

# Surveying and Mapping in the Philippines

by

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### *Salient Geographic Features of the Philippines:*

The Philippine archipelago is composed of 7,107 islands. It is divided into three (3) main island groups, namely: Luzon, Visayas and Mindanao. It lies between 4° 15' N and 21° 25' N latitude and between 112° 15' E and 127° E longitude. The total land area of the country is about 300,000 square kilometers 46% of which is classified as forest and woodlands. The country has 2,229,438 square kilometers of territorial waters that is rich in marine life, and has 36,289km of coastline. The terrain is mostly mountainous with narrow to extensive coastal lowlands. The highest point is the peak of Mt. Apo in Mindanao at 2,954m above mean sea level.

The climate is tropical with an average temperature of 27°C and humidity of about 75%. There are two distinct seasons, the dry and the wet. The rainy months starts from June to October when the southwest monsoon brings the rains.

### *Agencies Involved in Mapping and Surveying:*

During the government reorganization in 1987, a central mapping agency was established to integrate and coordinate mapping and surveying activities in the Philippines. The National Mapping and Resource Information Authority (NAMRIA) was created to carry out water, coastal and land surveys, mapping, remote sensing, information management and statistical services for the government and the general public.

Surveying and mapping, however, is not solely undertaken by NAMRIA. Other government agencies also perform surveying and mapping activities to effectively carry out their respective mandates. Private mapping and surveying companies are upgrading their capabilities to keep in stride with present technology and cope with the demand for geographic information.

### **Geodetic Surveying:**

The NAMRIA is responsible for the establishment and maintenance of the primary geodetic control network of the country.

Prior to 1991, the geodetic network consisted of triangulation chains mostly along the coast. The network was established during those times to provide horizontal control in the conduct of hydrographic surveying for the production of nautical charts. The control network was considered in the old standard as having second-order accuracy and referenced to the Luzon Datum with Clarke 1866 as the reference ellipsoid.

Recognizing the need for a more accurate and homogenous national geodetic framework, the Global Positioning System (GPS) technology was utilized to establish a First Order Network with the support of the Australian government in 1992. GPS stations were established all over the country, consisting 330 first order stations, 101 second order stations, and 36 third order stations. A total of 84 old stations were occupied. The network was developed using multi-stations observed simultaneously. Each succeeding figure had common stations with preceding figures. In this way, a network of well connected figures was built up. A geoid model for the Philippines was also developed as part of the project. Considering the implications of using a global geocentric datum which includes large shift in coordinates, the horizontal datum was retained utilizing the same reference ellipsoid. The vertical datum has been slightly modified by the adoption of a more realistic geoid/spheroid separation at the datum origin. The resulting new framework is known as the Philippine Reference System 1992 (PRS 92). Transformation parameters from WGS 84 to PRS 92 and vice versa are available.

An executive order was issued by the government directing the connection to PRS 92 of all surveys in the country by the year 2000. This deadline was extended to year 2006. Densification of the GPS stations to make it more accessible to surveyors is still in progress. Moreover, due to the prohibitive cost of GPS equipment, local surveyors still adopt the conventional method in most property surveys.

In the pipeline is the setting up of an Integrated Geospatial Referencing Facility (IGRF) in the country. The project includes:

a. Geographic Reference Stations: seven (7) permanent geographic DGPS reference stations shall be established transmitting on HF band providing both land and marine coverage. Sixteen (16) dual frequency receivers will be used in tying Real Time Kinematic (RTK) reference stations to the national geodetic network. These would have facilities for continuous data logging and would be set-up later for permanent or semi-permanent observations for miscellaneous geodetic applications.

b. Coastal DGPS Reference Stations: eight (8) Permanent Coastal DGPS reference stations shall be established to provide sea-based operators within the country's water transmitting on HF band. The coastal reference stations shall also have facilities for continuous data logging of raw GPS and integrity data.

c. RTK Transition Zone System: Six (6) pairs of RTK transmitters/mobiles will provide mobility and high accuracy to overcome the geographic boundaries and bridge the operational gap between land and sea activities of NAMRIA and other users.

## **Cadastral and Property Surveys:**

Three (3) government agencies are involved in the survey and approval for titling of lands classified as alienable and disposable. These are the Land Management Sector of the Department of Environment and Natural Resources (DENR), the Department of Agrarian Reform (DAR), and the Land Registration Authority (LRA).

Generally, it is the DENR that undertakes cadastral surveys of untitled properties either by administration or by contract with private surveyors. However, for lands declared as agrarian reform areas, the DAR undertakes its own cadastral surveys. The approval of these surveys, however, is the responsibility of DENR. The Original Certificates of Titles are issued by either DENR or DAR.

The LRA is in charge of the management of records of titled properties and is mandated to approve subdivision, consolidation and relocation surveys of titled properties. .

The Certificates of Titles are entered into the Register of Deeds in a particular administrative subdivision.

Presently, the land records in the aforementioned offices are still in the analog format. For this reason, the LRA has embarked on a massive program to computerize land records and management.

## **Topographic Mapping:**

Before 1987, no specific Philippine government agency was in charge of topographic mapping . With the government reorganization on that year, the NAMRIA was designated as the central mapping agency and assumed the task of topographic mapping.

NAMRIA is currently producing and maintaining the following maps:

642 map sheets	- 1:50,000	Topographic Maps
55 map sheets	- 1:250,000	Topographic Maps
Growth Centers	- 1:10,000/1:5,000	Topographic Maps
Regional and Provincial	-	Administrative Maps

The 1:10,000 topographic maps are presently being produced covering growth areas and population centers. There is now the gradual shift to this scale as the primary base map. This will entail the production of about 10,000 map sheets to cover the whole country.

The main source of data for base mapping is aerial photography. Data capture is by photogrammetric techniques utilizing computer-aided analog stereo plotters and an analytical plotter in 3D-AutoCAD environment. A digital photogrammetric workstation (DPW) recently was acquired by NAMRIA.

In 1999, the NAMRIA started utilizing digital map production technology, with the use of open PC based desktop systems like the Macromedia Freehand which costs less than the map publishing system softwares.

The NAMRIA is currently revising its 1:50,000 topographic maps. The old series which was produced by the US Corps of Engineers is in the 10' x 15' format. In the 1980's, the then US Defense Mapping Agency (DMA), now the National Imagery and Mapping Agency (NIMA), produced a new series, Series 701, which is in the 15' x 15' format. The revision of the 1:50,000 topographic map series being undertaken by NAMRIA involves reformatting of the map sheet similar to the S701 of US DMA and is now known as the Philippine National Topographic Map Series.

Similarly, the 1:250,000 topographic map series is undergoing revision.

Planimetric revision is being done using satellite images supplemented by field data (integration of the 3S technology – GPS, RS.GIS). Generalized information from the larger scale maps were also incorporated in the smaller scale maps whenever available.

Starting in 1999, the cartographic process was computerized wherein analog maps are converted into digital form, while cartographic enhancement and color separation were done in PC-based desktop system using Map Publisher in Macromedia Freehand.

Due to insufficiency of budgetary support, only 35 % of the country's topographic maps is updated at present.

With the acquisition of a Digital Photogrammetric Workstation by NAMRIA new product lines will evolve, namely: digital orthophoto maps, Digital Elevation Model (DEM) and other byproducts derived from Digital Photogrammetry.

Due to the growing demand for digital geographic data to support revision of cartographic products and various GIS applications, four (4) private surveying and mapping contractors have invested in Digital Photogrammetry. These firms also have their own aircraft and aerial survey camera for aerial photography.

## **Thematic Mapping:**

Special purpose maps are being produced by both government and private agencies by the government and the private sector with information coming from sources. Medium-scale land use and land cover maps are being updated using multi-sensor satellite images and standard and small-format aerial photographs supplemented by field survey and ground truthing. GIS plays an important role in this activity, with its ability to manipulate large volume of spatial data and generate corresponding attribute information. It can likewise integrate different types of data (from different sources) in a single analysis and undertake high-speed classification. Geologic, forest, soil, land suitability and other thematic maps are updated using the same methodology.

The Philippines, being located along the circum-Pacific Ring of Fire, is prone to natural calamities. Disaster damage mitigation through hazard mapping and environmental risk assessment are being undertaken to help save lives and properties in the event these disasters occur.

Large scale thematic information like those found on cadastral maps are being gathered through field surveys. Decision making on cross-border issues, land boundary disputes and investigations of fake titles, among others, requires accessible, accurate and relevant geographic information to come up with an efficient system of land administration. Another effective alternative method of data source was already identified, and this is the use of digital orthophoto and high-resolution satellite orthoimages. These will be piloted on selected areas starting this year. One perceived problem is the limited photographic window and high cost of satellite imageries.

It is recognized that urban areas are the economic engines of developing countries. Extraction of various themes for large scale applications like utilities mapping, telecommunications networking, urban development and environmental planning are being undertaken by NAMRIA and private contractors upon request from the Local Government Units (LGU's) and the private sector.

## **Remote Sensing:**

The Philippines was one of the pioneers in the use of remote sensing in the South East Asia Region. The former Natural Resources Management Center, an agency that was later merged with NAMRIA, made use of remote

sensing in a wide range of applications related to natural resource inventory, assessment and mapping.

In the 1980s, remote sensing was used in the RP-German Forest Resources Inventory Projects to produce forest resource condition maps using LANDSAT and SPOT data and aerial photographs. This was followed by the World Bank-SSC-NRMC/NAMRIA project on Mapping of Natural Conditions of the Philippines using SPOT data. The project produced 43 land cover maps at scale 1:250,000 covering approximately 98% of the country.

Remote sensing received added impetus with the launch of the Philippine-Australia Remote Sensing Project in 1990 through AIDAB assistance. The project provided for the upgrading of the remote sensing capabilities of NAMRIA and the Philippine Atmospheric, Geophysical, Astronomical Services Administration (PAGASA). It is through the same project that the National Remote Sensing Center (NRSC) was established at NAMRIA. The NRSC now serves as the country's archiving, processing and applications center of remotely sensed data. The institutionalization of short training programs and graduate courses at the University of the Philippines made possible under the project ensured a steady development of a pool of skilled manpower with expertise in remote sensing technology and applications.

The following are among the recent developments of remote sensing in the Philippines:

a. Forestry-related applications: The Japanese government through the Japan Forest Technical Association (JAFTA) has extended assistance to the Philippines for the implementation of the Information System Development Project for the Management of Tropical Forests. The project utilized LANDSAT TM taken in 1988 and 1993 to produce vegetation index difference image showing the change in vegetation. A land use/forest type change image showing the patterns of change was also produced in each classification category.

b. Land Resource Evaluation – In the Department of Agriculture, the Bureau of Soils and Water Management (BSWM) was a beneficiary of a Philippine-Japan cooperation project to establish a soil research and development center. Its major concern is the application of remote sensing and GIS technologies in the inventory and mapping of agriculture and land resources.

c. Coastal and Marine Resources Management – Remote sensing technology has been used in the ecological assessment activities of the Fishery Sector Programme, a project implemented by the Department of Agriculture and the DENR. Baseline information on the physiographic environment and coastal areas have been generated to serve as input to

policy formulation on fishery and coastal resource assessment and management.

The Philippine Coastal, Aquatic and Marine Resources Development (PCAMRD) of the DOST has incorporated the application of remote sensing in its project, Coastal Land Resource Project (CLRP) to generate the information needs of local CLRP study groups in conducting field investigations.

The NAMRIA is undertaking coastal resource mapping and mangrove inventory for the Coastal Environment Program (CEP) in support of the project of the DENR.

The Marine Science Institute (UPMSI), University of the Philippines is the implementor of the phase 2 of the AIDAB-ASEAN Coastal Living Resources project, which seeks to train research scientists to produce timely coastal environment information which will directly aid the projects on coastal living resources research and management activities.

d. Disaster Mitigation and Preparedness – PAGASA, the country's weather bureau is operating ground receivers of Japanese Meteorological Satellite (GMS) and the National Oceanographic and Atmospheric Administration (NOAA) polar orbiting satellites. Presently, it is receiving data from GMS-5, which was launched in 1995, that provides hourly visible and infrared images. PAGASA has been relying on these imageries on their day to day analysis and weather forecasts.

The Philippine Institute of Volcanology and Seismology (PHIVOLCS), initiated a three year project sponsored by the UNESCO and the International Union of Geological Sciences on "Mitigation of Volcanic Hazards in the Philippines". Under this project, four active volcanoes, namely Pinatubo, Mayon, Taal and Ragang were selected for investigation and monitoring of changes using interferometry techniques.

e. Institutional and Manpower Capability Build-Up – The National Coordinating Committee for Remote Sensing (NCCRS) has been organized to systematize activities of agencies involved in the implementation of remote sensing projects.

In education and training, the University of the Philippines is implementing graduate program and several short courses on remote sensing.

The Philippines was host to the UN/ESA Workshop on Microwave Remote Sensing Applications on 22 – 26 April 1996. The ASEAN Conference on Remote Sensing (ACRS) was likewise held in Manila on 16-20 November 1998.

## **Hydrographic Charting:**

Hydrographic surveying in the country was started by the U.S. Coast and Geodetic Survey (USCGS), using the conventional method, during the early 1900's. In the late 1950's, the Philippines took over the responsibility of charting and surveying the vast waters of the country through the then Bureau of Coast and Geodetic Survey (BCGS) under the Ministry of National Defense. The fleet of ships left by the USCGS were utilized up to the time when they were no longer seaworthy. It was in the 1960's when the BCGS acquired three (3) survey vessels through grant from the Commonwealth of Australia.

With the 1987 reorganization, BCGS was merged with NAMRIA.

Presently, the NAMRIA is maintaining 31 General and Sailing Charts and 147 Coastal and Harbor charts. In view of the many sea accidents that happened in the past, the conduct of a comprehensive hydrographic survey is one of the priority programs of the government. Furthermore, the bathymetry of the country's maritime territory including the limits of the exclusive economic zone is yet to be defined.

In the early 1990's, the NAMRIA embarked on a project which ranked the Philippines as one of the leading hydrographic institution in the Asian region. Two (2) new multi-disciplinary research vessels were acquired from Spain and delivered in 1998 and 1999 to enhance the government's hydrographic, oceanographic and nautical charting capabilities. These vessels are equipped with state-of-the-art survey and navigational equipment and complimented by shore-based processing and printing facilities. Both vessels are being utilized to produce updated nautical charts, delineate the different maritime boundaries and to provide base information for efficient management of the country's marine resources.

With the acquisition of these new vessels, NAMRIA can now pursue a long-term hydrographic survey program produce new charts of the Exclusive Economic Zone (EEZ), ports and harbors, and the periodic updating of Nautical Charts covering the Philippine waters.

The shore-based data post processing and chart production system will ensure fast delivery and publication of nautical charts. A GIS-based processing system post processes survey data, converts paper charts into digital format, and creates digital databases. Likewise, a new large format two-color offset printing press was acquired. The NAMRIA will eventually shift from the traditional to modern techniques in hydrographic surveying and chart production.

Despite these development, there is still serious backlog in hydrographic and charting activities which affects the government's conduct of national and international maritime affairs commitments as well as the private sector's initiative on marine resources exploration and exploitation.

Electronic Navigation Charts (ENC), the data of Electronic Chart Display and Information Systems (ECDIS) that facilitates the integration of vessel traffic information into the ships navigation system, is being widely used in the international maritime community. Hydrographic offices in some parts of Asia are starting to provide the seafarers with ENC's. The NAMRIA is expecting to provide the same for the Philippine waters to gain competitiveness in the maritime industry. It is likewise envisioned to rescheme the existing paper chart series in order to adequately cover the major shipping routes.

### **GIS and the National Spatial Data Infrastructure:**

In this age of Information Technology, Geographic Information Systems (GIS) has taken the center stage in surveying and mapping. It has been used as a tool in automating the otherwise tedious processes in surveying and mapping.

The issue of spatial data infrastructure had emerged in the past decade as a basic framework for addressing problems concerning geo-information related activities such as data duplication, high cost of spatial data acquisition, restricted access to geoinformation, difficulty in data interchange, and growing demand for timely and accurate geoinformation.

In 1993, the Inter-agency Task Force on Geographic Information (IATFGI) was created with the NAMRIA and the National Statistical Coordinating Board (NSCB) as the Chairman and Co-Chairman and was originally composed of seven (7) member government agencies. It is primarily tasked to promote and coordinate the efficient development, management and utilization of geographic information in the country.

The IATFGI is tasked with the following functions: a) review current policies, decisions, thrusts, programs and projects related to the management of GIS; b) determine the issues affecting the development of GIS in the country and recommend measures to enhance its development; c) recommend appropriate mechanism for the coordination of agencies involved in GIS; d) conduct and inventory geographic holdings and projects; e) develop and recommend minimum standards for GIS interchange; and f) create technical working groups (TWG's) for specific purposes.

Five (5) TWG's were created namely: a) Agriculture, Environment and Natural Resources; b) Lands and Survey; c) Infrastructure and Utilities; d) Socio-Economics; and e) research, training and technology.

In support of the objectives of the IATFGI, the project entitled " The Establishment of a Technical, Operational and Legal Framework for the Management of Geographic Information in the Philippines" is being implemented. The project is being funded by INFODEV/World Bank and is envisioned to develop a basic framework for coordinated management of geographic information by multiple agencies with NAMRIA taking the lead and for the establishment of a national spatial data infrastructure (NSDI).

### **Current Issues and Problems:**

NAMRIA has undertaken numerous projects involving digital mapping, advance information technology and information system development since its creation in 1987. The organization recognized the need to rationalize existing systems and information technology and to develop a vision and plan for its future development. A project concept and strategy was developed under the support of the CANADIAN government through the Canadian International Development Agency (CIDA) called the Information Technology Strategic Plan (ITSP). Currently, the ITSP is in the initial phase of implementation. It is intended to put in place the essential elements of a geographic infrastructure, improve data access and sharing of map products (one-stop-shop), resource inventory data and systems experience by laying out the foundation for a national cooperative mapping and resource information system.

It is also recognized that the quality of the data is critical to judging the applications for which they are appropriate (accurate and timely information). Data quality (precise vs. accurate) is a characteristic that affects its usefulness. In this context, standards must be applied for collecting, processing, storing and interchange of data to ensure data integration and fusion. Government inter-agency committees, to include the private sector have been created to resolve issues such as data standardization, metadata, geographic names, licensing, copyright, royalties and value-added package of cartographic products.

One common problem in developing countries is that government agencies are vulnerable to reduction in budgetary resource allocation. The rapid turn-over of technical personnel is another problem. This is because surveyors and other geospatial professionals are highly in demand since they are now the heart of a technological revolution in information system due to their training and experience in both capturing, managing and presenting

geospatial data. However, current training is dependent on availability of scarce foreign training grants.

A congressional bill was proposed for the NAMRIA modernization. It is a ten year program that is anchored on capability build up of the agency in the fields of mapping, data acquisition and information technology. It will ensure adequate funding over and above its current budget for the development of NAMRIA's capabilities to better undertake its programs and mandate as the central surveying and mapping agency of the government. It includes an equipment acquisition program and the implementation and institutionalization of a continuing human resource development and management program for personnel.