No.

DEPARTMENT OF PUBLIC
WORKS AND HIGHWAYS
THE REPUBLIC OF THE
PHILIPPINES

# THE STUDY
# ON
# THE NATIONWIDE FLOOD RISK ASSESSMENT
# AND
# THE FLOOD MITIGATION PLAN
# FOR THE SELECTED AREAS
# IN
# THE REPUBLIC OF THE PHILIPPINES

**FINAL REPORT**

**VOLUME III**
**-SUPPORTING REPORT-**

**MARCH 2008**

JAPAN INTERNATIONAL COOPERATION AGENCY

CTI Engineering International Co., Ltd.

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**COMPOSITION OF FINAL REPORT**

| | |
|---|---|
| VOLUME I | SUMMARY REPORT |
| VOLUME II | MAIN REPORT |
| VOLUME III | SUPPORTING REPORT |
| VOLUME IV | DATA BOOK |

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# THE STUDY ON THE NATIONWIDE FLOOD RISK ASSESSMENT AND THE FLOOD MITIGATION PLAN FOR THE SELECTED AREAS IN THE REPUBLIC OF THE PHILIPPINES

**FINAL REPORT**
**VOLUME III**
**SUPPORTING REPORT**

**A. GENERAL CONDITION**

**B. GIS DATABASE**

**C. SCREENING AND IMPLEMENTATION SCHEDULE**

**D. FIELD SURVEY AND SELECTION OF RIVER BASINS BY THE FIRST SCREENING**

**E. GROUPING AND SELECTION OF MODEL RIVER BASINS**

**F. HYDROLOGIC/INUNDATION ANALYSES AND PRELIMINARY DESIGN FOR MODEL RIVER BASINS**

**G. STRUCTURAL MEASURES**

**H. NON-STRUCTURAL MEASURES**

**I. INITIAL ENVIRONMENTAL EXAMINATION (IEE)**

**J. PROJECT COST ESTIMATE**

**K. ECONOMIC EVALUATION OF STRUCTURAL MEASURES**

# A. General Condition

# Table of Contents

Page

## List of Tables

**Table**



## List of Figure

**Figure**



## List of Tabs.

**Tab.**

## List of Figs.

**Fig.**

# A. GENERAL CONDITION

## 1 SOCIO ECONOMIC CONDITIONS

### 1.1 The Macro Economy

According to the Mid-Term Philippine Development Plan (2004-2010), the economic situation in the Philippines is described as follows:

#### 1.1.1 Growth of GNP

The Philippine economy grew at a respectable pace over the period 2001-2003. This notwithstanding internal fiscal deficit and peace and order issues, which were a concern for investors, as well as external challenges, geopolitical tensions in the aftermath of 9/11, slump in the electronics and information technology sector, severe acute respiratory syndrome (SARS), and continuous increase in the price of oil. The gross national product (GNP), adjusted for price changes, steadily grew from 3.0 percent in 2001 to 4.7 percent in 2003 and to 6.3 percent in the first semester of 2004. Over the period 2001-2003, GNP expanded at an average of 4.5 percent while gross domestic product (GDP) expanded at an average of 4.0 percent. GNP was on track of MTPDP targets, while GDP expanded at a low pace. However, although growth has been respectable, this is more modest compared to those of other Asian countries (Refer to Tab.A-1-1 and Tab.A-1-2).

#### 1.1.2 Key Growth Sector

The key growth driver was services, which expanded at an average rate of 5.1 percent over the period 2001-2003 and to a strong 6.9 percent in the first semester of 2004. The continued expansion in this sector is largely owed to the telecommunications sector as telecommunication companies continue to expand outside of Metro Manila. Added to this are the new investments in the call/contact centers, business process outsourcing (BPOs) and software development.

The trade sector has also performed very well due to strong personal consumer spending, which has been supported by the steady growth of the agriculture sector and remittances of overseas Filipino workers (OFWs) who are now being deployed in higher paying jobs as Information and Communications Technology (ICT) professionals, teachers, and nurses/caregivers.

Agriculture rose at an average of 3.8 percent over the period 2001-2003, which further surged to 6.3 percent in the first semester of 2004. Favorable weather conditions complemented by government programs led to respectable growths in major sub-sectors such as paddy and corn, fishery, poultry and livestock. Prices were also favorable during this period leading to improving farm incomes.

On the other hand, industry growth was more sluggish, expanding at a mere 2.8 percent over the period, although strengthening to 5.6 percent in the first semester of 2004. Growth has been dragged down by the steep cuts in public construction to control the deficit, as well as the difficulty of some

manufacturing industries to compete under increasing global competition. One bright spot was mining, which grew at double-digit rates given favorable international metal prices.

### 1.1.3 Fiscal Deficit

The fiscal deficit emerged as the key macroeconomic problem, as actual performance severely fell short of the targets. The consolidated public sector deficit surged to 5.5 percent of FDP while the National Government deficit rose to 4.6 percent of GDP. Among the 14 monitored non-financial government corporations, the National Power Corporation (NPC), the Light Rail Transportation Authority (LRTA) and the National Food Authority (NFA) had registered the largest deficits. The rising deficit pushed the public sector debt to balloon to 137.5 percent of GDP by 2003.

### 1.1.4 External Balance

Despite the fiscal and domestic debt problem, the country's external balances have remained healthy although the sources of foreign exchange need to be diversified. The current account balance has been positive but this largely comes from remittances of OFWs rather than trade in goods. Recently, however, inflows from contact/call sources and other exports of services have contributed to higher foreign exchange inflows and avoid external payment problems in the future.

### 1.1.5 Unemployment

Unemployment has stayed high, as the number of jobs generated has not been adequate to absorb the influx of labor entrants. Using the official methodology, the unemployment rate stood at 11.4 percent in 2003 despite the 3.2 million jobs generated in 2001-2003. Using the International Labor Organization (ILO)-based definition, unemployment stood at 7.35 percent in 2003, which has barely changed since 2001. Unemployment would have to fall further to significantly reduce poverty.

## 1.2 Population

Based on the Census of Population and Housing conducted decennially by the National Statistics Office, the total population of the Philippines as of May 1, 2000 was 76,504,077 persons (refer to Tab.A-1-3). This was higher by 7,887,541 persons or about 10.31 percent from the 1995 census (with September 1, 1995 as reference date). It was 10 times the Philippine population in 1903 when the first census was undertaken.

The expansion of the Philippine population reflected a 2.36 percent average annual growth rate in the 1995-2000 period. This figure recorded a slight increase from a declining growth rate, which started in the first half of the seventies. The last increase recorded in population growth rates was during the intercensal period 1948 to 1960 at 3.07 percent. The recent growth rate was 0.04 percent higher than the annual growth during the early part of the nineties. If the average annual growth rate continues, the population of the Philippines is expected to double in 29 years.

Similarly, the number of households in the country edged up in 2000. This indicated an increase of 1,770,753 households over the 1995 census. The average household size in 2000 was five persons, a slight decrease from 1995 (5.07 persons).

More than half (55.97 percent) of the 76.5 million total population resided in Luzon with eight regions, followed by Mindanao (23.70 percent) with six regions, and the Visayas (20.30 percent) with only three regions.

Of the regions comprising the Philippine archipelago, Southern Tagalog (Region 4) was the biggest in terms of population size. Southern Tagalog registered a total population of 11,793,655 persons accounting for 15.42 percent of the Philippine population. The National Capital Region (NCR) followed with 9,932,560 persons or 12.98 percent of the total population. Central Luzon (Region 3) registered the third largest population with 8,030,945 persons or 10.50 percent of the total population. These three regions combined comprised 38.90 percent of the total population.

Among the provinces in the country, Pangasinan (2.43 million persons) of Region I (Ilocos), was the largest in terms of population size. Cebu (2.38 million persons), Bulacan (2.23 million persons), Negros Occidental (2.14 million persons) and Cavite (2.06 million persons) followed. These were the provinces that surpassed the two millionth population mark. Of the 21 provinces with more than one million population, 13 provinces were in Luzon, five in the Visayas and three in Mindanao.

On the contrary, the four smallest provinces with less than a hundred thousand population were Batanes (16.5 thousand persons), Camiguin (74.2 thousand persons), Siquijor (81.6 thousand persons) and Apayao (97.1 thousand persons) (Refer to Tab.A-1-4).

### 1.3 Poverty

In the notes on poverty in the Philippines prepared by Dr. Clarence Henderson, the following statement is made:

During the 1990's, the Philippines made significant progress in fighting poverty. According to the Family Income and Expenditure Survey of 1997, poverty incidence fell from 49.3% of the total population in 1985 to 40.6% in 1994 and 36.8% in 1997.

According to an ADB study conducted by Ernie Pernia and Arsenio Balisacan, however, the decline in poverty rates did nothing to improve the country's inequitable income distribution. Despite the more-or-less sustained economic growth from 1985 to 1997, the poorest 20% of the population only improved their income 0.5% for every 1% growth in average income. In other words, they slipped further behind and income inequality became even more extreme.

The absolute gains were attributable to rapid economic growth during the Ramos administration, increased foreign investment, relative political stability, and decent public sector revenues associated with the privatizations introduced as part of the FVR reform agenda.

Although the Philippines escaped the Asian financial crisis in better shape than many of its neighbors, the crisis did have a significant impact, an impact exacerbated by the damage done to the agricultural

sector by the El Niño phenomenon during 1997-98. Rising prices and a weakened labor market, causing poverty to begin edging up again, hard hit both urban and rural sectors. These factors contributed to a major increase in the number of Filipinos earning less than US$276 a year (considered the minimum required to meet basic living requirements here), from 27 million in 1997 to 31 million in 2000 (39.4% of the population).

# 2 NATURAL CONDITIONS

## 2.1 Geography

The Philippine archipelago is geographically located between latitude 4°23'N and 21°25'N and longitude 116°E and 127°E. It is composed of 7,101 islands with a land area of 299,764 $km^2$ starting from the point near the southern tip of Taiwan and ending close to northern Borneo and its breadth is about 965 km. The Philippine coastline adds up to 17,500 km with three prominent bodies of water surrounding the archipelago: the Pacific Ocean on the east, the South China Sea on the west and north, and the Celebes Sea on the south. This position accounts for much of the variations in the geographic, climatic and vegetation conditions in the country (refer to Fig.A-2-1).

Alluvial plains, narrow valleys, rolling hills and high mountains characterize the topography of the bigger islands, particularly, Luzon and Mindanao. The highest mountains are found in Mindanao and Luzon, with altitudes varying from 1,790 m to 3,144 m. Most of the smaller islands are mountainous in the interior, surrounded by narrow strips of discontinuous flat lowlands, which constitute the coastal rims. The shorelines of both large and small islands are irregular.

The Philippines' fertile land accounts for the more than 900 species of orchids representing 100 genera that have been found. The sampaguita is the national flower. Among the country's fauna are some endangered species like the Philippine Eagle, the tarsier and the mouse dear.

Metro Manila is strategically located in the middle of Luzon, on the eastern coast of Manila Bay and at the mouth of the Pasig River, sprawled over an area of 626 $km^2$. The City of Manila sits in the middle of a swampy deltaic plain formed by accumulated sedimentary deposits form the Pasig River and other streams. The city is between the bay to the West, the highlands to the East, and Laguna de Bay to the Southeast. Most of its densely populated areas are found along the Pasig River that runs across the metropolis dividing it into two sections, the north and the south.

## 2.2 Climate

The Philippines has a tropical climate. At sea level, temperatures rarely fall below 27°C. The country experiences an average temperature ranging from 28°C to 36°C and humidity varies from 70% to 85% depending on the time of year. Interior valleys and leeward sides of islands tend to be warmer, while mountain slopes and peaks and windward sides of islands tend to be cooler.

The highest annual rainfall amount (9,006 mm) in the country was recorded in Baguio City in 1910 and the lowest (94.2 mm) in Vigan City, Ilocos Sur in 1948. Rainfall averages about 2,030 mm a year,

with more precipitation in coastal plains than in sheltered inland valleys. In the western part of the country, the rainy season occurs during the summer monsoon, from May to November, when the wind blows from the southwest; the dry season occurs during the winter monsoon, from December to April, when the wind blows from the northeast. In contrast, the eastern side of the country receives most of its rainfall during the winter monsoon and has no true dry season.

Tropical storms are common from June to October. About 20 typhoons strike the Philippines every year, mostly on the eastern coasts of Luzon and Samar, bringing high winds and flooding that sometimes result in property damage and loss of life.

The classification of climate is basically based on rainfall characteristics rather than temperature variations. The rainfall variability, topography and air stream direction define the climate at different parts of the country. As shown in Fig.A-2-2, the various areas in the Philippines are thus characterized by four types of climates, which are based on dry and wet seasons induced by minimum or maximum rain periods, according to the modified Corona's Climate Classification:

Type I : Two pronounced seasons, dry from November to April, wet during the rest of the year;

Type II : No dry season with a very pronounced maximum rainfall period from November to January;

Type III : Seasons are not very pronounced with relatively dry season from November to April and wet season during the rest of the year; and

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

Rainfall in the Philippines is brought about by different rainfall-causing weather patterns such as air streams, tropical cyclones, the Intertropical Convergence Zone (ITCZ), fronts, easterly waves, local thunderstorm, etc. About 47% of the average annual rainfall in the country is attributed to the occurrence of tropical cyclones, 14% to the monsoons while 39% are due to the effects of the other weather disturbances. The significance of each of these climatic influences varies with the time of the year.

Tropical cyclones are characterized by a low-pressure center where winds of varying intensities blow around this center. The tropical cyclones are the most destructive weather disturbances because they are accompanied by strong winds aside from large amounts of rains. They contribute largely to the rainfall from May to December and result to annual maximum quantities in many areas of the country especially in Luzon and Visayas. Tropical cyclones are classified according to maximum wind speed near the center as follows:

Tropical Depression (TD) - winds with speeds from 45 to 63 kph;

Tropical Storm (TS) - winds with speeds from 63 to 117 kph; and

Typhoon (T) - winds with speeds of more than 117 kph.

Fig.A-2-3 illustrates the monthly representative typhoon tracks and probability of occurrence within the Philippine area of responsibility (PAR).

The ITCZ is a series of cloudiness that oscillates from May to October. It typically appears in the southwestern portion of the archipelago in May and moves north reaching its northernmost position in July or August. It begins moving back southward in August, moving south of the Philippines by November, and its southernmost position in January and February. Several floods in Mindanao are caused by the ITCZ.

The monsoons are wind flows coming from the northeast or southwest. The northeast and southwest monsoons trigger the onset and recession of the rainy season in the Philippines. The southwest monsoon may begin as early as mid-April and end as late as early November, depending on location, while the northeast monsoon may affect the country from November to March. The eastern coastal areas have a marked rainy season from October to March when the northeast monsoon is dominant. During the period from May to October when the southwest monsoon and tropical cyclone seasons are dominant, the western coastal areas receive heavy rainfall that may trigger flooding and landslides.

Topography also modifies the climate of a locality. In general, the windward side of a mountain receives more precipitation due to topographic effect compared with the leeward side. Maximum rainfall is also observed at intermediate elevations. When a rapid change in elevation occurs, a "splash effect" usually occurs and results to significant rainfall. The "splash effect" is a phenomenon that results when cold air moves down slope from precipitating clouds and causes the formation of another cloud at a lower elevation.

Another weather disturbance that effect the eastern sections of the Philippines from November to late April or early May is the cold front. The cold front coupled with topography produce rainfall along the eastern coasts and occasionally over the middle and western portions of the country. Other rainfall-producing systems are the easterly waves, which are frequent in summer and affect the mountainous and eastern coastal areas. Thunderstorms are localized, or small-scale disturbances that produce considerable amount of rainfall occur over a relatively short period of time.

## 2.3 Geology

The Philippine archipelago could be considered as wedges caught between two oppositely dipping subduction zones (see Fig.A-2-4 for the geological map of the Philippines). The North and Central Luzon are situated between the Manila Trench and the East Luzon Trench. These trenches are interpreted as subduction zones where the ocean submarine floor under thrusts beneath the continental or island massif. A similar situation can be observed in the Visayas Shelf between the Sulu-Negros Trench and the Philippine Trench.

Trending toward NNW to N direction, the alignment of these trenches (especially the two major ones, Philippine Trench and East Luzon Trench) characterizes the Philippine Archipelago as a zonal structure with several wide belts connecting island to island arch-wise in the same trend with trenches.

The archipelago consists essentially of two separable and distinct structural units, a mobile belt and a stable region. The mobile belt covers almost all the archipelago and is characterized by the concentration of earthquake epicenters, numerous active and inactive volcanoes and deeply sheared zone forming narrow canyons, intermountain basins and straits. The stable region, which embraces mainly Palawan and Sulu Sea in the southwestern part of the country, is essentially seismic and shows the virtual absence of Tertiary igneous activity.

Great variety of rocks exists in the country: igneous, sedimentary and metamorphic. Basement complex is generally made up of gabbro, andesites, agglomerates, serpentine, greisses, schist, volcanic breccias, volcanic tuff, quartzite and basalt flows. Igneous rock is generally basic to semi-basic, i.e., low to intermediate in silica content.

Philippine soils have considerable depth even on relatively steep slopes due to rapid chemical weathering and slow physical weathering of rocks. However, due to this rapid chemical decomposition, organic matter in the Philippines is very small. Plant material in the tropical forest is about two to three times that in the temperate forest, but because of rapid chemical decomposition, very little humus is found in tropical soil. Carbon dioxide and organic acids provided by this plant material through decomposition attack the rocks, causing their rapid chemical weathering.

## 2.4 River Basins

### 2.4.1 Water Resources Regions

For purposes of comprehensive planning of water resources development, the National Water Resources Council (NWRC) divided the Philippines into 12 water resources regions (WRR), as shown in Fig.A-2-5 and listed in Tab.A-2-1. Major considerations taken into account in this regionalization are hydrological boundaries defined by physiographic features and homogeneity in climate of the different parts of the country.

Drawn up from institutional considerations, the Philippines is divided into 17 political regions: Region 1 to 12, NCR, CAR, ARMM and CARAGA. NCR covers Metro Manila. These 17 regions are further subdivided into smaller political units: provinces, cities/municipalities and barangays; the smallest being the barangay.

Actually the water resources regions generally correspond to the existing political regions, except for Ilocos, Cagayan, Central Luzon and Northern Mindanao where there are minor deviations dictated primarily by hydrological boundaries.

### 2.4.2 Identification of River Basins

Large rivers, some of which are navigable, traverse the principal islands of the Philippines. The longest river is the Cagayan, in northern Luzon. Other important rivers of Luzon include the Agno and Pampanga, crossing the Central Luzon Valley; the Abra, flowing through the Cordillera Central and irrigating the mountainside rice terraces; the Pasig, a commercially important artery flowing

through the City of Manila; and the Bicol, the primary river of the Bicol Peninsula. The major rivers of Mindanao are the Mindanao (Cotabato), which receives the waters of the Pulangi, and the Agusan.

In the report "Principal River Basins of the Philippines" published by NWRC in October 1976, NWRC identified the principal river basins (PRBs) of the Philippines with these objectives: 1) to delineate and codify the PRBs for hydrologic purposes; 2) to determine the physical characteristics of each basin; 3) to generate interest on the minor river basins with potentials for development; 4) to define the major river basins (MRBs) in the country and trigger national interest in water resources development; 5) to prepare water resources regional maps showing the principal rivers and their respective basin boundaries to aid in the preparation of regional water resources plans and programs; and 6) to initiate an extensive, continuous program for collecting and organizing data on these basins for a complete characterization of each basin.

For the purpose of identification, principal river basins are defined as those with at least 40 $km^2$ of drainage area. River basins with areas of at least 1,400 $km^2$ are classified as major river basins as shown in Tab.A-2-2. The locations of the major river basins are shown in Fig.A-2-6.

The identification included not only drainage area but also other physical characteristics of the river basin, such as the location and elevation of the headwater and outlet, extent of built-up area, cultivated area, grassland area, soils, channel gradient, drainage density and extent of level area, where these information were considered then as sufficient for subsequent framework studies but necessary to update them as made more than 30 years.

Counting the number of PRBs listed in the above-said report, 421 principal river basins were identified with drainage areas varying from 41 $km^2$ to 25,649 $km^2$. However, 79 of which are parts of major river basins where the rivers are tributaries of major rivers, and the rest are independent PRBs.

# 3 FLOODS

## 3.1 Flood Conditions

The vulnerability of the Philippines to flooding is more pronounced in the 421 principal river basins scattered all over the Philippine archipelago with an average of 20 typhoons each year. Under intense rainfall, overflowing of waterways, inundation and deposition of sediment in flood plains, extensive flood damages often result. Monsoons also bring heavy rains that cause flooding. Flood-prone areas are extensively located in Eastern Mindanao, Northern Samar, Central Luzon and Bicol Region. Approximately, there is an aggregate total of about 1,316,230 ha susceptible to flooding nationwide; of which almost 423,000 ha or 32% are located in Central Luzon alone.[1]

1 Source: Philippine Flood Control 1977, NWRC

### 3.1.1 Type of Flood Conditions

#### (1) Flashflood including Debris, Mudflow and Lahar Floods

The tragic flash flood on 5 November 1991 that claimed the life of almost 8,000 people in Ormoc City, Leyte Province is a classic example of a flashflood. Flashfloods are local floods of great volume sometimes including massive sediment and short duration. A flashflood generally results from a torrential rain or "cloudburst" on relatively small and widely dispersed streams. Runoff from intense rainfall results in high flood and sediment waves. Discharges quickly reach a maximum and diminish almost as rapidly. Flash floods are particularly common in mountainous areas but are also a potential threat in any area where the terrain is steep, surface runoff rates are high, streams flow in narrow canyons, and severe thunderstorms prevail.

#### (2) Riverine Flood

Frequently experiencing typhoons, overbanking of the Agno River had caused damaging floods in the Pangasinan Plain. It was estimated that a total area of 180,000 to 200,000 ha are prone to flooding in the provinces of Pangasinan and Tarlac. The population in these areas is conservatively estimated at 700,000. In 1972, Agno River inundated almost its entire flood-prone area with damages estimated at Php 2 billion, making it the largest flood ever recorded (Source: Water and Flood, DPWH/JICA, 2004).

Riverine floods such as those in the Agno River are caused by rainfall over large areas. These floods differ from flashfloods in their extent and duration. Whereas flashfloods are of short duration in small streams, riverine floods take place in river systems whose tributaries may drain large geographic areas. Floods on large river systems may continue for periods ranging from a few hours to days.

#### (3) Inland Flood

The overtopping of flood discharge from a river channel causes riverine floods. On the other hand, rainfall of which area is, in principle, protected by river or coastal dike, but difficult to drain from the inland causes inland floods. Such areas are situated in flat, lowland along river courses and in coastal areas. Flood conditions may not be severe, but flood occurs very frequently and causes severe economic damage relatively over time.

#### (4) Flood by Bank Scouring

In the Philippines, bank scouring can be observed in many places, especially, at the foot of volcanoes, where the soil is made up of volcanic ash. In such areas, the river channel is prone to meander and change course when flooding occurs. The bank is easily scoured, and houses and public facilities alongside are seriously damaged.

**(5) Others**

There may be other natural disaster types such as coastal erosion and landslide. However, these natural disaster types may not be directly related to floods. In principle, these natural disasters are not included in this Study.

### 3.1.2 Flood Damages

From 1990 to 2003 alone, the Philippines experienced an average of 3.5 destructive typhoons a year with damage costing up to Php 96.6 billon mostly incurred from flood-damaged properties, infrastructures and crops. From damage figures of the Office of Civil Defense (OCD) and the National Disaster Coordinating Council (NDCC), most typhoons entering the PAR undoubtedly take the heaviest toll on lives and properties. This incurs a heavy cost on the economy of the Philippines, especially upon the agriculture sector. It has been reported that an average of 900 persons were killed, and the estimated cost of approximately Php 8 billion is assumed to be due to typhoons and associated flooding events over the period covered.

The loss of human lives and damages to agricultural crops as well as private properties, as well as the interruption of business operations, tend to hinder economic development and the efficient delivery of basic social services. Flood damage is estimated at 2% of the national budget and almost double the yearly budgetary allocation of the DPWH for flood control.

Tab.A-3-1 lists the amounts of flood damage incurred for the last 26 years (1980 - 2005) in the Philippines. Figure A.3.1 shows the annual behavior of casualties.

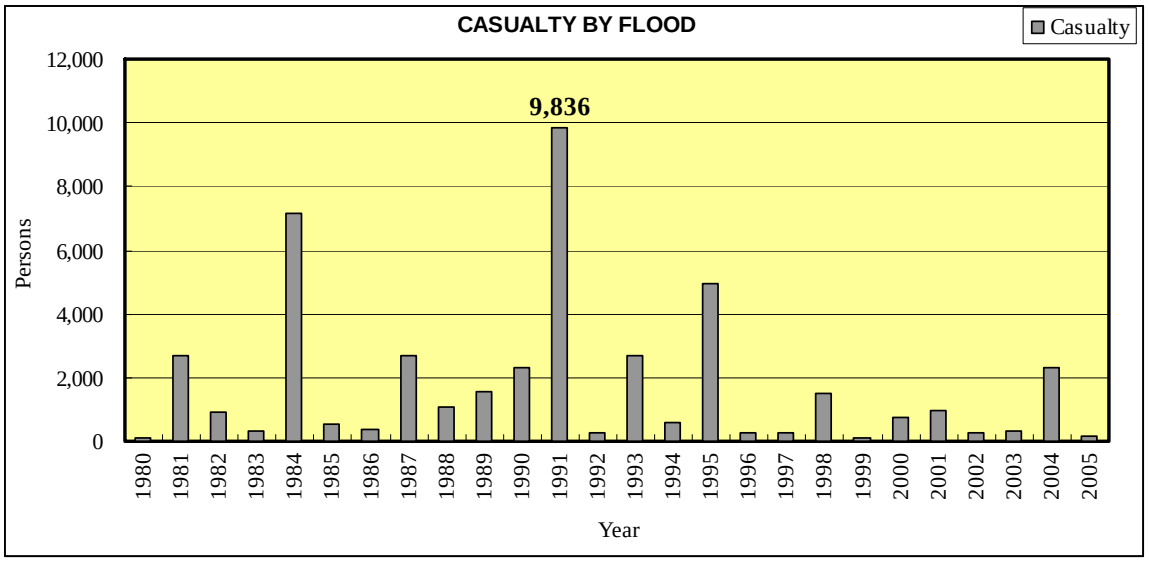



**Figure A.3.1 Annual Casualty by Flood**

The Tab.A-3-2 summarizes the tropical cyclones, whose casualties exceeded 100 persons in total.

### 3.2 Flood Control Projects

By end of 2000, the total area provided by the DPWH with river control and drainage facilities reached about 305,725 ha. This represents 62.03% of the total potential coverage area of 492,831 ha. Extensive networks of flood control measures (such as dikes, river walls, river and channel improvement/dredging) have been undertaken in the major river basins of Agno, Cagayan, Pampanga, Bicol and Agusan. Likewise, major components of the flood control and drainage program in Metro Manila have been built, particularly, additional drainage mains, pumping stations (including the recently completed Balut, Vitas and San Andres pumping stations), estero (creek) improvement works, dredging and related facilities.

In Ormoc City, the first phase of the JICA-assisted Flood Mitigation Project has already been completed. This involved the construction of three (3) slit dams and reconstruction of five (5) bridges.

In Butuan City, Phase I of the Lower Agusan Development Project was completed in 1999, which involved the construction of a 10.6 km embankment levee, 5.28 km concrete floodwall, including related structures such as floodgates and drainage sluices and dredging works at the Agusan River.

Under the Medium-Term Philippine Development Plan (MTPDP) 2001-2004, the medium-term targets ***for flood control and drainage infrastructure*** are the following:

(a) Implementation of desirable flood control and drainage projects in major river systems, including the provision of adequate structural schemes especially for flooding in Metro Manila and other highly urbanized industrial centers;

(b) Projected total accomplishment of 1.4 million ha over the plan period 2001-2004. Controlling the flow of rivers and the provision of drainage is the main priority. In covering this additional area, the total area with flood control and drainage facilities would reach about 1.70 million ha, or 87.57% of total coverage for river control and drainage by 2004. Total investment requirements for the program are about Php 34.79 billion; and

(c) Implementation of priority flood control projects in the following areas: Agno, Laoag, Lower Cagayan, Mt. Pinatubo Rehabilitation, Iloilo, Lower Agusan, Lower Cotabato, West Mangahan, KAMANAVA (Kaloocan, Malabon, Navotas and Valenzuela), and Pasig River in Metro Manila.

Table A.3.1 below presents the revised and updated Medium-Term Infrastructure Program of the DPWH covering the period 1999-2004.

**Table A. 3.1 1999-2004 DPWH Medium-Term Infrastructure Program**

(In mil. Pesos, Current Prices)

| Projects | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | Later Years | Total |
|---|---|---|---|---|---|---|---|---|
| National Roads | 24,273 | 22,951 | 28,161 | 29,063 | 39,983 | 41,640 | 238,564 | 186,070 |
| *Arterial Roads* | *16,018* | *14,134* | *17,422* | *17,046* | *27,738* | *28,116* | *94,630* | *120,468* |
| *Secondary Roads* | *4,747* | *6,172* | *7,871* | *8,689* | *8,515* | *9,918* | *107,855* | *45,913* |
| *Urban Roads* | *3,505* | *2,645* | *2,868* | *3,328* | *3,735* | *3,606* | *36,079* | *19,690* |
| Flood Control | 4,384 | 4,791 | 6,089 | 8,285 | 9,641 | 10,773 | 66,160 | 43,963 |
| Other Projects | 581 | 2,147 | 458 | 719 | 905 | 1,950 | - | 6,760 |
| Various Infra Incl. Local Project* | 606 | 14,999 | 1,720 | 8,430 | 8,430 | 11,864 | - | 46,050 |
| Total | 29,843 | 44,889 | 36,429 | 46,497 | 58,958 | 66,228 | 304,724 | 282,843 |

*Note: *Provincial Development Assistance allocated to every Congressional District*
*Source: DPWH web-site*

## 4 ORGANIZATIONS

The organizations related to flood control in the Philippines are as discussed below.

### 4.1 Department of Public Works and Highways

The Department of Public Works and Highways (DPWH) is one of the three departments under the executive branch of the Philippine Government undertaking major infrastructure projects. The DPWH is mandated to undertake: (a) planning of infrastructure, such as roads and bridges, flood control, water resources projects and other public works; and (b) design, construction, and maintenance of national roads and bridges, and major flood control systems. These activities are undertaken in support of the national objectives of: (a) alleviating rural poverty and attaining food security; and (b) expanding industries for greater productivity and global competitiveness as envisioned in the MPDP 2001-2004.

The DPWH functions as the engineering and construction arm of the Government tasked to continuously develop its technology for the purpose of ensuring the safety of all infrastructure facilities and securing for all public works and highways the highest efficiency and quality in construction.

#### 4.1.1 Functions

The functions for the development of infrastructure projects (e.g., roads, bridges, flood control facilities and water supply) consisting of four phases (Project Identification, Preparation, Implementation, and Operation and Evaluation) are, as follows:

**(1) Project Identification**

It is the process of collecting potential projects with expected return of investments.

**(2) Project Preparation**

In the project preparation phase, the following works are undertaken:

- Project Feasibility Study;
- Inclusion in the Medium-Term Plan;
- Fund Appropriation;
- Detailed Engineering; and
- Inclusion of Project Annual Program.

**(3) Project Implementation**

In this phase, the following works are undertaken:

- Fund Release;
- Right-of-Way Acquisition;
- Bidding and Contracting;
- Construction;
- Completion and Acceptance; and
- Payment.

**(4) Project Operation and Evaluation**

National roads and bridges, major flood control structures, and related facilities of national importance remain under the responsibility of the DWPH during the operational phase. The Regional and District Engineering Offices undertake the maintenance of the facilities generally by administration.

Impact evaluation or post-project appraisal is an attempt to assess the results of a project and, as a function of the results, of the means employed to achieve them.

### 4.1.2 Organization

The Organizational structure of the Department of Public Works and Highways is pursuant to Executive Order No. 124 dated 30 January 1987. The authorities and areas of responsibilities are based on Department Order Nos. 114, 127 and 149 Series of 2003. The organization is divided into that of central office and regional offices. The organization charts are shown in the Fig.A-2-7.

**(1) Central Office**

As of August 2004, there were 10 bureau level offices and 7 project management offices (PMOs) in the Central Office of DPWH.

Among the seven PMOs, the PMO for Major Flood Control and Drainage Projects (MFCDP) and Mount Pinatubo Emergency mainly undertakes flood control and sabo projects, which are usually foreign-assisted.

**(2) Regional Offices**

There are 16 regional offices nationwide to mainly undertake the locally funded infrastructure projects. Under these regional offices are the 176 district engineering offices. In the Regional Office, there are usually six divisions and one regional equipment service, of which the Engineer V is placed as the division chief except for the Administrative and the Comptrollership and Financial Management divisions. Furthermore, 75 to 80 engineers are assigned to perform services and the operation of infrastructure projects under the engineering division.

In a region or under each regional office are 10 to 15 district engineering offices. As of 2002, the total number of DPWH engineers in the regional offices nationwide is estimated to be around 7,000 to 8,000 permanent employees.

## 4.2 National Governments related to Flood Control

### 4.2.1 Department of Environment and Natural Resources (DENR)

As provided for under Section 4 of E.O. 192, the DENR is mandated to be the primary government agency responsible for the conservation, management, development and proper use of the country's environment and natural resources, including those in reservations, watershed areas and lands of the public domain, as well as the licensing and regulation of all natural resources utilization as may be provided by law in order to ensure equitable sharing of the benefits derived therefrom for the welfare of the present and future generations of Filipinos.

The Secretary of Environment and Natural Resources is the head of the present DENR organizational structure, assisted by three (3) Undersecretaries and three (3) Assistant Secretaries, each assigned to a key functional office. Six (6) bureaus represent the staff sectoral bureaus. The organization of DENR is as shown in Fig.A-2-8.

There are four attached agencies/corporations, as follows:

- National Mapping and Resource Information Authority (NAMRIA);
- Natural Resources Development Corporation (NRDC) ;
- Laguna Lake and Development Authority (LLDA); and
- National Water Resources Board (NWRB).

### 4.2.2 National Economic and Development Authority (NEDA)

The National Economic and Development Authority (NEDA), as mandated by the Philippine Constitution, is the country’s independent economic development and planning agency. It is headed by the President as chairman of the NEDA Board, with the Secretary of Socio-Economic Planning, concurrently NEDA Director-General, as vice-chairman. All Cabinet members, as well as the Central Bank Governor, are members of the NEDA Board.

The powers and functions of the NEDA reside in the NEDA Board. It is the country's premier social and economic development planning and policy coordinating body.

Assisting the NEDA Board in the performance of its functions are the following five cabinet-level interagency committees:

- Development Budget Coordination Committee (DBCC);
- Infrastructure Committee (InfraCom);
- Investment Coordination Committee (ICC);
- Social Development Committee (SDC); and
- Committee on Tariff and Related Matters (CTRM).

The organization of NEDA is as shown in Fig.A-2-8.

### 4.2.3 National Irrigation Administration (NIA)

NIA was established in 1963 as a government agency charged with the development, operation and maintenance of irrigation systems all over the country.

NIA aims to develop water resources for irrigation and provide corollary services in line with the agricultural development program of the national government. In particular, NIA is to develop irrigation systems in support of the national food production program, whose level of service should be adequate to enhance the economic and social growth in the rural areas.

Its organizational set-up consists of a seven-man Board of Directors and a Management hierarchy headed by an administrator who is assisted by a deputy administrator and four assistant administrators, namely, the assistant administrators for: (a) Project Development and Implementation; (b) Systems Operations and Equipment Management; (c) Finance and Management; and (d) Administrative Services.

### 4.2.4 Laguna Lake Development Authority (LLDA)

The Laguna Lake Development Authority was organized in 1966 by virtue of Republic Act 4850 as a quasi-government agency with regulatory and proprietary functions. By virtue of Presidential Decree 813 in 1975 and Executive Order 927 in 1983, its powers and functions were further strengthened to include environmental protection and jurisdiction over surface waters of the lake basin. In 1993, the administrative supervision over LLDA was transferred to the Department of Environment and Natural Resources (DENR) through Executive Order 149.

The principal function is to lead, promote and accelerate the development and balanced growth of the Laguna de Bay basin within the context of national and regional plans and policies for social and economic development and to carry out the development of the basin (Refer to http://www.llda.gov.ph/oranization_and_management.htm).

LLDA management and operation is carried out through its Technical, Administrative and Corporate Management Divisions under the direct supervision of a General Manager and an Assistant General Manager.

The organization of LLDA is as shown in Fig.A-2-9.

### 4.2.5 Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA)

PAGASA's mandate is to provide protection against natural calamities and utilize scientific knowledge as an effective instrument to insure the safety, wellbeing and economic security of all the people, and for promotion of national progress.

PAGASA has been reorganized with the following major functions at present:

- Maintain a nationwide network pertaining to observation and forecasting of weather and other climatologically conditions affecting national safety, welfare and economy;
- Undertake activities relative to observation, collection, assessment and processing of atmospheric and allied data for the benefit of agriculture, commerce and industry;
- Engage in studies of geophysical and astronomical phenomena essential to the safety and welfare of the people;
- Undertake researches on the structure, development and motion of typhoons and formulate measures for their moderation; and
- Maintain effective linkages with scientific organizations here and abroad, and promote exchange of scientific information and cooperation among personnel engaged in atmospheric, geophysical and astronomical studies.

The organization of PAGASA is as shown in Fig.A-2-9.

### 4.2.6 National Water Resources Board (NWRB)

NWRB was created by virtue of PD 424 and renamed from Council to Board through EO 124-A with powers to coordinate and integrate water resources development activities. It is the agency mandated to administer and enforce PD 1067, otherwise known as the Water Code of the Philippines, with the functions of regulating the utilization, exploitation, development, control, conservation or protection of water resources; including the Economic Regulation of water utilities operation under PD 1206 and CA 146 on the Public Service Law.

In particular, the jurisdictional powers, functions and duties of NWRB include:

- Formulate policies and guidelines on water resources development and management;
- Effect cross-sectoral and inter-departmental coordination of water resources development activities;
- Grant/issue water permits and certificates of public convenience and necessity;

- Advise NEDA on matters relating to water resources development plan, programs and projects; and
- Exercise jurisdiction over disputes concerning water allocation and utilization.
- NWRB previously under the DPWH has been transferred to the Office of the President. The membership of the Board has been reconstituted under EO No. 123 to exclude those with direct claims on water resources. The present composition of the Board is shown, as follows:

| | | |
|---|---|---|
| Chair | : | Secretary of Environment and Natural Resources |
| Vice-Chair | : | Secretary of Socio-Economic Planning |
| Members | : | Secretary of Justice |
| | | Secretary of Finance |
| | | Secretary of Health |
| | | Director, National Hydraulic Research Center (NHRC), UP |
| | | Executive Director, NWRB Secretary |

### 4.2.7 National Disaster Coordinating Council (NDCC)

NDCC was created under PD No. 1566 for "Strengthening the Philippines Disaster Control, Capability and Establishing the National Program on Community Disaster Preparedness."
Its functions and responsibilities are, as follows:

- Advise the President on the status of disaster preparedness programs, disaster operations and rehabilitation efforts undertaken by the government and the private sector;
- Advise the lower-level Disaster Coordinating Councils and Disaster Control Groups through the Office of Civil Defense in accordance with the guidelines on disaster management;
- Formulate policy guidelines on emergency preparedness and disaster operations involving relief and rehabilitation;
- Formulate a comprehensive disaster management plan based on various calamities/disaster that often hit the country (i.e., drought, flooding, typhoon, earthquake, etc.); and
- Others.

Members of NDCC are composed of several governmental agencies concerned such as the Department of Environment and Natural Resources (DENR), the Department of Finance (DOF), the Department of National Defense (DND), the Department of Public Works and Highways (DPWH), and the National Economic and Development Authority (NEDA).

### 4.2.8 National Hydraulic Research Center (NHRC-UPERDFI)

The NHRC is an attached research center to the University of the Philippines Engineering Research and Development Foundation, Inc. (UPERDFI), which was formally organized in 1972 as a private, non-stock, non-profit corporation based in the University of the Philippines, Diliman Campus.

The objectives of UPERDFI are to promote and support engineering research and development in the country, in furtherance and enhancement of its economic development.

The UPERDFI maintains the earlier established capacity for research and development in the College of Engineering, in the National Engineering Center, and in the National Hydraulic Research Center. Especially, the NHRC has developed into a regional center of excellence in water resources researches in Southeast Asia.

Not limited to the flood control sector, the NHRC has been conducting some hydraulic researches and tests for the nation's major water resources development projects such as the Mangahan Floodway, the Magat Multipurpose Dam, the Iloilo Flood Control Project, and the Laoag River Basin Flood Control and Sabo Project in the last two decades.

### 4.2.9 Philippine Institute of Volcanology and Seismology (PHIVOLCS)

As stipulated in Executive Order No. 128, PHIVOLCS is mandated to perform the following functions:

- Predict the occurrence of volcanic eruptions and earthquakes and their geotectonic phenomena;
- Determine how eruptions and earthquakes shall occur and also areas likely to be affected;
- Exploit the positive aspects of volcanoes and volcanic terrain in furtherance of the socio-economic development efforts of the government;
- Generate sufficient data for forecasting volcanic eruptions and earthquakes;
- Formulate appropriate disaster-preparedness and mitigation plans; and
- Mitigate hazards of volcanic activities through appropriate detection, forecast and warning system.

## 5 LAWS AND REGULATIONS

### 5.1 Water Code

The Water Code of the Philippines (Presidential Decree No. 1067, issued on December 31, 1976) is the basic water law of the Philippines.

The objectives of the Water Code are stipulated in the Article 2, as follows:

- Establish the basic principles and framework relating to the appropriation, control and conservation of water resources to achieve the optimum development and rational utilization of these resources;
- Define the extent of the rights and obligation of water users and owners including the protection and regulation of such rights;
- Adopt a basic law governing the ownership, appropriation, utilization, exploitation, development, conservation and protection of water resources and rights to land related thereto; and

- Identify the administrative agencies, which will enforce this Code.

As an ownership of waters, the Code stipulates in Article 5: "Rivers and Their National Beds belong to the State." The flood control aspect is stipulated in Chapter V, Control of Waters, as follows:

Art. 53: To promote the best interest and the coordinated protection of flood plain lands, the Secretary of Public Works, Transportation and Communications[2] may declare flood control areas and promulgate guidelines for governing flood plain management plans in these areas.

Art. 55: The government may construct necessary flood control structures in declared flood control areas, and for this purpose it shall have a legal easement as wide as may be needed along and adjacent to the riverbank and outside the bed or channel of the river.

It is significant that the Water Code has presented the idea of flood plain management in an early stage that such idea has come up to the international flood control field only recently. Unfortunately, the DPWH has conducted several master plan studies including flood plain management but has not exercised the authority stipulated in Article 53[3] to implement the flood plain management plan and to promulgate such guidelines yet.

## 5.2 Local Governmental Code of 1991

### 5.2.1 Policy

The Local Government Code of 1991 has come into effect as RA 7160 declaring the following policies:

- It is hereby declared the policy of the State that the territorial and political subdivisions of the State shall enjoy genuine and meaningful local autonomy to enable them to attain their fullest development as self-reliant communities and make them more effective partners in the attainment of national goals. Toward this end, the State shall provide for a more responsive and accountable local government structure instituted through a system of decentralization whereby local government units shall be given more powers, authority, responsibilities, and resources. The process of decentralization shall proceed from the national government to the local government units;
- It is also the policy of the State to ensure the accountability of local government units through the institution of effective mechanisms of recall, initiative and referendum; and
- It is likewise the policy of the State to require all national agencies and offices to conduct periodic consultations with appropriate local government units, non-governmental and people's organizations, and other concerned sectors of the community before any project or program is implemented in their respective jurisdictions.

[2] Department of Public Works, Transportation and Communications (DPWTC) is now DPWH.

[3] NWRB is on the process of amending the IRR of the Water Code and the proposal of the study on the creation of National Flood Management Committee (under 7.3.3) can be considered in the said amendment.

### 5.2.2 Basic Services and Facilities of LGUs Stipulated in Local Government Code

LGUs have the responsibility to deliver basic services including flood control facilities, which are intended primarily to service the needs of residents of the municipality or province and funded out of municipality or province funds.

In the case of national funds given to LGUs for infrastructure projects, the Code or in any other laws or regulations does not specify which will render such services, the National Government or the LGUs.

The DPWH has a rule as an interim measure for such projects to be handed over to LGUs with acceptance agreement when the project is completed. Some of LGUs, however, decline to accept and such cases cause problems on operation and maintenance of the facilities.

#### (1) Infrastructure in LGUs

Flood control and drainage are included in the following section of the Local Government Code:

*SEC. 17. Basic Services and Facilities.* - Local government units shall endeavor to be self-reliant and shall continue exercising the powers and discharging the duties and functions currently vested upon them. They shall also discharge the functions and responsibilities of national agencies and offices devolved to them pursuant to this Code.

Local government units shall likewise exercise such other powers and discharge such other functions and responsibilities as are necessary, appropriate, or incidental to efficient and effective provision of the basic services and facilities, as enumerated in Tab.A-5-1.

While, the public works and infrastructure projects and other facilities, programs and services funded by the National Government or those wholly or partially funded from foreign sources are not covered under this Section, except in those cases where the local government unit concerned is duly designated as the implementing agency for such projects, facilities, programs and services.

#### (2) Maintenance of Infrastructure in LGUs

Councils of LGUs shall enact ordinances, approve resolutions and appropriate funds for the general welfare of the LGUs and its inhabitants to ensure the efficient and effective delivery of the basic services and facilities as provided in item 1) above and shown in Tab.A-5-1.

### 5.2.3 Technical Assistance

As Operative Principles of Decentralization in Section 3, it is stipulated that the realization of local autonomy shall be facilitated through improved coordination of national government policies and programs and extension of adequate technical and material assistance to less developed and deserving LGUs.

### 5.3 Presidential Decree for NDCC

A Presidential Decree on Disaster Control, Capability and Establishing Community Disaster Preparedness, known as "PD for NDCC", was created under PD 1566 in 1978 for "Strengthening the Philippines Disaster Control, Capability and Establishing the National Program on Community Disaster Preparedness", creating National Disaster Coordinating Council, enhancing the survival capability and economic stability against all types of disasters whether natural or man-made, and responding to a cogent requirement for pre-disaster planning, community disaster preparedness and positive, precise disaster control action for rescue evacuation, relief and rehabilitation to insure the survival of the country.

### 5.4 Environmental Code

The Environmental Code of the Philippines was issued as Presidential Decree No. 1152 on June 6, 1977. The Code is composed of five (5) Titles, namely:

- Air Quality Management;
- Water Quality Management;
- Land Use Management;
- Natural Resources Management and Conservation; and
- Waste Management.

Flood control concern is stipulated in Title IV, Natural Resources Management and Conservation, with Forestry and Soil Conservation in Chapter III and Flood Control and Natural Calamities in Chapter IV along with the other sectors such as Fisheries and Aquatic Resources, Wildlife, Energy Development, Conservation and Utilization of Surface Ground Waters, Mineral Resources. These chapters present the promotion of watershed management including flood control and soil conservation which is appreciated as a forerun of recent idea of river basin management.

## 6 RELATED FLOOD CONTROL PROJECTS

Sabo and flood control projects have been implemented under foreign assistance, mostly by the Government of Japan. The projects under GOJ assistance can be classified into: (1) GOJ grant aid projects; (2) JICA studies; and (3) OECF/JBIC projects, as shown in the Tabs.A-6-1, A-6-2, A-6-3, respectively. Based on these tables, during the last 34 years from 1971 to 2004, 53 projects and studies with the total amount of 138,173 million yen (excluding costs of JICA studies) have been implemented. The salient features of these projects by category are, as follows:

### 6.1 Grant Aid Projects of GOJ

Nine grant aid projects with the total cost of 9,198 million yen have been implemented during the last 34 years (see Tab.A-6-1). The implementation agencies were PAGASA, University of the Philippines (UP) and DPWH.

PAGASA implemented two projects with the total cost of 101 million yen (1% of the total amount) relating to the flood forecasting and warning systems in the Pampanga River Basin. UP implemented one project relating to the National Hydraulic Research Center. On the other hand, the DPWH implemented six projects with the total cost of 9,037 million yen (98%) relating to:

- Retrieval of flood prone areas in Metro Manila;
- Equipment procurement for Mt. Pinatubo;
- Flood mitigation works in Ormoc City;
- Rehabilitation of the flood control and warning system in Metro Manila; and
- Construction of Hydraulic Laboratory.

### 6.2 JICA Studies

Seventeen (17) studies have been implemented during last 34 years (see Tab.A-6-2). The implementation agencies were PAGASA and DPWH.

PAGASA implemented one study (6% of the total number of the studies) on the flood forecasting system. On the other hand, DPWH implemented 16 studies (94%), which are classified into:

- Flood Control and Sabo: 6 studies around Mt. Mayon, Mt. Pinatubo and Laoag;
- Flood Control: 5 studies in major river basins (Pampanga, Panay, Agno, Ilog-Hilabangan and Lower Cagayan);
- Flood Control and Drainage, or Drainage alone: 3 studies in Metro Manila; and
- Others (disaster prevention): 2 studies around Mt. Mayon and in Camiguin Island.

Based on these, it can be said that the JICA studies were implemented in Metro Manila, major river basins (Pampanga, Panay, Agno, Ilog-Hilabangan and Lower Cagayan), principal river basin (Laoag), Mt. Mayon, Mt. Pinatubo and Camiguin Island.

### 6.3 OECF/JBIC Projects

Twenty-seven (27) OECF/JBIC projects (L/A base) with the total cost of 128,975 million yen have been implemented during the last 34 years (see Tab.A-6-3). The implementation agencies were PAGASA and DPWH.

PAGASA implemented four projects with the total cost of 12,390 million yen (10% of the total amount) relating to the flood forecasting and warning systems for dam operation, etc. On the other hand, the DPWH implemented 23 projects with the total cost of 116,585 million yen (90%), which are classified into:

- Flood Control: 15 projects in Pampanga, Pasig-Marikina, Agusan, Agno and allied rivers, Iloilo City and Metro Manila;
- Flood Control and Drainage, or Drainage alone: 3 projects in Metro Manila;
- Flood Control and Sabo: 1 project in Laoag; and

- Others (volcano hazard mitigation, telemetering and small dams): 4 projects at Mt. Pinatubo and nationwide.

Based on these, it can be understood that the OECF/JBIC projects were implemented mainly in Metro Manila, major river basins (Pampanga, Pasig-Marikina, Agusan and Agno), selected urban centers (Laoag and Iloilo) and Mt. Pinatubo.

# 7 POLICY AND DIRECTION FOR FLOOD CONTROL

Several national development plans have been prepared to orient the policy and direction for economic and infrastructure development including flood control in the Philippines. Selected among them are the Medium-Term Philippine Development Plan 2004-2010, the Medium-Term DPWH Infrastructure Development Plan (2005-2010), the National Flood Mitigation Framework Plan, and the National Framework for Physical Planning (2001-2030).

## 7.1 Medium-Term Philippine Development Plan 2004-2010 (MTPDP 2004-2010)

The Medium-Term Philippine Development Plan (MTPDP) is a detailed roadmap towards achieving common goal of reducing poverty through job creation and enterprise.

As for natural disaster prevention, strategies are mainly divided into two, namely Non-structural Measures and Structural Measures. Their strategies are excerpted as below:

1. Non-structural Measures
   a. Complete the geo-hazard mapping of the remaining 13 regions;
   b. Conduct soil stability measures (e.g., reforestation and planting in riverbanks) for landslide-vulnerable areas; and
   c. Ensure integration of disaster preparedness and management strategy in the development planning process at all levels of governance. This shall be done through the following activities, namely, among others: periodic risk assessments, updating of respective land use policy based on the assessment, conduct of disaster management orientation/training among LGU officials and concerned local bodies, institutionalization of community-based mechanisms for disaster management (e.g., inclusion of legitimate disaster management organization at various Disaster Coordinating Councils), and advocating for the bill on "Strengthening the Philippine Disaster Management Capability."

2. Structural Measures
   a. Keep at the optimum the conveyance capacities of existing river channel floodways, drainage canals, esteros through riverbank protection, dredging/desilting, observance of river easements, relocation of informal settlers, proper disposal of garbage, and efficient maintenance in coordination with LGUs; and
   b. Provide adequate flood control and drainage facilities in all flood/sediment disaster prone areas to mitigate flooding as well as rehabilitate and improve existing facilities.

The points to be understood in MTPDP 2004-2010 policy are summarized, as follows:

- Flooding shall be mitigated through complex enhancement between government policies, organizations, laws, physical countermeasures, etc., under the philosophy that flooding cannot be controlled by human techniques completely; and
- In addition, flood management shall be considered as one of Integrated Water Resources Management schemes.

In accordance with the policy, the following priority flood management projects are scheduled:

- Mt. Pinatubo Hazard Urgent Mitigation II;
- Iloilo Flood Control Project;
- Lower Agusan Flood Control Project Stage 1, Phase 2;
- Bicol River Basin and Watershed Management;
- Agno and Allied Rivers Flood Control;
- KAMANAVA Flood Control;
- Metro Manila Flood Control Project - West of Mangahan Floodway;
- Pasig-Marikina River Channel Improvement Project, Phase II;
- Cagayan River Flood Control Project;
- Panay River Flood Control Project; and
- Lower Cotabato River Flood Control Project.

## 7.2 Medium-Term DPWH Infrastructure Development Plan 2005-2010

DPWH, which is mandated to administrate flood control and sabo projects, has set the following nine (9) tasks to be solved/improved for the implementation of effective flood and landslide disaster mitigation:

- Formulate an overall Master Plan for flood control program adopting the principle of management and river basin approach;
- Pursue comprehensive planning of prioritized major and principal river basins, giving priority to maintenance rather than new construction;
- Provide adequate flood control and drainage facilities in all flood/sediment-disaster prone areas to mitigate flooding within tolerable levels;
- Pursue non-structural measures to mitigate floods, such as flood forecasting and warning and monitoring system, evacuation plan, hazard mapping and reforestation;
- Keep optimum conveyance capacities of river channel floodways, drainage canals, esteros, etc., through riverbank protection, dredging/de-silting, observance or river easement, and efficient management in coordination with LGUs;
- Establish database on river information including existing flood control, drainage and Sabo structures,

- Strengthen and maximize the capacity of the Flood Control and Sabo Engineering Center (FCSEC) to conduct basic and applied research and development, engineering program and human resources development;
- Strengthen the flood management capabilities of DPWH, LGUs and other concerned agencies; and
- Establish the National Flood Management Committee (NFMC) as inter-agency organization and policy governing body to integrate and lead all efforts on disaster mitigation and flood management, and formulate guidelines.

To realize the policy on development, the DPWH have the following investment programs:

**Table A.7.1 2005-2010 DPWH Medium-Term Investment Program**

(mil. Peso)

| Projects | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | Total (2005-2010) |
|---|---|---|---|---|---|---|---|
| National Roads | | | | | | | |
| Foreign Aid | 17,122 | 24,270 | 18,834 | 18,819 | 34,014 | 42,163 | 155,222 |
| Local Fund | 9,081 | 11,285 | 18,453 | 37,841 | 30,682 | 33,827 | 141,169 |
| Total | 26,203 | 35,555 | 37,287 | 56,660 | 64,696 | 75,990 | 296,391 |
| Flood Control | | | | | | | |
| Foreign Aid | 5,285 | 4,784 | 6,532 | 4,014 | 10,966 | 12,642 | 44,223 |
| Local Fund | 551* | 578* | 1,500 | 1,500 | 900 | 1,000 | 6,029 |
| Total | 5,836 | 5,362 | 8,032 | 5,514 | 11,866 | 13,642 | 50,252 |
| Other Local Fund | 7,232 | 7,380 | 17,342 | 12,132 | 8,892 | 8,640 | 61,618 |
| Grand Total | 39,271 | 48,297 | 62,661 | 74,306 | 85,454 | 98,272 | 408,261 |

*Note:* 2005-2010 Medium-Term Public Investment Program (August 2006). Others from the same reference revised in May, 2007.*

## 7.3 National Flood Mitigation Framework Plan (Draft: June 2006)

### 7.3.1 Current Situation and Needs

#### (1) Background

Flood and other water-induced disasters are becoming regular occurrences in the country. These recent occurrences have shown a rising trend of disasters nationwide coupled with the seemingly reactive postures of both government and the populace. Acknowledging the need to immediately address flood and flood/sediment related disasters which hamper the socio-economic development of the country, the President has directed the formulation of a National Flood Mitigation Framework Plan to facilitate the harmonious and coordinated efforts of the various government agencies and other stakeholders in mitigating flood and other water-induced disasters, at the same time rationalizing investments of other sectors.

**(2) Disaster Mitigation Framework**

Disaster Coordinating Councils (DCCs) at different levels were created under PD 1566, which provides the nation's principles in disaster mitigation. Issues and concerns hampering the effective disaster mitigation in the country were enumerated (e.g., the local calamity fund is not available for pre-disaster activities).

**(3) Flood Mitigation Constraints**

The existing constraints on flood mitigation have been identified, as follows:

- Limited budget; and
- Limited human resources/expertise and equipment.

### 7.3.2 Goals and Objectives

**(1) Goals**

The goal set in this National Flood Mitigation Framework Plan (NFMFP) is the protection of communities and the environment, and the enhancement of their coping capacities from/against flood and other water-induced hazards (includes sediment hazards) through non-structural and structural measures.

**(2) Objectives**

Specific objectives of the Framework Plan are, as follows:

- To reduce the impacts of flood and other water-induced hazards by integrating and harmonizing measures in the following areas: (a) Major river basins, (b) High-risk principal/small rivers, (c) Areas within faultlines, (d) Volcanic areas, and (e) High-risk coastal areas; and
- To develop hazard mitigating measures, such as: (a) Structural Measures, (b) Non-structural Measures, and (c) Response, Recovery and Development.

### 7.3.3 Policies and Strategies

In the implementation of the NFMFP, the following policies shall be pursued:

- Composition of the framework on flood mitigation by the following approaches;
  - Structural Measures (Reducing Hazard Magnitude)
  - Non-Structural Measures (Reducing Vulnerability)
  - Response, Recovery and Development (Mitigating Impacts)
- Use of Integrated Water Resources Management (IWRM) principles in guiding the development of approaches;

- Rational and equitable implementation of mitigation measures, i.e., based on river basin master plans; and
- Establishment by LGUs of community-based rainfall and water level monitoring in coordination with PAGASA and BRS-DPWH, respectively.

### 7.3.4 Strategies

In line with the goals, objectives and policies, the following strategies are recommended:

- The concerned agencies shall cooperate and coordinate their responsibilities consistent with the framework of flood mitigation and in accordance with the Responsibility Matrix;
- A river basin management plan shall be formulated for each prioritized river basin, focusing on flood mitigation; and
- Countermeasures shall be suited to local conditions, culture and resources.

### 7.3.5 Framework of Flood Mitigation

Various activities under the structural (reducing vulnerability), non-structural (reducing hazard magnitude) and response, recovery and development (mitigating impacts) approaches are listed including those for institutional strengthening.

### 7.3.6 Implementation Plan

Government agencies, LGUs and other stakeholders shall implement the mitigation programs and measures described. This will require the commitment of the government to support the programs, and understanding and support of the LGUs and beneficiaries.
The following non-structural and structural measures shall be implemented:

**(1) Non-structural Measures**

- NAMRIA Base Map Updating;
- Harmonization of Hazard Maps;
- Hydrological Information Dissemination;
- Watershed Management;
- Coastal Resources Management; and
- Community Disaster Management.

**(2) Structural Measures**

- Ongoing Foreign-Assisted Flood Control Projects;
- River Basins Scheduled for Implementation until 2010;
- Feasibility/Detailed Engineering and Implementation of Priority Projects Identified in the High Risk Flood and Sediment Disaster Prone Areas (DPWH);

- Feasibility/Detailed Engineering and Implementation of Sabo Projects in Identified Sabo Sites (DPWH);
- Master Plan for the Remaining 7 Major River Basins (No existing MP);
- Update of Completed Master Plans of four (4) Major River Basins (DPWH);
- SWIM/SWIP Projects (NIA/BSWM and DA/DPWH);
- River Improvement Projects and Drainage Projects under the District Engineering Offices of the DPWH Regular Funds;
- River Improvement Projects and Drainage Projects under the Local Government Units; and
- Provision of Structural Complement (i.e., check dams) for Erosion Control and Reforestation.

# 8 ENVIRONMENT

## 8.1 Forest Ecosystem

The Philippine upland/forest ecosystem refers to areas with at least a slope of 18 percent. It comprises an estimated 45 percent of the country's total land area and directly supports approximately 30 percent of the population, including the indigenous peoples. The forest cover is estimated at 7.168 million hectares or 23.9 percent of the total land area based on 2002 satellite mapping. The forest ecosystem provides ecological benefits to agricultural production, industries, water and power needs. A watershed with adequate forest cover supports lowland agriculture by ensuring continuous supply of water for irrigation. They also prevent soil erosion and consequent loss of fertile topsoil and siltation of the coastal areas and water bodies. It also sustains the supply of surface and groundwater for domestic use in the lowlands.

However, the country's watersheds have been severely degraded, thus reducing the capacity to provide vital ecological services and economic benefits.

## 8.2 Biodiversity

The Philippines is considered as one of the 17 megadiverse countries in the world. These countries hold about 70 percent of the world's total diversity in flaura and fauna. In the Philippines alone, there are over 52,000 species. Of these, 13,500 are plants comprising 5 percents of the world's flora. About 68 percent of the country's reptiles, 78 percent of amphibians, 64 percent to the mammals and 44 percent of the birds are considered unique in the Philippines. In terms of uniqueness or endemism, many of the country's species rank in the top ten in the world. Considering land density and density of flora and fauna, the Philippines may even be considered to the most megadiverse country. However, the species in the Philippines are considered to be among the most threatened in the world. The Philippines, together with Madagascar, is considered as the hottest of the spots or the most

severely threatened of the megadiverse countries. The destruction of the original forests, freshwater and marine ecosystems have led to unmatched biodiversity crisis.

Biodiversity resources offer many economic opportunities such as ecotourism, sources of raw ingredients of pharmaceutical and industrial products, and genetic materials for the development of crops and animals for flood and commerce. Biodiversity also nourishes our forests and largely responsible for forest regeneration. However, continued degradation of forests, wetlands and marine areas has caused substantial biodiversity loss in the country.

### 8.3 Coastal and Marine Ecosystem

The coastal and marine ecosystems include coral reefs, sea grass and alga beds, mangroves, a variety of productive fisheries, beach systems, estuaries and lagoons. In terms of area, the Philippine coastal zone extends to an area of about 11,000 $km^2$ of land and 267,000 $km^2$ of water. Thus, the coastal and marine ecosystems are considered an important source of livelihood for about 70 percent of the country's municipalities and compose 80 percent of the country's territory. This serves as a rich source of fish and aquatic products used for food, habitat for countless underwater wildlife, and natural areas for recreation, tourism and related activities. However, the productivity of the coastal and marine ecosystems has continuously been threatened by destructive fishing methods, siltation and pollution, among others. It is estimated that 5.0 percent of the country's coral reefs are in excellent condition, mangroves have declined by as much as 57.0 percent in the last 23 years and sea grass losses have been estimated at 30-50 percent over the last 50 years. The widespread loss of mangroves, living corals and sea grass beds has severely eroded the capacity of this particular ecosystem to support life. There are considerable biodiversity loss and population decreases among the pelagic and crustaceans as well as self-bottomed organisms. In addition, an increasing number of coastal communities and lands have become more vulnerable to tidal surges and waves highly associated with the country's seasonal typhoons.

## Tab.A-1-1 MTPDP 2004-2010 Targets vs. Actual Performance

| Item | 2001 | | 2002 | | 2003 | | 2004 | |
|---|---|---|---|---|---|---|---|---|
| | MTPDP | ACTUAL | MTPDP | ACTUAL | MTPDP | ACTUAL | MTPDP | LATEST ACTUAL |
| GNP (growth rate in %) | 3.4 | 3.5 | 4.1-4.6 | 4.3 | 5.5-6.0 | 5.6 | 5.8-6.4 | 6.1[2/] |
| GDP (growth rate in %) | 3.3 | 3 | 4.0-4.5 | 4.3 | 5.4-5.9 | 4.7 | 5.7-6.3 | 6.3[2/] |
| Inflation rate | 6.0-7.0 | 6.1 | 5.0-6.0 | 3 | 4.5-5.5 | 3 | 4.5-5.5 | 4.8[3/] |
| 91-day T-bill rate | 11.0-12.0 | 9.9 | 10.0-11.0 | 5.4 | 9.5-10.5 | 6 | 9.5-10.5 | 7.2[3/] |
| NG Fiscal Deficit (as percent of GDP) | -4 | -4 | -3.3 | -5.2 | -2.3 | -4.6 | -0.9 | -3.6[2/] |
| Consolidated Public (as percent of GDP) | -4.6 | -4.6 | -3.5 | -5.5 | -2.2 | -5.5 | -0.6 | 4.7[4/] |
| Public Debt (as percent of GDP) | n.a. | 120.1 | n.a. | 130.4 | n.a. | 137.5[1/] | n.a. | n.a. |
| Current Account (as percent of GDP) | 5.7 | 1.8 | 3.2 | 5.7 | 2.7 | 4.2 | 1.5 | 5.1[2/] |
| Gross International Reserves (US $ Bn) | 14 | 15.6 | 14.4 | 16.2 | 15.3 | 16.9 | 16.6 | 16.0[5/] |
| (no. of months in imports) | 4.2 | 4.6 | 4.2 | 4.7 | 4.1 | 4.7 | 4 | 4.3 |
| Employment generation (in thousand) | 726-830 | 1703 | 874-953 | 907 | 1030-1116 | 566 | 1089-1183 | 1234[6/] |
| Unemployment rate (in %) | 10.73-11.6 | 11.1 | 9.98-10.51 | 11.42 | 8.82-9.63 | 11.38 | 7.55-8.64 | 12.13[7/] |
| Unemployment (ILO-based definition) | n.a. | 7.53 | n.a. | 7.7 | n.a. | 7.35 | n.a. | 7.63 |

*1/ PreliminaryFY 2003 figure (which still includes intrasectoral debt)*
*2/ First Semester 2004*
*3/ As of January-September 2004*
*4/ As of 1st quarter 2004*
*5/ As of August 2004*
*6/ Jan-July actual*
*7/ Jan-Apr-July 2004 Average*
*n.a. - not available*

## Tab.A-1-2 Comparative GDP Growth Rates of Asian Countries (in percent)

| Country | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|
| Philippines | 0.3 | 2.1 | 4.4 | 4.7 | 5.8 | 5.2 | -0.3 |
| Malaysia | 8.9 | 9.9 | 9.2 | 9.8 | 10.0 | 7.3 | -7.4 |
| Indonesia | 7.2 | 7.3 | 7.5 | 8.4 | 7.6 | 4.7 | -13.1 |
| Thailand | 8.1 | 8.4 | 9.0 | 9.2 | 5.9 | -1.4 | -10.5 |
| Taiwan | 7.5 | 7.0 | 7.1 | 6.4 | 6.1 | 6.7 | 4.6 |
| Hong Kong | 6.6 | 6.3 | 5.5 | 3.9 | 4.3 | 5.1 | -5.0 |
| South Korea | 5.4 | 5.5 | 8.3 | 8.9 | 7.0 | 4.7 | -6.9 |
| China | 14.3 | 13.5 | 12.8 | 10.5 | 9.6 | 8.8 | 7.8 |
| Singapore | 6.7 | 12.3 | 11.4 | 8.0 | 8.1 | 8.6 | -0.9 |
| Country | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 S1 | |
| Philippines | 3.4 | 4.4 | 3.0 | 4.3 | 4.7 | 6.3 | |
| Malaysia | 6.1 | 8.9 | 0.3 | 4.1 | 5.3 | 7.8 | |
| Indonesia | 0.8 | 4.9 | 3.3 | 3.7 | 3.9 | 4.4 | |
| Thailand | 4.4 | 4.8 | 2.1 | 5.4 | 6.7 | 6.4 | |
| Taiwan | 5.4 | 5.9 | -2.2 | 3.6 | 3.2 | 7.2 | |
| Hong Kong | 3.4 | 10.2 | 0.5 | 1.9 | 3.2 | 9.5 | |
| South Korea | 9.5 | 8.5 | 3.8 | 7.0 | 3.1 | 5.4 | |
| China | 7.0 | 7.6 | 7.3 | 8.0 | 9.1 | 9.7 | |
| Singapore | 6.9 | 9.7 | -2.0 | 2.2 | 1.1 | 10.0 | |

*Sources: Country Statistical Websites*
*Asian Regional Information Center (ARIC), ADB*
*2002 World Development Indicators (WDI)*

**Tab.A-1-3 Population Distribution by Region, 2000**

| Region | Total Population | Percent |
|---|---|---|
| Philippines | 76,504,077 | 100.00 |
| NCR | 9,932,560 | 12.98 |
| CAR | 1,365,412 | 1.78 |
| I - Ilocos | 4,200,478 | 5.49 |
| II - Cagayan Valley | 2,813,159 | 3.68 |
| III - Central Luzon | 8,030,945 | 10.50 |
| IV - Southern Tagalog | 11,793,655 | 15.42 |
| V - Bicol | 4,686,669 | 6.13 |
| VI - Western Visayas | 6,211,038 | 8.12 |
| VII - Central Visayas | 5,706,953 | 7.46 |
| VIII - Eastern Visayas | 3,610,355 | 4.72 |
| IX - Western Mindanao | 3,091,208 | 4.04 |
| X - Northern Mindanao | 2,747,585 | 3.59 |
| XI - Southern Mindanao | 5,189,335 | 6.78 |
| XII - Central Mindanao | 2,598,210 | 3.40 |
| XIII - Caraga | 2,095,367 | 2.74 |
| ARMM | 2,412,159 | 3.15 |

*Source: NSO, Various Censuses of Population and Housing*

**Tab.A-1-4 Provinces with More than One Million Population, 2000**

| Rank | Province | Population |
|---|---|---|
| 1 | Pangasinan | 2,434,086 |
| 2 | Cebu* | 2,377,588 |
| 3 | Bulacan | 2,234,088 |
| 4 | Negros Occidental* | 2,136,647 |
| 5 | Cavite | 2,063,161 |
| 6 | Laguna | 1,965,872 |
| 7 | Batangas | 1,905,348 |
| 8 | Rizal | 1,707,218 |
| 9 | Nueve Ecija | 1,659,883 |
| 10 | Pampanga* | 1,614,168 |
| 11 | Leyte | 1,592,336 |
| 12 | Iloilo* | 1,559,182 |
| 13 | Camarines Sur | 1,551,549 |
| 14 | Quezon* | 1,482,955 |
| 15 | Zamboanga del Sur* | 1,333,456 |
| 16 | Isabela | 1,287,575 |
| 17 | Bohol | 1,139,130 |
| 18 | Negros Orriental | 1,130,088 |
| 19 | Albay | 1,090,907 |
| 20 | Tarlac | 1,068,783 |
| 21 | Bukidnon | 1,060,265 |

**excluding highly urbanized city/cities*

*Source: NSO, 2000 Census of Population and Housing*

**Tab.A-2-1 List of Water Resources Regions**

| Code | Name | Major River Basin | No. of Principal Rivers |
|---|---|---|---|
| WRR I | Ilocos Region | Abra River | 14 |
| WRR II | Cagayan Valley | Cagayan River | 39 |
| WRR III | Central Luzon | Pampanga and Agno Rivers | 24 |
| WRR IV | Southern Tagalog | Pasig-Laguna de Bay Rivers | 97 |
| WRR V | Bicol Region | Bicol River | 30 |
| WRR VI | Western Visayas | Panay, Jalaur and Ilog-Hilabangan Rivers | 37 |
| WRR VII | Central Visayas | - | 19 |
| WRR VIII | Eastern Visayas | - | 34 |
| WRR IX | Southwestern Mindanao | - | 34 |
| WRR X | Northern Mindanao | Agusan, Cagayan de Oro and Tagoloan Rivers | 29 |
| WRR XI | Southeastern Mindanao | Davao, Tagum-Libuganon, Buayan Rivers | 35 |
| WRR XII | Southern Mindanao | Agus and Mindanao Rivers | 30 |

*Source: "Principal River Basin of the Philippines" published by NWRC in October 1976*

**Tab.A-2-2 Eighteen Major River Basins**

| Code No. | Rank | River Basin | Water Resources Region | Catchment Area ($km^2$) |
|---|---|---|---|---|
| 02001 | 1 | Cagayan | Region II | 25,469 |
| 12342 | 2 | Mindanao | Region XI and XII | 23,169 |
| 10315 | 3 | Agusan | Region XIII | 10,921 |
| 03059 | 4 | Pampanga | Region III | 9,759 |
| 03070 | 5 | Agno | Region III | 5,952 |
| 01036 | 6 | Abra | Region I | 5,125 |
| 04076 | 7 | Pasig-Laguna Bay | NCR and Region IVA | 4,678 |
| 05114 | 8 | Bicol | Region V | 3,771 |
| 02028 | 9 | Abulug | Region II | 3,372 |
| 11303 | 10 | Tagum-Libuganon | Region XI | 3,064 |
| 06235 | 11 | Ilog-Hilabangan | Region VI and VII | 1,945 |
| 06197 | 12 | Panay | Region VI | 1,843 |
| 10331 | 13 | Tagoloan | Region X | 1,704 |
| 12336 | 14 | Agus | Region XII and ARMM | 1,645 |
| 11307 | 15 | Davao | Region XI | 1,623 |
| 10332 | 16 | Cagayan | Region X | 1,521 |
| 06205 | 17 | Jalaur | Region VI | 1,503 |
| 11364 | 18 | Buayan-Malungun | Region XI | 1,434 |

*Source: "Principal River Basins of the Philippines" published by NWRC in October 1976*

**Tab.A-3-1 Recorded Annual Flood Damages, Philippines, 1980-2005**

| Year | Population Affected | | Causalities | | | House Damaged | | Damage Value* (mil. Peso) |
|---|---|---|---|---|---|---|---|---|
| | Families | Persons | Dead | Missing | Injured | Totally | Partially | |
| 1980 | 248,164 | 1,666,498 | 36 | 4 | 55 | 16,510 | 51,101 | 1,472 |
| 1981 | 250,325 | 1,472,417 | 484 | 264 | 1,922 | 44,994 | 159,251 | 1,273 |
| 1982 | 266,476 | 1,569,017 | 337 | 223 | 347 | 84,027 | 97,485 | 1,754 |
| 1983 | 140,604 | 747,155 | 126 | 168 | 28 | 29,892 | 85,072 | 523 |
| 1984 | 741,510 | 4,048,805 | 1,979 | 4,426 | 732 | 310,646 | 313,391 | 416 |
| 1985 | 318,106 | 1,643,142 | 211 | 300 | 17 | 8,204 | 211,151 | 3 |
| 1986 | 287,240 | 1,524,301 | 171 | 43 | 155 | 3,162 | 14,595 | 1,838 |
| 1987 | 464,162 | 2,591,914 | 1,020 | 213 | 1,455 | 180,550 | 344,416 | 8,763 |
| 1988 | 1,173,994 | 6,081,572 | 429 | 195 | 468 | 134,344 | 585,732 | 8,675 |
| 1989 | 501,682 | 2,582,822 | 382 | 89 | 1,088 | 56,473 | 184,584 | 4,494 |
| 1990 | 1,265,652 | 6,661,474 | 676 | 262 | 1,392 | 223,535 | 636,742 | 11,713 |
| 1991 | 150,894 | 759,335 | 5,201 | 4,278 | 357 | 15,458 | 83,664 | 74 |
| 1992 | 418,964 | 2,097,693 | 145 | 95 | 51 | 3,472 | 8,342 | 7,359 |
| 1993 | 1,523,250 | 8,202,118 | 814 | 214 | 1,637 | 166,004 | 456,773 | 25,038 |
| 1994 | 670,078 | 3,306,783 | 266 | 54 | 260 | 58,869 | 226,291 | 3,401 |
| 1995 | 1,710,619 | 8,567,666 | 1,255 | 669 | 3,027 | 294,654 | 720,502 | 57,781 |
| 1996 | 260,581 | 1,254,989 | 124 | 49 | 97 | 2,690 | 17,557 | 10,109 |
| 1997 | 777,997 | 3,954,175 | 199 | 28 | 66 | 13,225 | 53,980 | 4,842 |
| 1998 | 1,590,905 | 7,197,953 | 498 | 116 | 873 | 137,020 | 406,438 | 17,823 |
| 1999 | 270,424 | 1,281,194 | 56 | 3 | 25 | 144 | 687 | 1,555 |
| 2000 | 1,426,965 | 6,852,826 | 338 | 59 | 370 | 24,573 | 195,536 | 7,217 |
| 2001 | 756,938 | 3,629,295 | 431 | 134 | 418 | 14,899 | 54,422 | 6,924 |
| 2002 | 538,600 | 3,546,469 | 169 | 33 | 71 | 2,980 | 15,947 | 829 |
| 2003 | 702,223 | 3,362,991 | 139 | 28 | 182 | 12,306 | 51,579 | 4,567 |
| 2004** | - | - | 1,046 | 437 | 836 | - | - | 7,679 |
| 2005** | - | - | 62 | 36 | 51 | - | - | 2,487 |
| Total | 16,456,353 | 84,602,604 | 16,594 | 12,420 | 15,980 | 1,838,631 | 4,975,238 | 198,609 |

** ) Total damages in infrastructure, agriculture and private properties.*

*** ) Source: DSWD for Casualties.*

*- ) Not available here.*

**Tab.A-3-2 Destructive Tropical Disturbance and Corresponding Casualties, Philippines**

| Tropical Disturbance | Date of Occurrence | Casualties | | |
|---|---|---|---|---|
| | | Dead | Missing | Injured |
| T Ruping | Nov 10-14, 1990 | 508 | 246 | |
| TS Uring | Nov 2-6, 1991 | 5,101 | 1,256 | 292 |
| TD Ditang | July 17-21, 1992 | 36 | 77 | |
| T Kadiang | Sep 30-Oct 7, 1993 | 126 | 26 | 37 |
| T Monang | Dec 3-4, 1993 | 273 | 90 | 607 |
| T Puring | Dec 24-29, 1993 | 187 | 52 | 280 |
| TS Mameng | Sep 27 - Oct 1, 1995 | 116 | 126 | 49 |
| TS Pepang | Oct 26 -30, 1995 | 265 | 67 | 323 |
| T Rosing | Oct 31 - Nov 3, 1995 | 936 | 316 | 4,152 |
| T Emang & TS Gading | Sept 16-21, 1998 | 108 | 20 | |
| Loleng | Oct 15-23, 1998 | 303 | 29 | 751 |
| Reming | Oct 26-Nov 1, 2000 | 114 | 10 | |
| T Feria | July 2-6, 2001 | 188 | 44 | 241 |
| T Nanang | Nov 6-10, 2001 | 236 | 88 | 169 |
| Hambalos, Inday | June 28-July 14, 2002 | 85 | 4 | 45 |
| T Harurut | July 19-21, 2003 | 64 | 2 | 154 |
| T Igme | June 25-July 2, 2004 | 57 | 20 | 39 |
| T Unding | Nov 14-21, 2004 | 56 | 79 | 25 |
| TD Winnie | Nov 28-30, 2004 | 821 | 417 | 400 |

*T: Typhoon, TS: Tropical Storm, TD: Tropical Depression*

*Source: Office of Civil Defense*

**Tab.A-5-1 Powers, Duties, and Functions of Councils of LGUs**

| Barangay | Municipality | Province |
|---|---|---|
| Provide for the construction and maintenance of barangay facilities and other public works projects chargeable to the general fund of the barangay or such other funds actually available for the purpose. | - Provide for the esTablishment, maintenance, protection, and conservation of communal forests and watersheds, tree parks, greenbelts, mangroves, and other similar forest development projects.<br>- Authorize the esTablishment, maintenance and operation of ferries, wharves, and other structures, and marine and seashore or offshore activities intended to accelerate productivity.<br>- Subject to existing laws, provide for the esTablishment, operation, maintenance, and repair of an efficient waterworks system to supply water for the inhabitants; regulate the construction, maintenance, repair and use of hydrants, pumps, cisterns and reservoirs; protect the purity and quantity of the water supply of the municipality and, for this purpose, extend the coverage of appropriate ordinances over all territory within the drainage area of said water supply and within one hundred (100) meters of the reservoir, conduit, canal, aqueduct, pumping station, or watershed used in connection with the water service; and regulate the consumption, use or wastage of water. | Subject to applicable laws, facilitate or provide for the esTablishment and maintenance of a waterworks system or district waterworks for supplying water to inhabitants of component cities and municipalities. |

**Tab.A-6-1 GOJ Grant Aid Projects (1971-2004)**

| Year | Agency | Project | Amount (million Yen) | Status |
|---|---|---|---|---|
| 1972 | PAGASA | Flood Forecasting and Warning System in Pampanga River Basin | 80 | Completed |
| 1977 | UP | Strengthening of National Hydraulic Research Center | 60 | Completed |
| 1980 | PAGASA | Rehabilitation of Flood Forecasting and Warning System in Pampanga River Basin | 21 | Completed |
| 1989 | DPWH | Retrieval of Flood Prone Areas in Metro Manila | 1,231 | Completed |
| 1991 | DPWH | Equipment for Mt. Pinatubo Hazard Urgent Mitigation | 1,455 | Completed |
| 1992 | DPWH | Retrieval of Flood Prone Areas in Metro Manila (II) | 1,254 | Completed |
| 1997-2001 | DPWH | Flood Mitigation in Oemoc City (I) & (II) | 3,255 | Completed |
| 2000 | DPWH | Rehabilitation of Flood Control Operation and Warning System in Metro Manila | 1,048 | Completed |
| 2002 | DPWH | Construction of Hydraulic Laboratory Building | 794 | Completed |
| Total | | 9 Projects | 9,198 | |

*Source: "Water & Floods", DPWH, March 2004*

**Tab.A-6-2 JICA Studies (1971-2004)**

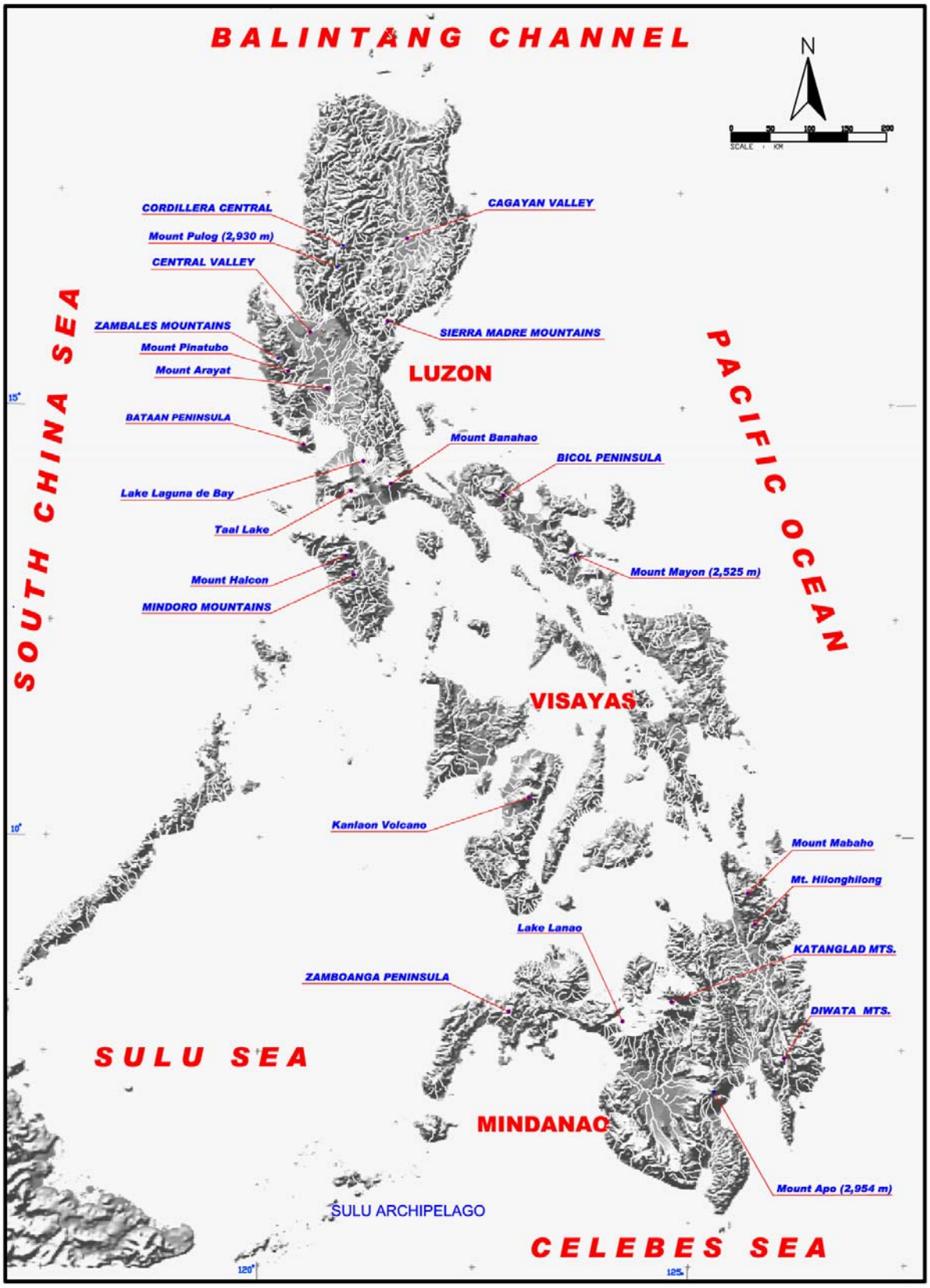
| Year | Agency | Project | Status |
|---|---|---|---|
| 1976-1978 | DPWH | Planning Report on the Pasig-Potrero River Flood Control and Sabo Project | Completed |
| 1976-1977 | PAGASA | Survey for the Flood Forecasting System Project | Completed |
| 1978-1981 | DPWH | Master Plan for Mayon Volcano Sabo and Flood Control Project | Completed |
| 1979-1982 | DPWH | Pampanga Delta Development Project | Completed |
| 1982-1983 | DPWH | Re-study of Mayon Volcano Sabo and Flood Control Project | Completed |
| 1983-1986 | DPWH | Panay River Basinwide Flood Control Study | Completed |
| 1987-1990 | DPWH | Study on Flood Control and Drainage Project in Metro Manila | Completed |
| 1988-1991 | DPWH | Study of Agno River Basin Flood Control Project | Completed |
| 1989-1991 | DPWH | Study on Ilog-Hilabangan River Basin Flood Control Project | Completed |
| 1992-1995 | DPWH | The Study on Flood Control and Mudflow Control for Sacobia-Bamban/ Abacan River Basin Draining from Mt. Pinatubo | Completed |
| 1996-1997 | DPWH | The Study on Sabo and Flood Control in the Laoag River Basin | Completed |
| 2000 | DPWH | The Study on Comprehensive Disaster Prevention Around Mayon Volcano | Completed |
| 2000 | DPWH | The Study on Existing Drainage Laterals in Metro Manila (LDSP) | Completed |
| 2000 | DPWH | The Feasibility Study on Lower Cagayan River Flood Control Project | Completed |
| 2002-2003 | DPWH | The Study in Sabo and Flood Control for Western River Basins of Mount Pinatubo | Completed |
| 2003 | DPWH | Basic Study on Disaster Prevention & Reconstruction Project for Camiguin Island, Mindanao (LDSP) | Completed |
| 2003 | DPWH | Study on Drainage Improvement in Core Area of Metropolitan Manila | Completed |
| Total | | 17 Studies | |

*Source: "Water & Floods", DPWH, March 2004.*

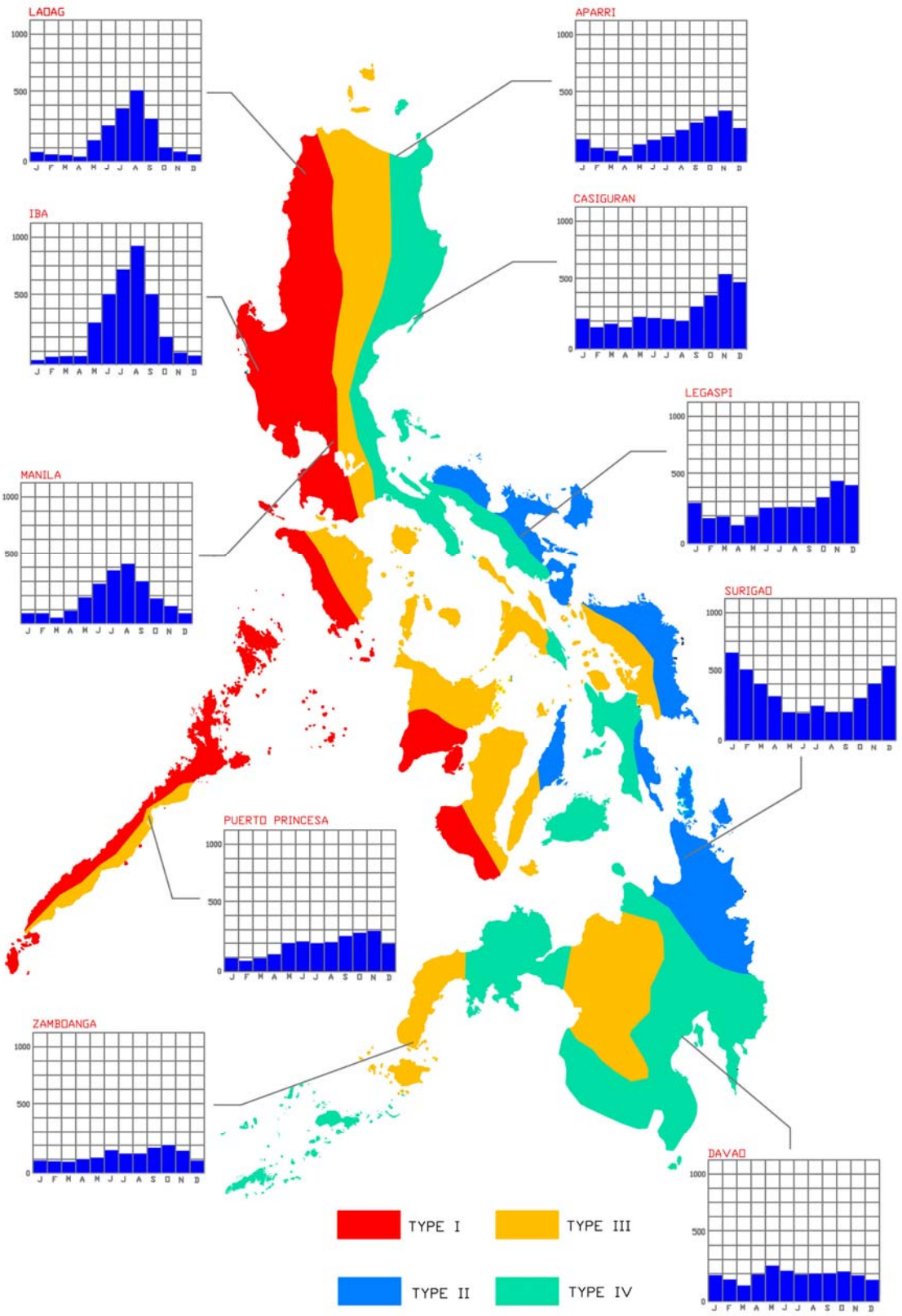
**Tab.A-6-3 OECF/JBIC Projects (1971-2004)**

| L/A Date | Agency | Project | L/A Amount (million Yen) | Status |
|---|---|---|---|---|
| 03/23/1973 | PAGASA | Flood Forecasting and Warning System in Pampanga River Basin | 3,028 | Completed |
| 08/01/1974 | DPWH | Flood Control Dredging Project in the Pampanga, Bicol & CoTabato River Basins | 3,187 | Completed |
| 09/09/1975 | DPWH | Pasig River Flood Control Project | 5,112 | Completed |
| 01/04/1978 | PAGASA | The Flood Forecasting Systems Project | 1,774 | Completed |
| 11/09/1978 | DPWH | River Dredging Project (II) | 2,429 | Completed |
| 05/31/1982 | DPWH | Lower Agusan Development Project (ES) | 330 | Completed |
| 05/31/1982 | PAGASA | Flood Forecasting and Warning System for Dam Operation Project | 3,600 | Completed |
| 09/09/1983 | DPWH | Nationwide Flood Control Dredging Project (Telemetering) | 1,140 | Completed |
| 05/07/1984 | DPWH | Metro Manila Drainage System Rehabilitation Project | 3,012 | Completed |
| 05/30/1986 | DPWH | Pampanga Delta Development Project (ES) | 705 | Completed |
| 05/30/1986 | PAGASA | Flood Forecasting and Warning System for Dam Operation Project (II) | 3,988 | Completed |
| 01/27/1988 | DPWH | Metro Manila Flood Control Project (II) | 10,818 | Completed |
| 01/27/1988 | DPWH | Small Water Impounding Management Project | 3,193 | Completed |
| 01/27/1988 | DPWH | Lower Agusan Development Project, Stage I, Phase I | 3,372 | Completed |
| 02/09/1990 | DPWH | Pampanga Delta Development Project, Flood Control Component (I) | 8,637 | Completed |
| 02/09/1990 | DPWH | North Laguna Lakeshore Urgent Flood Control & Drainage Project (ES) | 454 | Completed |
| 08/30/1995 | DPWH | Agno and Allied Rivers Urgent Rehabilitation Project | 8,312 | Completed |
| 03/29/1996 | DPWH | Mt. Pinatubo Hazard Urgent Mitigation Project | 6,911 | Completed |
| 03/18/1997 | DPWH | The Metro Manila Flood Control Project West of Mangahan Floodway | 9,411 | Completed |
| 03/18/1997 | DPWH | Lower Agusan Development Project (Flood Control Component - Phase II) | 7,979 | Completed |
| 09/10/1998 | DPWH | Agno River Flood Control Project (II-A) | 6,734 | Completed |
| 12/28/1999 | DPWH | Pasig-Marikina River Channel Improvement Project (ES) | | Completed |
| 12/28/1999 | DPWH | Mt. Pinatubo Hazard Urgent Mitigation Project (II) | 9,013 | Completed |
| 04/07/2000 | DPWH | KAMANAVA Flood Control and Drainage System Improvement Project | 8,929 | On-Going |
| 05/30/2001 | DPWH | Laoag River Basin Flood Control and Sabo Project | 6,309 | On-Going |
| 05/30/2001 | DPWH | Agno River Flood Control Project (Phase II-B) | 2,789 | On-Going |
| 03/28/2002 | DPWH | Iloilo Flood Control Project | 6,790 | On-Going |
| Total | | 27 Projects | 128,975 | |

*Source: "Water & Floods", DPWH, March 2004.*




| | |
|---|---|
| THE STUDY ON THE NATIONWIDE FLOOD RISK ASSESSMENT AND THE FLOOD MITIGATION PLAN FOR THE SELECTED AREAS IN THE REPUBLIC OF THE PHILIPPINES | **Fig.A-2-1** |
| JAPAN INTERNATIONAL COOPERATION AGENCY | **Topography of the Philippines** |

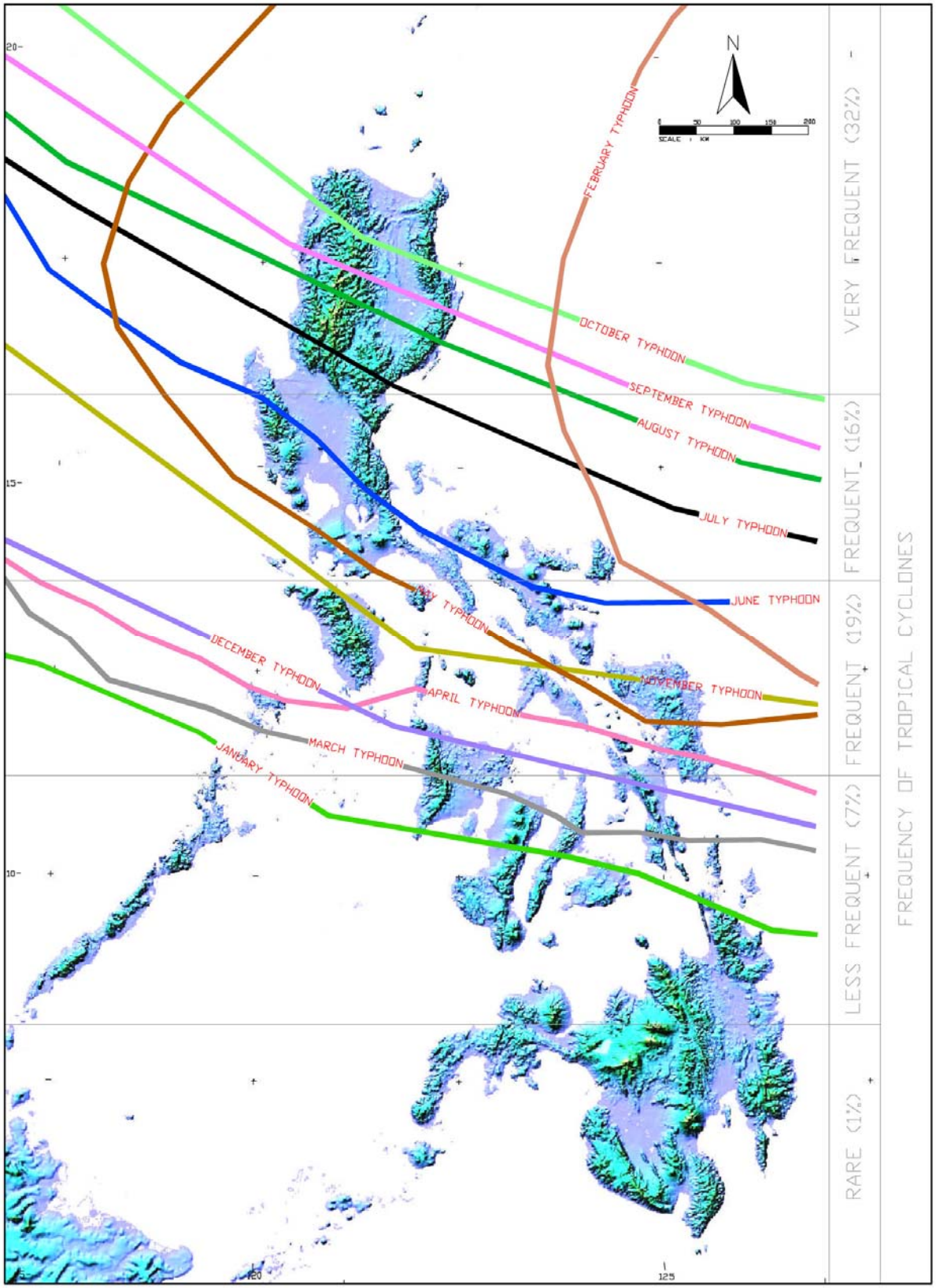



THE STUDY ON THE NATIONWIDE FLOOD RISK ASSESSMENT AND THE FLOOD MITIGATION PLAN FOR THE SELECTED AREAS IN THE REPUBLIC OF THE PHILIPPINES

JAPAN INTERNATIONAL COOPERATION AGENCY

**Fig.A-2-2**

**Climatological Map of the Philippines**

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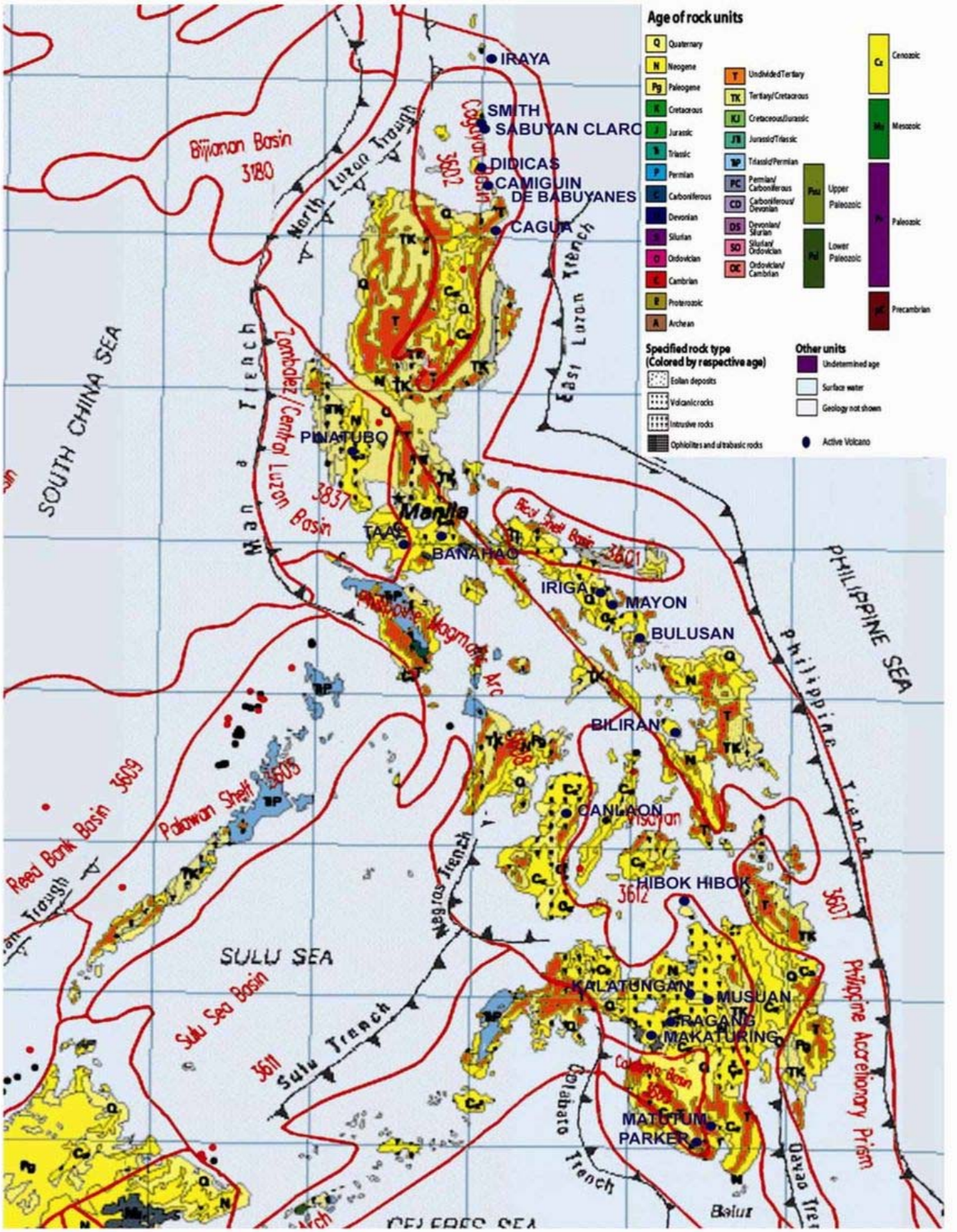
|---|---|
| THE STUDY ON THE NATIONWIDE FLOOD RISK ASSESSMENT AND THE FLOOD MITIGATION PLAN FOR THE SELECTED AREAS IN THE REPUBLIC OF THE PHILIPPINES | **Fig.A-2-3** |
| JAPAN INTERNATIONAL COOPERATION AGENCY | **Typhoon Tracks** |

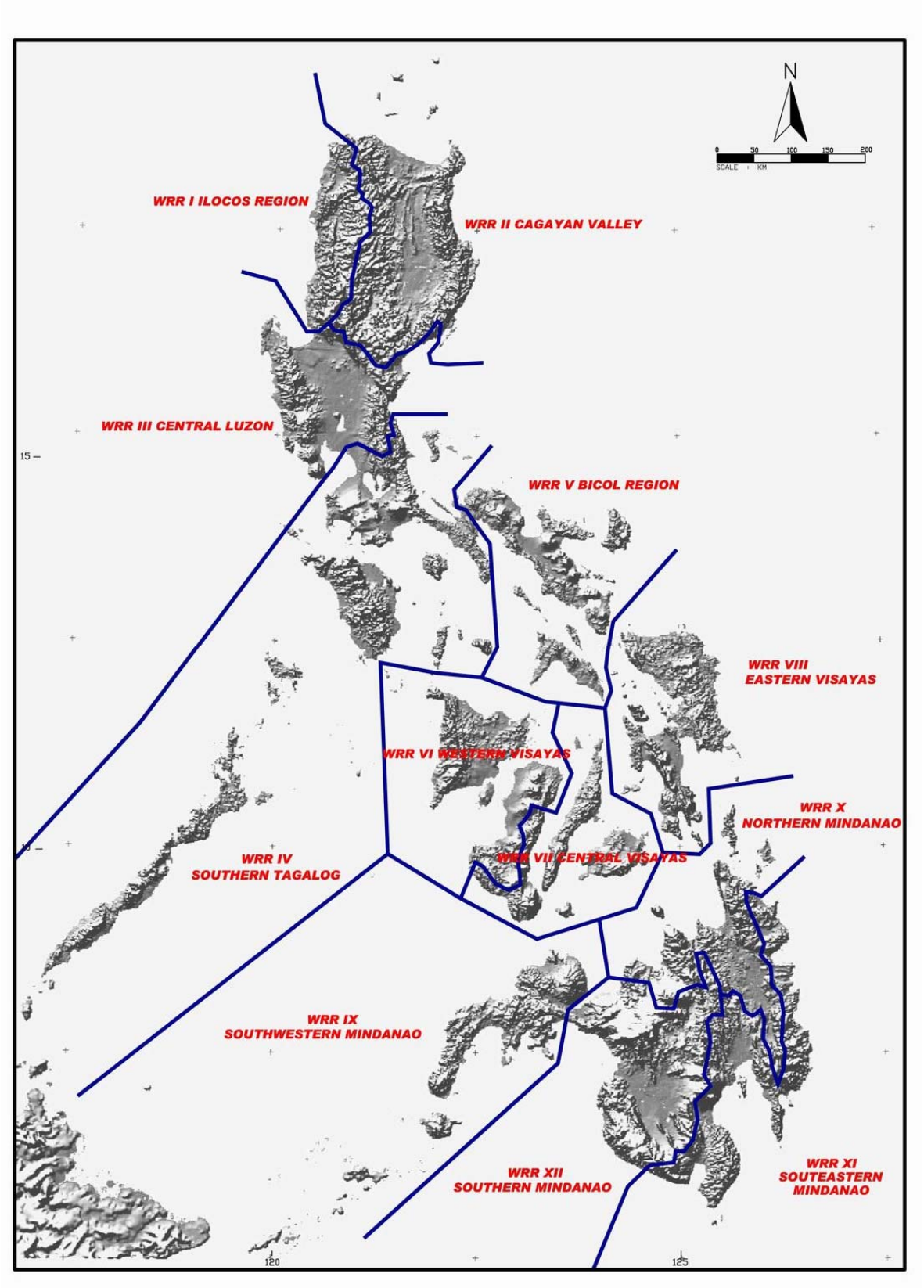



THE STUDY ON THE NATIONWIDE FLOOD RISK ASSESSMENT AND THE FLOOD MITIGATION PLAN FOR THE SELECTED AREAS IN THE REPUBLIC OF THE PHILIPPINES

JAPAN INTERNATIONAL COOPERATION AGENCY

**Fig.A-2-4**

**Geological Map of the Philippines**

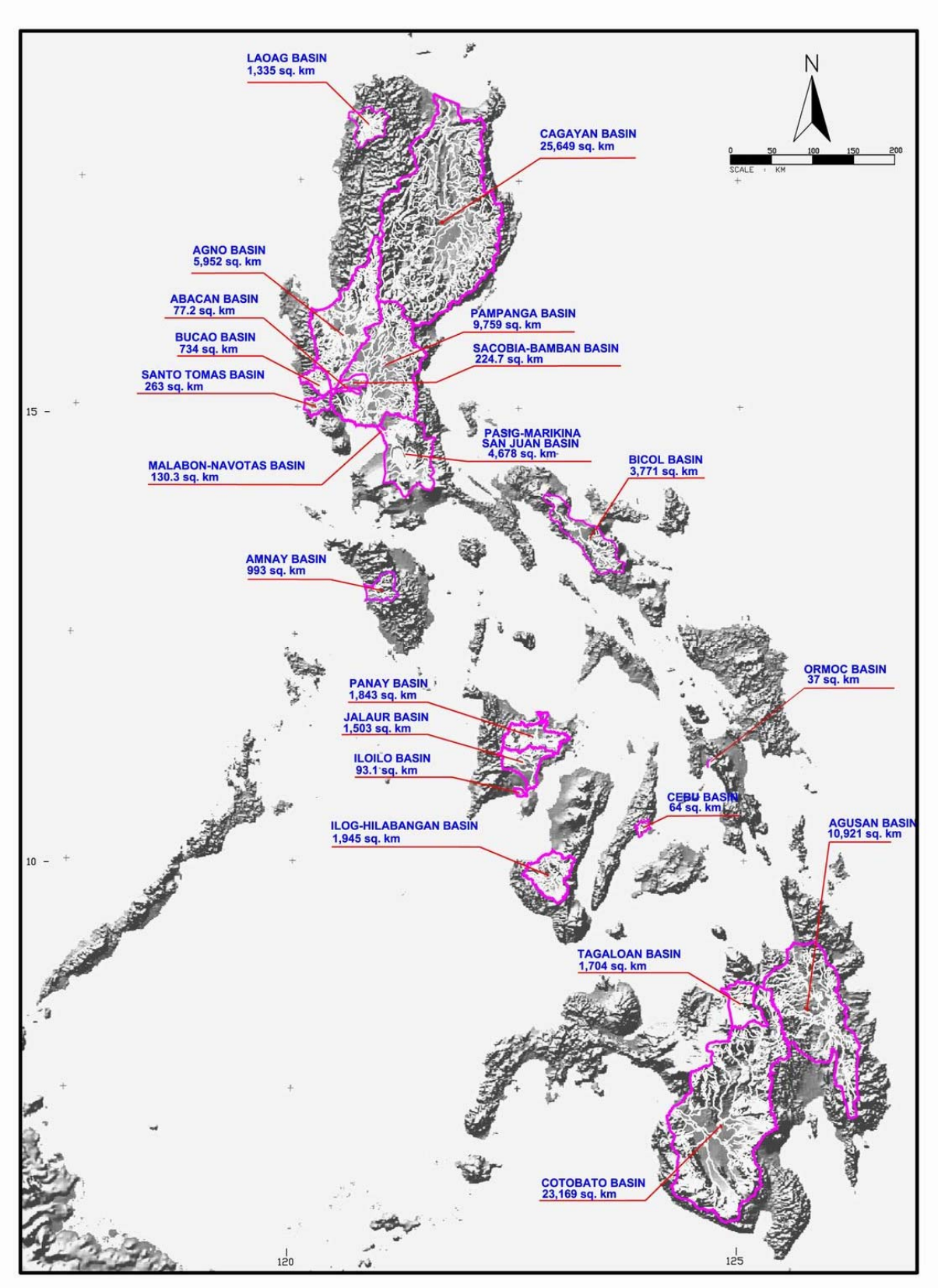



THE STUDY ON THE NATIONWIDE FLOOD RISK ASSESSMENT AND THE FLOOD MITIGATION PLAN FOR THE SELECTED AREAS IN THE REPUBLIC OF THE PHILIPPINES

JAPAN INTERNATIONAL COOPERATION AGENCY

**Fig.A-2-5**

**Boundaries of Water Resources Region**




Note) Basin areas are indicated for reference.

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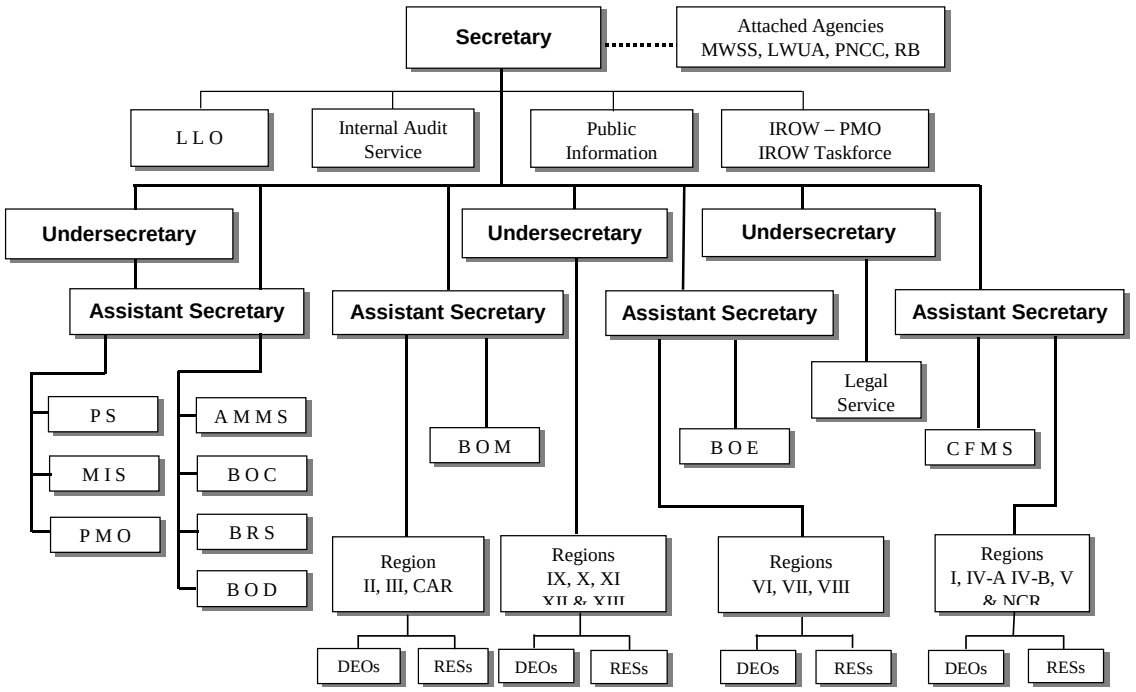
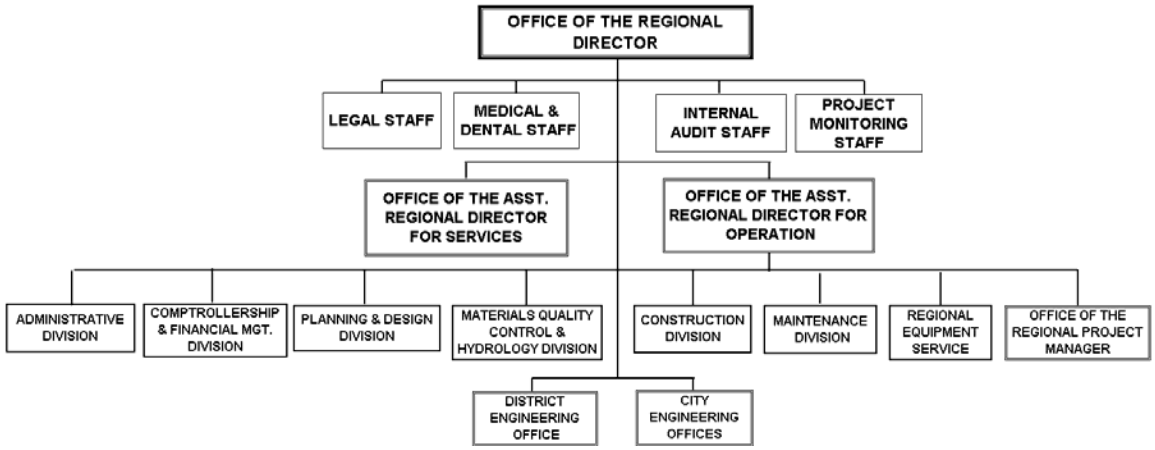
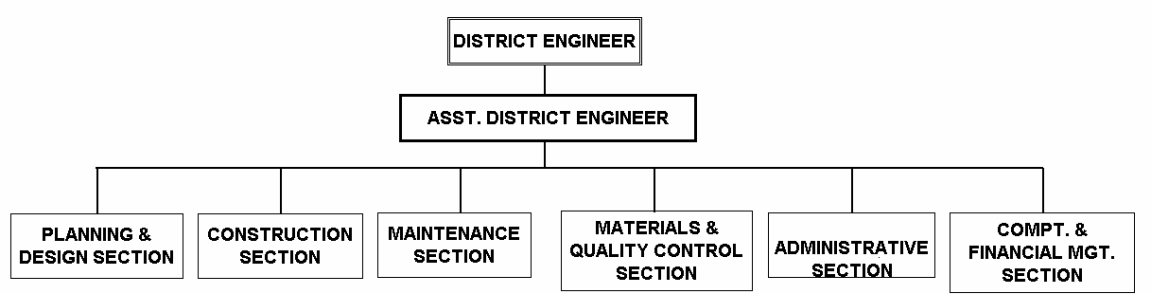
| THE STUDY ON THE NATIONWIDE FLOOD RISK ASSESSMENT AND THE FLOOD MITIGATION PLAN FOR THE SELECTED AREAS IN THE REPUBLIC OF THE PHILIPPINES | **Fig.A-2-6** |
| JAPAN INTERNATIONAL COOPERATION AGENCY | **Major River Basins** |

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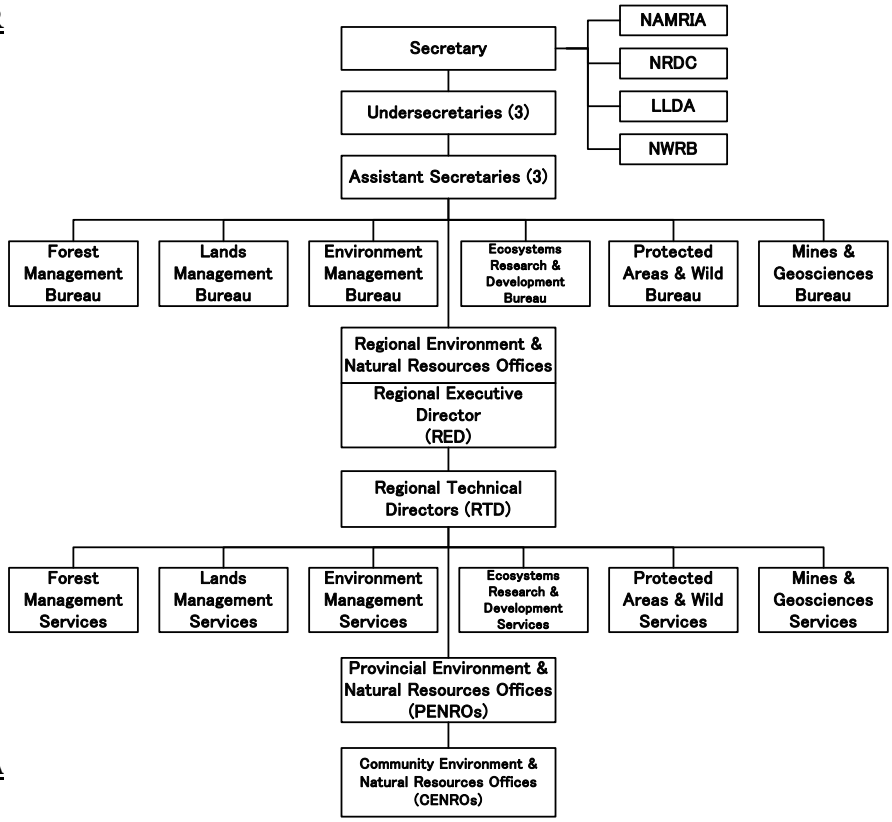
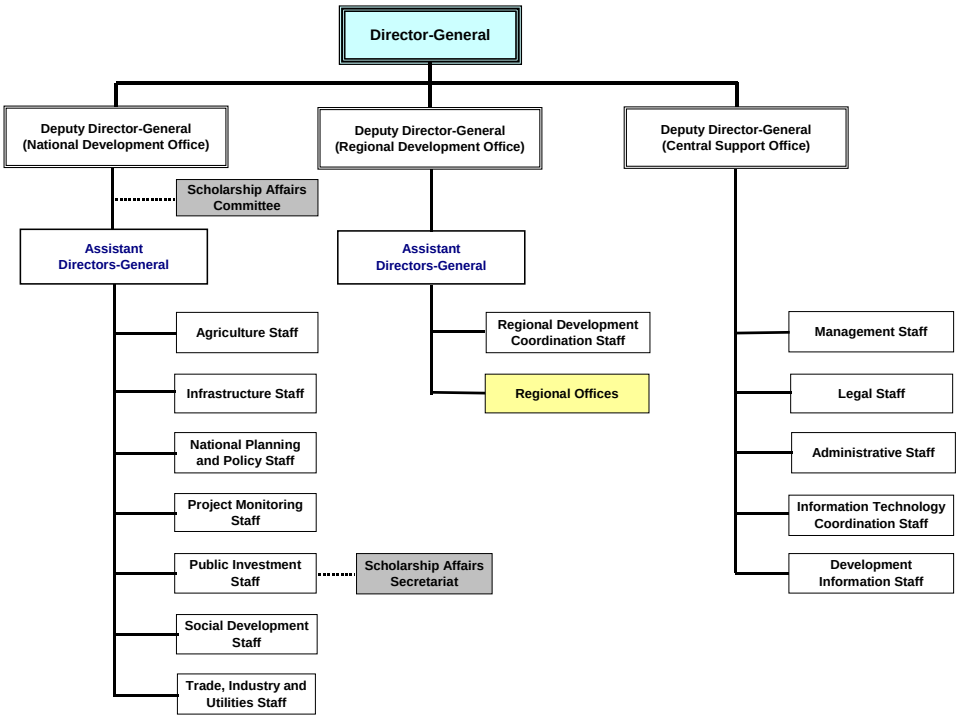
| THE STUDY ON THE NATIONWIDE FLOOD RISK ASSESSMENT AND THE FLOOD MITIGATION PLAN FOR THE SELECTED AREAS IN THE REPUBLIC OF THE PHILIPPINES | **Fig.A-2-7** |
| JAPAN INTERNATIONAL COOPERATION AGENCY | **Organization Chart of DPWH** |

**DENR**




**NEDA**



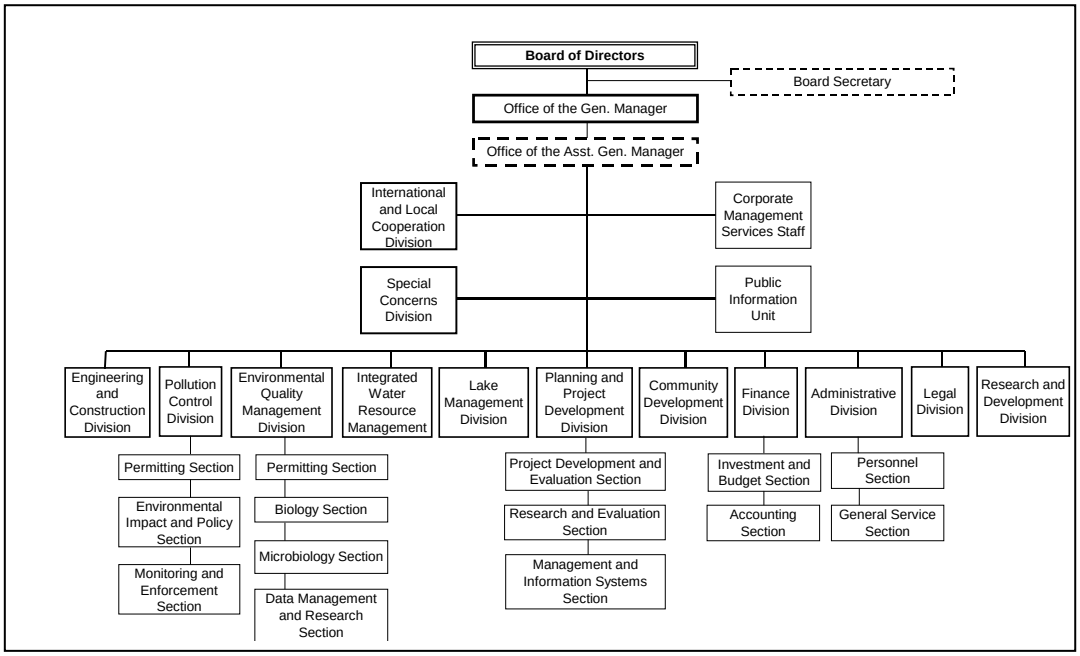

THE STUDY ON THE NATIONWIDE FLOOD RISK ASSESSMENT AND THE FLOOD MITIGATION PLAN FOR THE SELECTED AREAS IN THE REPUBLIC OF THE PHILIPPINES

JAPAN INTERNATIONAL COOPERATION AGENCY

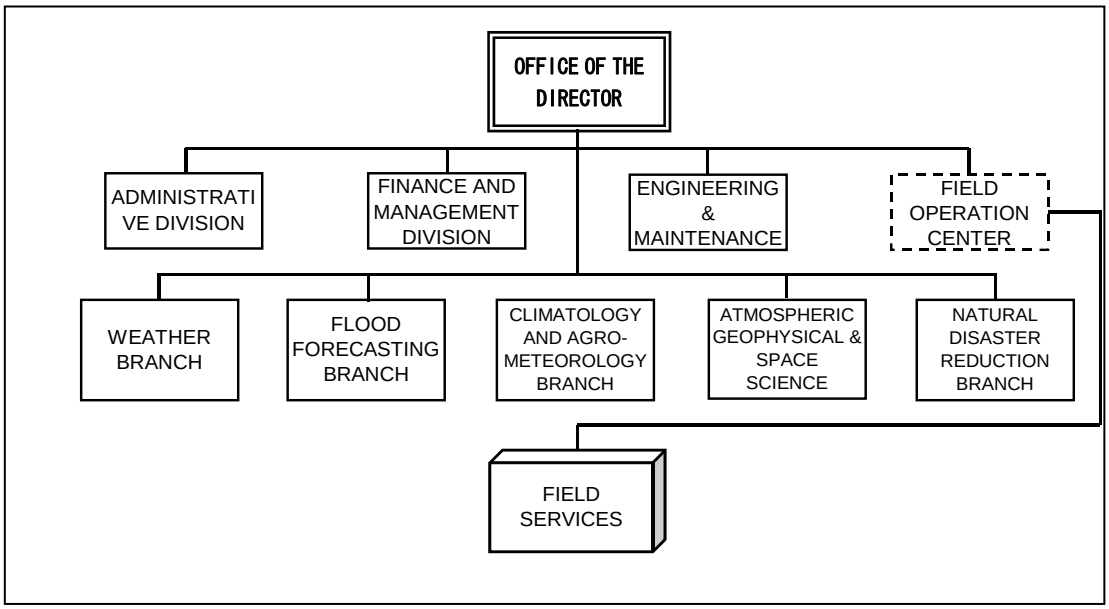
**Fig.A-2-8**

**Organization Chart of DENR & NEDA**

**LLDA**




**PAGASA**

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| THE STUDY ON THE NATIONWIDE FLOOD RISK ASSESSMENT AND THE FLOOD MITIGATION PLAN FOR THE SELECTED AREAS IN THE REPUBLIC OF THE PHILIPPINES | **Fig.A-2-9** |
| JAPAN INTERNATIONAL COOPERATION AGENCY | **Organization Chart of LLDA & PAGASA** |

# B. GIS Database

# Table of Contents

## List of Table

**Table**



## List of Tabs.

**Tab.**



## List of Figs.

**Fig.**



## List of Annexes

# B. GIS DATABASE

## 1 GIS AND GIS DATABASE

Understanding the natural phenomena is crucial for the decision making process while dealing natural disaster, such as flood. The process becomes more complex when it has to take consideration of human and socioeconomic factor. The flood event in the area with no human/socioeconomic activities has relatively matter of lesser concern than the area with human and socioeconomic activities.

Once problem is identified and underlying process is understood, it is desirable to list out the required input data for particular modeling or analysis chosen to solve the problem. Sometimes it is necessary to have alternative model or need to modify the model to fit with the local situation and need along with some consideration of available data as well. Based on the listed required data, next step is to prepare the list of probable institution from where the data can be obtained.

In this Study, both natural as well as socioeconomic variables (factors) have been considered for the flood hazard risk assessment. Accordingly, the selection and design of database have been created to address and fulfill these requirements. The main source of data is from secondary sources. However, some fresh data input has been considered, specifically for the most crucial one, for example river basin boundary delineation.

In simple term, GIS (Geographic Information System) is a tool to answer questions about a location (geographic information). The information stored in a database by layers of information can be combined for a devised logic to draw a conclusion. Thus, GIS is a tool that utilizes GIS database for defined purpose and analysis and complement to each other. GIS is useful and applicable for any analysis where one has to answer and take care of location. In working term, it is the organized activities for (i) measuring aspects of geographic phenomena and processes; (ii) representing these measurements, usually in the form of a computer database, to emphasize spatial themes, entities and relationships; (iii) operating upon these representations to produce more measurements and to discover new relationships by integrating disparate sources and (iv) transforming these representations to conform to other frameworks of entities and relationships. Finally, the results are generally outputted as maps, figure/graphs, table, etc.

### 1.1 GIS and River Basin

River basin or watershed area is a geographic identity defined by the total land area from which water drains into a particular stream or river. In GIS, it is represented by a polygon that defines boundary of drainage area. The size and shape of river basin polygon depend upon (i) area classification and (ii) geomorphology of the landscape in question, topography in specific, respectively.

In this Study, river basins are classified, as follows:

(a) Major River Basins
(b) Principle River Basins
(c) Other River Basins

The major river basins have catchment areas of more than 1,400 $km^2$. It comprises a few to several principle river basins. The principle river basins are defined as those with more than 40 $km^2$ in catchment area. The remaining river basins are defined as the other river basins.

## 1.2 GIS Database

### 1.2.1 Nomenclature and Coding

Proper GIS Database should be created for the logical analysis. Being the national level analysis, while including several variables and attributes, this is very crucial issues and has been dealt accordingly. A standard nomenclature and coding have been provided to each entity, which facilitates the data linking and analysis. The main entities are shown below with their main and sub categories:

Geopolitical

- Region
- Province
- City/Municipality

Natural

- Water Resources Region
- Major River Basin
- Principle River Basin
- Other River Basin

To facilitate screening and analysis in more efficient way, a river basin map coverage of the national level has been prepared based on the following method:

- Some of the major and principle river basins have been subdivided into sub-basins, however, the name of the basin kept intact by giving numerical suffix (1, 2, 3….).
- All of river basins have been merged to create national level river basin map coverage.

The sources of nomenclature and coding for geopolitical entity are NSO (National Statistics Office) yearbook of year 2000, while for natural entity are taken from NWRB (National Water Resources Board) as well as devised by the Study Team where it is not available or defined.

NSO nomenclature represents the historically assigned names, while 6 digits numerical code has been assigned to city/municipality in general. The definition of the code is, as follows:

(a) First two digits represent region
(b) Second two digits represent province

(c) Last two digits represent the city/municipality

However, there are some exceptions of these rules. For example, the city/municipality inside the Metro Manila has been provided with 9 digit coding system. Furthermore, the Study Team has assigned some special code for the entity, which has been modified. One such example is Kalinga-Apayao province where code "983281" (six digit code for province) has been assigned to accommodate the socioeconomic data both from Kalinga and Apayao provinces when they were separate entities. The first 4 digits represent the original code of Kalinga province while the last 2 digits are taken from the original code of Apayao province.

For natural entities, NWRB coding system has been adopted for the first three (water resources region, major river basin and principle river basin), while newly devised for the other river basins by the Study Team. A brief description of coding system has been given below:

(a) Water resources region: 2 digits starting from "01" to "12" from north to south of the country
(b) Major river basin: 5 digits; first 2 digits represent water resources region
(c) Principle river basin: 5 digits; first 2 digits represent water resources region
(d) Other river basin: 6 digits; first 2 digits represent water resources region followed by 1 digit, "9", representing special code for other river basin. Last 3 digits are serial number, starting as 001 for given water resources region
(e) National river basin: 6 digits; first digit represents arbitrary number "9" followed by two digits for water resources region. Last three digits are serial number, starting as 001, for given water resources region.

This coding system is named as "STUDY_CODE" in the map coverage attribute table. Furthermore, the name of basin is given as "RIVER_NAME".

### 1.2.2 Socioeconomic Data

The socioeconomic data are mainly related to the demography, basic economic activities of the populous and damages related to the flood hazard. Most of the data have been obtained in the printed texts, which have been converted to digital format. The processing steps of these data are, as follows:

(a) Obtaining printed text from relevant authorities/institutes
(b) Digital conversion (mostly manual typing) into XLS format
(c) Converting to database format
(d) Relating the database to appropriate entity, mostly political/geopolitical map coverage

### 1.2.3 Geophysical and Natural Event Data

Being a natural phenomenon, the geophysical and the natural event data are very crucial to assess the flood hazard risk. Furthermore, for national level study, data covering the entire country are required. Accordingly, data that have national level coverage or can be extracted for the whole nation have

been considered and archived in this GIS database. The list of archived data is presented in Table B.1.1.

**Table B.1.1 Source of Geophysical and Natural Event Data**

| Name | Source | Definition/Remarks |
|---|---|---|
| Political Boundary | FCSEC/NSO | City and municipality boundary map based on year 2000 census; Provincial boundary map; Water resources region boundary map; Political region map |
| Road Network | DPWH | National road network representing major roads (scale unknown) |
| Bridge Location | DPWH | National bridge location archive |
| River Network | FCSEC/JICA | National river network (scale unknown) |
| River Basin | ST | Generated watershed boundary for whole country; Scale 1:250,000 |
| DEM | SRTM/NASA | Extracted from SRTM (The Shuttle Radar Topography Mission), Feb. 2000 /NASA global elevation dataset; 90 meter grid |
| Rainfall Isohyet | DPWH/JICA | Probable daily rainfall isohyet |
| Flood Susceptibility | MGB | Extracted utilizing geology, slope and elevation; Scale 1:250,000 |
| Flashflood Exit Point | MGB | Extracted utilizing slope and local geophysical condition; Scale 1:250,000 |
| Rainfall Station Location | PAGASA | Locations of synoptic stations with estimated probable daily rainfall |
| Volcanic Location | PHILVOLCS | Location of active and potential volcanoes (in degree and minute) and some of attributes obtained from PHILVOLCS web site; The point location GIS data created by Study Team |
| Forest Cover and Land Use | NAMRIA | Forest cover and land use data for the whole Philippines at 1:100,000 Scale, which was prepared from 2002/03 Landsat data and verified during 2004/05. The data is prepared by RS&RDAD of NAMRIA |
| Topographic Maps | NAMRIA /FCSEC/JICA | Scanned and geolocated copy of 1:250,000 and 1: 50,000 Scale maps. |

Note:

DPWH: Department of Public Works and Highways

NAMRIA: National Mapping and Resource Information Authority

MGB: Mines and Geosciences Bureau

JICA: Japan International Cooperation Agency

RS&RDAD: Remote Sensing and Resource Data Analysis Department, NAMRIA

DEM: Digital Elevation Model

NSO: National Statistics Office

PAGASA: Philippine Atmospheric, Geophysical & Astronomical Services Administration

PHILVOLCS: Philippine Institute of Volcanology and Seismology

ST: JICA Study Team

It is desirable to have fresh and updated geophysical data, however, most of the time it is difficult to prepare and obtain such data. There is some time line for the data showing up to when it can be used with confidence. For example, Land Cover/Land Use map can be used most confidently within 5 years from the date of its preparation and can be extended up to 10 years in case of unavailability. Similarly, the topographic maps should be of less than 50 years old. For our purpose, the forest cover and land use data can be used more confidently while topographic data seem touching the borderline.

### 1.2.4 Creation of Metadata

Metadata is an integral part of GIS database. It gives vital information about the data, thus facilitate its use. The user can refer to metadata to get detailed information on attribute, besides general information on the data. Most of the data obtained from various sources were lacking metadata, thus some times become almost impossible to define some of the attribute attached to the data. Effort has been made to define all attributes and information used in this Study.

A detailed embedded metadata have also been created. Summary of the metadata has been presented here for a few datasets as example (Figs. B-1-1 and B-1-2).

### 1.3 Map Projections System

The geophysical data can be located properly only if they have been projected with well defined projection system. Projection system becomes more crucial when one has to overlay more than one geophysical map coverage data. Here, several such data is being used, hence, the projection systems become more important.

#### 1.3.1 Map Projection Systems in the Philippines

There are following types of map projection currently being used in various institutions and organizations:

(a) Universal Transverse Mercator (UTM)
(b) Geographic
(c) Philippine Transverse Mercator (PTM)

UTM, a cartesian coordinate system, is a series of global projections that divide the earth into 60 zones, six degrees for each zone. Geographic is a traditional projection system utilizing degree as its unit. PTM is a local projection system designed specifically for surveying political boundaries in the Philippines. It reduces distortion by creating a series of central meridians. While UTM has only two zones to cover the country, PTM uses five separate zones. The five zones are as follows:

(a) Zone I: 117°E Area west of 118°E
(b) Zone II: 119°E Palawan and Calamian Islands
(c) Zone III: 121°E Luzon (except SE), Mindoro
(d) Zone IV: 123°E SE Luzon, West Mindanao
(e) Zone V: 125°E East Mindanao, Bohol, Samar

Regarding the UTM zones, 50 for Palawan Region and for the rest of the country 51 is used. For both UTM and PTM, the unit is in meters. Most commonly used datum and spheroid are, as follows:

(a) Datum: Luzon, WGS84
(b) Spheroid: Clarke 1866, WGS84

Luzon 1911 (also commonly referred as Luzon) is the most commonly used datum for the Philippines. Most of the map series published by the NAMRIA use the Luzon datum. Any spatial data created from digitized maps are most likely to be based on it. Luzon uses the Clark 1866 ellipsoid and its origin is located just south of Luzon at Balanacan, Marinduque Island.

WGS84 is a commonly used worldwide datum developed from satellite measurements of the earth. It is rapidly becoming the preferred datum around the world. Satellite images are often published using this datum. Unlike most datums, the origin for WGS84 is the center of the earth. The ellipsoid is also

called WGS84. Transformation parameters to convert from most national or local datum to WGS84 are published and can often be found in GIS and related software.

In 1992, NAMRIA created the Philippine Reference System datum of 1992 (PRS92). Basically, it is an adjustment of the Luzon datum. The original datum observations from Luzon 1911, used in PRS92, have been recomputed. PRS92 uses a total of 467 GPS locations, of which 330 are first order accuracy. The Luzon datum location network consists of survey data of second order accuracy or below. NAMRIA has published transformation parameters for PRS92 to WGS84 but there is no published accuracy assessment.

Another datum is Luzon-Mindanao. Differences between Luzon and Luzon-Mindanao require different transformation parameters to properly convert locations to WGS84. Some software programs identify Luzon-Mindanao as a separate datum. This is incorrect. Luzon-Mindanao is not a separate datum, it is the Luzon 1911 datum with different WGS84 transformation parameters.

### 1.3.2 Selected Map Projection for the Study

In recent days, most of the measurements are taken in metric system. Since this Study is conducted for the whole country, it is desirable to use UTM system. However, there is one difficulty due to the location with respect to the UTM zones. Since the country is divided into two zones (50 and 51 North), it is not allowed to create single coverage, which can contain whole country using UTM. In order to overcome this problem, initially geographic projection system was used for overlay operation. Then, the outputs were divided into two regions, i.e., “Palawan” region and “Rest of the Country” region, which can be re-projected back to UTM system. For attribute extraction and mathematical/logical combination/analysis, such re-projection is not required.

The definitions of the two projection systems used are, as follows:

(a) Universal Transverse Mercator (UTM)
- Datum: Luzon
- Spheroid: Clarke 1866
- Zone: 50 N (Palawan) and 51 N (Rest of the Country)
- Unit: Meters

(b) Geographic
- Datum: WGS84
- Spheroid: WGS84
- Unit: Decimal Degree (dd)

In some cases, the national level map coverage data are obtained in UTM or PTM projection system in single coverage and defined in one zone form the source institution itself. For example, in case of UTM, such defined zone is 51 N, thus it is impossible to segregate them in appropriate zones and used as such. Although, it is not appropriate to use such data, however in the light of unavailability of alternative source of data, there is no option left but to use such data.

Besides, for the model river basins, following projection system has been employed. This is due to the utilization of the satellite data, which are originally projected into UTM with WGS84 datum and spheroid.

(c) Universal Transverse Mercator (UTM)

- Datum: WGS84
- Spheroid: WGS84
- Zone: 51 N
- Unit: Meters

# 2 BASIC APPROACH OF GIS ANALYSIS

NDCC identified and listed 947 city/municipalities as flood prone areas. This list makes the start point for this Study. Besides, it has been decided that the flood risk assessment should be conducted on the river basin basis.

The national level political boundary map (2000) has been obtained from the NSO. The socioeconomic data, which are based on political boundary, have been arranged into river basin data to meet the assessment objective.

## 2.1 Scale of Analysis

The scale of analysis for the First Screening is set at 1:250,000. Accordingly, most of the data collected are in this scale. However, some data, such as Forest Cover and Land Use, are in better scale of 1:100,000. As the analysis is in digital, the scale factor does not pose any hindrance, such as for map overlay.

After the First Screening, initially better scale was considered for the Second Screening, however, data with better scale (in digital format) is not available for national level. Thus, the Study Team has been forced to use the same scale for the Second Screening. Fortunately, there are scanned and geo-located data of 1:50,000 scale topographic map, which are produced by NAMRIA in hard copy and scanned and geo-located by FCSEC.

## 2.2 Unit of Analysis

The unit of analysis is river basin. As described earlier, there are classified into three (3) levels. However, while assessing for flood risk, all river basins are treated equally irrespective of their categories. The First Screening resulted into 120 river basins, which have been used for the subsequent screening and analysis.

## 2.3 Data Arrangement

For geospatial analysis purpose, all the data have been arranged into river basin level. For this purpose, river basin data are obtained through the converting from administrative boundary data and

the extracting from GIS data. In the conversion and extraction, one of the following GIS methods is applied to obtain the desirable variable considering suitability for the particular case:

(a) Direct overlay between river basin boundary map and variable map coverage

(b) Converting map coverage of variable data into grid format, and intersecting with river basin boundary map

# 3 GIS DATA SETUP FOR THE SECOND SCREENING AND MODEL RIVER BASINS

Geophysical data collected so far for GIS database are in various scale of mapping. The most detailed digital map coverage is 1:100,000 scale for Land Use/Land Cover map. Besides, the topographic elevation data are in digital grid format (90 X 90 m).

Based on this database, 120 river basins have been selected through the First Screening. It is obvious that the Second Screening should be based on more detailed database. To this end, further data collection drive has been attempted including GIS. The main supplementary geophysical data are detailed topographic map. Fortunately, there is availability of 1:50,000 scale topographic map in JPG format at FCSEC data library. The geo-located version of this dataset has been obtained and used here.

## 3.1 Types of Data

### 3.1.1 Primary Source

Primarily, the existing GIS database is used for the extraction of the basic basin data, such as basin boundary, land area and name of the river. Regarding basin boundary data, those which were prepared during the First Screening have been utilized due to the limited period of this Study. As an example, the Pola River Basin is illustrated in Annex B.1. In similar way, such data have been extracted for the 120 river basins.

### 3.1.2 Secondary Source

Broad categories and items of GIS database for the Second Screening have been identified as shown below. These data are collected and complied in GIS database for the selected 120 basins. As an example, the Pola River Basin has been chosen to illustrate the data extraction (refer to Annex B.1).

#### (1) Name of City/Municipality

It is ideal to have the list of major settlement for each river basin. However, due to lack of data, it might not be possible. From the existing data (political boundary of city/municipality), the list of city/municipality is prepared. In the future, it is desirable to have such list up to Barangay level.

**(2) District Boundary/Name**

From the district boundary map, the name(s) of district(s) inside the river basin have been extracted and listed for the respective river basin.

**(3) Main Road and Bridges inside the basins**

The digital data of main national road network (linear feature coverage) and national level bridge location (point feature coverage) have been obtained from the DPWH. From these data, the inventory of the road and bridge for each basin is extracted and archived into GIS database.

**(4) Population**

No additional data has been collected for population. Rather existing GIS database has been used.

**(5) Detailed Land Use/Land Cover**

From the 1:100,000 NAMRIA Land Cover/Land Use map, the share of land use types for basin is extracted and archived in the GIS dataset. This data are most updated land classification available in the country. It has 23 categories of land use/land cover types. Based on the definition of the "classes of categories of land use/land cover types", these have been grouped into 9 main classes for analysis in this study.

### 3.1.3 Topographic Map of 1:50,000 Scale

The scanned and geo-located topographic maps have been imported to create the necessary topographic database. The required number of 1:50,000 scale topographic sheets, those overlap with the 120 river basins, have been used.

### 3.1.4 Flood Inundation

Flood inundation data simulated by Hec-GeoRAS have been used to extract the necessary statistics data for each river basin.

## 3.2 Data Information Table for Selected River Basins

A comprehensive data have been extracted for the 120 basins. The data have been exported and tabulated in XLS format. The data extraction format has been illustrated in Tab. B-3-1. The procedure for the data extraction is presented below:

(a) A data extraction format has been prepared.
(b) Using the river basin boundary, the national level coverage thematic data (road, bridge, city/municipality boundary, land use, etc.) from GIS database have been clipped using map overlay function in GIS.

(c) The required statistics have been calculated, summarized and exported.
(d) The exported data have been tabulated using predefined format.

### 3.3 GIS Analysis for Variable Calculations

Using various tools and operators, a set of required information has been extracted based on predefined data format. As an example, GIS analytical procedure to calculate river channel improvement length is described below:

(a) River stretch for inundated area overlapping with the land use categories is marked while taking account of the hydrological aspects.
(b) Accumulated length for these river stretches gives the total length for river channel improvement.

### 3.4 Additional Data Information for Model River Basins

Following six river basins have been selected for the model river basins:

(a) Ilog-Hilabangan
(b) Dungcaan
(c) Meycauayan
(d) Kinanliman
(e) Tuganay
(f) Dinanggasan

Besides, already archived during the First and Second Screening, some of the fresh data have also been collected for these river basins. One of such data is the Landsat TM satellite data, which is in WGS84 map projection system originally. To avoid the data mismatch, all of the additionally collected data have been re-projected into WGS84 datum.

The scale of analysis for the model river basins is 1:50,000, which is much better than that used during the First and Second Screening. However, this resulted into some degree of data overlay problem, specifically the river basin boundaries and scanned topographic maps. In order to address these problems, further editing on the river basin boundaries has been employed wherever required.

## 4 PRESENTATION, HARDWARE AND SOFTWARE, MAINTENANCE AND TRAINING

### 4.1 Presentation of Results

In order to grasp the real world situations, it is important to present the GIS map coverage and related attribute data using maps, figures and tables. Such presentation is crucial for the decision making process on natural hazards including flood. Accordingly, GIS outputs have been presented in the following forms:

(a) GIS Map: Map layouts with appropriate geographical entities and attribute data are prepared. Particular attentions are paid on the map composition so as to present maximum level of map details, while ensuring simplicity and easy to understand map legends. The output maps have also been converted to suitable image formats such as JPG.
(b) Table: The GIS data have been converted to tabular in XLS format.
(c) Figure: Besides the tables, the data are also presented in figures and charts.

## 4.2 Hardware and Software

Most of the institutes visited for data collection are currently using one of the following GIS/mapping software:

(a) MapInfo
(b) ArcGIS/ArcView
(c) EDRISI

It has also been found that most of them have not updated their software for long time. Thus, in most of the cases, old version of software is still in use. However, in terms of hardware specifically computer, situation is much better. In most of the cases, computers in use are good enough to handle the professional software. In order to perform the Study, necessary hardware and GIS software were purchased. The specifications of these hardware and GIS software are shown below:

**Table B.4.1 List of Hardware and Software Acquired**

| S. No. | Items | Quantity |
|---|---|---|
| **Hardware** | | |
| 1 | Desktop Computer with Intel 945 3.4 GHz Dual Core Processor | 1 |
| **GIS Softeware** | | |
| 2 | ArcVIEW 9.1 SU | 1 |
| 3 | ArcGIS Spatial Analyst Extension 9.2 SU | 1 |
| 4 | ArcGIS 3D Analyst Extension 9.2 SU | 1 |

*Note: The license type is desktop single user.*

## 4.3 Data Maintenance and Update

### 4.3.1 Structure of the Database

The database is simply structured so that any person who has basic computer knowledge can reach to the desired dataset. The desired dataset can be accessed with clicking the folder and subfolder. The list of dataset is shown in Tab. B-4-1. To become familiar with the database, one need to open the folder and read the “ReadMe.doc” files first. In most of the case it will give following information:

(a) Source of the data
(b) Date of the collection/compilation/creation
(c) Name of the folder and brief description of the files, dataset and inside coverage
(d) Basic information about the data

(e) Detailed inbuilt metadata in the map coverage

On the other hand, to make things simple and clear, the metadata, which include basic general and attribute information, have been encrypted as much as possible. However, in some cases, it is not complete because such metadata are not available at original source. As it is widely known, the metadata are the most important information that must be consulted before updating the database.

### 4.3.2 Time Frame of Database Updating

There is no dispute that database should be updated immediately once the original source get any change. However, in many cases, it is not feasible to update the data immediately. Hence, time frame is considered for the database updating. Regarding the time frame of database updating, following three categories might be applicable:

#### (1) Long Time

Some of the land features do not change much and can be used for long time. For example, general topography of the country is, more or less, remains unchanged for considerably long time at macro scale. Thus, topography map of the country does not require frequent updating. In this connection, river basin boundaries might be used for long time.

#### (2) Less Frequent

Less frequent need of map updating might be, for example, defined as around 5-6 years time frame, depending upon the requirements, importance, etc. The update requirements for land features, statistical data and political boundaries are described below:

Some land features, for example land use/land cover map of a country, keep changing with the time, but such change is not so significant within a year and not economically feasible to update it every year.

In general, statistical data on socioeconomic items are surveyed with varying intervals, e.g., from three (3) to ten years. Thus, these should be updated on less frequent.

In the Philippines, the political boundary, specifically city/municipality and barangay, is keep changing more often. While checking city/municipality data, some level of data error has been found. Such error should be updated as soon as information is made available from concerned authority. It is proposed that these should be updated on less frequent.

#### (3) Frequent

NDCC announces information on damages, evacuation, rescue and so on caused by tropical cyclones, monsoons, etc. on daily basis. On the other hand, DSWD publishes casualty data on natural and man-made disasters on yearly basis. These data need to be updated frequently according to its necessity.

### 4.3.3 Features to be Updated

GIS database primarily comprises two types of features, namely (i) geographic and (ii) attributes. While keeping the geographic feature intact, several attribute features can be added or linked to it in tabular format. Once the geographic features updated, the attributes for the new added/updated features should also be added/updated. The features to be updated are described below:

**(1) Geographic Features**

There are three (3) types of geographic features in this database, namely (i) point, (ii) line and (iii) polygon. This database also includes both ArcInfo coverage as well as shape files (ArcMap can read and use both of them). Care should be taken while defining the data types during updating and rebuilding the data. If the point data are built or exported as polygon, for example, the related features become disabled.

**(2) Attribute Features**

The attributes of the dataset can be found in attribute table attached to map coverage. Most of the dataset have been attached with additional attributes that explain the related information about dataset. There are some default attributes generated by software, for example, area and perimeter incase of polygon type of dataset. The default attributes get updated automatically once the geographic features are updated, while additional attributes need to be updated by user separately/interactively.

The new set of information can be added by defining new attribute column in attribute table. Alternatively, the new information can be kept separately in table and linked to the dataset by defining common “Id”. The attributes should be edited either by typing individually or by calculating them after selecting desirable group of features.

**(3) Metadata**

Metadata are “data” about the “data”. A simple example of the metadata is library catalogue containing information (metadata) about publications (data). In GIS, the dataset (coverage/ shape files) is data, while the text explaining about its features (both geographic and attributes) is called metadata. Metadata are an important and integral part of GIS database, and, in many cases, the dataset might have little value without metadata. It is obvious that once any of dataset features get updated, the metadata should also be updated accordingly. In this Study, the metadata have been encrypted with the map coverage. The metadata can be viewed using “ArcCatalog”.

**(4) Adding New Dataset**

The GIS database is updated once the new dataset is added to it. The selection of additional new dataset depends upon requirements. New datasets can be produced by modifying/manipulating the original one.

## 4.4 GIS Training

The GIS analysis along with the creation of GIS database makes backbone of this Study. Considering the level of required analysis and current understanding of counterpart, there might be a gap in GIS understanding and capabilities. Thus, it had been recognized that the GIS training had been necessary for the counterpart. In addition to this, the counterparts were requesting GIS training. Considering these, it has been agreed to conduct training program sometime during the Second Screening. Finally, three days training, from 25 to 27 June, 2007, was conducted at the IT Training Room 1 of the DPWH. One (1) PC for each participant was prepared and necessary software package was installed prior to the training. A brief description of the training is presented subsequently.

### 4.4.1 Training Objective

The training has been conducted to introduce GIS concepts and train the capabilities with specific reference to flood risk assessment. The specific objectives are to:

(a) Introduce GIS and GIS Database
(b) Introduce ESRI ArcMap software for data input, analysis and output

### 4.4.2 Methodology

**(1) Preparation of Course Outline**

The main topics and course outline have been prepared, as follows:

(a) Based on GIS understanding level of the counterpart, a tentative course outline was prepared by GIS expert of the Study Team.
(b) After receiving comments and suggestions from the DPWH, the training course was finalized.
(c) In the beginning of the first day of the training, a simple questionnaire on need assessment was distributed to the participants to assess their level of GIS understanding.
(d) Based on this assessment, the focal area of software and demonstration level were determined.

**(2) Training Method**

Handout training was adopted as a basic method for this training. The method employed here is summarized below:

- Lecture
- Presentation of case study
- Demonstration by the trainer
- Practice by the trainee

**(3) Main Topics of the Training**

The main topics of the training are, as follows:

- Introduction of GIS
- GIS data and GIS database
- Introduction of ArcGIS/ArcView
- Data roaming
- Data query
- Logical operator and map overlay
- Data editing/updating
- Extracting new data layers
- Map composition and printing to the file

**(4) Training Materials**

With limited time, effort had been given to prepare sufficient training materials. The main items of such materials have been listed below:

(a) Lecture note and demonstration handout (Training Manual)

(b) Training CD, containing:

- Digital version of lecture note/manual
- Reference materials for further reading
- Sample data for exercise
- Result of exercise and project files

(c) Case study presentation materials

(d) Exercise materials

(e) General stationary

(f) Required software package installation

(g) Demo version of software CD for distribution (ArcGIS 9.1 with ArcView and Spatial and 3D Analyst Extensions)

The software package was remained fully functional for 2 months. This enabled some of the participants to practice for further learning.

### 4.4.3 Training Evaluation

At the end of the training program, the participants were asked to evaluate the training program using training evaluation questionnaire. Most of the participants evaluated the training with ample satisfaction (refer to Annex B.2). In addition to this, the participants had suggested advance level training with longer period. Total 25 participants from DPWH, including regional offices, participated in the training program. Overall, the set objectives were achieved with success and satisfaction.

## Tab. B-3-1 Data Extraction Format for the 120 River Basins

| Name of Basin: | | | | |
|---|---|---|---|---|
| Data Items | Name/Description | Units | Data | Remarks |
| River Basin | Area | sq. km | | |
| | Perimeter | km. | | |
| Population | Year 2000 | person | | Census Population |
| | Year 2005 | | | Projected Population |
| Road | …… | km. | | Length |
| | …… | | | |
| Bridge | …… | Number | | Type |
| | …… | | | |
| River | …… | km. | | Length |
| | …… | | | |
| District | …… | sq. km. | | Area |
| | …… | | | |
| City/Municipality | …… | sq. km. | | Area |
| | …… | | | |
| Name of Urban Center | …… | name | | Main City Centers |
| | …… | | | |
| Land Use of River Basin | Forest | Area, sq. km. | | Natural, Plantation, Bamboo |
| | Mangrove Forest | | | |
| | Wooded & Natural Land | | | Shrub, Grassland, Barren, Marshland |
| | Annual Crop | | | Agricultural Land |
| | Perennial Crop | | | |
| | Pasture | | | |
| | Fish pond | | | |
| | Built-up Area | | | |
| | Water body | | | Inland Water |
| Simulated Flood Inundation | Area | hectare | | Total Area and Average Depth for River Basin |
| | Average Depth | meter | | |
| Inundated Area by Land Use | Forest | hectare | | Inundated area by land use except Water body, which is considered as permanently inundated. |
| | Mangrove Forest | | | |
| | Wooded & Natural Land | | | |
| | Annual Crop | | | |
| | Perennial Crop | | | |
| | Pasture | | | |
| | Fish pond | | | |
| | City……Built-up Area | | | |
| | City……Built-up Area | | | |
| | Municipality……Built-up Area | | | |
| | Municipality……Built-up Area | | | |
| Inundated Area by Administrative Boundary | city ……total | hectare | | Total Inundated Area by City/Municipality |
| | city ……total | | | |
| | Municipality ……total | | | |
| | Municipality ……total | | | |
| Inundated City/Municipality Population | city …… | person | | Proportion of City/Municipality Population Inside Inundated Area; Year 2000 Census Data |
| | city …… | | | |
| | Municipality …… | | | |
| | Municipality …… | | | |
| Inundation Average Depth by Land Use | Forest | meter | | |
| | Mangrove Forest | | | |
| | Wooded & Natural Land | | | |
| | Annual Crop | | | |
| | Perennial Crop | | | |
| | Pasture | | | |
| | Fish pond | | | |
| | City……Built-up Area | | | |
| | City……Built-up Area | | | |
| | Municipality……Built-up Area | | | |
| | Municipality……Built-up Area | | | |

## Tab. B-4-1 Organization of Database (1/5)

First Screening

| No. | Description | File Location |
|---|---|---|
| | | |
| **1** | **All river basin** | **E:\GIS_Database\Final\Basin_All** |
| 1.1 | GIS data for the locations of river basins | \basin_f |
| 1.2 | Locations of river basins | \SHP\Basin_Fin.shp |
| | | |
| **2** | **1:50,000 Topographic map of some of the selected river basin for second screening** | **E:\GIS_Database\Final\Basin_Topo** |
| 2.1 | Scanned and Geo-located topographic map around "Pola" basin | \3159_I2.jpg |
| | | \3159_II.jpg |
| | | \3159_III.jpg |
| | | \3159_I.jpg |
| 2.2 | Topographic maps of surrounding area of Pola basin | \Pola.jpg |
| 2.3 | Clipped and mosaicked topographic map of Pola basin | \Pola51.jpg |
| | | |
| **3** | **Selected 100 basins for second screening, through screening process** | **E:\GIS_Database\Final\Basin100** |
| 3.1 | Selected 100 after 1st screening | \Basin100_fin.shp |
| | | |
| **4** | **Cyclone related data** | **E:\GIS_Database\Final\Cyclone** |
| 4.1 | Cyclone and other original data file received from Ms. Lina of DPWH on November 6, 2006 | \flood prone with tropical cyclone data.xls |
| 4.2 | Frequency of tropical cyclone calculated by Record Year 1948-2000 | \Cyclone_Final.xls |
| 4.3 | Province wise attribute table for cyclone | \Cyclone_Final_Attribute.xls |
| 4.4 | Province wise attribute table for cyclone | \Cyclone_Final_Attribute.dbf |
| 4.5 | Interpolated grid of cyclone using provincial coverage and "Cyclone_Final_Attribute.dbf" | \Cyclone_Grid.img |
| | | \Cyclone_Grid.rrd |
| 4.6 | Interpolated grid of cyclone using provincial coverage and "Cyclone_Final_Attribute.dbf" | \Cyclone_Grid.tif |
| | | \Cyclone_Grid.tif.rrd |
| | | |
| **5** | **Data obtained from DPWH** | **E:\GIS_Database\Final\DPWH** |
| 5.1 | City\Municipality political boundaries | \Original_Data\City_Municipal.shp |
| | | \Original_Data\Cities and Municipalities.shp |
| 5.2 | Bridge location | \Original_Data\Bridges.shp |
| 5.3 | Road network | \Original_Data\LRS.shp |
| 5.4 | Points locations of the road network | \Original_Data\LRP's.shp |
| 5.5 | Node locations of the road network | \Original_Data\Nodes.shp |
| 5.6 | Weather station location | \Original_Data\weather\sde_Weather_Stations.shp |
| 5.7 | Buffer zone of weather station | \Original_Data\weather\sde_Weather_zones.shp |
| 5.8 | River network | \Original_Data\river\sde_River.shp |
| 5.9 | Road network | \Extracted\road\LRS.shp |
| 5.1 | Bridge location | \Extracted\bridge\Bridges.shp |
| 5.11 | River network | \Extracted\river\sde_River.shp |
| | | |
| **6** | **Data obtained from FCSEC** | **E:\GIS_Database\Final\FCSEC** |
| 6.1 | Rainfall-Isohyetal data for different return period in Mapinfo format | \Original_Data\Isohytes_Original_Mapinfo |
| 6.2 | Rainfall-Isohyetal data for different return period in SHP format | \Original_Data\Isohytes_Original_SHP |
| 6.3 | Slope coverage | \Original_Data\SLOPE\SLOPE.SHP |
| 6.4 | River coverage | \Original_Data\River\phil-rivers_polyline.shp |
| 6.5 | Soil coverage | \Original_Data\SOIL\soiltexture.shp" |
| 6.6 | Engineering district boundary coverage | \Original_Data\District_Bnd\Phil_deo.shp |
| 6.7 | Selected rainfall-isohyetal coverage of 25 year return period | \Extracted\Iso25rain\yr25iso-poli.shp |
| | | \Extracted\Iso25rain\yr25iso.shp |
| 6.8 | River coverage | \Extracted\River_Data\phil-rivers_polyline.shp |
| 6.9 | Engineering district boundary coverage | \Extracted\District_bnd\Phil_deo.shp |
| | | |
| **7** | **Input, results and other related data of first screening** | **E:\GIS_Database\Final\First_Screening** |
| | | |
| | | |
| **8** | **Additional basins under consideration for second screening** | **E:\GIS_Database\Final\Konno_Additional_Basin** |
| | Additional river basin | \Additional_Basin4.shp |
| | | |
| **9** | **Data obtained from MGB** | **E:\GIS_Database\Final\MGB_Flood** |
| 9.1 | Flood exit point | \Original_Data\flood_exitpts_point.shp |
| 9.2 | Predicted flood prone areas | \Original_Data\floodprone_area_region.shp |
| 9.3 | Plotted map showing the flood prone area and flood exit points | \Original_Data\2Flood_phil_with_exitpts.jpg |
| 9.4 | Plotted map showing the flood prone area and probable land slide area. | \Original_Data\Flood_Lslide_A0_munibdy_2DPWH.bmp |
| 9.5 | Table showing the estimated area for flood prone by province | \Original_Data\List of Flood Prone Areas.xls |
| 9.6 | Interpolated grid of flood prone area; grid size 250 meter; projection UTM; Value 1 is flood prone area | \Extracted\MGB-Flood.tif |
| 9.7 | Estimated flood prone area by city\municipality | \Extracted\List-Flood-Municipality.xls |
| | | |
| **10** | **Data obtained from NAMRIA (Land use\land cover coverage of Philippines)** | **E:\GIS_Database\Final\NAMRIA** |
| 10.1 | Region 6 coverage | \lu6 |
| 10.2 | Region 7 coverage | \lu7 |
| 10.3 | Region 8 coverage | \lu8 |
| 10.4 | Region 9 coverage | \lu9 |
| 10.5 | Region "Luzon" coverage | \luzon |
| 10.6 | Region "Mindanao" coverage | \mindanao |
| 10.7 | Palawan" coverage | \pala: Region |
| 10.8 | Summary of Land Use\Land Cover categories | \Land_Cover_Categories.xls |
| | | |
| **11** | **Others** | **E:\GIS_Database\Final\Others** |
| 11.1 | ArcGIS software purchase and other related documents | \ESRI-Software |
| 11.2 | Questionnaire | \Field_Survey |
| 11.3 | GIS training related files | \GIS-Training |
| | | |
| **12** | **Rainfall data from PAGASA** | **E:\GIS_Database\Final\PAGASA** |
| 12.1 | Original rainfall, 2 to 100 years return period, data and the location of the rain gauge stations. | \Return period.xls |
| | | |
| **13** | **Regional boundary coverage** | **E:\GIS_Database\Final\Regional_Boundary** |
| 13.1 | Original dataset of regional boundary of Philippines | \Original\reg.shp |
| 13.2 | Map projection defined regional boundary of Philippines | \Projected\Admin_Region.shp |
| | | |
| **14** | **SRTM Elevation (DEM) data** | **E:\GIS_Database\Final\SRTM-DEM** |
| 14.1 | Original and reprojected DEM data | \SRTM-DEM |
| 14.2 | Original "ACS" files (Plain text file in ASCII format) and imported grid files | \ASCII_DEM |
| 14.3 | Literature related to the data | \DOC |
| | | |
| **15** | **Update city\municipality boundary coverage** | **E:\GIS_Database\Final\Update_City** |
| 15.1 | List of city and municipality | \Final_Updated_List_of_City_Municipality.xls |
| 15.2 | City and Municipality Area by Province | \CityMunicipality_Total_Area.xls |
| 15.3 | Built-up area under city and municipality by Province | \CityMunicipality_Built-up_Area.xls |
| 15.4 | Updated city\municipality boundary coverage | \SHP\ citymun.shp |
| | | |
| **16** | **Volcano location** | **E:\GIS_Database\Final\Volcano** |
| 16.1 | Volcano location in Philippines â Downloaded from PHIVOLCS web site by Mr. Toto on 14 Nov 2006. | \Volcano_location_Final.xls |
| 16.2 | Attribute table for volcano location created from file "Volcano_location_Final.xls" | \Volcano_Attributes.xls |
| 16.3 | Attribute table for volcano location created from file "Volcano_location_Final.xls" | \Volcano-Attribute.dbf |
| 16.4 | Generated Arc\Info coverage of volcanic location | \vol_loc |
| 16.5 | Volcanic location coverage in SHP file format | \SHP |
| | | |
| **17** | **Isohyetal 25 year return rainfall data** | **E:\GIS_Database\Final\Yr25Rain** |
| 17.1 | Interpolated 25 year return period rainfall grid (1 X 1km); Projection UTM. File format IMG | \iso25rain-grid.img |
| | | |
| **18** | **National river basin coverage with the list of all city\municipality intersected by the particular river basin** | **E:\GIS_Database\Final\Basin_citymun (basin.shp)** |

## Tab. B-4-1 Organization of Database (2/5)

Second Screening: Hec-GeoRAS Simulation Results

| Basin | Description | File Location |
|---|---|---|
| Group 1 basins | Main folder | E:\GIS_Database\Hec_Simulation_Result\HECRas30May2007 |
| | | |
| | mxd files: | |
| | 1. Flood potential area | E:\GIS_Database\Hec_Simulation_Result\HECRas30May2007\(basin name)\MXD\ |
| | | |
| | Jpg files: | |
| | 1. Flood potential area | E:\GIS_Database\Hec_Simulation_Result\JPG\(basin name).jpg |
| | | |
| | shp files: | |
| | 1. River improvement length | E:\GIS_Database\Hec_Simulation_Result\HECRas30May2007\(basin name)\River_Imp.shp |
| | 2. Flood potential area | E:\GIS_Database\Hec_Simulation_Result\HECRas30May2007\(basin name)\Flood_rev\Flood_inundation_area.shp |
| | 3. Basin boundary | E:\GIS_Database\Hec_Simulation_Result\HECRas30May2007\(basin name)\abra_bnd.shp |
| | 4. River | E:\GIS_Database\Hec_Simulation_Result\HECRas30May2007\(basin name)\Clip\Modified_River\river.shp |
| Group 2 basins | Main folder | E:\GIS_Database\Hec_Simulation_Result\Additional1June2007 |
| | | |
| | mxd files: | |
| | 1. Flood potential area | E:\GIS_Database\Hec_Simulation_Result\Additional1June2007\(basin name)\MXD\ |
| | | |
| | Jpg files: | |
| | 1. Flood potential area | E:\GIS_Database\Hec_Simulation_Result\JPG\(basin name).jpg |
| | | |
| | shp files: | |
| | 1. River improvement length | E:\GIS_Database\Hec_Simulation_Result\Additional1June2007\(basin name)\River_Imp.shp |
| | 2. Flood potential area | E:\GIS_Database\Hec_Simulation_Result\Additional1June2007\(basin name)\Flood_rev\Flood_inundation_area.shp |
| | 3. Basin boundary | E:\GIS_Database\Hec_Simulation_Result\Additional1June2007\(basin name)\abra_bnd.shp |
| | 4. River | E:\GIS_Database\Hec_Simulation_Result\Additional1June2007\(basin name)\Clip\Modified_River\river.shp |
| Group 3 basins | Main folder | E:\GIS_Database\Hec_Simulation_Result\Revise25June2007 |
| | | |
| | mxd files: | |
| | 1. Flood potential area | E:\GIS_Database\Hec_Simulation_Result\Revise25June2007\(basin name)\MXD\ |
| | | |
| | Jpg files: | |
| | 1. Flood potential area | E:\GIS_Database\Hec_Simulation_Result\JPG\(basin name).jpg |
| | | |
| | shp files: | |
| | 1. River improvement length | E:\GIS_Database\Hec_Simulation_Result\Revise25June2007\(basin name)\River_Imp.shp |
| | 2. Flood potential area | E:\GIS_Database\Hec_Simulation_Result\Revise25June2007\(basin name)\Flood_rev\Flood_inundation_area.shp |
| | 3. Basin boundary | E:\GIS_Database\Hec_Simulation_Result\Revise25June2007\(basin name)\abra_bnd.shp |
| | 4. River | E:\GIS_Database\Hec_Simulation_Result\Revise25June2007\(basin name)\Clip\Modified_River\river.shp |
| Group 4 basins | Main folder | E:\GIS_Database\Hec_Simulation_Result\Revise25June2007 |
| | | |
| | mxd files: | |
| | 1. Flood potential area | E:\GIS_Database\Hec_Simulation_Result\HECRas23May2007\(basin name)\MXD\ |
| | | |
| | Jpg files: | |
| | 1. Flood potential area | E:\GIS_Database\Hec_Simulation_Result\JPG\(basin name).jpg |
| | | |
| | shp files: | |
| | 1. River improvement length | E:\GIS_Database\Hec_Simulation_Result\HECRas23May2007\(basin name)\River_Imp.shp |
| | 2. Flood potential area | E:\GIS_Database\Hec_Simulation_Result\HECRas23May2007\(basin name)\Flood_rev\Flood_inundation_area.shp |
| | 3. Basin boundary | E:\GIS_Database\Hec_Simulation_Result\HECRas23May2007\(basin name)\abra_bnd.shp |
| | 4. River | E:\GIS_Database\Hec_Simulation_Result\HECRas23May2007\(basin name)\Clip\Modified_River\river.shp |

Group 1 basins: Abra, Abulug, Agos, Aguang, Agus, Aklan, Alaminos, Amburayan, Amnay, Angat, Bacolod, Bac-Vintar, Bago, Balamban, Balete, Balincuguin, Bararo, Baroc, Baua, Bauang, Bicol, Bongabon, Boston, Buaya, Buayan, Bucao, Cabicungan, Cagaray, Cagayan, Cagaya de Oro, Catarman, Catarman 1S, Daet, Daguitan, Dagupan, Daraga, Davao, Donsol, Guinale, Hijo, Himocaan, Imus, Iponon, Iyam, Jose Dalman, Kaliwa, Kapumpong, Labayat, Labo, Lake Mainit, Lal-L02, Legaspi, Maco, Magasawang Tubig, Magbando, Malaylay, Mandulog, Mapangi, Maranding, Mataber, Mataling, Nakar2, Nakar2b, Nayam, Nituan, Padada, Pagbangaran, Pagsangahan, Palanan, Pamplona, Panay, Patalan, Pola, Polomolok, Pula, Ragay, Real1, Real2, Sapang Dako, Sibuguey, Silay Santa Maria, Sipocong, Siquil, Santa Tomas, Surigao, Tagaloan, Tago, Tagum, Tayabas, Tian, Tignoan, Tumaga, Umiray

Group 2 basins: Agno, Balatukan, Bantayan, Cadacan, Cairawan, Cebu, Chico, Dalanas, Dale, Guinabasan, Jaro Aganan, Lamut, Lipadas, Mananga, Mangahan, Meycauayan, Pampanga, Rio Chico, San Juan, Sibalom, Sipalay, Talomo, Tibiao, Tuganay, Upper Agusan, Upper Marikina

Group 3 basins: Ambayawan, Banila, Guagua, Ilog-Hilabangan, Jalaud, Mindanao, Olongapo

Group 4 basins: Aringay

## Tab. B-4-1 Organization of Database (3/5)

Second Screening: Topographic Maps

| No. | Description | File Location | No. | Description | File Location |
|---|---|---|---|---|---|
| | | | | | |
| 1 | **Technical aspects** | **E:\GIS_Database\Hec_Simulation_Result** | 2.8.6 | Cebu_III_Deo | \UM-092_Cebu_III_Deo |
| 1.2 | Technical aspects of Hec Simulation | \technical spec.doc | 2.8.7 | Cebu_IV_Deo | \UM-093_Cebu_IV_Deo |
| 1.2 | List of Previous and Recent Flood Control and Sabo Studies (1954-2004) | \existing studies.nov.16.doc | 2.8.8 | Cebu_City_Deo_-_burned | \UM-094_Cebu_City_Deo_-_burned |
| 1.3 | 2nd Screening Schedule | \HECsch.xls | 2.8.9 | Cebu_Sub_Deo | \UM-095_Cebu_Sub_Deo |
| | | | 2.8.10 | Negros_Oriental_II_Deo | \UM-096_Negros_Oriental_II_Deo |
| 2 | **Topographic maps** | **E:\GIS_Database\Topo_Soft_Copy** | 2.8.11 | Negros_Oriental_I_Deo | \UM-097_Negros_Oriental_I_Deo |
| 2.1 | Region I | \Region_I | 2.8.12 | Negros_Oriental_III_Deo | \UM-098_Negros_Oriental_III_Deo |
| 2.1.1 | Ilocos_Norte_I_Deo | \UM-001_Ilocos_Norte_I_Deo | 2.8.13 | SIQUIJOR_DEO | \UM-099_SIQUIJOR_DEO |
| 2.1.2 | Ilocos_Norte_II_Deo | \UM-002_Ilocos_Norte_II_Deo | | | |
| 2.1.3 | Ilocos_Sur_I_Deo | \UM-003_Ilocos_Sur_I_Deo | 2.9 | Region VIII | \Region_VIII |
| 2.1.4 | Ilocos_Sur_II_dEO | \UM-004_Ilocos_Sur_II_dEO | 2.9.1 | Biliran_Deo | \UM-100_Biliran_Deo |
| 2.1.5 | La_Union_I_Deo | \UM-005_La_Union_I_Deo | 2.9.2 | Leyte_I_Deo | \UM-101_Leyte_I_Deo |
| 2.1.6 | La_Union_II_Deo | \UM-006_La_Union_II_Deo | 2.9.3 | Leyte_II_Deo | \UM-102_Leyte_II_Deo |
| 2.1.7 | Pangasinan_I_Deo | \UM-007_Pangasinan_I_Deo | 2.9.4 | Leyte_III_Deo_-BURNED | \UM-103_Leyte_III_Deo_-BURNED |
| 2.1.8 | Pangasinan_II_Deo | \UM-008_Pangasinan_II_Deo | 2.9.5 | Leyte_IV_Deo | \UM-104_Leyte_IV_Deo |
| 2.1.9 | Pangasinan_III_Deo | \UM-009_Pangasinan_III_Deo | 2.9.6 | Leyte_V_Deo | \UM-105_Leyte_V_Deo |
| 2.1.10 | Pangasinan_Sub_Deo | \UM-010_Pangasinan_Sub_Deo | 2.9.7 | Southern_Leyte_Deo | \UM-106_Southern_Leyte_Deo |
| | | | 2.9.8 | Tacloban_City_Sub_Deo | \UM-107_Tacloban_City_Sub_Deo |
| 2.2 | Region II | \Region_II | 2.9.9 | EASTERN_SAMAR_DEO | \UM-108_EASTERN_SAMAR_DEO |
| 2.2.1 | Batanes_Deo | \UM-011_Batanes_Deo | 2.9.10 | Northern_Samar_I_Deo | \UM-109_Northern_Samar_I_Deo |
| 2.2.2 | Cagayan_I_Deo | \UM-012_Cagayan_I_Deo | 2.9.11 | Northern_Samar_II_Deo | \UM-110_Northern_Samar_II_Deo |
| 2.2.3 | CAGAYAN_II_Deo | \UM-013_CAGAYAN_II_Deo | 2.9.12 | Samar_I_Deo | \UM-111_Samar_I_Deo |
| 2.2.4 | Cagayan_III_Deo | \UM-014_Cagayan_III_Deo | 2.9.13 | Samar_II_Deo | \UM-112_Samar_II_Deo |
| 2.2.5 | Isabela_I_Deo | \UM-015_Isabela_I_Deo | | | |
| 2.2.6 | Isabela_II_Deo | \UM-016_Isabela_II_Deo | 2.10 | Region IX | \Region_IX |
| 2.2.7 | Isabela_III_Deo | \UM-017_Isabela_III_Deo | 2.10.1 | Isabela_City_Sub_Deo | \UM-113_Isabela_City_Sub_Deo |
| 2.2.8 | Isabela_IV_Deo | \UM-018_Isabela_IV_Deo | 2.10.2 | Zamboanga_City_Deo | \UM-114_Zamboanga_City_Deo |
| 2.2.9 | Nueva_Viscaya_Deo | \UM-019_Nueva_Viscaya_Deo | 2.10.3 | ZAMBOANGA_DEL_NORTE_I_DEO | \UM-115_ZAMBOANGA_DEL_NORTE_I_DEO |
| 2.2.10 | Nueva_Viscaya_Sub_Deo | \UM-020_Nueva_Viscaya_Sub_Deo | 2.10.4 | Zamboanga_Del_Norte_II_Deo | \UM-116_Zamboanga_Del_Norte_II_Deo |
| 2.2.11 | Quirino_Deo | \UM-021_Quirino_Deo | 2.10.5 | Zamboanga_Del_Norte_III_Deo | \UM-117_Zamboanga_Del_Norte_III_Deo |
| | | | 2.10.6 | ZAMBOANGA_DEL_SUR_I_DEO | \UM-118_ZAMBOANGA_DEL_SUR_I_DEO |
| 2.3 | Region III | \Region_III | 2.10.7 | Zamboanga_Sibugay_Deo | \UM-119_Zamboanga_Sibugay_Deo |
| 2.3.1 | Aurora_Deo | \UM-022_Aurora_Deo | 2.10.8 | ZAMBOANGA_DEL_SUR_III_Deo | \UM-120_ZAMBOANGA_DEL_SUR_III_Deo |
| 2.3.2 | Bataan_I_Deo | \UM-023_Bataan_I_Deo | | | |
| 2.3.3 | Bataan_II_Deo | \UM-024_Bataan_II_Deo | 2.11 | Region X | \Region_X |
| 2.3.4 | BULACAN_I_Deo | \UM-025_BULACAN_I_Deo | 2.11.1 | Bukidnon_I_Deo | \UM-121_Bukidnon_I_Deo |
| 2.3.5 | BULACAN_II_Deo | \UM-026_BULACAN_II_Deo | 2.11.2 | Bukidnon_II_Deo | \UM-122_Bukidnon_II_Deo |
| 2.3.6 | Nueva_Ecija_I_DEO | \UM-027_Nueva_Ecija_I_DEO | 2.11.3 | Bukidnon_III_Deo | \UM-123_Bukidnon_III_Deo |
| 2.3.7 | BULACAN_II_Deo | \UM-026_BULACAN_II_Deo | 2.11.4 | Camiguin_Deo | \UM-124_Camiguin_Deo |
| 2.3.8 | Nueva_Ecija_I_DEO | \UM-027_Nueva_Ecija_I_DEO | 2.11.5 | Misamis_Occidental_Deo | \UM-125_Misamis_Occidental_Deo |
| 2.3.9 | Nueva_Ecija_II_Deo | \UM-028_Nueva_Ecija_II_Deo | 2.11.6 | Misamis_Occidental_Sub_Deo | \UM-126_Misamis_Occidental_Sub_Deo |
| 2.3.10 | Pampanga_I_Deo | \UM-029_Pampanga_I_Deo | 2.11.7 | Misamis_Oriental_I_Deo | \UM-127_Misamis_Oriental_I_Deo |
| 2.3.11 | Pampanga_II_Deo | \UM-030_Pampanga_II_Deo | 2.11.8 | Misamis_Oriental_II_Deo | \UM-128_Misamis_Oriental_II_Deo |
| 2.3.12 | Pampanga_Sub_Deo | \UM-031_Pampanga_Sub_Deo | 2.11.9 | Cagayan_De_Oro_City_Deo | \UM-129_Cagayan_De_Oro_City_Deo |
| 2.3.13 | Tarlac_Deo | \UM-032_Tarlac_Deo | 2.11.10 | Lanao_Del_Norte_II_Deo | \UM-130_Lanao_Del_Norte_II_Deo |
| 2.3.14 | Tarlac_Sub_Deo | \UM-033_Tarlac_Sub_Deo | 2.11.11 | Lanao_Del_Norte_I_Deo | \UM-131_Lanao_Del_Norte_I_Deo |
| 2.3.15 | Zambales_Deo | \UM-034_Zambales_Deo | | | |
| 2.3.16 | Zambales_sub_Deo | \UM-035_Zambales_sub_Deo | 2.12 | Region XI | \Region_XI |
| | | | 2.12.1 | Compostela_Valley_Deo | \UM-132_Compostela_Valley_Deo |
| 2.4 | Region IV A | \Region_IV_A | 2.12.2 | Davao_City_Deo | \UM-133_Davao_City_Deo |
| 2.4.1 | Batangas_I_Deo | \UM-036_Batangas_I_Deo | 2.12.3 | Davao_Del_Norte_Deo | \UM-134_Davao_Del_Norte_Deo |
| 2.4.2 | Batangas_II_Deo | \UM-037_Batangas_II_Deo | 2.12.4 | Davao_Del_Sur_Deo | \UM-135_Davao_Del_Sur_Deo |
| 2.4.3 | Batangas_III_Deo | \UM-038_Batangas_III_Deo | 2.12.5 | Davao_Del_Sur_Sub_Deo | \UM-136_Davao_Del_Sur_Sub_Deo |
| 2.4.4 | Batangas_Sub_Deo | \UM-039_Batangas_Sub_Deo | 2.12.6 | Davao_Oriental_Deo | \UM-137_Davao_Oriental_Deo |
| 2.4.5 | Cavite_Deo | \UM-040_Cavite_Deo | 2.12.7 | Davao_Oriental_II_Deo | \UM-138_Davao_Oriental_II_Deo |
| 2.4.6 | Cavite_Sub_Deo | \UM-041_Cavite_Sub_Deo | | | |
| 2.4.7 | LAGUNA_I_DEO | \UM-042_LAGUNA_I_DEO | 2.13 | Region XII | \Region_XII |
| 2.4.8 | LAGUNA_II_DEO | \UM-043_LAGUNA_II_DEO | 2.13.1 | Cotabato_I_Deo | \UM-139_Cotabato_I_Deo |
| 2.4.9 | LAGUNA_SUB_DEO | \UM-044_LAGUNA_SUB_DEO | 2.13.2 | Cotabato_II_Deo | \UM-140_Cotabato_II_Deo |
| 2.4.10 | QUEZON_I_DEO | \UM-045_QUEZON_I_DEO | 2.13.3 | Sultan_Kudarat_Deo | \UM-141_Sultan_Kudarat_Deo |
| 2.4.11 | Quezon_II_Deo | \UM-046_Quezon_II_Deo | 2.13.4 | Saranggani_Deo | \UM-142_Saranggani_Deo |
| 2.4.12 | Quezon_III_Deo | \UM-047_Quezon_III_Deo | 2.13.5 | South_Cotabato_Deo | \UM-143_South_Cotabato_Deo |
| 2.4.13 | QUEZON_SUB_DEO | \UM-048_QUEZON_SUB_DEO | 2.13.6 | GENERAL_SANTOS_DEO | \UM-144_GENERAL_SANTOS_DEO |
| 2.4.14 | Rizal_I_Deo | \UM-049_Rizal_I_Deo | 2.13.7 | Cotabato_City_Sub_Deo | \UM-145_Cotabato_City_Sub_Deo |
| 2.4.15 | Rizal_II_Deo | \UM-050_Rizal_II_Deo | | | |
| | | | 2.14 | Region XIII | \Region_XIII |
| 2.5 | Region IV B | \Region_IV_B | 2.14.1 | Agusan_Del_Norte_Deo | \UM-146_Agusan_Del_Norte_Deo |
| 2.5.1 | MARINDUQUE_DEO | \UM-051_MARINDUQUE_DEO | 2.14.2 | Butuan_City_Deo | \UM-147_Butuan_City_Deo |
| 2.5.2 | Mindoro_Occidental_Deo | \UM-052_Mindoro_Occidental_Deo | 2.14.3 | Agusan_Del_Sur_I_Deo | \UM-148_Agusan_Del_Sur_I_Deo |
| 2.5.3 | Mindoro_Occidental_Sub_Deo | \UM-053_Mindoro_Occidental_Sub_Deo | 2.14.4 | Agusan_del_sur_II_Deo | \UM-149_Agusan_del_sur_II_Deo |
| 2.5.4 | Mindoro_Oriental_Deo | \UM-054_Mindoro_Oriental_Deo | 2.14.5 | Surigao_Del_Norte_I_Deo | \UM-150_Surigao_Del_Norte_I_Deo |
| 2.5.5 | Southern_Mindoro_Deo | \UM-055_Southern_Mindoro_Deo | 2.14.6 | Surigao_Del_Norte_II_Deo | \UM-151_Surigao_Del_Norte_II_Deo |
| 2.5.6 | Palawan_I_Deo | \UM-056_Palawan_I_Deo | 2.14.7 | Surigao_Del_Norte_Sub_Deo | \UM-152_Surigao_Del_Norte_Sub_Deo |
| 2.5.7 | Palawan_II_Deo | \UM-057_Palawan_II_Deo | 2.14.8 | Surigao_Del_Sur_I_Deo | \UM-153_Surigao_Del_Sur_I_Deo |
| 2.5.8 | Palawan_III_DEO | \UM-058_Palawan_III_DEO | 2.14.9 | Surigao_Del_Sur_II_Deo | \UM-154_Surigao_Del_Sur_II_Deo |
| 2.5.9 | Romblon_Deo | \UM-059_Romblon_Deo | | | |
| | | | 2.15 | NCR | \NCR |
| 2.6 | Region V | \Region_V | 2.15.1 | Metro_Manila_I_Deo | \UM-155_Metro_Manila_I_Deo |
| 2.6.1 | Albay_Deo | \UM-060_Albay_Deo | 2.15.2 | Metro_Manila_II_Deo | \UM-156_Metro_Manila_II_Deo |
| 2.6.2 | Albay_Sub_Deo | \UM-061_Albay_Sub_Deo | 2.15.3 | Metro_Manila_III_Deo | \UM-157_Metro_Manila_III_Deo |
| 2.6.3 | Camarines_Norte_Deo | \UM-062_Camarines_Norte_Deo | 2.15.4 | Malabon-Navotas_Sub_Deo | \UM-158_Malabon-Navotas_Sub_Deo |
| 2.6.4 | Camarines_Sur_I_Deo | \UM-063_Camarines_Sur_I_Deo | 2.15.5 | North_Manila_Deo | \UM-159_North_Manila_Deo |
| 2.6.5 | Camarines_Sur_II_Deo | \UM-064_Camarines_Sur_II_Deo | 2.15.6 | South_Manila_Deo | \UM-160_South_Manila_Deo |
| 2.6.6 | Camarines_Sur_III_Deo | \UM-065_Camarines_Sur_III_Deo | 2.15.7 | Quezon_City_I_&_II_Deo | \UM-161_Quezon_City_I_&_II_Deo |
| 2.6.7 | Camarines_Sur_IV_Deo | \UM-066_Camarines_Sur_IV_Deo | | | |
| 2.6.8 | CATANDUANES_DEO | \UM-067_CATANDUANES_DEO | 2.16 | CAR | \CAR |
| 2.6.9 | Masbate_Deo | \UM-068_Masbate_Deo | 2.16.1 | Abra_Deo | \UM-163_Abra_Deo |
| 2.6.10 | Masbate_sub_I_Deo | \UM-069_Masbate_sub_I_Deo | 2.16.2 | Apayao_I_Deo | \UM-164_Apayao_I_Deo |
| 2.6.11 | Masbate_Sub_II_Deo | \UM-070_Masbate_Sub_II_Deo | 2.16.3 | Apayao_II_Deo | \UM-165_Apayao_II_Deo |
| 2.6.12 | Sorsogon_Deo | \UM-071_Sorsogon_Deo | 2.16.4 | Benguet_I_Deo | \UM-166_Benguet_I_Deo |
| 2.6.13 | Sorsogon_Sub_Deo | \UM-072_Sorsogon_Sub_Deo | 2.16.5 | Benguet_II_Deo | \UM-167_Benguet_II_Deo |
| | | | 2.16.6 | Baguio_City_Deo | \UM-168_Baguio_City_Deo |
| 2.7 | Region VI | \Region_VI | 2.16.7 | Ifugao_Deo | \UM-169_Ifugao_Deo |
| 2.7.1 | Aklan_Deo | \UM-073_Aklan_Deo | 2.16.8 | Kalinga_Deo | \UM-170_Kalinga_Deo |
| 2.7.2 | ANTIQUE_DEO | \UM-074_ANTIQUE_DEO | 2.16.9 | Mt._Province_Deo | \UM-171_Mt._Province_Deo |
| 2.7.3 | Capiz_Deo | \UM-075_Capiz_Deo | | | |
| 2.7.4 | Guimaras_Deo | \UM-076_Guimaras_Deo | 2.17 | ARMM | \ARMM |
| 2.7.5 | Iloilo_I_Deo | \UM-077_Iloilo_I_Deo | 2.17.1 | Lanao_Del_Sur_Deo | \UM-172_Lanao_Del_Sur_Deo |
| 2.7.6 | Iloilo_II_Deo | \UM-078_Iloilo_II_Deo | 2.17.2 | Sulu Deo | \UM-173 Sulu Deo |
| 2.7.7 | Iloilo_III_Deo | \UM-079_Iloilo_III_Deo | 2.17.3 | TAWI-TAWI_DEO | \UM-174_TAWI-TAWI_DEO |
| 2.7.8 | Iloilo_IV_Deo | \UM-080_Iloilo_IV_Deo | 2.17.4 | Maguindanao_Deo | \UM-175_Maguindanao_Deo |
| 2.7.9 | Iloilo_City_Deo | \UM-081_Iloilo_City_Deo | 2.17.5 | Lanao_Del_Sur_Sub_Deo | \UM-176_Lanao_Del_Sur_Sub_Deo |
| 2.7.10 | Negros_Occidental_I_Deo | \UM-082_Negros_Occidental_I_Deo | | | |
| 2.7.11 | Negros_Occidental_II_Deo | \UM-083_Negros_Occidental_II_Deo | 2.18 | Rivers | \Rivers |
| 2.7.12 | Negros_Occidental_III_Deo | \UM-084_Negros_Occidental_III_Deo | | | |
| 2.7.13 | Negros_Occidental_IV_Deo | \UM-085_Negros_Occidental_IV_Deo | **3** | **Satellite images** | **E:\GIS_Database\Basin_River_Improvement** |
| 2.7.14 | Bacolod_City_Deo | \UM-086_Bacolod_City_Deo | 3.1 | Landsat7 satellite imagery used for the Model River Basins | \Landsat7_ETMMosaicUTM51WGS84 |
| | | | 3.2 | QuickBird sallite imagery used for the Model River Basins | \QuickBird_Rectified_UTM51WGS84 |
| 2.8 | Region VII | \Region_VII | | | |
| 2.8.1 | Bohol_I_Deo | \UM-087_Bohol_I_Deo | **4** | **Output maps** | **E:\GIS_Database\excel_files** |
| 2.8.2 | Bohol_III_Deo | \UM-088_Bohol_III_Deo | 4.1 | Output maps in JPG format | \fin_plot |
| 2.8.3 | Bohol_II_Sub_Deo | \UM-089_Bohol_II_Sub_Deo | | Output maps in GIS format | \mxd_for_documents |
| 2.8.4 | Cebu_I_Deo | \UM-090_Cebu_I_Deo | | | |
| 2.8.5 | Cebu_II_Deo | \UM-091_Cebu_II_Deo | **5** | **River basin locations** | **E:\GIS_Database\Other_MXD** |
| | | | 5.1 | Maps of the selected 56 river basins | \56_BASINS\56_basins_mod 2008.02.27.mxd |
| | | | 5.2 | Maps of the selected 100 river basins | \100_mxd\100_basin 2008.02.27.mxd |
| | | | 5.3 | Maps of the selected 120 river basins | \120_mxd\120_basin 2008.02.27.mxd |

## Tab. B-4-1 Organization of Database (4/5)

Model River Basins

| Model Basin | Description | File Location |
|---|---|---|
| DINANGGASAN | Main folder | E:\GISDATA\Basin_River_Improvement\Dinaggasan |
| | | |
| | mxd files: | E:\GISDATA\Basin_River_Improvement\Dinaggasan\MXD |
| | 1. Administrative boundaries | \Administrative Boundaries.mxd |
| | 2. Flood potential area | \Flood Area.mxd |
| | 3. Flood potential area (specific view) | \Flood Area (zoom).mxd |
| | 4. Land use | \Land Use.mxd |
| | 5. Topography | \Topographic.mxd |
| | 6. Counter measures, alternative 1 | \dinaggasan_ALT1.mxd |
| | 7. Counter measures, alternative 2 | \dinaggasan_ALT2.mxd |
| | | |
| | shp files: | |
| | 1. River | E:\GISDATA\Basin_River_Improvement\Dinaggasan\current_river\riverUTM51GCS.shp |
| | 2. Municipality boundaries | E:\GISDATA\Basin_River_Improvement\Dinaggasan\Municipality\Muni_Dinaggasan_WGSUTM51.shp |
| | 3. Basin boundary | E:\GISDATA\Basin_River_Improvement\Dinaggasan\basin_bdry\Dinag_Bsbndr_UTM51.shp |
| | 4. Flood potential area | E:\GISDATA\Basin_River_Improvement\Dinaggasan\Flood Area\Flood Area.shp |
| | 5. Land use | E:\GISDATA\Basin_River_Improvement\Dinaggasan\land_use\Lu_UTM51WGS.shp |
| | 6. Contour | E:\GISDATA\Basin_River_Improvement\Dinaggasan\Contour\Clip_Dinagassan_contour50.shp |
| | 7. Dinaggasan pt (for TIN creation) | no data |
| | 8. Dinaggasan TIN | E:\GISDATA\Basin_River_Improvement\Dinaggasan\DEMfrmSRTM\tinfrmsrtsft290mmclipped |
| | 9. Dinaggasan TIF | E:\GISDATA\Basin_River_Improvement\Dinaggasan\Dinaggasan_TIF\Dinaggasan_GE_1.TIF |
| | 10. Station point | E:\GISDATA\Basin_River_Improvement\Dinaggasan\current_river\RiverCountPoint.shp |
| | 11. Survey cross-section point | E:\GISDATA\Basin_River_Improvement\Dinaggasan\Cross-section\cs_pt1~5.shp |
| | 12. Survey cross-section line | E:\GISDATA\Basin_River_Improvement\Dinaggasan\cross-section\cs_l.shp |
| | 13. Countermeasures | E:\GISDATA\Basin_River_Improvement\Dinaggasan\Dinaggasan_Measures_tk_20071116\ |
| DUNGCAAN | Main folder | E:\GISDATA\Basin_River_Improvement\Duncaan |
| | | |
| | mxd files: | E:\GISDATA\Basin_River_Improvement\Duncaan\MXD |
| | 1. Administrative boundaries | \Administrative Boundaries.mxd |
| | 2. Flood potential area | \Flood Area.mxd |
| | 3. Flood potential area (specific view) | \Flood Area (zoom).mxd |
| | 4. Land use | \Land Use.mxd |
| | 5. Topography | \Topographic.mxd |
| | 6. Counter measures, alternative 1 | \duncaan_ALT1.mxd |
| | 7. Counter measures, alternative 2 | \duncaan_ALT2.mxd |
| | | |
| | shp files: | |
| | 1. River | E:\GISDATA\Basin_River_Improvement\Duncaan\dungcaan_River\river.shp |
| | 2. Municipality boundaries | E:\GISDATA\Basin_River_Improvement\Duncaan\municipality\Muni_Duncaan_WGSUTM51.shp |
| | 3. Basin boundary | E:\GISDATA\Basin_River_Improvement\Duncaan\basin_bdry\Dunc_Bsbndr_UTM51WGS.shp |
| | 4. Flood potential area | E:\GISDATA\Basin_River_Improvement\Duncaan\FloodArea\Fld_A_Sftd_215mm_modyfied.shp |
| | 5. Land use | E:\GISDATA\Basin_River_Improvement\Duncaan\landuse\Lu_UTM51WGS.shp |
| | 6. Contour | E:\GISDATA\Basin_River_Improvement\Duncaan\Contour\clip_Duncaan_Contour50.shp |
| | 7. Dinaggasan pt (for TIN creation) | duncaan_pt |
| | 8. Dinaggasan TIN | dung_tin_mod |
| | 9. Dinaggasan TIF | Dungcaan_tk/Dungcaan_GE_1.TIF |
| | 10. Station point | modified_STA_p/STA_p.shp |
| | 11. Survey cross-section point | cross-section/CrossSectionUTM51/CroSecPointUTM51.shp |
| | 12. Countermeasure | Dungcaan_Measures_tk20071114/ |
| ILOG-HILABANGAN | Main folder | E:\GISDATA\Basin_River_Improvement\ilog-hilabangan |
| | | |
| | mxd files: | E:\GISDATA\Basin_River_Improvement\ilog-hilabangan\MXD |
| | 1. Administrative boundaries | \Administrative Boundaries.mxd |
| | 2. Flood potential area | \Flood Area.mxd |
| | 3. Flood potential area (specific view) | \Flood Area (zoom).mxd |
| | 4. Land use | \Land Use.mxd |
| | 5. Topography | \Topographic.mxd |
| | 6. Counter measures, alternative 1 | \ilog_hilabangan_ALT1.mxd |
| | 7. Counter measures, alternative 2 | \ilog_hilabangan_ALT2.mxd |
| | 8. Counter measures, alternative 3 | \ilog_hilabangan_ALT2.mxd |
| | | |
| | shp files: | |
| | 1. River | E:\GISDATA\Basin_River_Improvement\ilog-hilabangan\current_River\riverUTM51WGS.shp |
| | 2. Municipality boundaries | E:\GISDATA\Basin_River_Improvement\ilog-hilabangan\Municipality\Muni_Ilog_hilabangan_WGSUTM51.shp |
| | 3. Basin boundary | E:\GISDATA\Basin_River_Improvement\ilog-hilabangan\basin_bdry\Ilog_Bsbndr_UTM51WGS.shp |
| | 4. Flood potential area | E:\GISDATA\Basin_River_Improvement\ilog-hilabangan\flood area\flood_poly_1_Union.shp |
| | 5. Land use | E:\GISDATA\Basin_River_Improvement\ilog-hilabangan\land_use\Lu_UTM51WGS.shp |
| | 6. Contour | E:\GISDATA\Basin_River_Improvement\ilog-hilabangan\Contour\Clip_ILOG_Hilabangan_Contour50.shp |
| | 7. Dinaggasan_pt (for TIN creation) | E:\GISDATA\Basin_River_Improvement\ilog-hilabangan\ilog_pt |
| | 8. Dinaggasan TIN | E:\GISDATA\Basin_River_Improvement\ilog-hilabangan\ilog_tin |
| | 9. Dinaggasan TIF | E:\GISDATA\Basin_River_Improvement\ilog-hilabangan\Ilog_tk\IlogHilabangan_Lowland_GE.tif |
| | 10. Planned river line | E:\GISDATA\Basin_River_Improvement\ilog-hilabangan\modified_river\New_River.shp |
| | 11. Station point (Current_river) | E:\GISDATA\Basin_River_Improvement\ilog-hilabangan\sta_pt\STA_pt_current.shp |
| | 12. Station point (Planned_river) | E:\GISDATA\Basin_River_Improvement\ilog-hilabangan\sta_pt\STA_pt_modified.shp |
| | 13. Survey cross-section point | E:\GISDATA\Basin_River_Improvement\ilog-hilabangan\cross-section\cs_pt\cs_pt1~6.shp |
| | 14. Countermeasure | E:\GISDATA\Basin_River_Improvement\ilog-hilabangan\IlogHilabangan_Measures_tk_20071114\ |
| KINANLIMAN | Main folder | E:\GISDATA\Basin_River_Improvement\kinanliman |
| | | |
| | mxd files: | E:\GISDATA\Basin_River_Improvement\kinanliman\MXD |
| | 1. Administrative boundaries | \Administrative Boundaries.mxd |
| | 2. Flood potential area | \Flood Area.mxd |
| | 3. Flood potential area (specific view) | \Flood Area (zoom).mxd |
| | 4. Land use | \Land Use.mxd |
| | 5. Topography | \Topographic.mxd |
| | 6. Counter measures, alternative 1 | \Kinanliman_ALT.mxd |
| | | |
| | shp files: | |
| | 1. River | E:\GISDATA\Basin_River_Improvement\kinanliman\Current_River\River_UTM51WGS.shp |
| | 2. Municipality boundaries | E:\GISDATA\Basin_River_Improvement\kinanliman\Municipality\Muni_Kinanliman_WGSUTM51.shp |
| | 3. Basin boundary | E:\GISDATA\Basin_River_Improvement\kinanliman\basin_bdry\Kinan_Bsbndr_UTM51WGS.shp |
| | 4. Flood potential area | E:\GISDATA\Basin_River_Improvement\kinanliman\floodarea.shp |
| | 5. Land use | E:\GISDATA\Basin_River_Improvement\kinanliman\land_use\Lu_UTM51WGS.shp |
| | 6. Contour | E:\GISDATA\Basin_River_Improvement\kinanliman\Contour\clip_Kinanaliman_contour50.shp |
| | 7. Kinanliman pt (for TIN creation) | E:\GISDATA\Basin_River_Improvement\kinanliman\kinanliman_pt\real1_pt.shp |
| | 8. Kinanliman TIN | E:\GISDATA\Basin_River_Improvement\kinanliman\kinanliman_tin-3504 |
| | 9. Tuganay TIF | E:\GISDATA\Basin_River_Improvement\kinanliman\kinanliman_tif\kinan_QBirRctifyed.tif |
| | 10. Station point | E:\GISDATA\Basin_River_Improvement\kinanliman\Current_river\RiverCountPoint.shp |
| | 11. Survey cross-section point | E:\GISDATA\Basin_River_Improvement\kinanliman\cross_section_survey\cross_section(resurvey)\KINANLIMAN\interpolated\cs_pt1~3.shp |
| | 12. Countermeasure | Kinanliman_Measures_tk_20071116/ |
| | 13. Flood inundation | E:\GISDATA\Basin_River_Improvement\kinanliman\geoRAS\steady flow10\Fld_Area_Intersect.shp |

## Tab. B-4-1 Organization of Database (5/5)

Model River Basins

| Model Basin | Description | File Location |
|---|---|---|
| MEYCAUAYAN | Main folder | E:\GISDATA\Basin_River_Improvement\meycauayan |
| | | |
| | mxd files: | E:\GISDATA\Basin_River_Improvement\meycauayan\MXD |
| | 1. Administrative boundaries | \Administrative Boundaries.mxd |
| | 2. Flood potential area | \Flood Area.mxd |
| | 3. Flood potential area (specific view) | \Flood Area (zoom).mxd |
| | 4. Land use | \Land Use.mxd |
| | 5. Topography | \Topographic.mxd |
| | 6. Counter measures, alternative 1 | \meycauayan_ALT1.mxd |
| | 7. Counter measures, alternative 2 | \meycauayan_ALT2.mxd |
| | | |
| | shp files: | |
| | 1. River | E:\GISDATA\Basin_River_Improvement\meycauayan\River\riverUTM51WGS.shp |
| | 2. Municipality boundaries | E:\GISDATA\Basin_River_Improvement\meycauayan\Municipality\Meycauayan_MuniBoundary_UTM51WGS.shp |
| | 3. Basin boundary | E:\GISDATA\Basin_River_Improvement\meycauayan\basin_bdry\Meyc_Bsbndr_UTM51WGS.shp |
| | 4. Flood potential area | E:\GISDATA\Basin_River_Improvement\meycauayan\SpecificFloodArea3\FloodArea3 Overall.shp |
| | 5. Land use | E:\GISDATA\Basin_River_Improvement\meycauayan\land_use\Lu_UTM51WGS.shp |
| | 6. Contour | E:\GISDATA\Basin_River_Improvement\meycauayan\Contour\clip_Meycauayan_contour20.shp |
| | 7. meycauayan pt (for TIN creation) | E:\GISDATA\Basin_River_Improvement\meycauayan\meycauayan_pt\meycauayan_pt.shp |
| | 8. meycauayan TIN | E:\GISDATA\Basin_River_Improvement\meycauayan\meycauayan_tin |
| | 9. Meycauayan TIF | E:\GISDATA\Basin_River_Improvement\meycauayan\Meycauayan_TIF\RectifyMeyacuayan_GE_WGS84UTM51.tif |
| | 10. Station point (Current_river) | E:\GISDATA\Basin_River_Improvement\meycauayan\River\WorkingFiles\RiverPOST_1Km.shp |
| | 11. Survey cross-section point | E:\GISDATA\Basin_River_Improvement\meycauayan\cross-section\cs_pt1~6.shp |
| | 12. Survey cross-section line | E:\GISDATA\Basin_River_Improvement\meycauayan\cross-section\cs_l.shp |
| | 13. Countermeasure | E:\GISDATA\Basin_River_Improvement\meycauayan\Meycauayan_Measures |
| TUGANAY | Main folder | E:\GISDATA\Basin_River_Improvement\tuganay |
| | | |
| | mxd files: | E:\GISDATA\Basin_River_Improvement\tuganay\MXD |
| | 1. Administrative boundaries | \Administrative Boundaries.mxd |
| | 2. Flood potential area | \Flood Area.mxd |
| | 3. Flood potential area (specific view) | \Flood Area (zoom).mxd |
| | 4. Land use | \Land Use.mxd |
| | 5. Topography | \Topographic.mxd |
| | 6. Counter measures, alternative 1 | \River Improvement Alt A.mxd |
| | 7. Counter measures, alternative 2 | \River Improvement Alt B.mxd |
| | 8. Counter measures, alternative 3 | \River Improvement Alt C.mxd |
| | | |
| | jpeg files: | E:\GISDATA\Basin_River_Improvement\tuganay\MXD\jpeg |
| | | |
| | shp files: | |
| | 1. River | E:\GISDATA\Basin_River_Improvement\tuganay\current_river\River_UTM51WGS.shp |
| | 2. Municipality boundaries | E:\GISDATA\Basin_River_Improvement\tuganay\Municipality\Muni_Tuganay_WGSUTM51.shp |
| | 3. Basin boundary | E:\GISDATA\Basin_River_Improvement\tuganay\basin_bdry\Tuga_Bsbndr_UTM51WGS.shp |
| | 4. Flood potential area | E:\GISDATA\Basin_River_Improvement\tuganay\geoRAS\Flood Area Overall.shp |
| | 5. Land use | E:\GISDATA\Basin_River_Improvement\tuganay\land_use\Lu_UTM51WGS.shp |
| | 6. Contour | E:\GISDATA\Basin_River_Improvement\tuganay\Contour\clip_Tuganay_contour50.shp |
| | 7. Dam site | E:\GISDATA\Basin_River_Improvement\tuganay\Dam\Dam.shp |
| | 8. Dam catchment | E:\GISDATA\Basin_River_Improvement\tuganay\Dam\Dam catchment.shp |
| | 9. Tuganay pt (for TIN creation) | E:\GISDATA\Basin_River_Improvement\tuganay\tuganay_pt\tuganay_pt_mod.shp |
| | 10. Tuganay TIN | E:\GISDATA\Basin_River_Improvement\tuganay\DEM_frm_SRTM/ |
| | 11. Tuganay TIF | E:\GISDATA\Basin_River_Improvement\tuganay\Tuganay_tk\RectifyTuganay_GE_UTM51.tif (Tuganay_GE2m_WGS84UTM51.tif) |
| | 12. Planned river line | E:\GISDATA\Basin_River_Improvement\tuganay\modified_river\River_center_UTM51WGS.shp |
| | 13. Station point (current river) | E:\GISDATA\Basin_River_Improvement\tuganay\STA_pt\Sta_pUTM51WGS.shp |
| | | E:\GISDATA\Basin_River_Improvement\tuganay\STA_pt\Sta_pWGSGCS.shp |
| | | E:\GISDATA\Basin_River_Improvement\tuganay\STA_pt\Sta_pLuzUTM51.shp |
| | | E:\GISDATA\Basin_River_Improvement\tuganay\STA_pt\Sta_pLuzGCS.shp |
| | 14. Station point (planned river) | E:\GISDATA\Basin_River_Improvement\tuganay\STA_pt\Sta_P_modUTM51WGS.shp |
| | | E:\GISDATA\Basin_River_Improvement\tuganay\STA_pt\Sta_P_modWGSGCS.shp |
| | | E:\GISDATA\Basin_River_Improvement\tuganay\STA_pt\Sta_P_modLuzUTM51.shp |
| | | E:\GISDATA\Basin_River_Improvement\tuganay\STA_pt\Sta_P_modLuzGCS.shp |
| | 15. Survey cross-section point | E:\GISDATA\Basin_River_Improvement\tuganay\cross-section\cs_shape\cs_pt1~6.shp |
| | 16. Survey cross-section line | E:\GISDATA\Basin_River_Improvement\tuganay\cross-section\Cross-section_l_mod.shp |
| | 17. Counter measures | E:\GISDATA\Basin_River_Improvement\tuganay\Tuganay_Measures_tk_20071115 |

Name of Coverage

## Legend

citymun — City/Municipality Political Boundary of Philippines ← Description of file

Format : Width, Precision or Number of decimals

Figure of Database Structure

| coverage "citymun" | | | |
|---|---|---|---|
| Number of Records: 1595 | | Cordinate System: utm51N_luzon1911 | |
| **Attribute** | **Data Type** | **Format** | **Description** |
| FID | OID | 4,0 | System Generated |
| Shape | Geometry | 0,0 | System Generated |
| MUNNAME | String | 100,0 | Name of City/Municipality |
| PRVNAME | String | 100,0 | Name of Province |
| REGID | String | 5,0 | Regional Code |
| MUNCODE | String | 12,0 | Standard City/Municipality Code |
| POP2000 | String | 16 | Population from Year 2000 Census |
| HH2000 | Number | 16,0 | Household # from Year 2000 Census |
| FLOOD_PRON | Number | 16,0 | MGB Flood Pron Area Classification |
| TYPE | Number | 5,0 | Updated City/Municipality Categories |
| Area_ha | Number | 17,2 | Area in Hectare |

System files

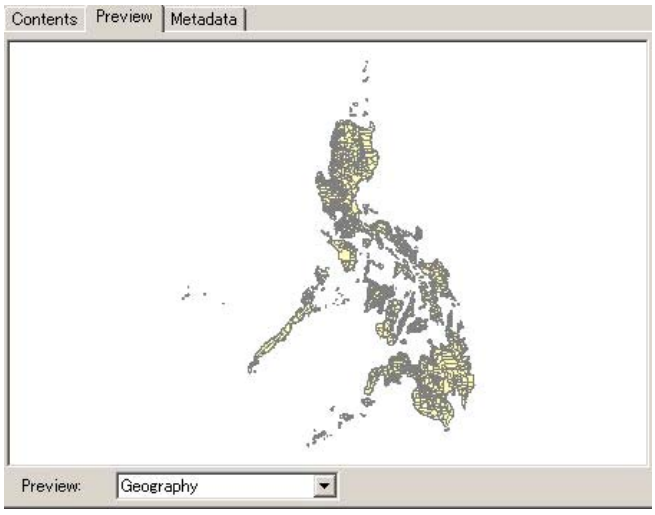
Code table

| Type | |
|---|---|
| **Code** | **Definition** |
| 1 | City Defined in Original Coverage |
| 2 | City Updated on May 14, 2007 based on the list available at http://en.wikipedia.org/wiki/List_of_cities_and_municipalities_in_the_Philippi |
| 3 | Municipalities |

Example list of attribute table

| FID | Shape | MUNNAME | PRVNAME | REGID | MUNCODE | POP2000 | HH2000 | FLOOD_PRON | TYPE | Area_ha |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Popygon | Senator Ninoy Aquino | Sultan Kudarat | 12 | 126512 | 30222 | 6172 | Yes | 3 | 23539.09 |
| 1 | Popygon | President Quirino | Sultan Kudarat | 12 | 126510 | 32721 | 6522 | Yes | 3 | 10971.25 |
| 2 | Popygon | Tacurong City | Sultan Kudarat | 12 | 126511 | 76354 | 14950 | Yes | 1 | 14767.19 |

Preview of data




THE STUDY ON THE NATIONWIDE FLOOD RISK ASSESSMENT AND THE FLOOD MITIGATION PLAN FOR THE SELECTED AREAS IN THE REPUBLIC OF THE PHILIPPINES

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. B-1-1

**Sample of Metadata of City/Municipality Boundary Map Coverage**

# Legend

Name of Coverage

**luzon:** **Forest Cover & Land Use Coverage of Luzon** ← Description of file

Format : Width, Precision or Number of decimals

Figure of Database Structure

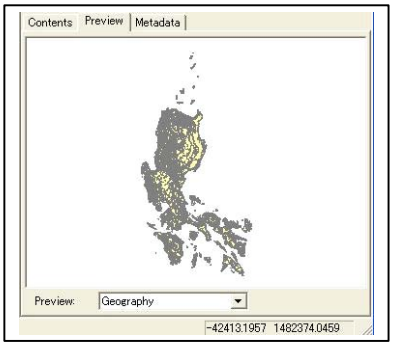
| coverage "luzon" | | | |
|---|---|---|---|
| Number of Records: 9202 | | Cordinate System: utm51N_luzon1911 | |
| **Attribute** | **Data Type** | **Format** | **Description** |
| AREA | Float | 8,5 | System Generated |
| PERIMETER | Float | 8,5 | System Generated |
| LUZON_ | Number | 4 | System Generated |
| LUZON_ID | Number | 4 | System Generated |
| CODE | Number | 2 | Forest Cover & Land Use Code |
| CLASS | String | 41 | Forest Cover & Land Use Class |
| SYMBOL | String | 16 | Forest Cover & Land Use Symbol |
| REG1_2_3_4 | Float | 8,3 | Copy of field "AREA" |
| REG1_2_3_5 | Float | 8,3 | Copy of field "PERIMETER" |
| ACRES | Float | 8,3 | Polygon Area in Acres |
| HECTARES | Float | 8,3 | Polygon Area in Hectares |

System files

Code table

| S. No. | CLASS | CODE | SYMBOL |
|---|---|---|---|
| 1 | Closed forest, broadleaved | 1 | NF4F |
| 2 | Closed forest, mixed | 2 | NF4M |
| 3 | Closed forest, coniferous | 3 | NF4C |
| 4 | Open forest, broadleaved | 4 | NF2B |
| 5 | Open forest, mixed | 5 | NF2M |
| 6 | Open forest, coniferous | 6 | NF2C |
| 7 | Mangrove forest | 7 | NFM |
| 8 | Bamboo/palm formation | 24 | NF3B |
| 9 | Forest plantation, broadleaved | 8 | FPB |
| 10 | Forest plantation, coniferous | 9 | FPC |
| 11 | Forest plantation, mangrove | 23 | FPM |
| 12 | Other wooded land, shrubs | 10 | Sh |
| 13 | Other wooded land, fallow | 11 | Fa |
| 14 | Other wooded land, wooded grassland | 12 | WGL |
| 15 | Other land, natural, barren land | 13 | BL |
| 16 | Other land, natural, grassland | 14 | GL |
| 17 | Other land, natural, marshland | 15 | ML |
| 18 | Other land, cultivated, annual crop | 16 | AC |
| 19 | Other land, cultivated, perennial crop | 17 | PC |
| 20 | Other land, cultivated, pastures | 18 | Pa |
| 21 | Other land, fishpond | 19 | Fs |
| 22 | Other land, built-up area | 20 | BUA |
| 23 | Inland water | 21 | IW |

Display sample of data




Example list of attribute table

| AREA | PERIMETER | LUZON_ | LUZON_ID | CODE | CLASS | SYMBOL | REG1_2_3_4 | REG1_2_3_5 | ACRES | HECTARES |
|---|---|---|---|---|---|---|---|---|---|---|
| 16619.963967200 | 607.509145619 | 2 | 2 | 20 | Other land, built-up area | BUA | 16619.96700000 | 607.51000000 | 4.107000 | 1.662000 |
| 13459.847249500 | 566.397077120 | 3 | 3 | 20 | Other land, built-up area | BUA | 13459.84500000 | 566.39700000 | 3.326000 | 1.346000 |
| 57034.481763400 | 1012.862934700 | 4 | 4 | 20 | Other land, built-up area | BUA | 57034.53700000 | 1012.86300000 | 14.093000 | 5.703000 |

THE STUDY ON THE NATIONWIDE FLOOD RISK ASSESSMENT AND THE FLOOD MITIGATION PLAN FOR THE SELECTED AREAS IN THE REPUBLIC OF THE PHILIPPINES

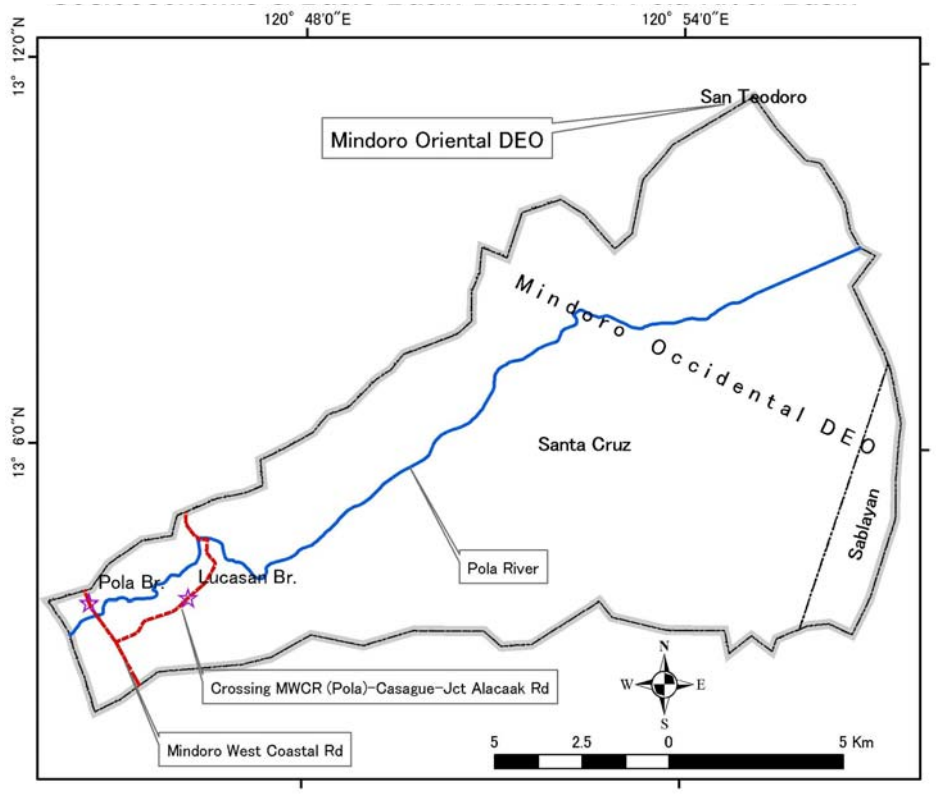
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. B-1-2

**Sample of Metadata of Forest Cover and Land Use Map Coverage**

# Annex B.1

# Example of Data Extraction for the Pola River Basin

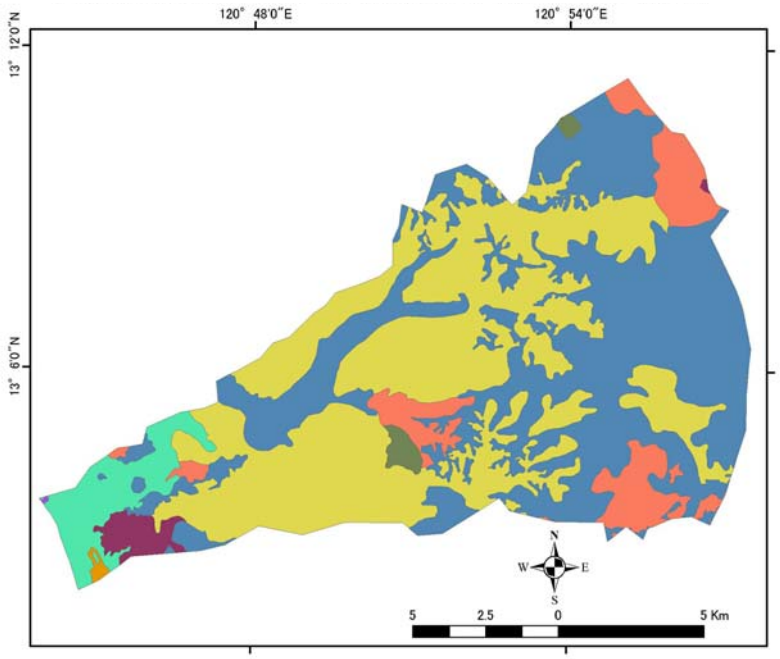



Legend

- Road
- Bridge
- River
- City Boundary
- District Boundary
- Basin Boundary

| Data Items | Name/Description | Data | Remarks/Units |
|---|---|---|---|
| Pola Basin | Area | 215.78 | sq. km |
| | Perimeter | 74.81 | km. |
| Population | Year 2000 | 9547 | person |
| | Year 2005 | 11009 | |
| Road | Jct Alacaak Rd | 5.74 | Length, km. |
| | Mindoro West Coastal Rd | 3.14 | |
| Bridge | Pola | Concrete | types |
| | Lucasan | Bailey | |
| River | Pola | 29.33 | Length, km. |
| District | Mindoro Occidental DEO | 215.778905 | Area, sq. km. |
| | Mindoro Oriental DEO | 0.000003 | |
| City | Sablayan | 9.584185 | Area, sq. km. |
| | Santa Cruz | 206.194721 | |
| | San Teodoro | 0.000001 | |

**Socioeconomic and Basic Basin Dataset of the Pola River Basin**




Legend

Categories

- AC
- GL
- ML
- NF2B
- NF2C
- PC
- Sh
- WGL

| Symbol | Class | Area (sq. km) |
|---|---|---|
| NF2B | Open forest, broadleaved | 3.44 |
| NF2C | Open forest, coniferous | 1.84 |
| AC | Other land, cultivated, annual crop | 10.70 |
| PC | Other land, cultivated, perennial crop | 0.04 |
| GL | Other land, natural, grassland | 90.71 |
| ML | Other land, natural, marshland | 0.41 |
| Sh | Other wooded land, shrubs | 17.47 |
| WGL | Other wooded land, wooded grassland | 91.16 |

**Distribution of Land Use/Land Cover of the Pola River Basin**

# Annex B.2

# Details of GIS Training

## Training Need Assessment, June 25, 2007

## (Before Training Session)

| S.No. | NAME | POSITION | RESPONSIBILITY | GIS KNOWLEDGE | GIS TOOLS | TRAINING NEED *(That Not Included in Course)* |
|---|---|---|---|---|---|---|
| 1 | Estelita M. Leonado | Economist II | | Fair (seen/heard only) | None | General GIS |
| 2 | Evith Renan Florendo | Engineer II | | Fair | None | Course outline is good enough |
| 3 | Ma. Lucila C. Pinero | Engineer IV | | Fair | None | ditto |
| 4 | Erwin R. Macatingrao | Draftsman II | | Fair | None | ditto |
| 5 | Leonardo P. Sanchez | Engineer III | | First time. No knowledge | None | |
| 6 | Leonila R. Mercado | Engineer IV | Proposal/Planning | No knowledge | None | ditto |
| 7 | Harold N. Uyap | Engineer III | Experiment/Research | Fair | Arcview | ditto |
| 8 | Dolores M. Hipolito | Project Manager II | Planning/Supervision | Fair | Arcview | ditto |
| 9 | Alain John R. Sotto | Engineer III | Design/EIA | Fair | None | Basins deliniation; run-off calculation |
| 10 | Aquilina T. Decilos | Engineer III | Preparation/Planning | Fair | None | Course outline is good enough |
| 11 | Justino Jaime T. Surot, Jr. | Engineer II | Bridge Mngt. System | Fair | GIS 8.1 | ditto |
| 12 | Jesse C. Felizardo | Engineer IV | Research/Training | Good | Map Info; Arc View | DTM/DEM & Geo-referencing |
| 13 | Rogelio A. Atilano | Engineer II | Survey & Investigations | Fair | None | Course outline is good enough |
| 14 | Rebecca T. Garsuta | Division Chief | Planning/Supervision | Fair | Arc View; Arc Info | |
| 15 | Mary Ann T. Bautista | Engineer III | Bridge Mngt. System | Fair | None | Course outline is good enough |
| 16 | Abduljalil M. Bansao | Engineer II | Management | Fair | None | GIS in analyzing flood control |
| 17 | Grecile Christopher R. Damo | Engineer III | Training/Pilot Project | Fair | Arc View | Course outline is good enough |
| 18 | Fitzgerald R. Icamen | Engineer II | Assessment/ Database Mgt. | Fair | None | ditto |
| 19 | Reynaldo C. Ganuelas | Engineer II | EA/Planning & Monitoring | Fair | None | ditto |
| 20 | Richard B. Delos Santos | Computer Operator | | Good | Map Info | ditto |
| 21 | Richelieu F.I. Lim | Engineer III | Design Discharge | Fair | None | ditto |

## Training Evaluation by the Participants, June 27, 2007

## (After Training Session)

| Participant No. | Eavluation of Training in Terms of | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Course Content | Training Design | Training Material | Hardware/ Software | Physical Facility | Coordination & Management | Instructor | Expectation Fulfillment (%) |
| 1 | ii | ii | ii | ii | ii | iii | ii | 60 |
| 2 | i | i | ii | i | ii | i | i | 90 |
| 3 | i | i | ii | i | i | ii | i | 90 |
| 4 | ii | i | i | i | ii | ii | i | 75 |
| 5 | i | i | i | ii | ii | i | i | 98 |
| 6 | ii | ii | ii | ii | i | i | i | 80 |
| 7 | i | i | i | i | i | i | i | 93 |
| 8 | ii | ii | ii | i | ii | ii | ii | - |
| 9 | i | ii | i | ii | | i | i | 90 |
| 10 | ii | ii | ii | i | ii | ii | i | 100 |
| 11 | i | i | ii | i | ii | i | i | 100 |
| 12 | ii | ii | i | ii | iii | ii | i | 80 |
| 13 | i | ii | ii | ii | ii | ii | ii | 80 |
| 14 | ii | ii | ii | ii | ii | ii | i | 95 |
| 15 | ii | ii | ii | ii | ii | ii | i | 100 |
| 16 | iii | iii | ii | ii | ii | iii | iii | 90 |
| 17 | ii | i | ii | ii | ii | ii | ii | 90 |
| 18 | i | i | i | ii | i | i | i | - |
| 19 | i | i | i | i | i | ii | i | 90 |
| 20 | i | i | i | i | i | i | i | 100 |
| 21 | i | i | i | i | i | ii | i | 98 |
| 22 | i | i | ii | i | i | ii | i | 80 |
| 23 | i | i | i | i | i | ii | i | 90 |
| 24 | - | - | - | - | - | - | - | Good |
| 25 | i | i | i | i | ii | i | i | 90 |
| | | | | | | | **Average** | **89** |
| **Legend: i Excellent; ii Good; iii Fair** | | | | | | | | |