JAPAN INTERNATIONAL COOPERATION AGENCY

DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS - ARMM
REPUBLIC OF THE PHILIPPINES

THE STUDY ON INFRASTRUCTURE (ROAD NETWORK) DEVELOPMENT PLAN FOR THE AUTONOMOUS REGION IN MUSLIM MINDANAO (ARMM) IN THE REPUBLIC OF THE PHILIPPINES

FINAL REPORT

VOLUME-II : MAIN TEXT

MARCH 2010

CTI ENGINEERING INTERNATIONAL CO., LTD.
YACHIYO ENGINEERING CO., LTD.

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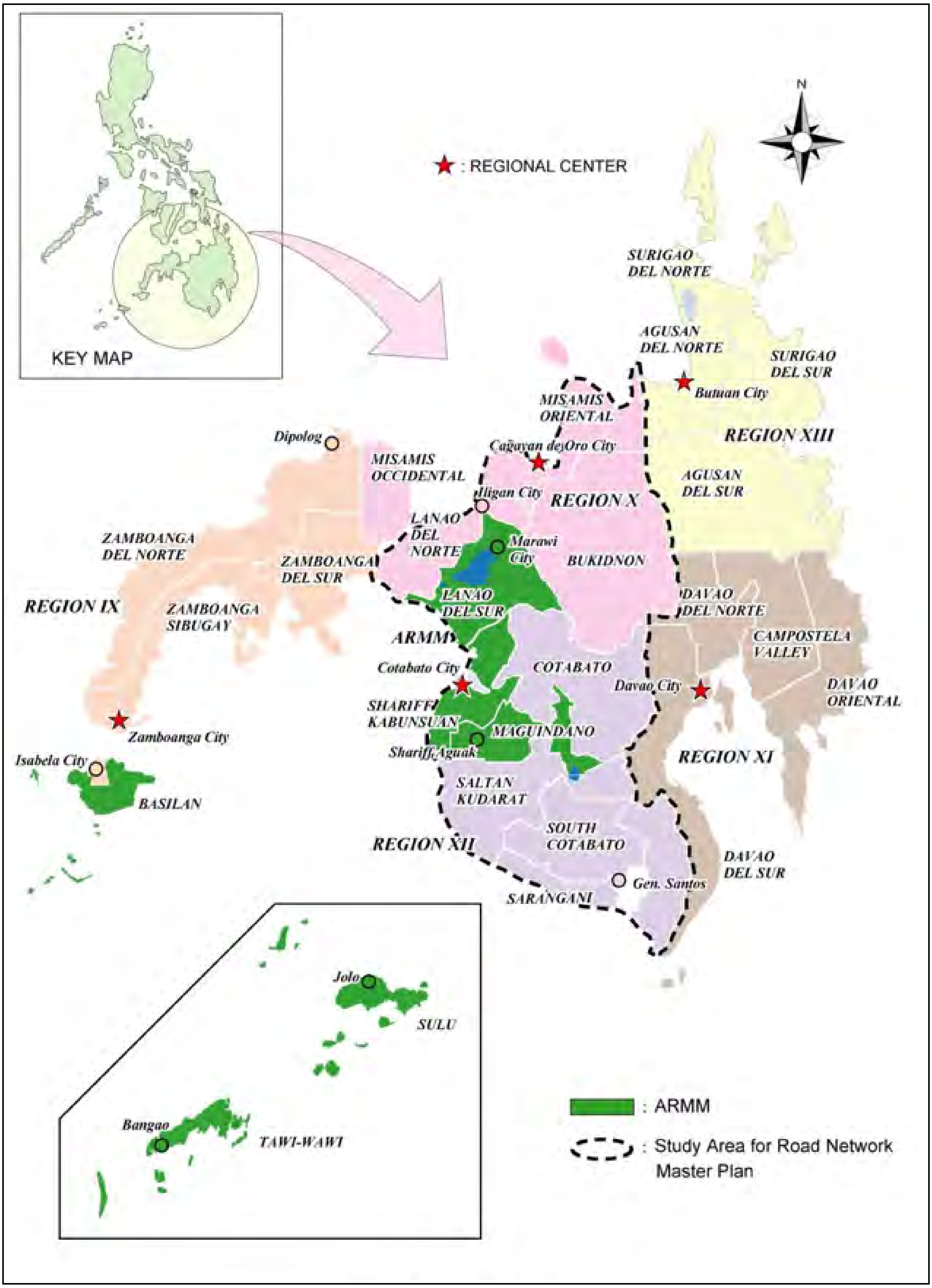

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ACRONYMS AND ABBREVIATIONS

AC	:	Asphalt Concrete
AESO	:	Area Equipment Service Office
AMWP	:	Annual Maintenance Work Program
ARMM	:	Autonomous Region in Muslim Mindanao
ASFP	:	ARMM Social Fund Project
AusAid	:	Australian Agency for International Development
BAS	:	Bureau of Agricultural Statistics
BIR	:	Bureau of Internal Revenue
CCCH	:	Coordinating Committee on the Cessation of Hostilities
CIDA	:	Canadian International Development Agency
CNC	:	Certificate of Non-Coverage
DA	:	Department of Agriculture
DAR	:	Department of Agrarian Reform
DENR	:	Department of Environment and Natural Resources
DEO	:	District Engineering Office
DIP	:	District Impact Project
DO	:	Department Order
DPWH	:	Department of Public Works and Highways
ECC	:	Environmental Compliance Certificate
EIA	:	Environmental Impact Assessment
EIRR	:	Economic Internal Rate of Return
EIS	:	Environmental Impact Statement
EMB	:	Environmental Management Bureau
EO	:	Executive Order
EOJ	:	Embassy of Japan
EU	:	European Union
GAA	:	General Appropriations Act
GEM	:	Growth with Equity in Mindanao
GIS	:	Geographic Information System
GOJ	:	Government of Japan
GRDP	:	Gross Regional Domestic Product
GRP	:	Government of the Republic of the Philippines
ICD	:	Institutional Capacity Development
ICT	:	Information and Communication Technology
IEE	:	Initial Environmental Examination
IMT	:	International Monitoring Team
IROW	:	Infrastructure Right-of-Way
IRR	:	Implementing Rules and Regulations
JBIC	:	Japan Bank for International Cooperation
J-BIRD	:	Japan-Bangsamoro Initiatives for Reconstruction and Development
JICA	:	Japan International Cooperation Agency
LARRIPP	:	Land Acquisition, Resettlement, Rehabilitation and Indigenous Peoples Policy
LGU	:	Local Government Unit
MBA	:	Maintenance by Administration
MBC	:	Maintenance by Contract
MEDCO	:	Mindanao Economic Development Council
MILF	:	Moro Islamic Liberation Front
MNLF	:	Moro National Liberation Front
MVUC	:	Motor Vehicle User's Charge
NEDA	:	National Economic Development Authority

NSO	:	National Statistics Office
OPAPP	:	Office of the Presidential Adviser on the Peace Process
PAP	:	Project Affected Person
PCCP	:	Portland Cement Concrete Pavement
PD	:	Presidential Decree
PIP	:	Provincial Impact Project
RA	:	Republic Act
RAP	:	Resettlement Action Plan
RIP	:	Regional Impact Project
ROW	:	Right-of-Way
RPDO	:	Regional Planning and Development Office
UN	:	United Nations
UNDP	:	United Nations Development Programme
UNESCO	:	United Nations Educational, Scientific and Cultural Organization
USAID	:	United States Agency for International Development
WB	:	World Bank

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF THE PROJECT

Mindanao Island is located in the southern part of the Philippines, with a land area of 102,000 km^2 and a population of 21 million, more than half of them are engaged in agriculture, forestry and fishery.

The Autonomous Region in Muslim Mindanao (ARMM) was first created in 1989. The plebiscites were held to ask people's will to be included in the ARMM, then ARMM was officially inaugurated in 1990. Peace agreement with the Moro National Liberation Front (MNLF) was reached in 1996, whereas peace talk with the Moro Islamic Liberation Front (MILF) which separated from MNLF in 1977 is still on-going.

Although the ARMM region has high development potentials with rich natural resources, the region is the poorest in the country and suffers serious poverty problems due to low level of economic development which mainly caused by the long-lasting conflicts. Deteriorated infrastructure brought by the long-lasting conflicts is serious bottleneck for urgent economic recovery and sustainable development.

With the creation of ARMM, the National Government devolved maintenance of national roads and other powers and functions to ARMM, however, the ARMM Government still needs to develop capacity for planning, programming, construction, operation and maintenance of infrastructure for better management of infrastructure.

In view of above, the Government of the Republic of the Philippines (hereinafter referred to as "GRP"), requested the conduct of "The Study on Infrastructure (Road Network) Development Plan for the Autonomous Region in Muslim Mindanao (hereinafter referred to as "the Study") to the Government of Japan (hereinafter referred to as "GOJ"). In response to the request of GRP, GOJ has decided to conduct "the Study", and exchanged Notes Verbales with GRP concerning the implementation of the Study.

GOJ has launched the initiative "J-BIRD (Japan-Bangsamoro Initiatives for Reconstruction and Development)". This study was implemented under the umbrella of this initiative.

Japan International Cooperation Agency (hereinafter referred to as “JICA”), the official agency responsible for the implementation of the technical cooperation program of GOJ, undertook the Study in accordance with the relevant laws and regulations enforced in Japan.
On the part of GRP, the Department of Public Works and Highways of Autonomous Region of Muslim Mindanao (hereinafter referred to as “DPWH-ARMM”) acted as the counterpart agency to the Japanese study team (hereinafter referred to as “the Study Team”) and also as the coordinating body in relation with other concerned governmental and non-governmental organizations for the smooth implementation of the Study.

1.2 OBJECTIVES OF THE STUDY

The objectives of the Study were:

- To formulate the Master Plan of development (construction, rehabilitation, improvement/betterment) / maintenance of road network in the ARMM and the surrounding Mindanao region (target year 2025);
- To conduct pre-feasibility study for the priority roads and bridges identified under the Master Plan;
- To develop reference materials / database that guides the road network development of the region; and
- To pursue technology transfer to the counterpart personnel in the course of the Study.

1.3 STUDY AREA AND STUDY ROADS

The Study covered the ARMM, Region XII and Region X, excluding the province of Misamis Occidental. For island provinces of Basilan, Sulu and Tawi-Tawi , the study focused on capacity development which includes preparation of inventory, database and maintenance plan, but excluded from the Master Plan Study. Roads to be studied were basically National Roads, however, Provincial Roads that are necessary for the road network consistency were added to the study roads.

1.4 SCOPE OF THE STUDY

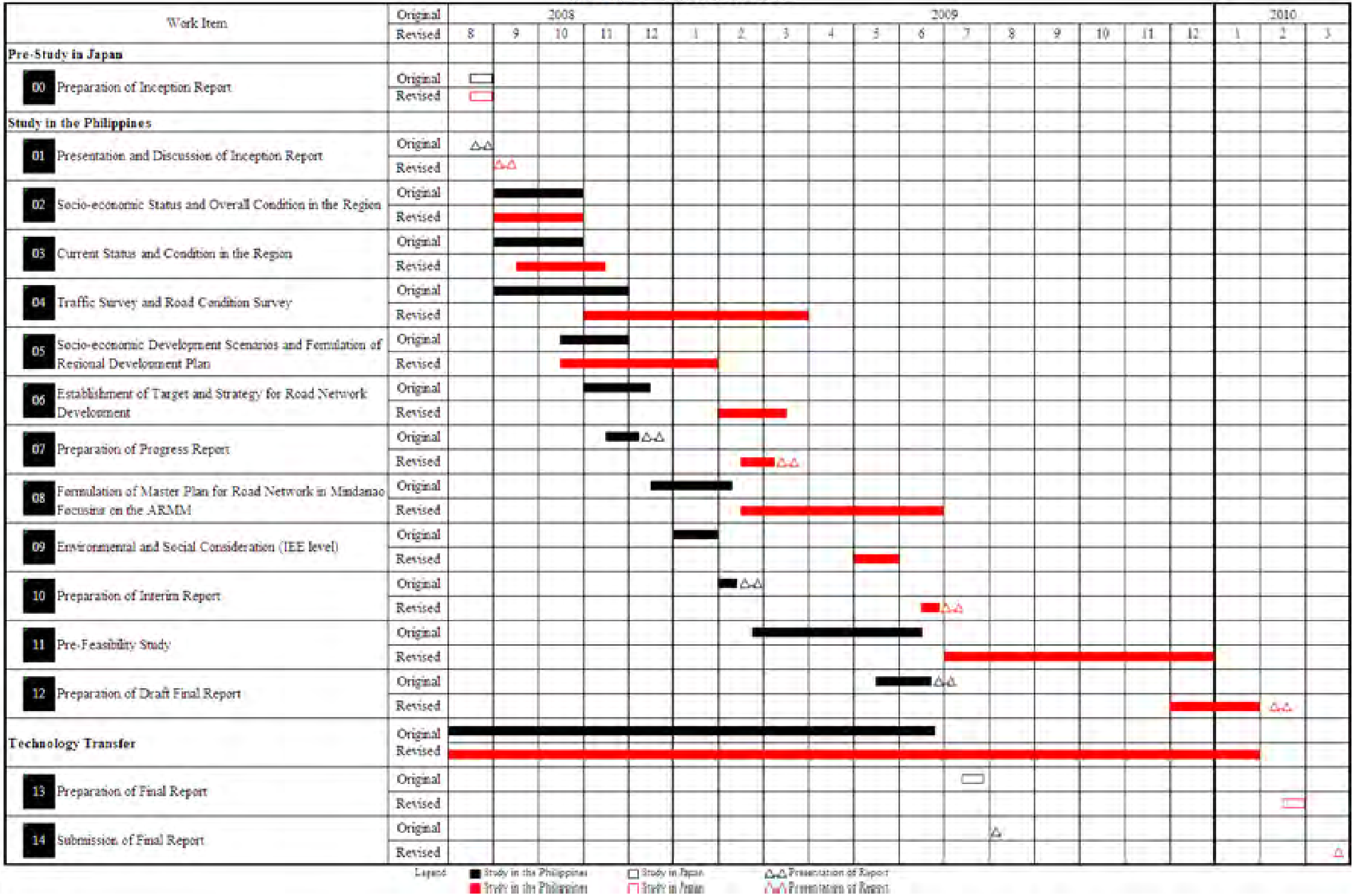
In order to achieve the above objectives, the Study covered the following items:

(1) Preparation of Inception Report
(2) Presentation and Discussion of Inception Report
(3) Socio-economic Status and Overall Condition in the Region
(4) Current Status and Conditions of Road Sector
(5) Traffic Survey and Road Condition Survey
(6) Study on Socio-Economic Development Scenarios and Formulation of Regional Development Plan
(7) Establishment of Target and Strategy for Road Network Development
(8) Preparation of Progress Report
(9) Formulation of Master Plan for Road Network in Mindanao Focusing on the ARMM
(10) Environmental and Social Consideration Study (IEE Level)
(11) Preparation of Interim Report
(12) Pre-Feasibility Study
   - Supplementary Survey for Selected Roads
   - Preliminary design for selected roads (including bridges)
   - Project cost estimate
   - Economic analysis
   - Environmental and social consideration (EIA Level)
   - Formulation of project implementation plan
(13) Technology Transfer
(14) Preparation of Draft Final Report
(15) Preparation and Submission of Final Report

1.5 SCHEDULE OF THE STUDY

The Study commenced in September 2008 and originally scheduled to be completed by the middle of August 2009, however, due to the peace and order situation of the study area, the schedule of the study was revised as shown in **Table 1.5-1**, and completed in March, 2010.

TABLE 1.5-1   STUDY SCHEDULE



1.6 ORGANIZATION TO CARRY OUT THE STUDY

The organization to carry out the Study is shown in **Figure 1.6-1**.

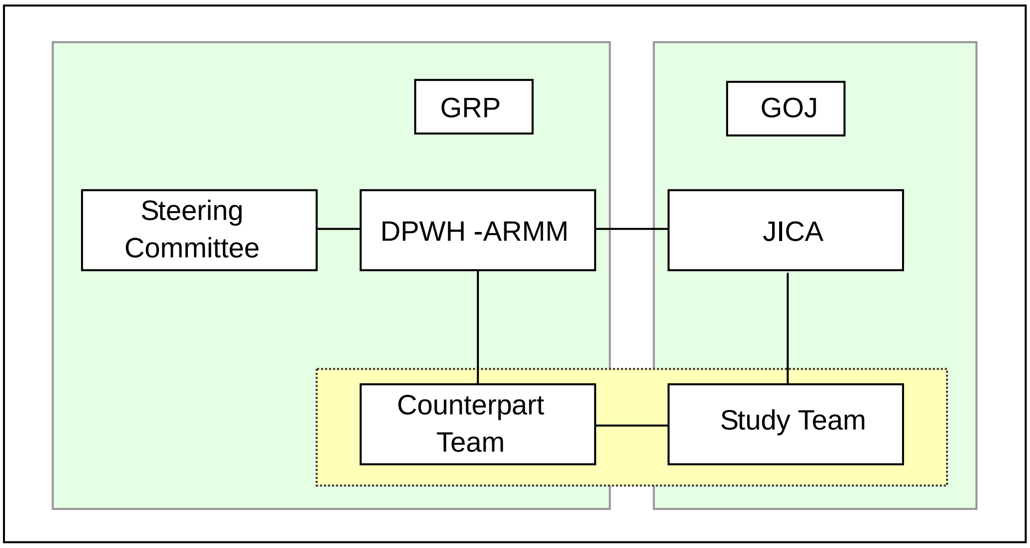


FIGURE 1.6-1 ORGANIZATION CHART

The Study was carried out by the Study Team organized by the JICA in close collaboration with DPWH-ARMM and other organizations concerned.

The Steering Committee was organized by the DPWH-ARMM to ensure the smooth conduct of the Study and to review and oversee the progress of the Study. The Steering Committee was composed of the following departments and organizations:

Steering Committee

Chairman:
- Titingalangit C. Sumagayan (Dec. 2009 to Mar 2010); *Regional Secretary, DPWH-ARMM*
- Razul K. Abpi (Sep. 2008 to Nov. 2009); *Regional Secretary, DPWH-ARMM*

Co-chairman:
- Gualoson A. Mamogkat; *Director, DPWH-ARMM*

Members:
- Diamadel E. Dumagay ; *Executive Director, Regional Planning and Development Office*
- Danilo A. Ong; *Chief, Planning & Program Division, DPWH-ARMM*
- Romeo N. Diocolano (Dec. 2009 to Mar 2010); *Director, TMS-ORG*
- Ramil L. Masukat (Sep. 2008 to Nov. 2009); *Director, TMS-ORG*

- Melvin B. Navarro; *Director, Planning Service, DPWH - National*
- Shinichi Kimura; *JICA Expert to ARMM*

A counterpart Team was organized by the DPWH-ARMM to collaborate with the Study Team in carrying out the Study. The members of the Counterpart Team were selected from the DPWH-ARMM.

The Counterpart Team was composed of the following members:

Team Leader	:	Titingalangit C. Sumagayan (Dec. 2009 to Mar 2010)
		Razul K. Abpi (Sep. 2008 to Nov. 2009)
Member	:	Guialoson A. Mamogkat
Member	:	Danilo A. Ong
Member	:	Nazer P. Ebus
Member	:	Pendatun E. Nur
Member	:	Sukarno A. Suleik
Member	:	Mangondaya M. Madid
Member	:	Yahiya A. Abdulkalim
Member	:	Abdulrahman Mokamad
Member	:	Hector F. Celis
Member	:	Flaviano Tabile
Member	:	Zainal N. Mlok, Jr.
Member	:	Emran B. Buisan
Member	:	Sindab M. Mangoda

The Study Team is composed of the following members:

1)	Mr. Mitsuo KIUCHI	:	Team Leader/Road Network Planner
2)	Mr. Osamu OHTSU	:	Regional Development Planner
3)	Mr. Koichi TSUZUKI	:	Road Maintenance Specialist
4)	Mr. Teodoro T. ENCARNACION	:	CapacityDevelopment(1)/ Institutional Management Specialist
5)	Dr. Takayuki TSUCHIDA	:	Capacity Development Specialist(2)
6)	Mr. Akio OKAZAKI	:	Bridge Planner
7)	Mr. Masayuki ISHIYA	:	Transport Planner
8)	Dr. Nashreen G. SINARIMBO	:	Traffic Survey/Logistics Planner
9)	Mr. Aristeo A. PORTUGAL	:	Agricultural Development Specialist
10)	Ms. Annabelle N. HERRERA	:	Environmental and Social Consideration Specialist

11) Mr. Makoto MITSUKURA	:	Natural Condition Specialist
12) Mr. Munetoshi MATSUO	:	Facilities Design Engineer
13) Mr. Ryoichi YAMASAKI	:	Construction Planner/Cost Estimator
14) Mr. Toshiaki HORII	:	Transport Economist

1.7 REPORTS

1.7.1 Reports Prepared

The following reports were prepared in the course of the Study and submitted to DPWH-ARMM;

- Inception Report
- Progress Report
- Interim Report
- Draft Final Report

1.7.2 Organization of the Final Report

The Final Report is organized as follows:

Volume I	:	EXECUTIVE SUMMARY
Volume II	:	MAIN TEXT
Volume III	:	ANNEXES
Volume IV	:	DRAWINGS

CHAPTER 2

PHYSICAL PROFILE OF THE STUDY AREA

2.1 TOPOGRAPHY

The Philippine Archipelago is situated in Southeast Asia between 4º23'N to 21º25'N latitude and between 116ºE to 127ºE longitude. It consists of 7,100 islands with a total land area of 300, 000 km^2. The Study Area is located in Mindanao, the second largest (102, 003 km^2) in terms of total land area, of the three (3) island groups that comprise the archipelago. The other island groups are namely Luzon, the largest with 138, 703 km^2, and Visayas, with 56, 607 km^2.

As shown in **Figure 2.1-1**, Mindanao Island can be divided into eight (8) topographical divisions, namely (i) Diwata Cordillera, (ii) Agusan Plain, (iii) Davao Upland, (iv) Bukidnon Plateau, (v) Cotabato Plain, (vi) Tiruray Upland, (vii) Lanao Plateau, and (viii) Zamboanga Upland. The Diwata Cordillera is a tightly folded mountain range which runs in an almost N-S orientation. It is located east of the Agusan River. The highest mountain in the range, with an elevation of 1,837 meters above sea level (masl) is Mt. Hilonghilong. Mt. Apo, the highest peak in the Philippines, with an altitude of 2,954 masl, is found in the Davao Upland.

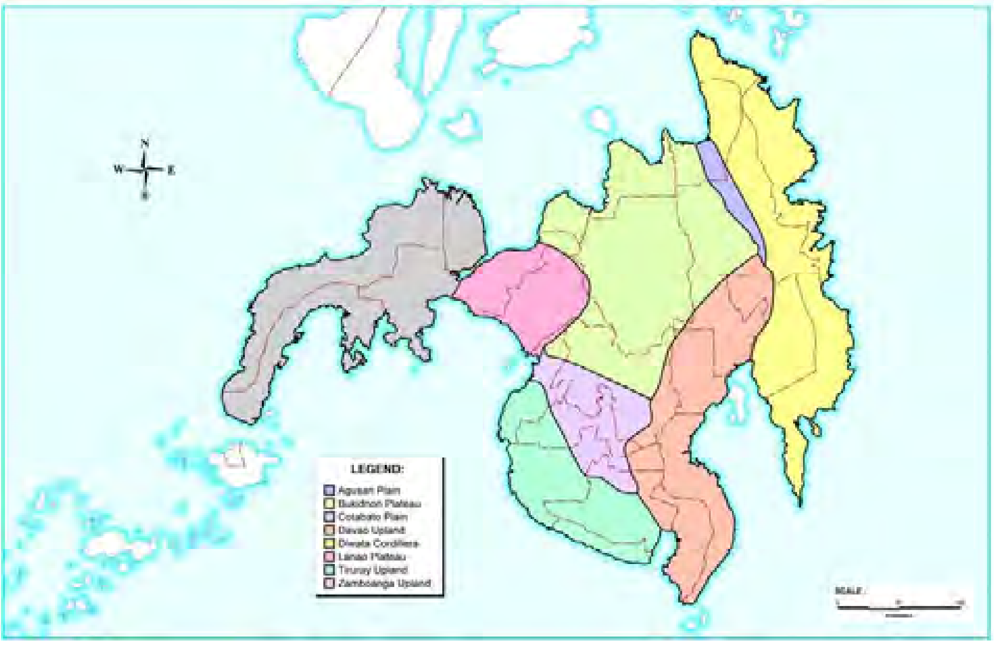


FIGURE 2.1-1 TOPOGRAPHICAL DIVISIONS OF MINDANAO ISLAND

The elevation map of Mindanao presented as **Figure 2.1-2** corroborates the topographic features mentioned above. As shown in the map, Lanao and Bukidnon plateaus, as well as the Davao and Tiruray Uplands have topographic highs with minimum elevation ranging from 500-750 masl. There are only two areas, namely the Cotabato Plain and the Agusan Valley Plain that can be considered as lowland, with elevations ranging from 0 – 250 masl. These topographic lows correspond to two (2) of the nine (9) sedimentary basins found within the Philippine Mobile Belt.

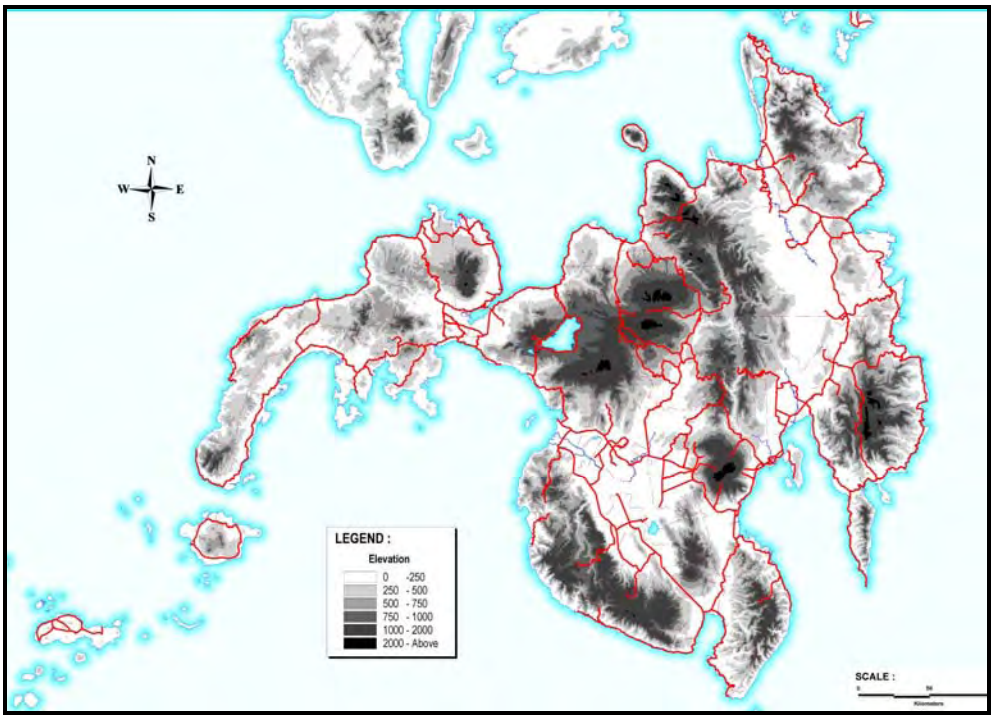


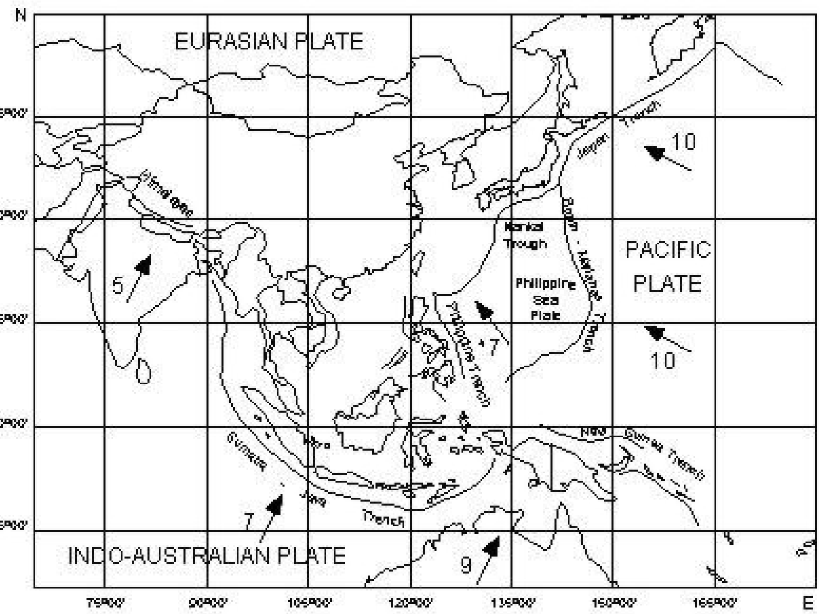
FIGURE 2.1-2 ELEVATION MAP OF MINDANAO ISLAND

2.2 GEOLOGY

The following section provides a brief summary of the geologic characteristics of the Philippines as discussed in the comprehensive report prepared by the Department of Environment and Natural Resources – Mines and Geosciences Bureau (DENR-MGB) entitled "***Geology and Mineral Resources of the Philippines***", Revised Edition 2004. In the succeeding subsections, emphasis is given on Mindanao Island where the Study Area is located.

2.2.1 Philippine Tectonics

The Philippines is located in a tectonically active region being situated in an area where three major tectonic plates in the Western Pacific Domain interact. These are the ***Pacific***, the ***Eurasian*** and the ***Indo-Australian Plates***. As such, natural phenomena such as earthquakes and volcanic eruptions will remain in the Philippines for as long as the current geodynamics do not change. It can be recalled that in July 16, 1990, a magnitude Ms7.8 earthquake struck Northern Luzon causing destruction to thousands of lives and properties. A year later, in June 1991, Mount Pinatubo, which was thought to be dormant for more than 300 years erupted and again resulted into death and devastation.



Source: Geology And Mineral Resources of the Philippines, Vol. 1, Revised Edition 2004.

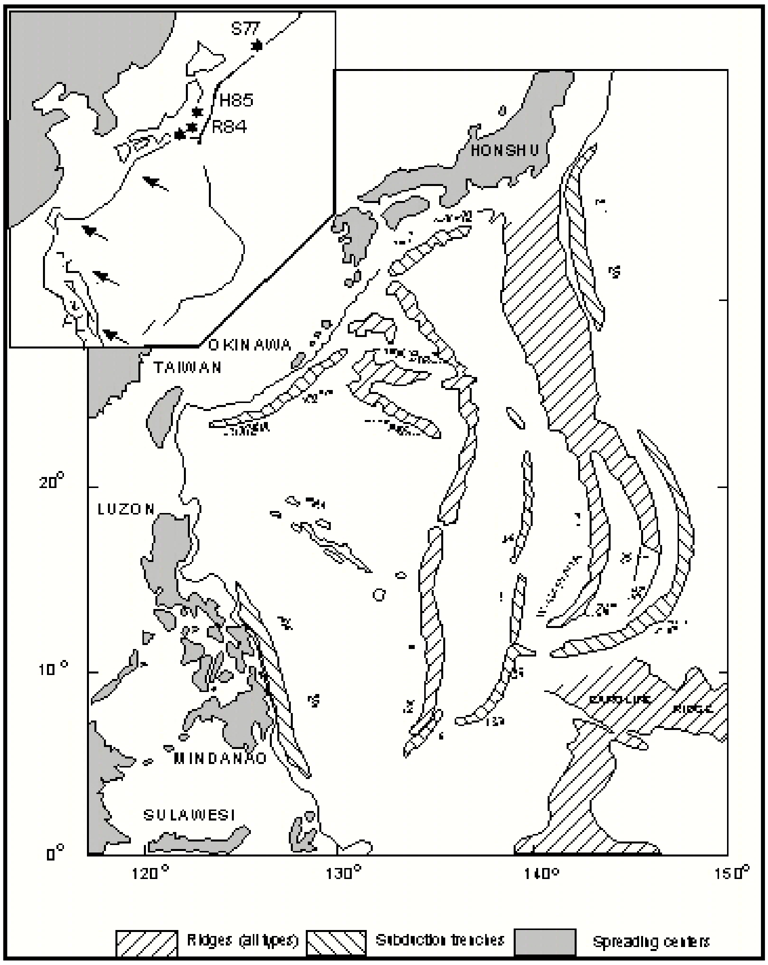
FIGURE 2.2.1-1 THE PHILIPPINES IN THE SOUTHEAST ASIA –WEST PACIFIC DOMAIN.

Note; Numbers beside arrows indicate rates of plate motion in cm/yr relative to Eurasia. Modified from Barrier, 1985.

The **Pacific Plate** is entirely composed of an oceanic lithosphere created between 150 and 0 Million years ago. It presently occupies almost a third of the total terrestrial surface, less than it did 200 Million years ago (Le Pichon and Huchon, 1984). The **Eurasian Plate** (or **Eurasia**) extends for over 11,000 kilometers from the Atlantic Ocean to the west to the Pacific Ocean to the east. Unlike the Pacific Plate, the Eurasian Plate is basically continental in nature, except for marginal basins created along its edges. The movement of this plate with respect to hot spots is considered weak (Morgan, 1981), in the order of only a few millimeters per year (3 mm/yr). The **Indo-Australian Plate** is composed of both continental and oceanic crusts. The continental crusts are presently represented by India and Australia, while the oceanic portion is represented by the Indian Ocean. The creation of the oceanic crust between India and Australia corresponds to the separation of the continental masses around 150 Million years ago. From 43 Million years ago, the mid-oceanic ridge separating the two continental blocks became inactive. Since then, a single Indo-Australian Plate is moving northwards.

The Southeast Asian Tectonic Region

The southwestern portion of the Western Pacific Domain is known as the Southeast Asian Tectonic Region. It is composed of the Philippine Sea Plate and the southeastern edge of the Eurasian Plate. The ***Philippine Sea Plate*** is developed at the western edge of the Pacific Plate. It roughly takes the form of a diamond (long axis directed N-S) whose edges are defined by deep trenches including the Marianas Trench, the deepest in this planet. It is an oceanic crust composed of several ocean basins separated by submarine ridges (refer to **Figure 2.2.1-2**).



Source: Geology And Mineral Resources of the Philippines, Vol. 1, Revised Edition 2004.

FIGURE 2.2.1-2. BATHYMETRIC FEATURES OF THE PHILIPPINE SEA PLATE. MODIFIED FROM RINGENBACH, 1992.

These ocean basins have an average depth of 4 to 6 km. They can be classified into two groups, namely; the *West Philippine Basin* and the *Other Basins*, the former being directly in contact with the Philippine archipelago. Except for the West Philippine Basin, the long axis of these basins is generally oriented N-S.

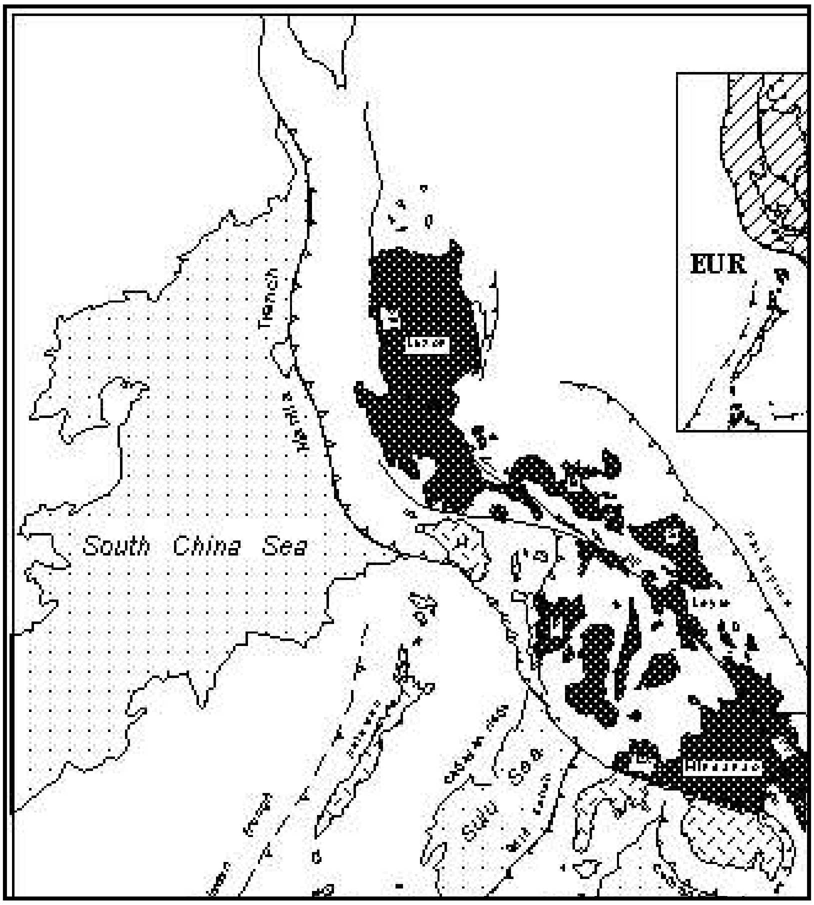
The *West Philippine Basin* is the largest of its type in the region, occupying around 50% of the Philippine Sea Plate. It is characterized by the presence of several submarine plateaus (Benham Rise and Anami and Oki-Daito Ridges) and a WNW-ESE lineament corresponding to the Central Basin Fault. The said Fault is composed of a series of en echelon ridges whose orientation makes an angle of around 15° (almost E-W) to its general direction (WNW-ESE).

The *Other Basins* include the Parece Vela - Shikoku and the Marianas Basins. Situated to the east of the West Philippine Basin, this Basin is an oceanic crust accreted on a N-S spreading axis. The oceanic basins are separated from each other by submarine ridges with axes that are generally oriented N-S which sometimes split into several branches. The 4 major ridges are the (i) Palau-Kyushu, (ii) Izu Bonin, (iii) Marianas and (iv) West-Marianas Ridges. Aside from these ridges, other bathymetric highs such as the Benham Rise or the Oki-Daito Platform are also present.

As shown in **Figure 2.2.1-2**, the Philippine Sea Plate is entirely surrounded by subduction zones. The edge of the Philippine Sea Plate is defined on the east by the Bonin-Marianas-Yap Trench System. To the northwest, the plate subducts under the Japanese archipelago along the Nankai and Ryukyu Trenches and enters into collision with the Eurasian margin in Taiwan. To the southwest, the plate is subducted into the Philippine archipelago along the East Luzon - Philippine Trench System.

The Southeast Asian Margin

From Japan to the Philippines, the boundary between the southwestern margin of the Eurasian Plate and the Philippine Sea Plate is active. This boundary is marked by on the north by subduction zones along the Nankai and Ryukyu Trenches and by an arc-continent collision zone in Taiwan. To the south, this boundary is defined by subduction zones, punctuated by collision zones bordering the western margin of the Philippine archipelago. This portion of the Eurasian margin is basically composed of marginal basins that successively opened in several phases within Tertiary times. The lithospheric plate is thus thinned (thinned margin) as a consequence of the creation of new oceanic crust. The resulting marginal basins are represented by the South China Sea Basin, the Sulu Sea Basin, and the Celebes Sea Basin. These basins are bordered by the continental blocks of Taiwan (true continental margin) and North Palawan (rifted from the Chinese margin) and by the volcanic arcs of Sulu and North Sulawesi (see **Figure 2.2.1-3**).



Source: Geology And Mineral Resources of the Philippines, Vol. 1, Revised Edition 2004.

FIGURE 2.2.1-3. TERRANE AFFINITY MAP OF THE PHILIPPINES ACCORDING TO RANGIN ET AL., 1990.

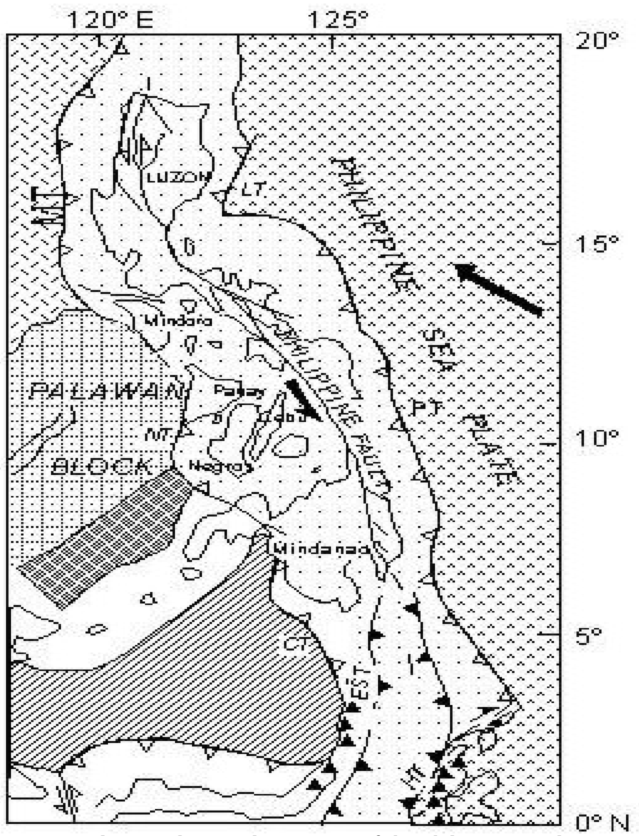
The South China Sea Basin bounds the Philippine archipelago to the NW. It is an oceanic basin whose axis is oriented NE-SW with average depths of 4 km. Morphological studies show the dominance of normal faults oriented N50°E on the southern portion of the basin would correspond to a NW-SE opening direction. A direct consequence of the opening of the China Sea is the separation of a microcontinental block from mainland China. This block corresponds today to the North Palawan Block.

Southeast of the North Palawan Block is a series of oceanic basins and ridges generally oriented along a NE-SW axis. From the NE, these are the (i) Sulu Sea Basin, divided into two by the Cagayan de Sulu Ridge, the Sulu-Zamboanga Ridge, and (ii) Celebes Sea Basin.

The Sulu Sea Basin is a small marginal basin located immediately to the SE of the North Palawan Block (**Figure 2.2.1-3**). It is subdivided by Cagayan Ridge into two subbasins namely the NW Subbasin and the SE Subbasin. The Sulu-Zamboanga Arc separates the Sulu Sea Basin from the Celebes Sea Basin. It is manifested as a group of islands in which some are classified as Pleistocene-Holocene with one active volcano.

The Philippine Mobile Belt

The Philippine Mobile Belt (PMB) is an actively deforming zone located between the Philippine Sea Plate and the eastern margin of the Eurasian Plate, where a complex system of subduction zones, collision zones and marginal sea basin openings are located. The subduction zones surrounding the Philippine Mobile Belt are with opposing polarities; i.e., subduction zones east of the mobile belt have westward vergence while those on the west are subducting eastward (refer to **Figure 2.2.1-4**).



Source: Geology And Mineral Resources of the Philippines, Vol. 1, Revised Edition 2004.

FIGURE 2.2.1-4. SIMPLIFIED TECTONIC MAP OF THE PHILIPPINES

Note; Adopted from Aurelio, 1992.

West-dipping subduction zones consist of the Philippine Trench (PT) and the East Luzon Trough (LT), whereas the Manila Trench (MT), Negros Trench (NT), and Cotabato Trench (CT) comprise the East-dipping zones.

2.2.2 Lithologic Units

The Philippine archipelago in general can be divided into two geologic entities, namely: the Philippine Mobile Belt (Gervasio, 1966) and the North Palawan Block. Each of these two entities are composed of different types of lithologic units that can be classified into four general groups, namely: (i) metamorphic rocks, (ii) ophiolites and ophiolitic rocks, (iii) magmatic rocks and active volcanic arcs, and (iv) sedimentary basins.

Metamorphic rocks in the Philippines can be divided into two categories, namely: (i) pre-Cretaceous metamorphic rocks of continental origin, and (ii) post-Jurassic metamorphic rocks of insular arc affinity. Pre-Cretaceous metamorphic rocks are represented by metamorphic formations located in North Palawan, Mindoro, Panay and neighboring islands. Rocks belonging to the Post-Jurassic group are distributed sporadically within the whole archipelago. They are essentially basic to ultrabasic in character, suggesting they have most likely originated from old island arcs.

Ophiolites and ophiolitic rocks in the Philippines are widespread in the whole archipelago. Usually occurring together with the pre-Tertiary metamorphic rocks, the ophiolitic rocks represent basement on which magmatic arcs were developed.

The oldest known magmatic rocks in the Philippines are found in Cebu Island, where dioritic rocks have been dated Early Cretaceous (Walther and others, 1981). Similar rocks have been recognized in neighbouring Bohol Island (Zanoria and others, 1984; JICA-MMAJ, 1985). In the Sierra Madre Range, magmatic formations dated Lower Eocene to Oligocene (Wolfe, 1981; Ringenbach, 1992; Billedo, 1994) also exist. Petrographically similar rocks are also present in Mindanao but their ages are more difficult to interpret due to the tectonic complexity of the island.

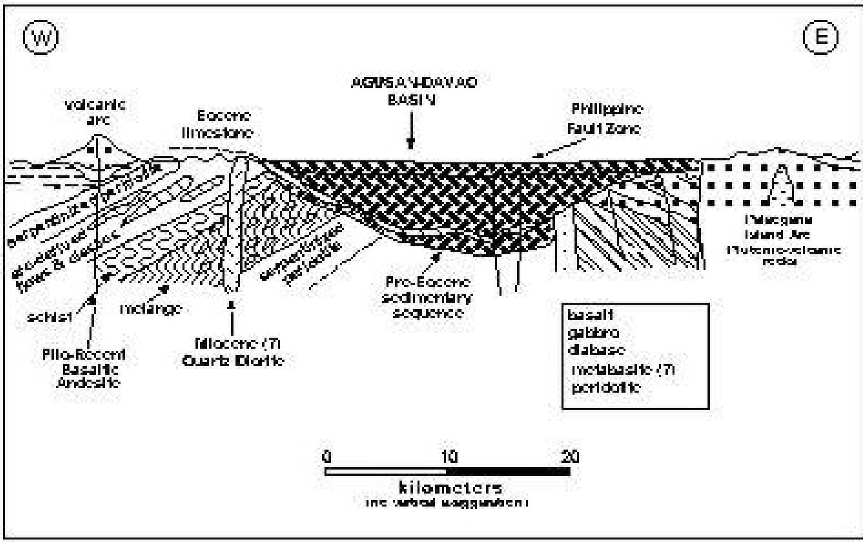
In terms of volcanic arcs, five distinct volcanic belts can be defined, namely: (i) the Luzon Volcanic Arc corresponding to the Manila Trench, (ii) the East-Philippine Volcanic Arc associated with the Philippine Trench, (iii) the Negros-Panay Arc linked to the Negros Trench, (iv) the Sulu-Zamboanga Arc formed by the Sulu Trench, and (v) the Cotabato Arc related to the Cotabato Trench. There is no volcanic arc corresponding to the East Luzon Trough. In a similar manner, the East Philippine Arc is well defined only from Bicol to Leyte but cannot be traced in eastern Mindanao. In Mindanao, the active volcanic chain that includes the highest peak in the archipelago, Mount Apo and the other volcanic cones in central Mindanao, are located more than 100 km away from any active subduction zone (e.g. Philippine Trench).

Nine individual basins can be distinguished within the Philippine Mobile Belt. These are the (i) Ilocos-Central Luzon Basin, (ii) Cagayan Valley Basin, (iii) Southern Luzon-Bicol Basin, (iv) Mindoro Basin, (v) Iloilo Basin, (vi) Visayan Sea Basin, (vii) Samar Basin, (viii) Agusan-Davao Basin, and (ix) Cotabato Basin.

The Agusan-Davao Basin

Among the sedimentary basins of the Philippine Mobile Belt, the Agusan-Davao basin has the thickest sedimentary fill, in places attaining a thickness of more than 12,000 m (Ranneft and others, 1960). It is formed over a mixed basement composed of ophiolitic and metamorphic rocks of unknown age, of pre-Oligocene arcs and Eocene limestones. The sedimentary fill is composed of Upper Oligocene - Lower Miocene limestones, followed by alternating layers of conglomerates, sandstones, shales and sometimes thin Middle

Miocene carbonaceous layers (refer to **Figure 2.2.2-7**). The Pliocene-Holocene cover is dominated by shallow marine deposits upgrading into fluviatile facies. The Agusan Davao-Basin follows a N-S trending axis and is traversed longitudinally by the Philippine Fault.

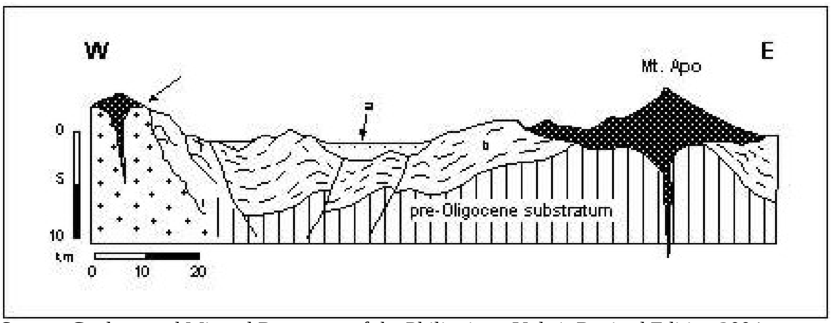


Source: Geology And Mineral Resources of The Philippines, Vol. 1, Revised Edition 2004.

FIGURE 2.2.2-1. SCHEMATIC SECTION ACROSS THE AGUSAN-DAVAO BASIN

The Cotabato Basin

The Cotabato Basin is another sedimentary basin in the island of Mindanao. It is located between the active volcanic arcs of Cotabato and central Mindanao (refer to **Figure 2.2.2-2**). The general stratigraphy is similar to that of the Agusan-Davao Basin, except that the Upper Miocene - Pleistocene portion is more exposed. This layer of the basin is composed mainly of relatively undeformed shallow marine deposits dominated by conglomerates, sandstones and shales, grading into deltaic and fluviatile characters towards the south. The more deformed lower sequence is principally composed of volcaniclastics with minor intercalations of limestones. Ranneft and others (1960) put the thickness of the sedimentary fill at about 8,000 m.



Source: Geology and Mineral Resources of the Philippines, Vol. 1, Revised Edition 2004.

FIGURE 2.2.2-2. SCHEMATIC SECTION ACROSS THE COTABATO BASIN

2.2.3 The Philippine Fault and Other Active Faults

The term "Philippine Fault" refers to a fault zone cutting almost the whole length of the archipelago. It has long been the subject of discussion especially regarding its exact trace, the rate at which it is moving and its geodynamic significance. The fault and its branches traverse the Philippines from Luzon to the north to Mindanao southwards, cutting across Bicol and the Visayas. As it traverses the whole length of the archipelago, the Philippine Fault presents at least three varying structural regimes. Consequently, three major segments can be distinguished according to structural character and data availability. These are the (i) Northern Segment – NW Luzon to Lamon Bay, (ii) Central Segment – Bondoc Peninsula to Leyte, and (iii) Southern Segment – Mindanao and the Moluccas.

The Southern Segment of the Philippine Fault – Mindanao and the Moluccas

The existence and character of the Philippine Fault in Mindanao are up to present very controversial. Field studies coupled with remote sensing data (Pubellier and others, 1991) show that the fault bounds the eastern flank of the Agusan-Davao Basin. In Surigao, the fault strikes N10-20°W. In Davao, it strikes practically N-S. In Surigao, a relay zone between two branches of the fault gives rise to a pull-apart feature expressed by the present-day Lake Mainit.

South of the lake, the Lianga Fault branches out southeastwards towards the Philippine Trench. Further south in Davao del Norte, the southeast-trending Mati Fault serves as the southern most branch of the fault. Recent GPS measurements (Aurelio, 2001) indicate a southward decrease in slip rate along the fault from around 2.4 cm/yr in Surigao to to about 1.0 cm/yr in Davao.

Extensive structural investigations by Quebral (1994) show that the Philippine Fault traverses a sedimentary basin (Agusan-Davao) developed over a single pre-Oligocene volcanic arc. This observation is inconsistent with the hypothesis that considers the Philippine Fault as having been inherited from an old suture zone allegedly arising from the collision of two volcanic arcs (Roeder, 1977; Silver and Moore, 1978 a and b; Moore and Silver, 1983; Hawkins and others, 1985; Florendo, 1987). It appears instead that in Mindanao, the fault reactivates old normal faults related to the formation of the Agusan-Davao Basin and that further to the south, it traverses the basin, the basement and the old volcanic arcs.

The Mindanao Fault

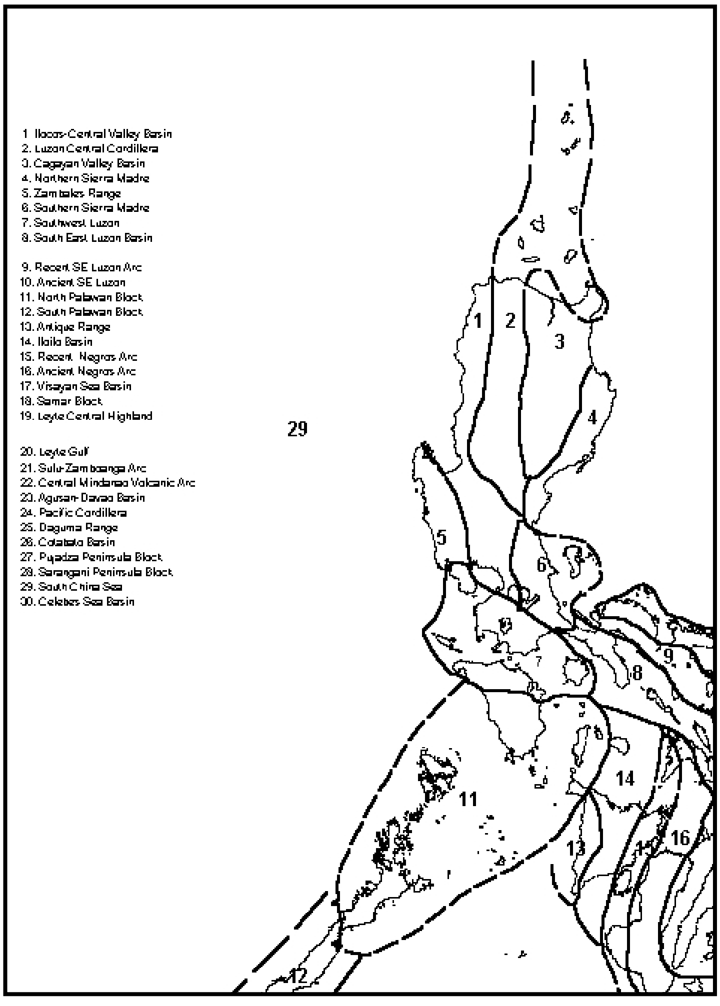
The Mindanao Fault is a prominent NW-trending linear fracture zone on the western third of Mindanao Island. It has two distinct segments, including that which separates the Daguma Range from the Cotabato Basin corresponding to the Cotabato Fault segment. This segment is highly linear and has features suggestive of normal faulting although it may have been a left lateral strike slip fault during its early history.

The Quaternary Mt. Parker volcano is located at the western end of this fault and, on radar images, seems to be cut by the fault. Terraces formed by Quaternary limestone mark the Daguma Range. These, together with the young morphology of incised river valleys, suggests a young age for the fault along which the Daguma Range was uplifted. Although Quaternary in age, it still has to be ascertained whether the fault is active or not (Quebral, 1994).

The Sindangan Fault segment represents the northern continuation of the fault towards northern Zamboanga. Focal mechanism solutions of earthquakes offshore and narrow shear zones transecting recent gravel deposits suggest active left-lateral faulting (Pubellier and others, 1991).

2.2.4 Stratigraphy and Petrology in the Philippines

The authors of the revised edition of the Geology and Mineral Resources of the Philippines (2004) improved the presentation of stratigraphy and petrology of specific areas in the Philippines according to their affinity to stratigraphic groupings (refer to **Figure 2.2.4-1**).



Source: Geology and Mineral Resources of the Philippines, Vol. 1, Revised Edition 2004.

FIGURE 2.2.4-1. STRATIGRAPHIC GROUPINGS IN THE PHILIPPINES

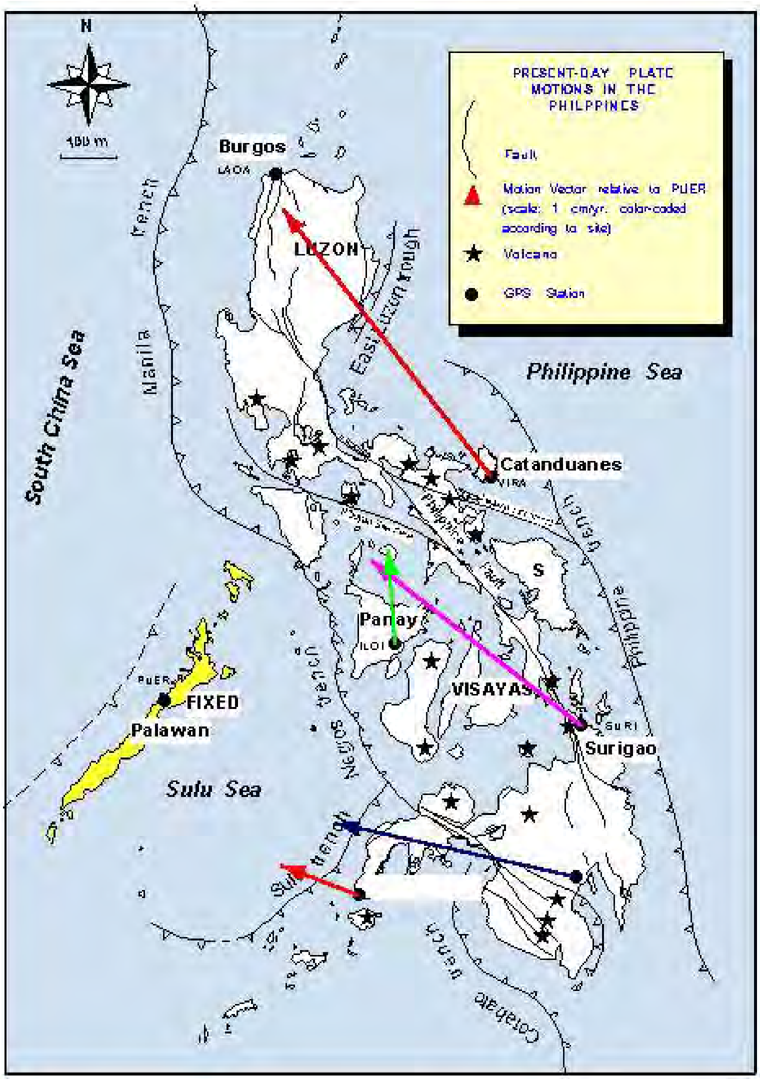
Stratigraphic Groupings correspond to areas with distinct stratigraphic character, which can be distinguished from those of adjacent areas. A brief summary of the said stratigraphic grouping is presented in **Table 2.2.4-1.** Shaded portions of the table correspond to stratigraphic groupings in the island of Mindanao.

TABLE 2.2.4-1 SUMMARY OF STRATIGRAPHIC GROUPINGS IN THE PHILIPPINES

SG No.	Name	Dominant Stratigraphic Character	Major Areas Covered
1	Ilocos-Central Luzon Basin	Sedimentary basin	Ilocos West Central Valley East Central Valley
2	Luzon Central Cordillera	Arc	Central Cordillera and Batanes group of islands
3	Cagayan Valley Basin	Sedimentary basin	Cagayan Valley
4	Northern Sierra Madre	Arc / Ophiolitic	Northern Sierra Madre
5	Zambales Range	Ophiolitic / Arc	Zambales Range
6	Southern Sierra Madre	Arc / Ophiolitic	Southern Sierra Madre
7	Southwest Luzon Uplands	Arc	Southwestern Luzon Marinduque Island Northern Mindoro
8	Southeast Luzon Basin	Sedimentary Basin / Arc	Bondoc Peninsula Masbate island group
9	Recent Southeast Luzon Arc	Arc	Southeast Luzon
10	Ancient Southeast Luzon Arc	Arc	Southeast Luzon
11	North Palawan Block	Continental / Metamorphic	Southern Mindoro North Palawan Northwest Panay Romblon island group
12	South Palawan Block	Ophiolitic	South Palawan
13	Antique Range	Ophiolitic / Metamorphic	Westen Panay
14	Iloilo Basin	Sedimentary Basin	Central Panay
15	Ancient Negros Arc	Arc	Eastern Panay Southwest Negros
16	Recent Negros Arc	Arc	Central Negros
17	Visayan Sea Basin	Sedimentary Basin	Eastern Negros Cebu Bohol Northwest Leyte
18	Samar Block	Sedimentary Basin / Arc	Samar
19	Leyte Central Highlands	Arc / Ophiolitic	Leyte
20	Leyte Gulf	Ophiolitic	Northeast Leyte Southern Samar Dinagat island group
21	Sulu-Zamboanga Arc	Arc	Sulu Archipelago Zamboanga – Misamis Occidental
22	Central Mindanao Arc	Arc	Central Mindanao
23	Agusan-Davao Basin	Sedimentary Basin	Agusan-Davao Valley
24	Mindanao Pacific Cordillera	Arc / Ophiolitic / Basin	Eastern Mindanao
25	Daguma Range	Arc	Western Cotabato
26	Cotabato Basin	Sedimentary Basin	Cotabato Valley
27	Saranggani Block	Arc	Saranggani Peninsula
28	Pujada Block	Ophiolitic	Pujada Peninsula
29	South China Sea Basin	Oceanic Crust / Basin	South China Sea
30	Sulu Sea Basin	Oceanic Crust / Basin	Sulu Sea
31	Celebes Sea Basin	Oceanic Crust / Basin	Celebes Sea
32	Philippine Sea Basin	Oceanic Crust / Basin	Philippine Sea

2.2.5 Present Day Plate Motions in the Philippines

Global Positioning System (GPS) measurements performed every two years since 1994 over a 42-station network distributed in Southeast Asia under the Project GEODYSSEA (GEODYnamics of South and SouthEast Asia) provided data for the analysis of the present-day motion of tectonic blocks in and around the Philippines. Motion vectors in the archipelago and vicinity are in the order of a few to several cm/yr. When micro-continental Palawan is held fixed, the slowest movements can be detected in Zamboanga at less than 2 ± .15 cm/yr westwards (See **Fig. 2.2.5-1**). Virac Island moves the fastest at over 7 ± .17 cm/yr northwestwards. Slower but comparable rates are detected between Surigao, Davao and Zamboanga. The largest extensional strain rate is detected on a NW-SE direction in NW Panay.



Source: Geology and Mineral Resources of the Philippines, Vol. 1, Revised Edition 2004.

FIGURE 2.2.5-1. MOTION VECTORS IN THE PHILIPPINES DEDUCED FROM GPS MEASUREMENTS

Southern Philippines

A strong westerly relative plate motion component is observed on the southernmost station in Davao. This direction is almost perpendicular to the Philippine Fault and Cotabato Trench but oblique to the Cotabato Fault Zone. While this may imply frontal subduction along the trench, the computed motion vector may also mean that there is practically no lateral movement along the Philippine Fault along this segment.

Further north in Nabunturan town, however, there are clear indications of recent activity along the fault (e.g. overturned Holocene alluvial deposits, Pleistocene anticlines cut by fault) while to the south in Mati and offshore Pujada, earthquakes possibly generated by a branch of the fault there, have been recorded for the past 100 years. From the Surigao station in the north of Mindanao Island, a significant movement of the Philippine Fault in the order of 2 cm/yr is registered.

To the west, it is interesting to note the occurrence of the Cotabato Fault, a prominent NW-SE trending structure also believed to be a left-lateral strike-slip fault (Pubellier and others, 1991; 1993), located behind the east-dipping Cotabato Trench. Seismicity along this subduction area is fairly high, although it is only known to occur on the northern segments of the Cotabato Fault Zone.

2.2.6 Active Volcanoes in the Philippines

Volcanic activity has been continuously active since Cretaceous times as suggested by the presence of magmatic belts of Cretaceous, Eocene, Oligo-Miocene and Plio-Holocene ages. At present, the Philippine Institute of Volcanology and Seismology lists 22 active volcanoes and 27 inactive ones in the archipelago. Please refer to **Tables 2.2.6-1** and **2.2.6-2,** respectively. Shaded entries refer to those located in the island of Mindanao.

TABLE 2.2.6-1. LIST OF ACTIVE VOLCANOES OF THE PHILIPPINES

No.	Name of Volcano	No. of Historical Eruptions	Date of Last Eruption / Known Activity	Location
1	Babuyan Claro	4	1917	Babuyan Island
2	Banahaw	3	1843	Laguna-Quezon Province
3	Biliran	1	1939	Biliran Island
4	Bud Dajo	2	1897	Jolo Island, Sulu
5	Bulusan	15	1995	Sorsogon
6	Cagua	2	1907	Cagayan
7	Camiguin de Babuyanes	1	1857	Babuyan Island Group
8	Canlaon	25	1996	Negros Oriental
9	Didicas	6	1978	Babuyan Island Group
10	Hibok-Hibok	5	1953	Camiguin Island
11	Iraya	1	1454	Batan Island, Batanes
12	Iriga	2	1642	Camarines Sur
13	Leonard		1,800 yrs ago	Davao
14	Makaturing	10	1882	Lanao del Sur
15	Matutum	1	1911	South Cotabato
16	Mayon	47	2001	Albay
17	Musuan (Calayo)	2	1867	Bukidnon
18	Parker	1	1640	South Cotabato
19	Pinatubo	3	1991	Zambales-Pampanga-Tarlac
20	Ragang	8	1916	Lanao del sur-Cotabato
21	Smith	5	1924	Babuyan Island
22	Taal	33	1977	Batangas

Source: PHIVOLCS (2002)

TABLE 2.2.6-2. LIST OF INACTIVE VOLCANOES OF THE PHILIPPINES

No.	Name of Volcano	Location
1	Apo	Davao
2	Balut	Davao
3	Cabalian	Southern Leyte
4	Cancajanag	Central Leyte
5	Corregidor	Bataan
6	Cuernos de Negros	Negros Oriental
7	Dakut	Sulu
8	Gorra	Sulu
9	Isarog	Camarines Sur
10	Kalatungan	Bukidnon
11	Labo	Camarines Sur
12	Lapac	Sulu
13	Malinao	Albay
14	Malindig (Marlanga)	Marinduque
15	Mandalagan	Negros Occidental
16	Maripipi	Leyte
17	Mariveles	Bataan
18	Natib	Bataan
19	Negron	Zambales
20	Parang	Sulu
21	Parangan	Sulu
22	Pitogo	Sulu
23	San Cristobal	Laguna-Quezon
24	Silay	Negros Occidental
25	Sinumaan	Sulu
26	Tukay	Sulu
27	Tumatangas	Sulu

Source: PHIVOLCS (2002)

2.3 METEOROLOGY

2.3.1 Climate

The Philippines, with an almost N-S orientation is located in southeast Asia with 4.7ºN to 21.5ºN latitude and 117ºE to 127ºE longitude. Climate over any particular area in the country is due to what is called, climatic controls interacting in various intensities and in different combinations. Among these are the (i) topography and geography of the place, (ii) the prevailing wind regimes (the northeast monsoon, southwest monsoon, and the North Pacific trades), (iii) semi-permanent cyclones and anticyclones which produce/cause wind regimes over the country, (iv) ocean currents, (v) various linear systems, and (vi) various tropical cyclones occurring in/affecting the country.

Climate has always been described in terms of rainfall distribution received in each locality. Using the Updated Modified Corona's classification, four (4) types of rainfall distribution in the country are defined with the use of the average monthly distribution of rainfall at the different stations. **Figure 2.3.1-1** shows a topographical presentation of these four (4) types.

Types of Rainfall Distribution in the Philippines

Type 1 refers to areas with two pronounced season, dry from December to May, and wet from June to November. Maximum rain period is from June to September. Areas characterized by this type are in general exposed to the southwest monsoon and get a fair share of rainfall brought about by tropical cyclones, occurring particularly during the maximum rain period. These are generally found along the western portions of the country.

Type 2 are for those areas with no dry season with very pronounced maximum rain period in December and January, although there is not a singly dry month. Areas characterized by this climatic type are exposed to the northeast monsoon being generally located along or very near the eastern coasts.

Type 3 refers to areas with no pronounced maximum rain period, with a short dry season lasting only from one to three months. This type is intermediate between Types I and 2, although it resembles the first more closely because of its short dry season. Areas of this type are partly shielded from the northeast monsoon but are exposed to the southwest monsoon, and also benefit from rainfall caused by tropical cyclones.

Type 4 are for those areas with rainfall more or less evenly distributed throughout the year. This resembles the second type more closely since it has no dry season.

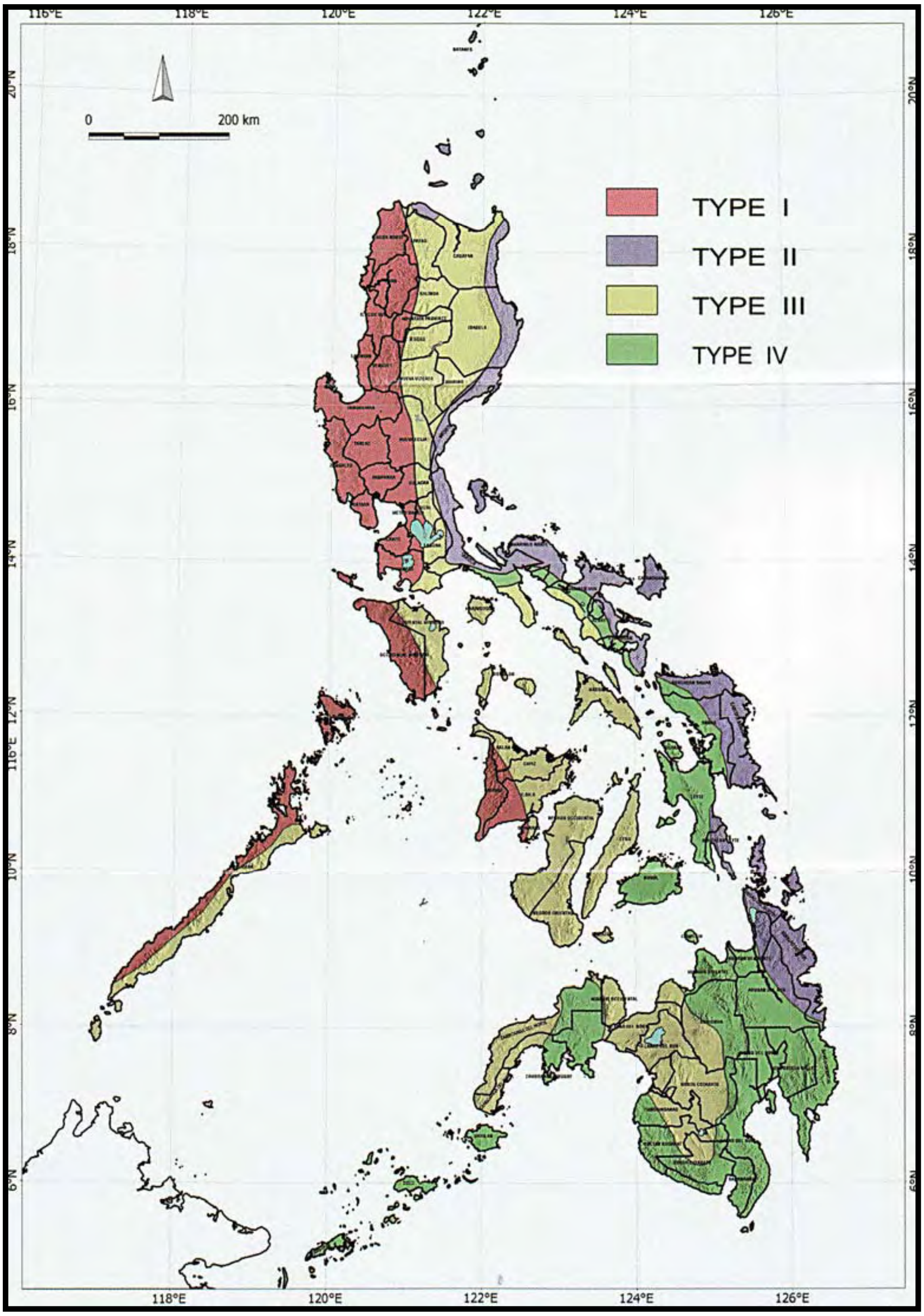


FIGURE 2.3.1-1. CLIMATE MAP OF THE PHILIPPINES

Note; Based on the Updated Modified Coronas Classification.

2.3.2 Rainfall and Temperature

Based on a recent study by PAGASA, about 50% of the annual average rainfall in the Philippines is attributed to the occurrence of tropical cyclones in its vicinities. Wettest parts consist of the northernmost part of Cagayan, Infanta, Polilio Island, eastern coasts of Leyte Island, Siargao Island, and Surigao del Sur with annual average rainfall of more than 4,000 mm. On the other hand, driest are the valleys in the Cordillera and the Sierra Madre ranges, the Central Plains of Luzon, Bataan, Batangas, Palawan, most parts of Region VII (southern portion of Cebu, most parts or Negros Oriental, and Bohol), the entire southern part of Mindanao including the southern tip of Zamboanga provinces and Basilan, Lanao del Norte, Misamis Occidental and parts of Misamis Oriental.

Average monthly and annual rainfall obtained from various weather stations in the Study Area are presented in **Table 2.3.2-1**. Average monthly and annual temperatures are provided in **Table 2.3.2-2**.

TABLE 2.3.2-1 AVERAGE MONTHLY AND ANNUAL RAINFALL IN THE STUDY AREA

Month	PAGASA Weather Stations					
	Malaybalay, Bukidnon	Gen Santos South Cotabato	Zamboanga Zamboanga Sur	Cotabato City	Lumbia Airport Misamis Or	MSU Marawi City Lanao del Sur
Period	1971-2000	1971-2000	1971-2000	1986-2000	1977-2000	1969-2001
Jan	181.3	67.0	43.6	74.1	82.8	117.3
Feb	133.3	60.6	54.1	75.5	65.0	115.3
Mar	131.0	41.7	44.4	117.4	44.8	94.3
Apr	129.4	55.4	56.6	135.5	58.1	93.9
May	231.1	65.9	80.2	246.7	109.8	185.4
Jun	316.9	114.5	134.9	276.1	207.7	246.1
Jul	329.4	101.4	154.8	255.3	244.1	216.4
Aug	301.4	82.0	131.1	232.8	205.2	187.8
Sep	302.8	85.4	144.6	203.5	204.4	206.9
Oct	315.6	101.8	188.8	228.6	188.1	188.0
Nov	187.1	82.2	120.8	237.6	138.6	148.7
Dec	181.5	67.7	62.2	93.5	105.8	128.9
ANNUAL	**2,741.0**	**925.6**	**1,216.1**	**2,176.5**	**1,654.4**	**1,929.1**

Source: Climatological Normals, PAGASA. February 2009

TABLE 2.3.2-2. AVERAGE MONTHLY AND ANNUAL TEMPERATURE IN THE STUDY AREA

Month	PAGASA Weather Stations					
	Malaybalay, Bukidnon	Gen Santos South Cotabato	Zamboanga Zamboanga Sur	Cotabato City	Lumbia Airport Misamis Or	MSU Marawi City Lanao del Sur
Period	1971-2000	1971-2000	1971-2000	1986-2000	1977-2000	1969-2001
Jan	23.2	27.5	27.6	28.0	25.4	22.2
Feb	23.3	27.7	27.7	28.0	25.6	22.2
Mar	23.8	28.3	28.1	28.5	26.2	23.0
Apr	24.7	28.6	28.4	28.7	27.3	23.5
May	25.1	28.3	28.5	28.4	27.9	23.7
Jun	24.4	27.4	28.0	27.7	27.3	23.5
Jul	23.9	27.0	27.7	27.6	26.8	23.3
Aug	23.9	27.1	28.0	27.7	27.1	23.3
Sep	24.0	27.3	28.0	27.8	26.9	23.5
Oct	24.1	27.5	27.9	27.7	26.7	23.3
Nov	24.1	27.7	28.0	27.8	26.4	22.8
Dec	23.6	27.6	27.8	27.8	25.7	22.6
Max Annual	**29.5**	**32.9**	**32.3**	**32.8**	**31.2**	**27.2**
Min Annual	**18.5**	**22.5**	**23.7**	**23.2**	**22.0**	**18.7**
ANNUAL AVE	**24.0**	**27.7**	**28.0**	**28.0**	**26.6**	**23.1**

Source: Climatological Normals, PAGASA. February 2009

2.4 NATURAL CALAMITIES

2.4.1 Tropical Cyclones

An annual average of 20 tropical cyclones enter the Philippine Area of Responsibility (PAR); 90% of these affect the country. Winds do most of the damage to structures and settlements. Most casualties result from flooding associated with tropical cyclones. **Table 2.4.1-1** shows the annual frequency of tropical cyclones in the PAR from 1957 to 2007. It is interesting to note that based on records of PAGASA, Mindanao Island excluding the northern part of Surigao Provinces are almost free of tropical cyclones. Among the provinces in the Visayas and Luzon Islands, Northern Samar and Masbate, followed by Mindoro Island have the most number of tropical cyclone passages, respectively.

TABLE 2.4.1-1 FREQUENCY OF TROPICAL CYCLONE PASSAGES IN THE PHILIPPINES (1957-2007)

Year	Tropical Depression	Tropical Storm	Typhoon	TOTAL
1957	2	3	10	15
1958	3	1	13	17
1959	1	5	12	18
1960	2	5	12	19
1961	6	8	9	23
1962	4	4	13	21
1963	2	6	8	16
1964	7	8	15	30
1965	4	6	11	21
1966	6	6	10	22
1967	3	7	11	21
1968	0	5	10	15
1969	3	3	9	15
1970	6	6	9	21
1971	4	10	13	27
1972	9	2	6	17
1973	3	4	5	12
1974	4	12	7	23
1975	3	2	9	14
1976	6	6	10	22
1977	5	6	8	19
1978	10	7	8	25
1979	3	6	13	22
1980	9	5	9	23
1981	5	7	11	23
1982	3	6	11	20
1983	3	11	9	23
1984	6	4	9	19
1985	2	5	10	17
1986	2	7	12	21
1987	2	1	13	16
1988	3	7	10	20
1989	2	5	9	19
1990	5	8	8	20

Year	Tropical Depression	Tropical Storm	Typhoon	TOTAL
1991	4	5	13	19
1992	3	4	9	16
1993	10	11	11	32
1994	6	5	13	24
1995	2	9	5	16
1996	3	6	8	17
1997	4	4	6	14
1998	4	2	5	11
1999	5	8	3	16
2000	5	5	8	18
2001	6	7	4	17
2002	5	2	6	13
2003	8	8	9	25
2004	5	7	13	25
2005	11	1	5	17
2006	4	5	11	20
2007	0	4	9	13

Source: PAGASA, 2009

2.4.2 Earthquakes

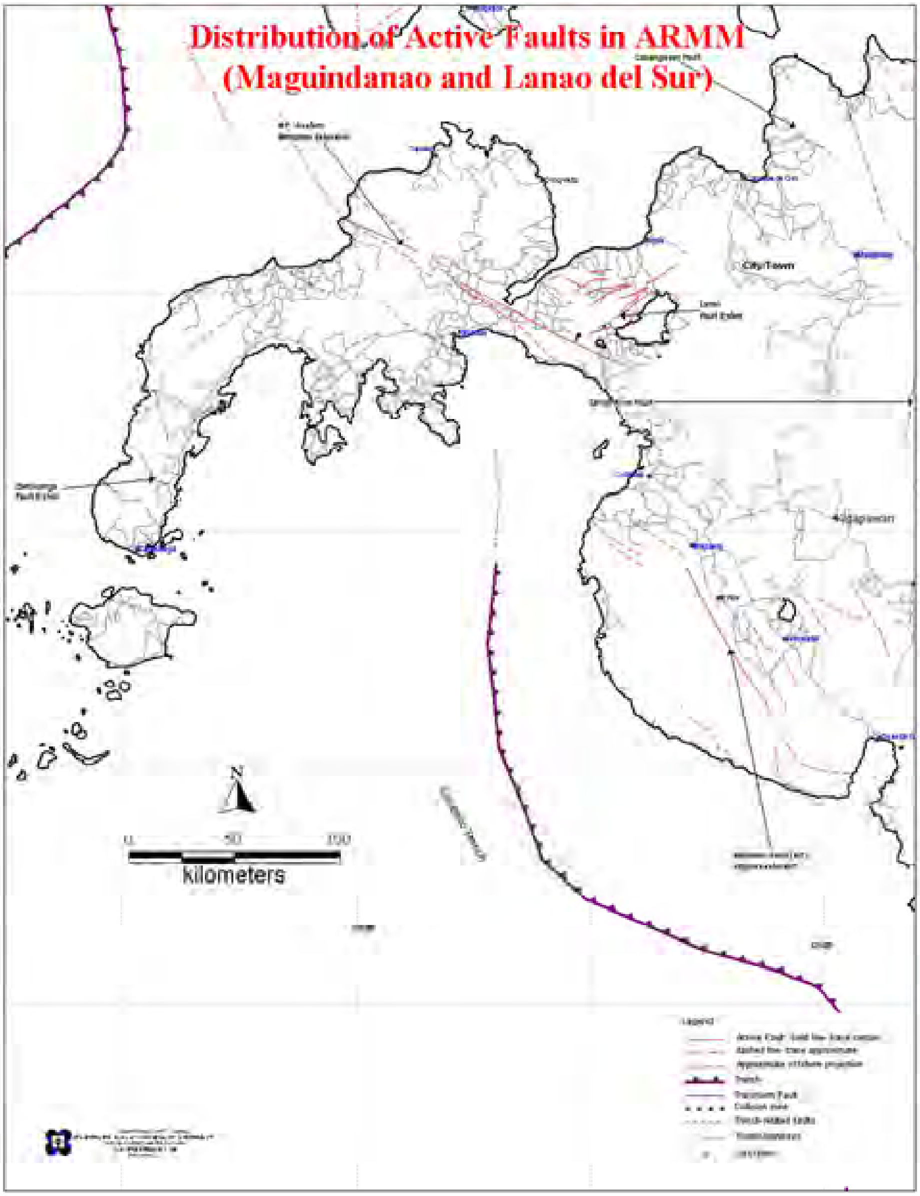
In Mindanao, the latest occurrence of a destructive earthquake was in August 17, 1976. The epicenter was traced at the Moro Gulf, claiming 3,739 lives, and leaving 8,000 people injured. For reference a list of destructive earthquakes from 1968 to 2003 is provided in **Table 2.4.2-1**. **Figure 2.4.2-1** shows the distribution of major earthquake generators---active faults in the entire archipelago. **Figures 2.2.4-2** and **2.2.4-3** on the other hand show the distribution of these active faults in the ARMM Region.

TABLE 2.4.2-1 DESTRUCTIVE EARTHQUAKES IN THE PHILIPPINES (1968-2003)

Date	Magnitude	Location/Name of Earthquake
02 August 1968	Ms7.3	Casiguran Earthquake
17 March 1973	Ms7.0	Ragay Gulf
17 August 1976	Ms7.9	Moro Gulf
17 August 1983	Ms6.5	Laoag Earthquake
08 February 1990	Ms6.8	Bohol Earthquake
14 June 1990	Ms7.1	Panay Earthquake
16 July 1990	Ms7.9	Luzon Earthquake
15 November 1994	Ms7.1	Mindoro Earthquake
27 May 1996	Ms5.6	Bohol Earthquake
07 June 1999	Ms5.1	Bayugan Earthquake
06 March 2002	Ms6.8	Palimbang Earthquake
15 February 2003	Ms6.2	Masbate Earthquake

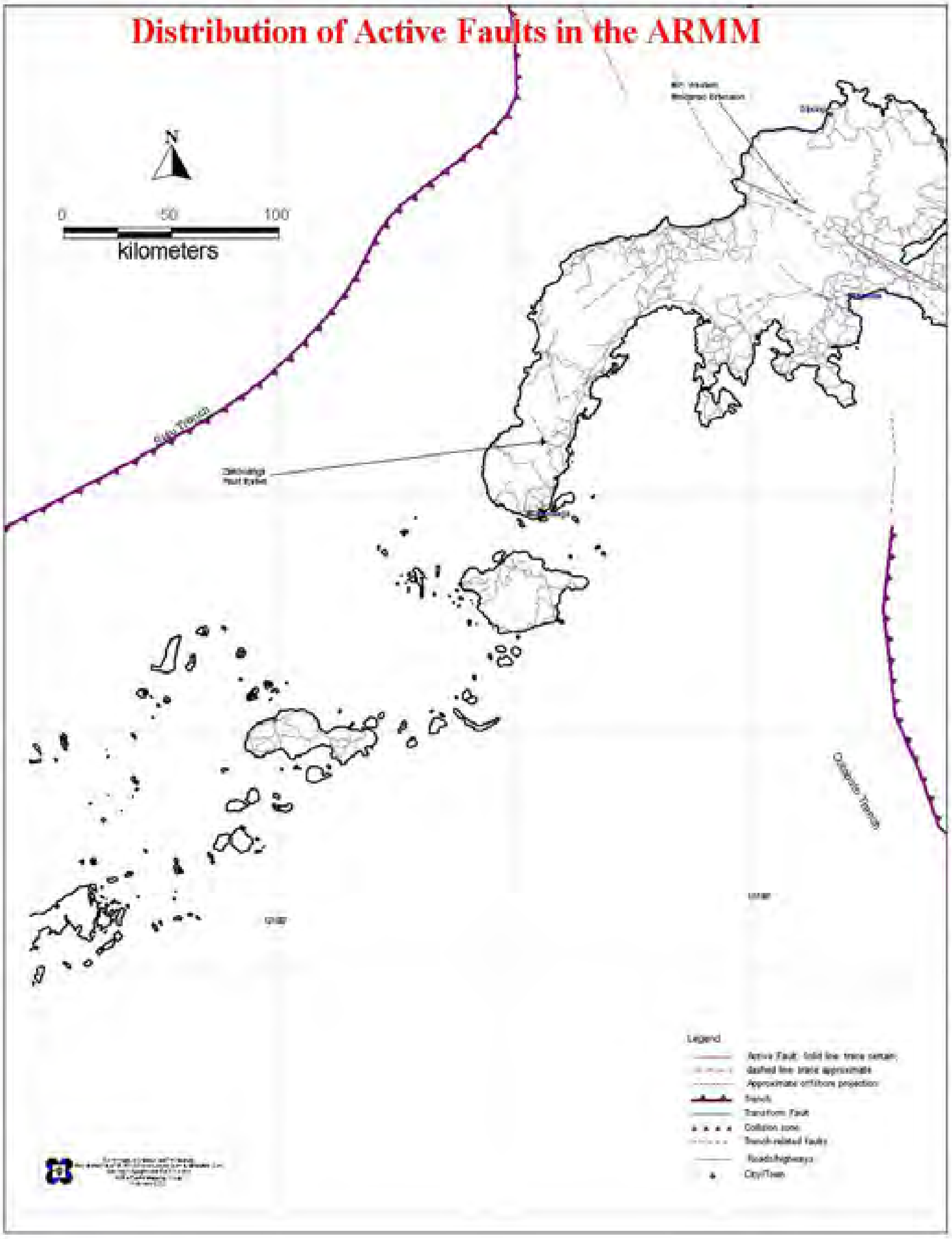
Source: PHIVOLCS

FIGURE 2.4.2-1 MAJOR EARTHQUAKE GENERATORS IN THE PHILIPPINE ARCHIPELAGO



Source: PHIVOLCS

FIGURE 2.4.2-2 MAJOR EARTHQUAKE GENERATORS IN THE ARMM REGION



Source: PHIVOLCS

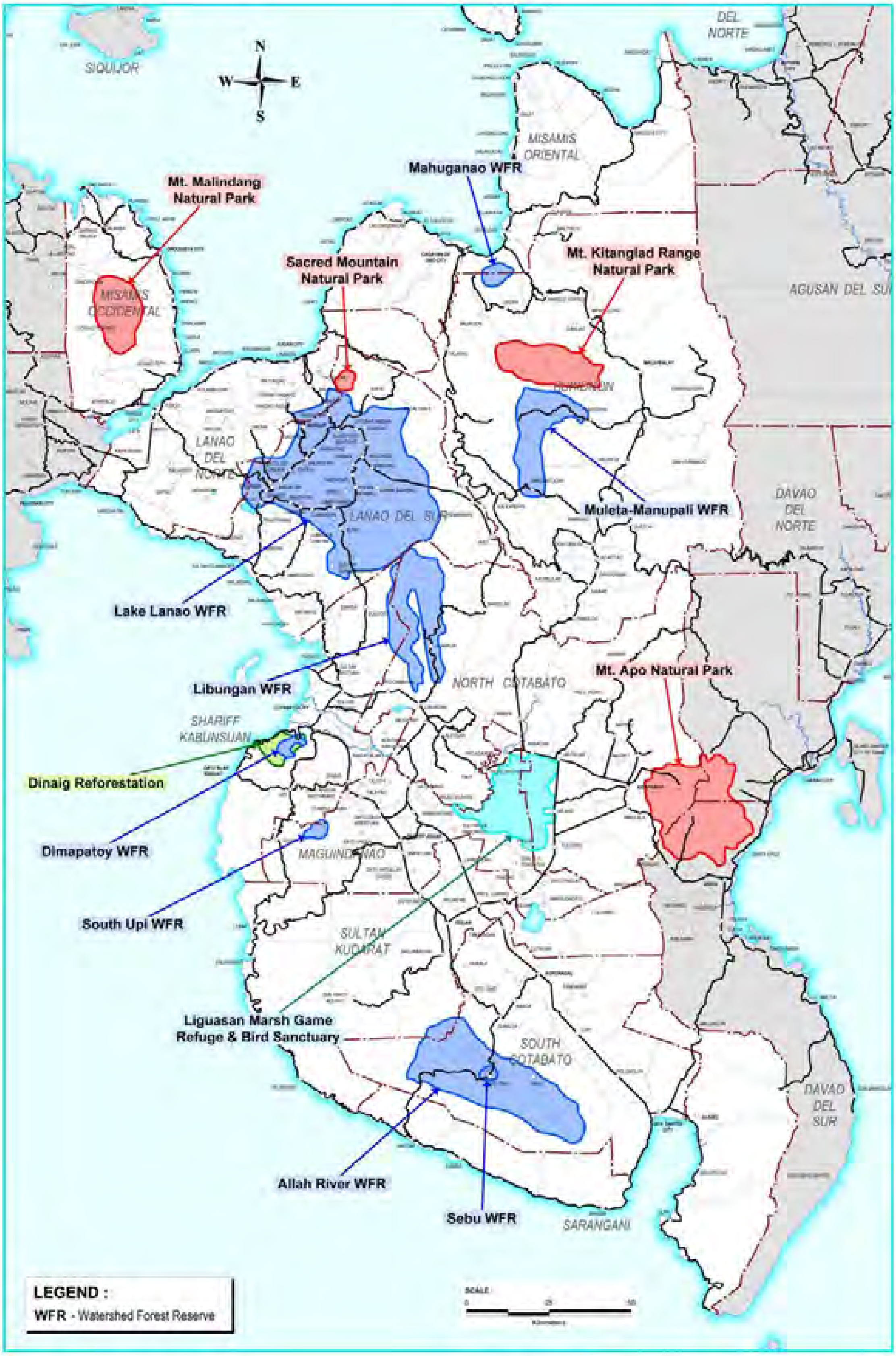
FIGURE 2.4.2-3 MAJOR EARTHQUAKE GENERATORS IN THE ARMM REGION

2.5 PROTECTED AREAS

Protected Areas, as defined by the DENR are "*Identified portions of land and water set aside by reason of their unique physical and biological significance, managed to enhance biological diversity and protected against destructive human exploitation*". In the Study Area there are three (3) main types of Protected Areas, namely (i) Natural Park, (ii) Game Refuge and Bird Sanctuary, and (iii) Watershed Forest Reserve.

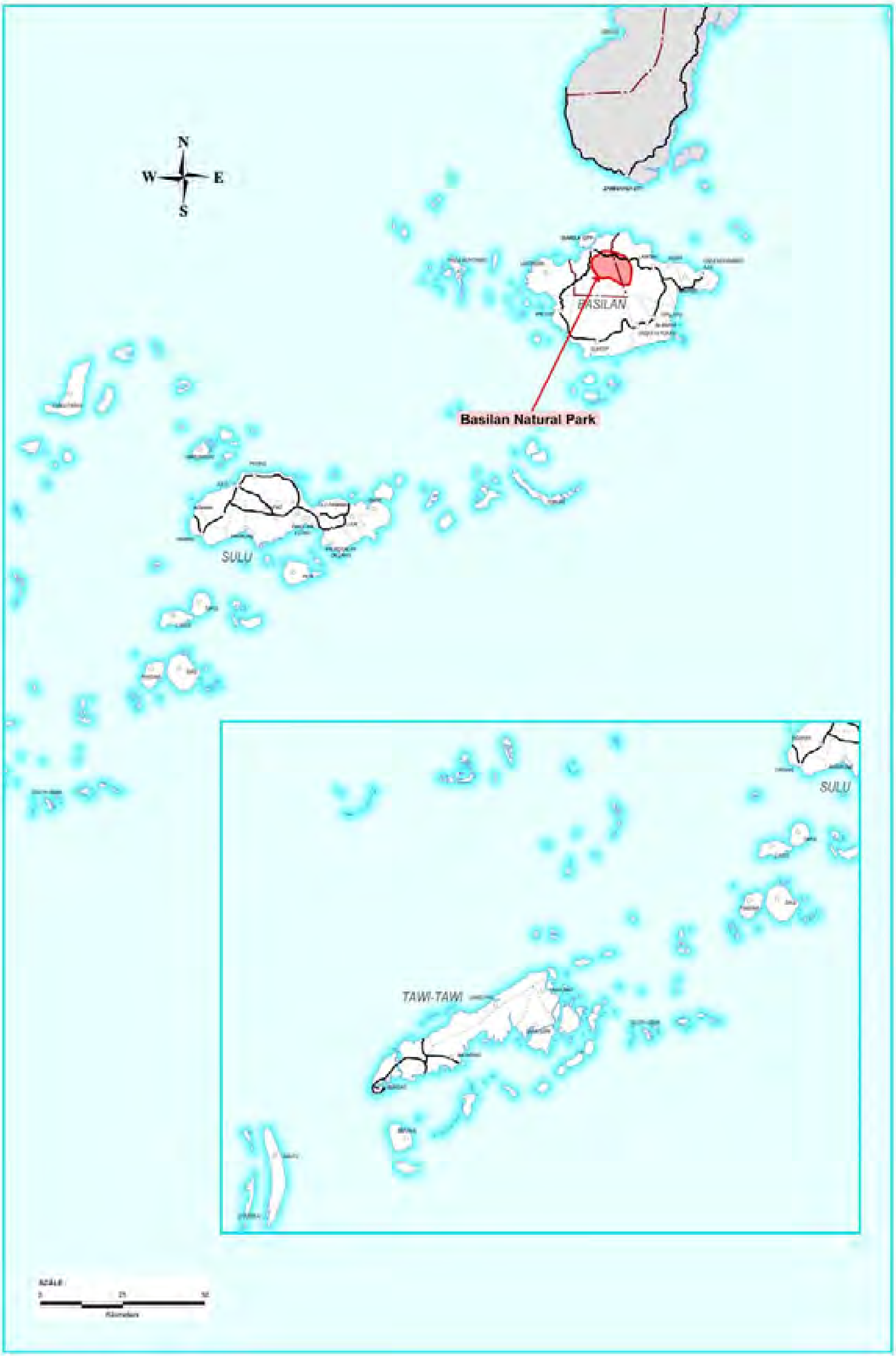
Natural Parks are defined as forest reservation areas essentially of natural wilderness character, which has been withdrawn from settlement, occupancy, or any form of exploitation except in conformity with approved management plan. These areas are set aside as such exclusively to conserve the area or preserve the scenery, the natural and historic objects, wild animals and plants, and thus provide enjoyment of these features in such areas. **Game Refuge and Bird Sanctuary** is a forestland designated for the protection of farm animals, birds and fish and closed to hunting and fishing in order that the excess population may flow and restock the surrounding areas. A **Watershed Forest Reservation** is a forestland reservation established to protect or improve the conditions of its water yield and to reduce sedimentation in the downstream areas.

In Region X, XII, and ARMM mainland consisting of Lanao del Sur, Maguindanao, and Shariff Kabungsuan, there are eight (8) Watershed Forest Reserves, one (1) Game Refuge and Bird Sanctuary, four (4) Natural Parks, and one (1) Reforestation Area (refer to **Figure 2.5-1**). In the ARMM island provinces of Sulu, Basilan, and Tawi-Tawi, there is only one (1) National Park, the Basilan National Park. The rest are mangrove areas for protection found most of the coastal areas in Sulu and Tawi-Tawi (see **Figure 2.5-2)**.



Source: Various records of DENR Region X, Region XII and ARMM

FIGURE 2.5-1 PROCLAIMED PROTECTED AREAS IN REGIONS X AND REGION XII



Source: Various records of DENR-ARMM

FIGURE 2.5-2 PROCLAIMED PROTECTED AREAS IN THE STUDY AREA