while the east side is open to the Pacific. The island forms a single mountain mass, rising to 701 meters, with limited coastal plains. Apart from the river valleys followed by the Bato – Viga Road, the rough interior uplands are virtually empty and unexplored.

Panay Island is a triangle shaped island. High mountain ranges runs in the north-south direction along the west coast, of which the highest peaks are Mt. Nangtud (2,049m), Mt. Nausan (1,650m), Mt. Inaman (1,350m) and Mt. Llorene (1,344m). Vast flat lands extend in the eastern areas of the said mountain range. In the flat land areas, numerous rivers are developed. Wet lands or swampy areas are located along the northern coast line.

Guimaras Island is located very close to Panay Island. The land is mostly rolling and flat terrain.

Negros Island is topographically divided into two areas by a high mountain range running in the north-south direction and located in the eastern area of the Island. Mt. Mandalagan (1,879m), Canlaon Volcano (2,465m), Mt. Cuemos de Negros (1903m), etc. are the high mountain peaks constituting the said range.

Wide flat plains are developed in the western area where numerous rivers are running.

Cebu Island is a long and narrow island developed in the north-south direction. Central portion is mountainous ranging from 300 to 1,000 meters in elevation. Narrow flat areas are located around Cebu City, Toledo City and northern tip areas.

Bohol Island is an oval-shaped island. Mountains ranging from 100 to 400 meters in elevation are spotted in the east-south area and the west area as well as in the central areas. Flat lands are found in the north-east area. Swampy areas are developed along the north-east coastal area.

Siquijor Island is a small round shaped island. The whole island is mountainous.

Biliran Island is a small round shaped island closely located to Leyte Island. The whole island is mountainous.

Leyte Island is also topographically divided into two areas by a mountain range in the central portion which runs from the north to the south. High peaks are Mt. Nacolod (948m), Mt. Lunas (1,260m), Mt. Cancajanag (1,350m) and Mt. Pina (728m). Flat lands are found in the north-east area.

Samar Island is topographically divided into two areas by a mountain range located in the central portion of the Island and running in the north-south direction. Mt. Capotoan (850m) is the highest peak. Flat lands are found in the northern coastal area, north-east coastal area, south-east area and south-west area.

Camiguin Island is a volcanic island situated in the Mindanao Sea, about seven (7) km from the mainland. The rugged, hilly terrain is dominated by seven volcanoes. The island has been devastated by eruptions several times in the past. The coastline alternates between black and white sand beaches and volcanic rock.

Mindanao Island is the second largest island in the Philippines. Topographical division of Mindanao Island is presented in Figure 1.1-2. Diwata Cordillera is a slender fold mountain range that is located to the east of Agusan River and runs nearly north to south. In the range, Mt. Hilong-hilong is the highest mountain with an elevation of 1,837 meters above the sea. Diwata Cordillera was formed by the orogenic movement in Miocene period. There are faults and developed fracture zones occurred by upheavals of the land after the fold.

Agusan Valley is a long vale that is located between Bukidnon Plateau and Diwata Cordillera and extends north and south. It originates in the mountain area east of Davao Gulf, goes up north being fed by many tributaries, and empties into Butuan Bay. Davao Upland is a mountainous area lying between Mt. Apo and Agusan River. Mt. Apo is the highest peak in the Philippines with an altitude of 2,954 meters. Bukidnon Plateau was formed by volcanic activities following the third orogenic movement in late Pleistocene.

Since Mindanao Island was formed by uniting several islands, there are coastal plains and terraces formed upheavals of the land.

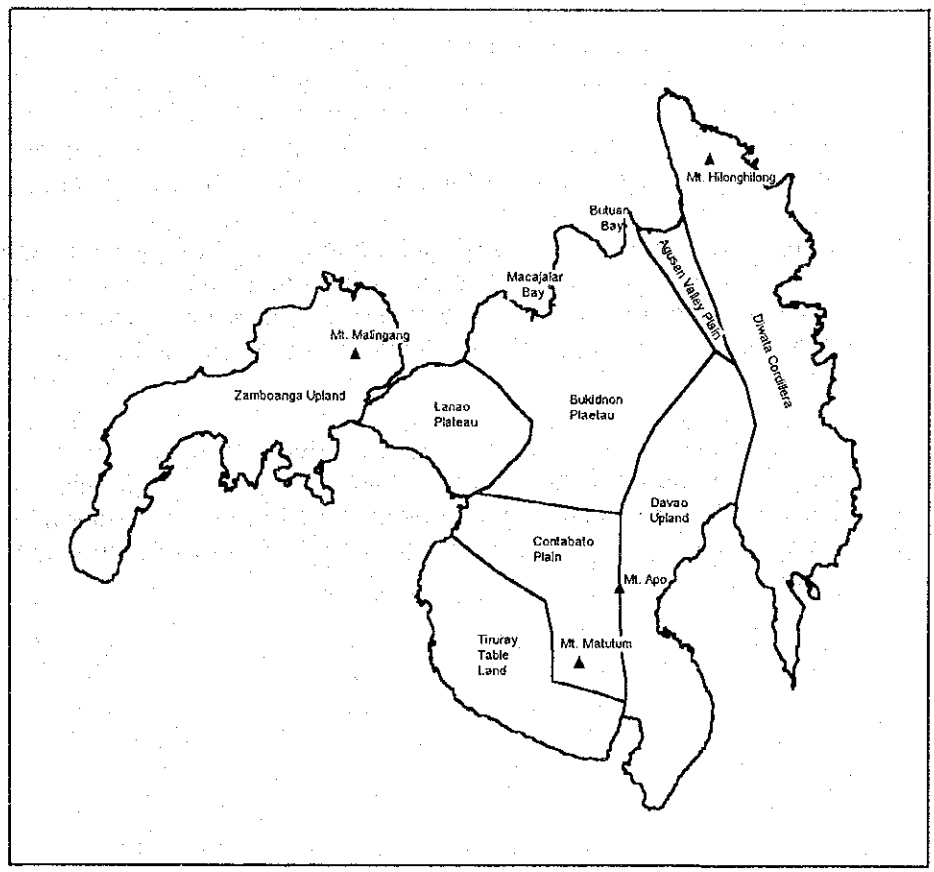


FIGURE 1.1-2 TOPOGRAPHICAL DIVISION OF MINDANAO ISLAND

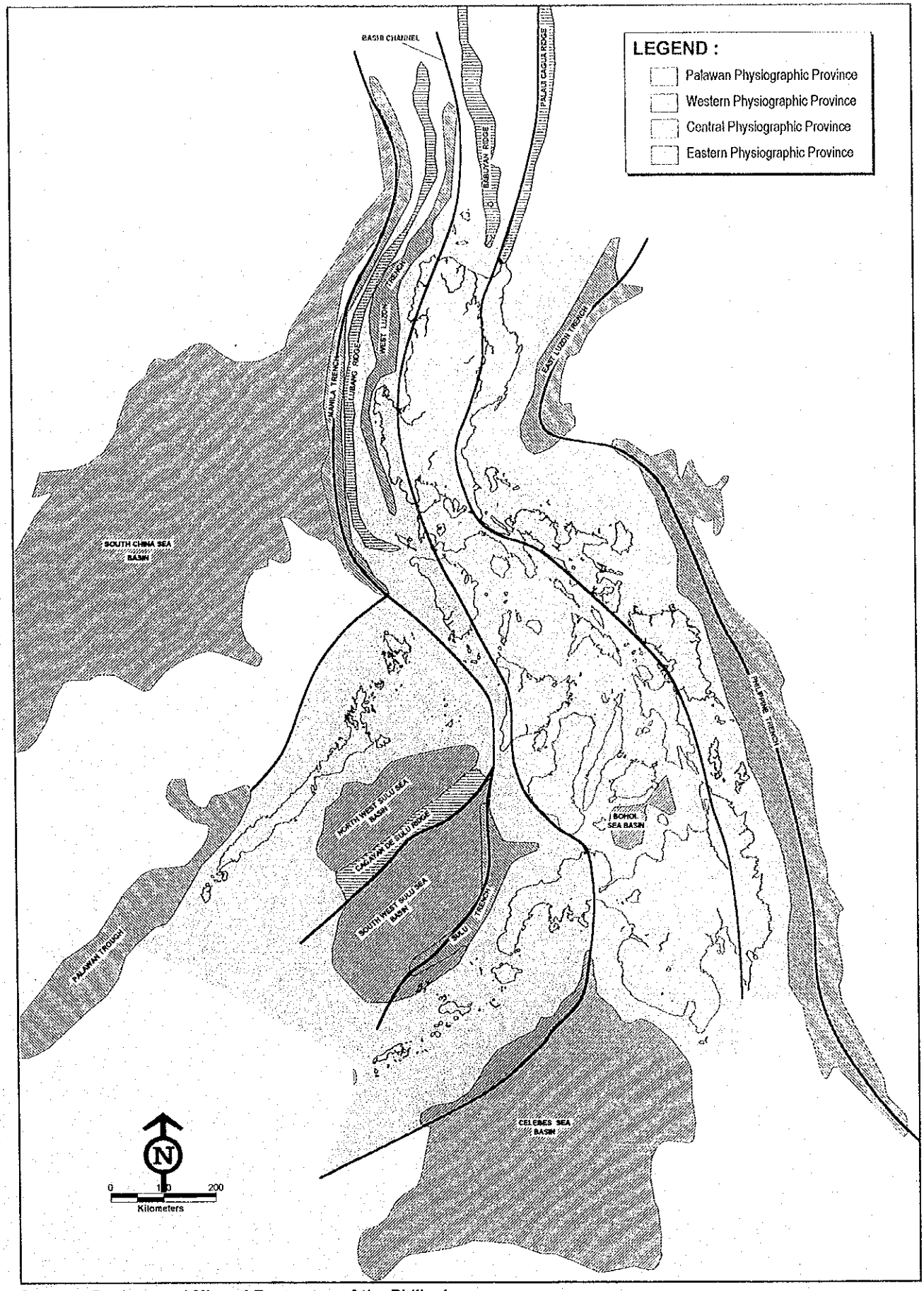
1.2 GEOLOGY

The Philippine Archipelago is located in the West Pacific Ocean where three great tectonic plates, the Eurasian Plate, Pacific Plate and Indo-Australian Plate intersect. It forms a roughly triangular area bounded by the Bashi Channel on the north, the North Luzon-Manila-Palawan Trench on the west, the Sulu-Sabah Ridge Complex and Cotabato Trench on the south, and the Philippine-East Luzon Trench on the east.

Morphologically, the Philippines may be described as a composite of linear, subparallel ridges alternating with basins and troughs following the trend of bordering trenches. The ridges are upthrusted and/or uplifted belts of ophiolite and volcano-plutonic complexes. The intervening lows are sedimentary basins and troughs exposed partly on land areas following uplift or folding. The archipelago is defined by a main arc of islands facing the Pacific and two narrower arcs projecting from its southwest flank linking it to Borneo. The main arc may be viewed as made up of convex arcs, the northern arc convex westward and the southern arc, convex eastward.

Considering both inland and submarine morphology, the Archipelago is divided into four (4) physiographic provinces, namely: 1) Palawan Physiographic Province 2) Eastern Physiographic Province; 3) Central Physiographic Province; and 4) Western Physiographic Province. (See Figure 1.2-1).

The Study Area is bounded by two deep trenches, and composed of successive ridges and traphs which are almost parallel to trenches. Geological characteristics and geologic time for each physiographical province are shown in Table 1.2-1. Geological map of the Philippines is presented in Figure 1.2-2.



Source : Geology and Mineral Resources of the Philippines

FIGURE 1.2-1 PHYSIOGRAPHIC PROVINCES OF THE PHILIPPINES

TABLE 1.2-1 SUMMARY OF PHYSIOGRAPHIC CONDITION FOR EACH PROVINCE

Physiographical Province	Physiographical Sub-Province	Geological Characteristics	Geologic Time Classification
Palawan	Northern Palawan	Under: Regionally metamorphosed Upper: Sedimentary rock, Marine deposit, terrestrial deposit.	Upper Paleozoic to Jurassic
	Central to Southern Palawan	Under: Metavolcanic rock, Metasedimentary rock. Upper: Sedimentary rock.	Cretaceous to Eocene Eocene to Middle Miocene
Western	Mindoro	Under: Metamorphic rock, Intrusive rock. Upper: Sedimentary rock.	Carboniferous to Paleogene Miocene to Pleistocene
	Zamboanga - Sulu Ridge	Metamorphosed Geosynclinal rock. Miocene sediments and volcanics. Quaternary volcanics.	Upper Paleozoic to Mesozoic Miocene Quaternary
Central	Marinduque	Under: Metamorphic rock. (Cretaceous) Upper: Volcanic rock. Sedimentary rock.	Cretaceous Eocene
	Masbate	Under: Sedimentary rock. Upper: Volcanic rock. Plutonic rock. Sedimentary rock	Pre-Cretaceous Tertiary
	Leyte	Under: Metamorphosed rock, Sedimentary rock, Volcanic rock. Upper: Marine deposit, Terrestrial deposit.	Lower-Middle Miocene Upper Miocene to Pleistocene
	Mindanao Central Cordillera	Under: Metavolcanic rock, Metasediment rock. Upper: Sedimentary rock, Volcanic rock.	Cretuceous to Paleogene Upper Miocene
	Agusan Davao Lowlands	Under: Sedimentary rock, Upper: Sedimentary rock,	Tertiary Pliocene to Pleistocene
	Cotabato Basin	Sedimentary rock	Upper Oligocene to Pleistocene
	Iloilo Basin in the Visayas	Metamorphic rock Metavolcanic rock Metasedimentary rock	Oligocene to Pleistocene Cretaceous to Lower Tertiary
	Visayan Basin Cebu	Metavolcanic rock, Metasedimentary rock, Intrusive rock.	Cretaceous to Tertiary
Eastern	Samar	Under: Metavolcanic rock, Metasedimentary rock, Intrusive rock. Upper: Volcanic rock, Sedimentary rock.	Upper Cretaceous to Paleogene Miocene to Pliocene

SOURCE: Bureau of Mines and Geo-Science, Geology and Mineral Resources of the Philippines

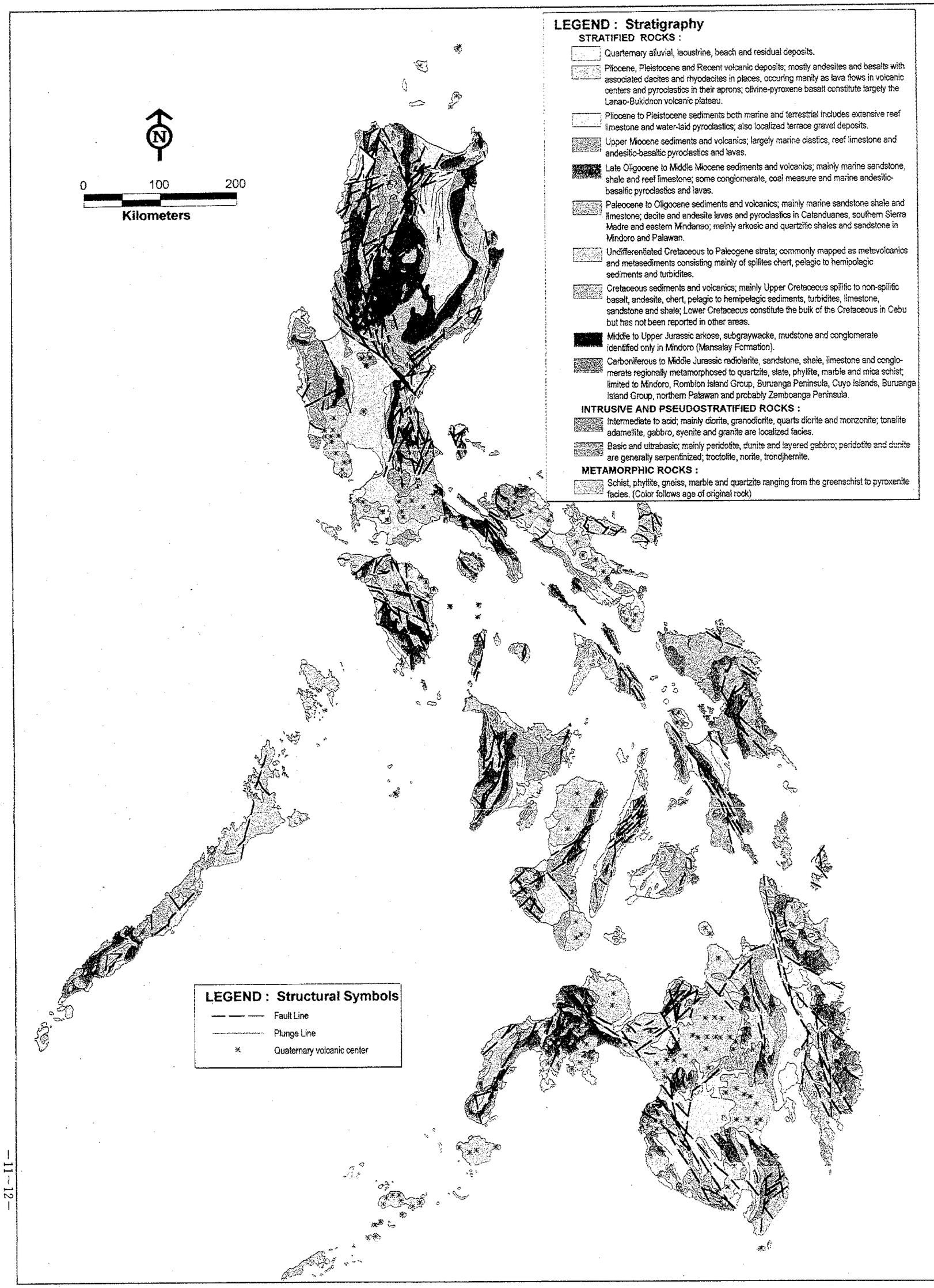


FIGURE 1.2 - 2 GEOLOGICAL MAP OF THE PHILIPPINES

1.3 METEOROLOGY

1.3.1 Climate

The climate of the Philippines is classified into four types by the Modified Corona's classification which was developed based mainly on the yearly type of rainfall distribution. The four types of climates are as follows:

Type -1 : Two pronounced seasons; dry from November to April, wet during the rest of the year. Maximum rain period is from June to September during the prevalence of southwest moonsoon. This type of climate is found in the western Mindoro, Negros, Palawan, and the southern part of Panay.

Type - 2 : There is no dry season, with a very pronounced maximum rainfall from November to January. There is no single dry month in the regions of this type. The regions having this type of climate are practically the whole of Samar; Eastern Leyte; and eastern portion of Mindanao.

Type - 3 : There is no pronounced maximum rain period, with a short dry season lasting only from one to three months. This type is intermediate between the preceding two, although it resembles to the first type more closely since it has a short dry season. Areas belong to this type of climate include northern Panay, eastern Negros, central and southern Cebu; part of central and southwestern Mindanao; and a large portion of eastern Palawan.

Type - 4 : Rainfall is more or less evenly distributed throughout the year. This type is an intermediate between the first and second types, but it resembles to the second more closely since it has no dry season. Areas with this type of climate are western Samar, Leyte, northern Cebu, the islands of Bohol, Jolo and a large portion of central and western Mindanao.

The type of climate is presented in Figure 1.3-1.

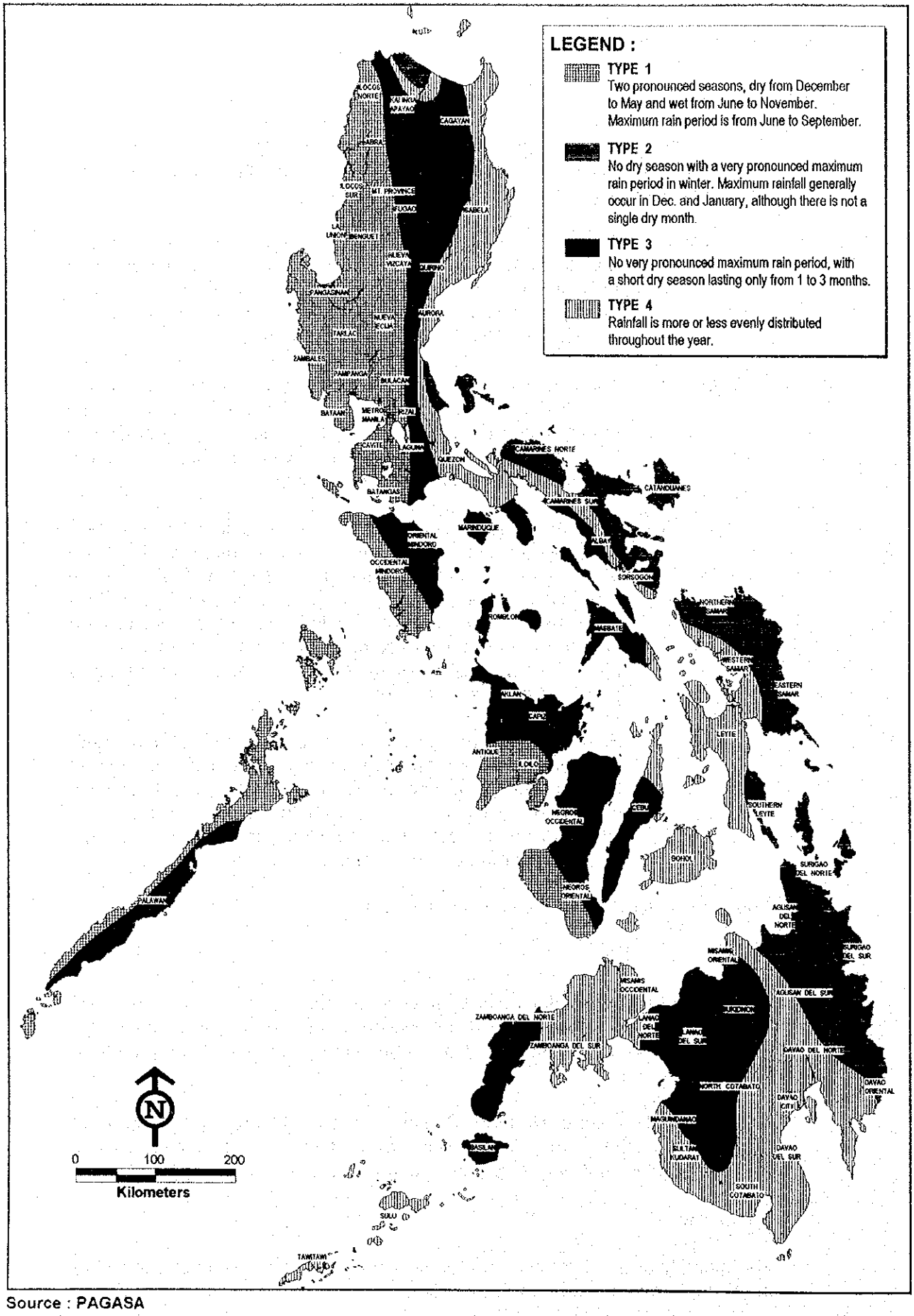
1.3.2 Rainfall

Monthly and annual rainfall records by weather stations in the Study Area are shown in Table 1.3-1, and the distribution of annual rainfall is presented in Figure 1.3-2, and the distribution of mean annual number of rainy days in Figure 1.3-3.

Annual rainfall height of Northern Samar, Surigao del Norte and Surigao del Sur exceeds 3,000 mm. Areas which exceed 500mm of monthly rainfall height are Palawan, Northern Samar, Surigao del Norte and Surigao del Sur.

1.3.3 Temperature

The monthly and annual average temperature records by weather stations in the Study Area are shown in Table 1.3-2.



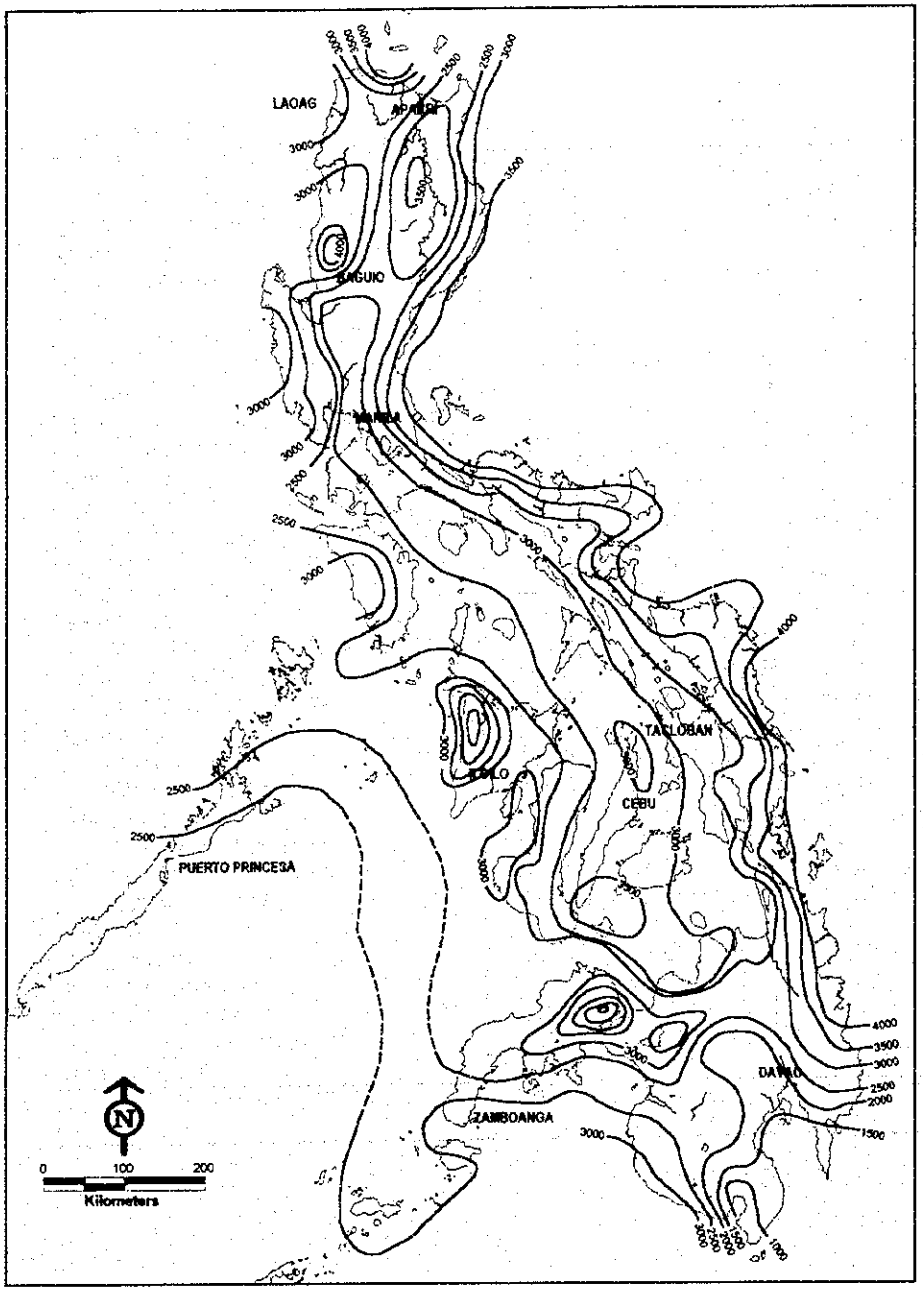
Source : PAGASA

FIGURE 1.3-1 CLIMATE MAP BASED ON MODIFIED CORONAS CLASSIFICATION

TABLE 1.3-1 MONTHLY AND ANNUAL RAINFALL (mm)

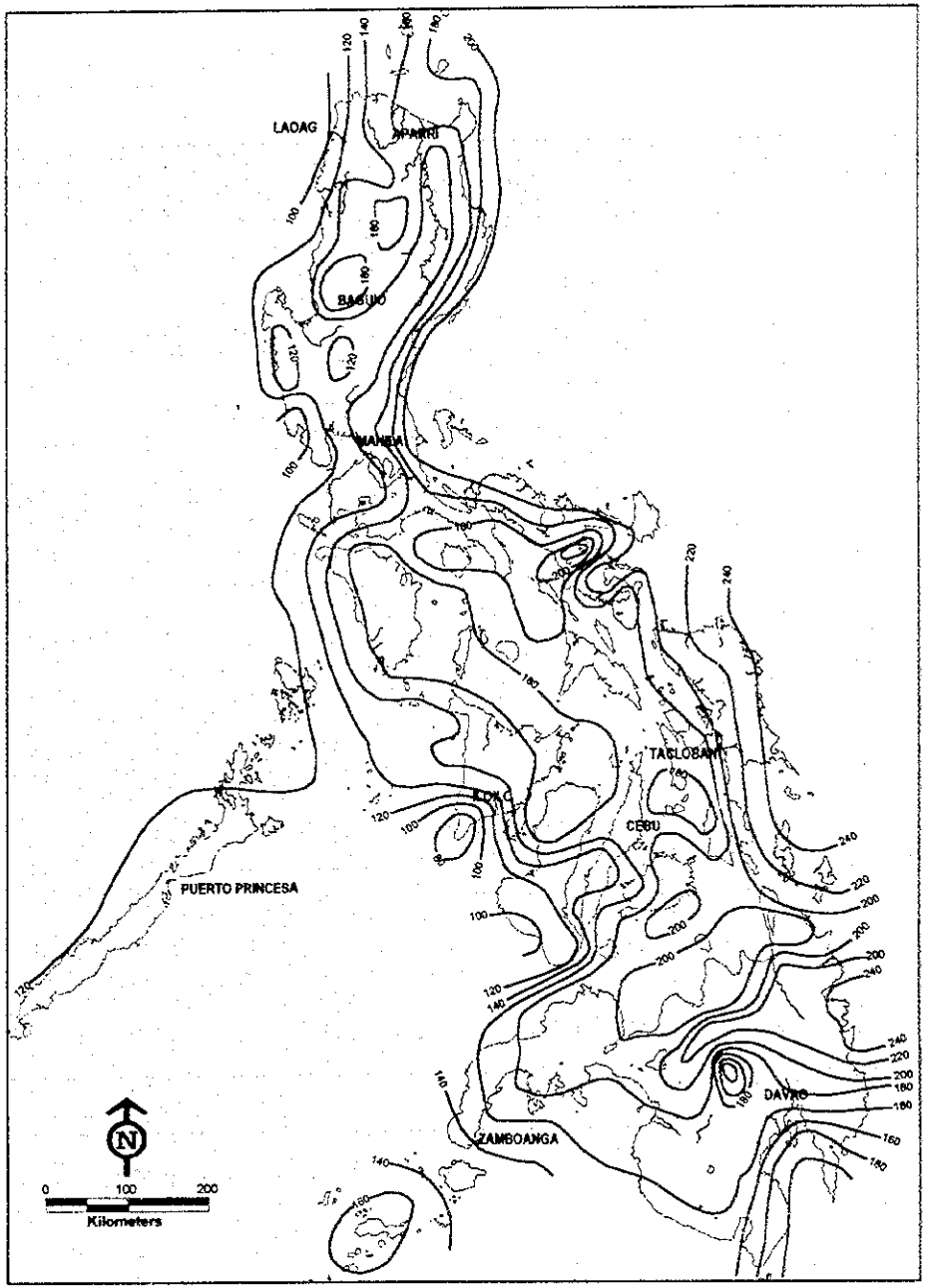
Weather Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Rainfall	Monthly Highest
Region: 4														
1. Calapan, Oriental Mindoro	85.7	48.9	55.6	94.3	157.8	191.1	221.0	191.3	214.7	301.3	245.3	192.0	1,986.8	301.3
2. Coron, Palawan	22.0	6.8	6.4	21.1	159.8	375.1	551.6	537.4	433.7	301.2	121.1	74.0	2,501.9	551.6
3. Cuyo, Palawan	8.9	0.6	5.4	37.7	184.2	380.5	433.8	430.8	372.4	297.4	132.0	44.4	2,223.1	433.8
4. Romblon	102.4	41.5	46.5	55.4	118.9	218.6	259.4	215.4	245.4	302.4	225.6	182.0	2,000.9	302.4
Region: 5														
5. Masbate, Masbate	162.2	77.4	58.9	48.7	121.5	156.3	198.5	179.4	225.1	214.7	251.3	244.8	1,929.1	251.3
6. Virac Radar, Catanduanes	347.1	198.3	145.6	160.6	168.1	262.0	250.4	167.5	250.8	402.5	536.0	560.0	3,448.8	560.0
7. Virac Synop, Catanduanes	191.7	99.3	99.9	158.4	158.4	241.7	235.1	163.5	236.0	348.3	439.5	444.9	2,766.0	444.9
Region: 6														
8. Roxas City, Aklan	96.5	39.5	46.7	51.1	124.4	244.9	264.9	230.2	230.3	297.2	242.7	147.1	2,004.7	297.2
9. Iloilo City, Iloilo	39.4	23.9	29.6	50.9	118.2	303.8	340.4	383.6	285.6	268.3	176.2	84.6	2,104.4	383.6
Region: 7														
10. Tagbilaran City, Bohol	102.8	69.4	69.7	65.1	76.4	122.1	118.6	108.4	130.0	171.6	183.2	118.0	1,325.9	183.2
11. Mactan International Airport, Cebu	99.9	66.4	54.2	41.8	69.2	179.4	194.6	149.2	183.3	174.0	156.4	127.0	1,466.1	194.6
12. Dumaguete City, Negros Oriental	78.5	52.0	45.3	40.6	65.6	107.8	118.3	105.8	135.6	157.6	134.8	97.0	1,134.9	157.6
Region: 8														
13. Tacloban City, Leyte	272.2	198.7	145.2	117.6	136.1	157.0	172.6	143.4	161.0	189.7	280.2	323.8	2,289.7	323.8
14. Maasin, Southern Leyte	203.9	117.0	99.8	57.3	61.7	124.3	159.1	158.6	164.2	209.4	186.3	178.3	1,574.8	209.4
15. Catarman, Northern Samar	425.1	231.3	183.8	134.8	138.7	194.2	210.7	149.1	202.7	324.5	511.3	539.2	3,220.8	539.2
16. Catbalogan, Western Samar	219.4	138.0	126.4	101.8	154.8	223.1	270.0	198.3	255.7	280.7	324.2	283.1	2,575.6	324.2
Region: 10														
17. Malaybalay, Bukidnon	130.6	104.0	101.0	100.6	229.2	308.6	317.8	311.9	305.6	312.0	182.5	126.8	2,530.4	317.8
18. Cagayan de Oro, Misamis Oriental	97.3	65.1	47.0	37.8	88.2	209.2	211.4	207.6	207.4	187.0	124.9	92.6	1,570.7	211.4
Region: 11														
19. Davao City, Davao del Sur	110.5	105.0	84.9	148.3	190.7	193.9	156.3	180.4	183.8	165.4	131.1	99.5	1,749.8	193.9
20. General Santos, South Cotabato	67.5	63.1	41.8	50.5	72.8	115.5	100.8	80.8	87.8	105.8	81.6	70.7	904.2	115.5
Region: 12														
21. Zamboanga City, Zambo. del Sur	56.2	49.7	41.5	61.0	106.9	161.3	143.4	129.9	169.5	202.3	163.2	107.8	1,392.7	202.3
Region: 13														
22. Butuan City, Agusan del Norte	301.7	197.4	135.9	101.3	110.8	132.1	159.9	101.5	143.6	195.1	156.8	223.6	1,949.3	301.7
23. Surigao, Surigao del Norte	612.7	475.7	337.2	249.4	143.8	135.2	167.0	142.6	147.6	258.3	455.6	529.5	3,630.8	612.7
24. Hinatuan, Surigao del Sur	670.2	504.9	431.5	311.0	239.8	254.1	205.2	183.5	201.7	241.7	365.6	561.0	3,970.7	670.2

SOURCE: PAGASA (1961-1995)



Source : PAGASA

FIGURE 1.3 - 2 DISTRIBUTION OF MEAN ANNUAL RAINFALL (mm)



Source : PAGASA

FIGURE 1.3 - 3 DISTRIBUTION OF MEAN ANNUAL NUMBER OF RAINY DAYS

TABLE 1.3-2 MEAN MONTHLY AND ANNUAL TEMPERATURE (°C)

Weather Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean Annual	Monthly Highest
Region: 4														
1. Calapan, Oriental Mindoro	25.3	25.8	26.8	28.0	28.2	27.8	27.3	27.3	27.4	27.1	26.6	25.7	27.0	28.2
2. Coron, Palawan	26.7	27.0	27.6	28.4	28.5	27.3	26.5	26.5	26.6	26.9	27.3	27.1	27.2	28.5
3. Cuyo, Palawan	27.2	27.3	28.0	29.1	29.3	28.5	28.0	28.1	28.0	28.1	28.2	27.6	28.1	29.3
4. Romblon	25.8	26.3	27.2	28.6	29.3	28.5	27.8	27.8	27.8	27.6	27.1	26.3	27.5	29.3
Region: 5														
5. Masbate, Masbate	26.3	26.5	27.5	28.8	29.6	29.1	28.6	28.6	28.4	28.2	27.6	26.8	28.0	29.6
6. Virac Synop, Catanduanes	25.6	25.7	26.3	27.2	27.9	28.0	27.7	27.9	27.6	27.1	26.8	26.1	27.0	28.0
7. Virac Radar, Catanduanes	23.7	23.9	24.7	25.7	26.5	26.6	26.3	26.4	26.3	26.0	25.3	24.4	25.5	26.6
Region: 6														
8. Roxas City, Aklan	26.3	26.4	27.2	28.4	28.9	28.4	27.9	28.0	27.9	27.7	27.5	26.8	27.6	28.9
9. Iloilo City, Iloilo	26.2	26.6	27.5	28.8	29.1	28.1	27.5	27.5	27.5	27.6	27.4	26.7	27.5	29.1
Region: 7														
10. Tagbilaran City, Bohol	26.2	26.4	26.9	27.8	28.5	28.3	28.0	28.4	28.2	27.8	27.4	26.8	27.5	28.5
11. Mactan International Airport, Cebu	26.8	27.0	27.7	28.7	29.3	28.7	28.2	28.4	28.2	28.0	27.8	27.2	28.0	29.3
12. Dumaguete City, Negros Oriental	26.7	26.7	27.4	28.5	28.9	28.4	28.0	28.2	28.0	27.9	27.8	27.3	27.8	28.9
Region: 8														
13. Tacloban City, Leyte	25.8	25.9	26.5	27.5	28.1	28.0	27.8	28.0	27.9	27.6	27.0	26.4	27.2	28.1
14. Maasin, Southern Leyte	26.0	26.2	26.7	27.6	28.1	27.5	27.2	27.4	27.2	27.0	26.7	26.2	27.0	28.1
15. Catarman, Northern Samar	25.4	25.5	26.0	26.9	27.9	28.0	27.7	28.1	27.7	27.1	26.5	25.8	26.9	28.1
16. Catbalogan, Western Samar	26.1	26.3	27.1	28.2	28.9	28.6	28.2	28.5	27.8	27.3	26.7	26.1	27.5	28.9
Region: 10														
17. Malaybalay, Bukidnon	23.0	23.1	23.6	24.5	24.9	24.1	23.6	23.7	23.8	23.9	24.0	23.4	23.8	24.9
18. Cagayan de Oro, Misamis Oriental	26.3	26.4	27.0	27.9	28.1	28.1	27.8	28.0	27.9	27.7	27.5	26.9	27.5	28.7
Region: 11														
19. Davao City, Davao del Sur	26.6	26.7	27.4	28.1	28.1	27.6	27.3	27.4	27.5	27.6	27.6	27.1	27.4	28.1
20. General Santos, South Cotabato	27.4	27.6	28.1	28.5	28.0	27.2	26.7	26.8	27.0	27.2	27.5	27.5	27.5	28.5
Region: 12														
21. Zamboanga City, Zambo. del Sur	26.9	27.0	27.6	28.0	28.2	27.7	27.5	27.6	27.5	27.4	27.5	27.2	27.5	28.2
Region: 13														
22. Butuan City, Agusan del Norte	25.9	26.1	26.8	27.9	28.6	28.2	26.9	28.0	27.8	27.5	27.1	26.4	27.3	28.6
23. Surigao, Surigao del Norte	25.7	25.8	26.5	27.3	28.2	28.2	27.9	28.1	28.1	27.6	26.8	26.3	27.2	28.2
24. Hinatuan, Surigao del Sur	25.8	25.8	26.3	27.0	27.7	27.7	27.7	27.8	27.7	27.5	27.0	26.4	27.0	27.8

SOURCE: PAGASA (1961-1995)