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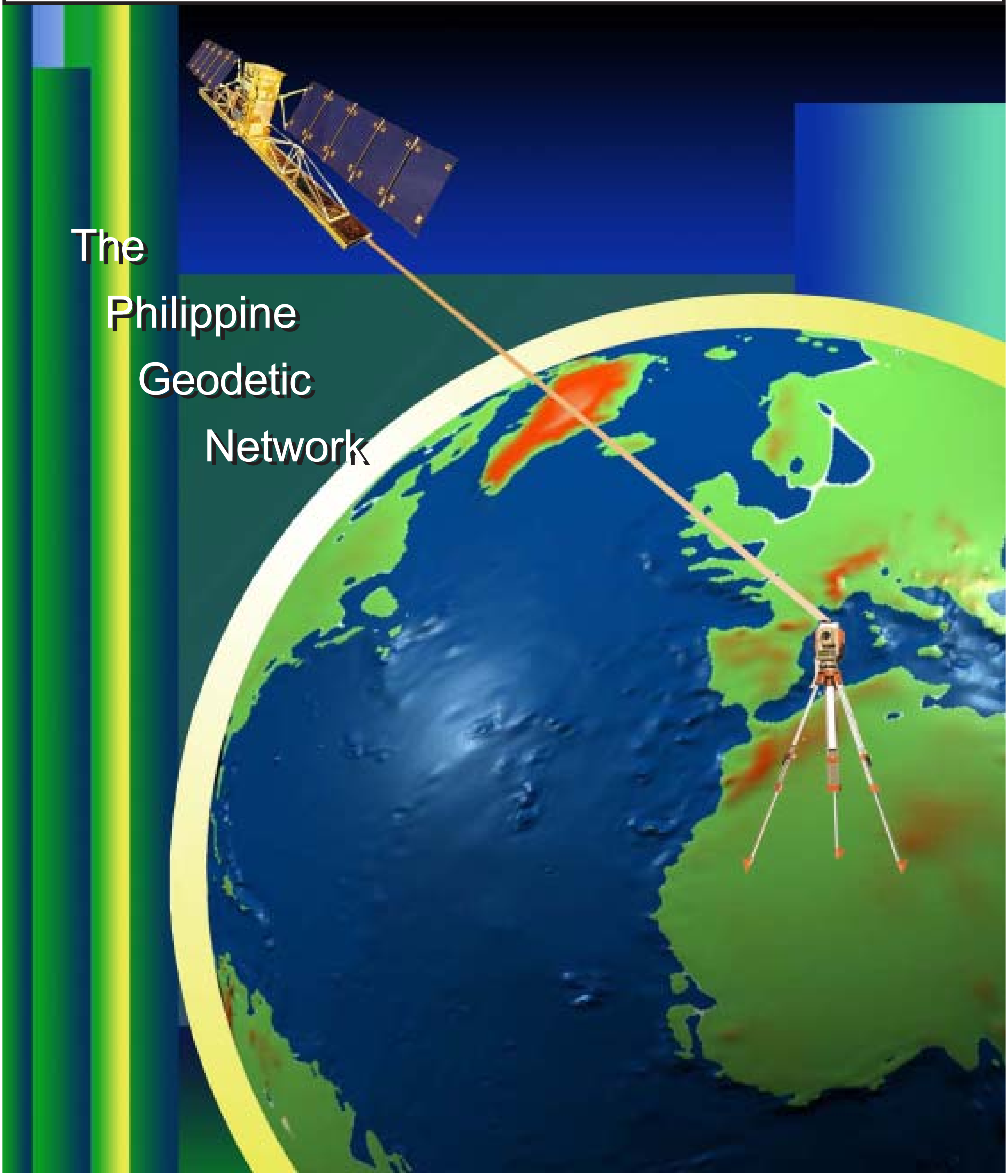

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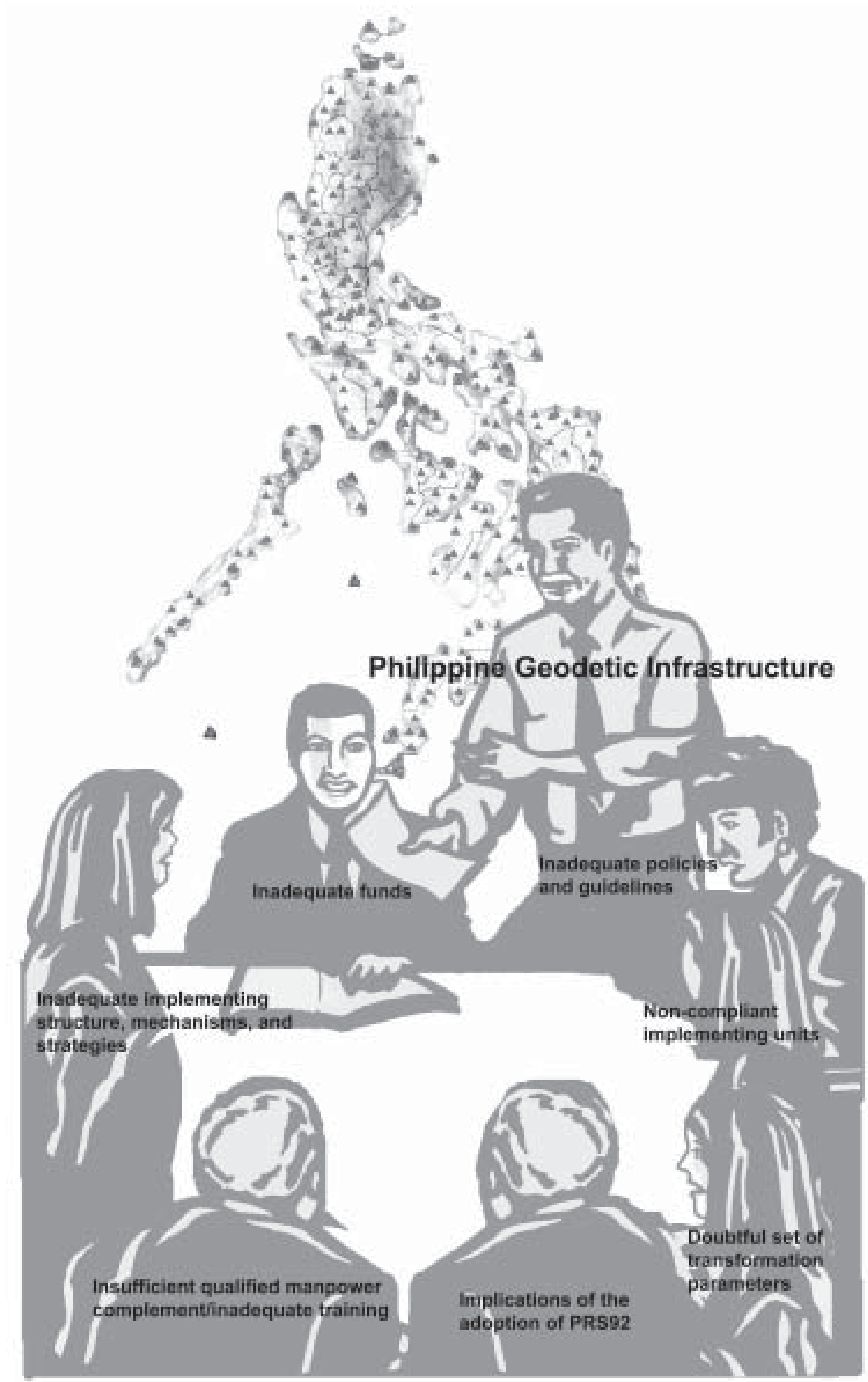
Editors' Note: Due to space constraints, we cannot publish the references consulted for the articles for this issue. Interested individuals may avail themselves of the lists from the authors.

Cover and spread design: Nancy M. de Jesus, Sheilah Mae G. Lopez, and Renato E. Eguia



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Revisiting the DORIS Beacon in NAMRIA

by Ramon R. Villanueva[1]

In April 1991, France brought into the Philippines the beacon, *Doppler Orbitography and Radiopositioning Integrated by Satellite* (*Détermination d'Orbite et Radiopositionnement Intégrés par Satellite*) or DORIS. DORIS was installed at NAMRIA which was chosen as one of the ground stations of the SSALTO. SSALTO (*Segment Sol multimissions d'Altimétrie, d'Orbitographie et de Localisation précise*) is the multimissions orbitography and altimeter center based in Toulouse, France which provides ground support systems for controlling DORIS.

The DORIS beacon installed on the rooftop of the NAMRIA Main Building continuously transmits parameters to the SSALTO such as the beacon's address code, the **date *modulo* 10 seconds**,[2] a time signal, meteorological data, and some beacon control data. The SSALTO then checks on the station's operations, processes measurements, and calculates the orbit of the satellite carrying the DORIS instrument. These data are useful to scientists studying the earth's shape and movement.

With the use of DORIS data, scientists are able to measure the motion of tectonic plates which cause earthquakes. Precise measurements by the DORIS beacon have made it possible to track imperceptible horizontal displacement. Other DORIS applications include orbit determination, earth gravity field, earth rotation, positioning, onboard orbit determination, and time tagging.

The level of performance DORIS accomplished for the past 14 years has enabled it to meet the criteria for processing orbit determination which is essential for space oceanography altimeter mission. Its accurate positioning capability has also been proven valuable for geodesy and geophysics application.

Today, through close cooperation with international partners, the DORIS system has built up a global network of 60 stations. Since its early mission in 1991, it has acquired over 50 million measurements for the international scientific community.

The DORIS system is constantly improving with more accurate orbit determination, more reliable and more compact components, and features being developed. Other upgrades are under study to further improve its performance and increase receiving capacity to meet the needs of new applications.

In the years ahead, demands on the performance of the DORIS system will increase. The DORIS instrument guarantees users a high quality service in providing long-term precise orbit determination. There will be a great boost for many fields of Earth Science with its enhanced performance.✦

The meteorological station being installed by ICED maintenance staff

Fully installed meteorological station

Doris beacon instrument with other accessories

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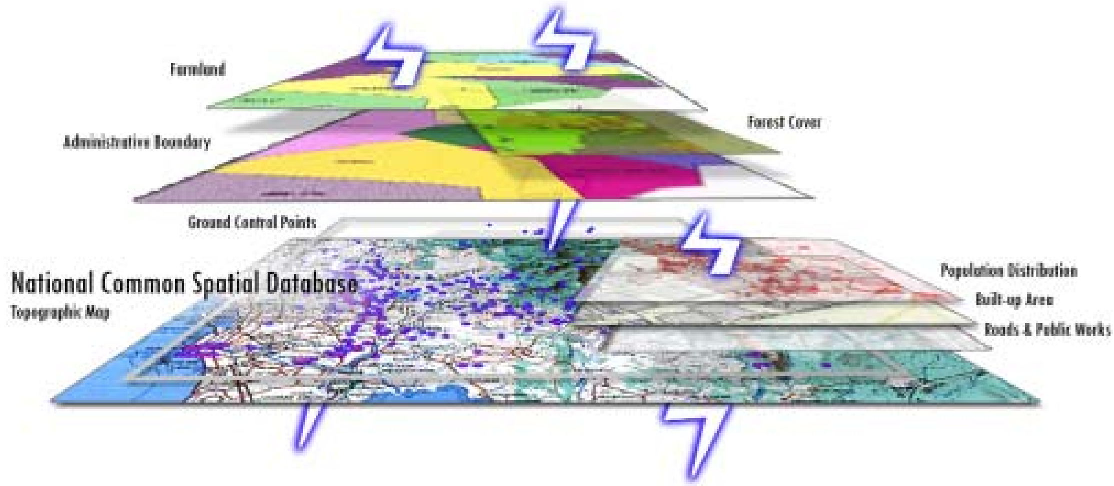
[1]*Engineer IV, Instrumentation and Communication Engineering Division (ICED), Engineering Services Department*

[2]*The **date modulo 10 seconds** refers to the date and time transmitted by the beacon which represent the number of elapsed 10-second sequences.*

NSDI and NCSD: Back to Back

compiled by John SF Fabic[1]



NATIONAL SPATIAL DATA INFRASTRUCTURE

NAMRIA has initiated the establishment of two major projects that can dramatically change the landscape of mapping in the country. These are the National Spatial Data Infrastructure (NSDI) and the National Common Spatial Database (NCSD). Together if realized, they will form the backbone of geographic information system (GIS) in the Philippines. Back to back or side by side, both projects will support thematic mapping activities of all sectors of society and will contribute immensely to the growth of the local mapping industry. While the NCSD envisions providing the base data, the NSDI basically recommends an infrastructure for the distribution and sharing of such data across various users.

The NSDI

The NSDI is a network of digital databases that are located throughout a country, which collectively, will provide the fundamental data needed to achieve the country's social, economic, human resources, and environmental development objectives. It is a national initiative that will offer better access to essential and consistent geographic information produced and maintained by different agencies or custodians across the country.

The formulation of a framework plan for the NSDI was made possible under the auspices of World Bank which provided assistance to the project entitled *"The Establishment of a Technical, Operational, and Legal Framework for the Management of Geographic Information in the Philippines."* The Inter-Agency Task Force on Geographic Information, chaired by NAMRIA, carried out this project. The NSDI comprises four components, namely: Institutional Framework, Technical Standards, Fundamental Datasets, and Access Networks. The component Fundamental Datasets will be addressed by the NCSD.

Rationale for the Establishment of the NSDI

The NSDI is intended to address the following concerns: (a) Increasing demand for geographic information by various users; (b) Increasing use of geographic/spatial information technologies [GIS, Global Positioning System (GPS) and Remote Sensing (RS)]; (c) Increasing activities for the acquisition and generation of geographic information on a project or isolated basis; (d) Duplicative efforts in data buildup for the same geographic area, uncoordinated efforts resulting in duplication or expensive data acquisition; (e) Lack of technical standards in the acquisition, sharing/exchange, management of geographic information, hampering effective use of geographic information; (f) Lack of policies on access, sharing/exchange, custodianship/ownership, creation, maintenance, and distribution of geographic information; (g) Inadequate institutional framework for the coordination of efforts for the establishment the NSDI; (h) Inadequate program for building and maintaining the fundamental framework datasets; (i) Inadequate appreciation of geographic information as a national resource; (j) Undervalued, underutilized geographic information resources available in government agencies; (k) New opportunities brought about by new developments in information and communication technologies (ICT); and (l) Global efforts to build national, regional, and global spatial data infrastructures.

Objectives of the NSDI

The objectives of the NSDI Framework Plan are: (a) To ensure that users of geographic information will be able to acquire consistent datasets to meet their requirements, even though the data are collected and maintained by different organizations; (b) To maximize government's return on investments in data collection and maintenance of the national fundamental datasets; (c) To reduce waste from unnecessary duplication of efforts in data creation and updating, and from use of inconsistent or poor quality data in planning and operations of programs and projects; (d) To help improve planning and decision making in government and businesses that are impacted by the location of people, places, things, and events; (e) To promote value-added activities, products, and services from the fundamental datasets; and (f) To promote private

[1]*Director I, Information Management Department (IMD)*

**Author's note: Graphic rendition by Romel J. Francisco, Computer Programmer III, Systems Development and Programming Division, IMD* industry development and facilitate active participation in geographic information acquisition, development, and provisioning to local and global markets.

Components of the NSDI

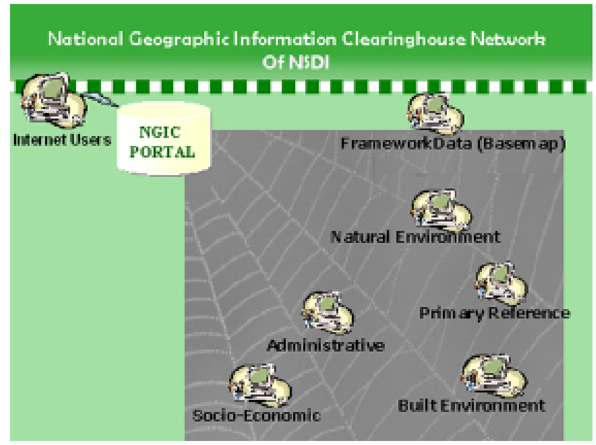
The NSDI has the following components:

1. The establishment of the *Institutional Framework*, which defines the policy and administrative arrangements for building, maintaining, accessing, and applying the standards and datasets, shall include the following activities: (a) Issuance of Executive Order creating the National Geographic Information Council (NGIC) as the highest policy and coordinating body for geographic information in the country and overseer of the establishment of the NSDI; (b) Formulation of the implementing rules and regulations to carry out the mandates and functions of the NGIC with NAMRIA as the NGIC Secretariat; (c) Creation and operation of Technical Working Groups and Committees to help the NGIC carry out its mandates; (d) Development of policies on data sharing, dissemination, pricing, custodianship, acquisition, maintenance, among others; (e) Development of advocacy and public awareness program; (f) Development of education and training program; and (g) Development of projects.

2. Formulation and adoption of *Technical Standards and Protocols*, which define the technical characteristics of the fundamental datasets and enable them to be integrated with other environmental, social, and economic datasets, shall include the following sub-components: (a) Metadatabases, (b) Data standards, (c) Data quality, (d) Primary reference system, and (e) Data exchange/sharing protocol.

3. Building of the *Fundamental Datasets*, which are produced within the institutional framework and fully comply with the technical standards, shall include the following activities: (a) Feasibility studies and planning, and (b) Projects to build the fundamental datasets contained in the NSDI.

4. Establishment of a *National Geographic Information Clearinghouse Network* (NGICN), which is the means by which the fundamental datasets are made accessible to the community in accordance with policy determined within the institutional framework, and to the technical standards agreed, shall include the following sub-components: (a) NGIC as the hub/portal of the clearinghouse network; (b) Sector hubs linked to the NGIC portal for primary reference, base map, natural environment, built environment, administrative and socioeconomic data; (c) Servers in data custodians; and (d) Data directory systems/catalog services.



Institutional Arrangement

The NGIC, through NAMRIA, shall operate and maintain the NGICN. The components of the NGICN include (a) Clearinghouse information communities such as agriculture, environment and natural resources sector; infrastructure and utilities sector; lands and surveys sector; and socio-economics sector; (b) Clearinghouse distributed and centralized databases; (c) Clearinghouse applications; (c) Clearinghouse communications networks; (d) Clearinghouse data models; and (e) Clearinghouse metadatabases. For this project, the scope will include only the setup of the clearinghouse network and the customization of metadatabases adapting to international standards.

The Nodes of the NGICN shall be the designated custodians of fundamental datasets, although these custodians may designate another data custodian or NAMRIA to host their site. It will be necessary for the Nodes to establish the appropriate structure and staffing to support their functions as data custodians of a fundamental dataset and providers of metadata concerning the fundamental datasets under their custodianship in the national directory system. The NGIC will support efforts of the Nodes to develop their own individual capability and capacity as data clearinghouses.

Economic Analysis

The country can benefit from better management of its geographic information by taking a perspective that starts from the national level and works down to the local level. The Price Waterhouse Benefit Study done for the Australian and New Zealand Land Information Council (ANZLIC) revealed a cost-benefit ratio of approximately 1:4 for data usage over a five-year study. This shows that for every dollar invested in Australia and New Zealand for producing geographic information, $4 of benefit was generated within the economy. For the period 1989-1994, these benefits were in the order of $4.5 billion. Benefits were distributed across the broad spectrum of economic activities ranging from the operation of electricity, gas, and water utilities to projects involving agriculture, mining, and environmental management.

The Price Waterhouse Benefit Study conducted for the ANZLIC also showed that the existing infrastructure for supplying geographic information has provided information to users at a cost far lower than alternative methods. If the existing infrastructure had not been in place and users had been forced to meet their data requirements from other sources, their costs would have been approximately six times higher. In that five-year study alone, establishing infrastructure has saved users in Australia and New Zealand over $5 billion.

In the Philippines, the same benefits would be realized with the establishment of an NSDI. The national government would have saved half of the current expenditures for the acquisition and use of geographic information were it not for the following major issues: (a) Lack of digital basemap to serve as reference for data integration and sharing; (b) Lack of technical standards for data integration and exchange; (c) Duplication of efforts and resources; (d) Data gap; and (e) Absence of lead agencies to serve some data requirements of users.

The NCSD

The NCSD is essentially the digitization of NAMRIA's topographic maps. It is a project that would stage the transformation of the current topographic maps into a new, sophisticated, and GIS-ready database. This geospatial database, together with attribute data, will be used by all the government departments and agencies, as well as the public as a common reference for all their thematic maps and applications. The effectiveness of the NCSD is enhanced when it is

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NSDI...
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based on a network system that provides easy access to various users. The NSDI and the NCSD complement each other in this regard.

Rationale for the Establishment of the NCSD

The NCSD is consistent with the development objectives of the Government Information System Plan (GISP), a blueprint for the government's ICT-based planning and development, which was prepared by the National Economic Development Authority. The GISP aims to harness the full potentials of ICT to ensure wider public access to government information and the efficient delivery of the government services to the public within the first decade of the 21st century. In the GISP, the importance of a national common spatial database focusing on GIS has been noted. It is mainly because GIS has proven to be invaluable for the government's decision making on various development activities, including conservation of natural resources, protection of environment, land use management, agricultural production, urban development, disaster response and mitigation, communications, defense and security, and transport among others.

More than 80 percent of planning, decision making, and operations in the government are related to or affected by location thereby making geographic information very essential to effective and efficient governance. At present, most government departments are still at the development stage in the utilization of GIS technology. One of the major reasons for this is that they have limited digital topographic maps available for utilization as the base layer.

The topographic maps that are commonly used now were produced by NAMRIA at various scales. The predominant scale is 1:50,000 which covers the entire Philippines and the next popular scale is 1:10,000 which covers some limited urban areas. However, it has been repeatedly pointed out that the current topographic maps at a scale of 1:50,000 are old and outdated. For instance, under the National Topographic Map Series, NAMRIA updated these maps in 1988 but only in few areas of Luzon, Visayas, and Palawan province. Most areas of Luzon are still based on the 701 series or aerial photographs taken between 1976 and 1979, while practically the whole of Mindanao and big portions of Visayas and Palawan are based on the 711 series or aerial photographs taken between 1947 and 1953. Although NAMRIA is currently digitizing the topographic maps on the basis of individual projects, this is occurring to a very limited degree in the country. Also there are other government departments digitizing the topographic maps for their respective applications, thus, duplication cannot be avoided.

Objective of the NCSD

The objective of the project is to establish a national common spatial database comprising an updated and digitized set of base data or topographic maps at accuracy levels of 1:50,000 and 1:10,000.

Establishment of the NCSD at 1:50,000 Accuracy Level

This phase, covering the whole country or about 300,000 sq. km. of land area, will consist of the following major activities: (a) Acquisition of satellite image, (b) Production of digital terrain model (50m grid), (c) Production of digital orthoimage (1:50,000), (d) Digitization and editing of data, (e) Integration and structuring of data for GIS, and (f) Cartographic enhancement of topographic database (1:50,000). The multilevel topographic database for 1:50,000 will primarily consist of the following coverages: contours, roads and railways, hydrology (rivers, lakes, and coastal lines), public buildings and structures, vegetation, administrative boundaries, and geographic names.

Establishment of the NCSD at 1:10,000 Accuracy Level

A larger scale of map is required for the country's progressive development, especially in urban and other priority areas. Therefore, it is recommended that a digital geospatial database of 1:10,000 accuracy level should be produced to cover the populated centers of about ten percent of the entire land area of the Philippines (approximately 30,000 sq. km.) from new aerial photographs.

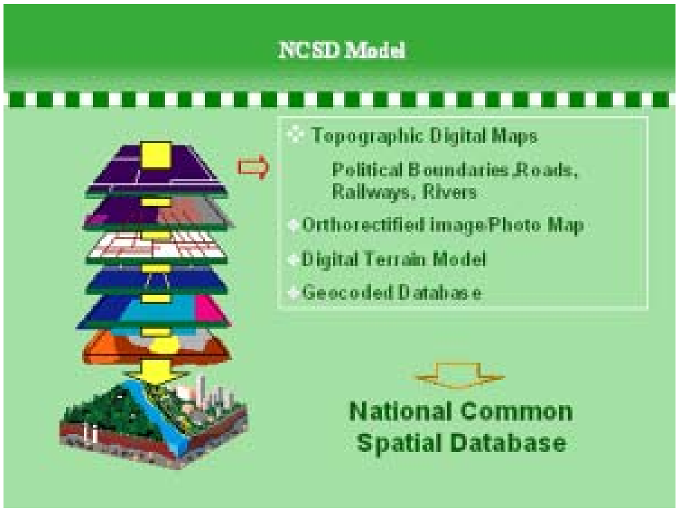
This phase will consist of the following major activities: (a) GPS aerial photography, (b) Aerial triangulation, (c) Terrain model (20m grid), (d) Digital orthophoto production, (e) Photogrammetric compilation, (f) Field editing and data filing, (g) Data integrating, structuring, and designing, and (h) Address-matching tables. The database of 1:10,000 accuracy level will primarily consist of the following coverages: roads and railways, river system (rivers, coastal lines, and lakes), contours, buildings, land classification, annotation, and administrative boundaries.

From its inception, it was already known that the entire project will cost the government a huge amount of money. Hence, in the implementation of the NCSD, priority may be given to the 1:50,000 accuracy level depending on the availability of budget or funding strategy to be undertaken. In this regard, funding assistance from foreign donors would possibly be sought out.

Establishment of the NAMRIA GIS Data Center (NGDC) and its Off-site Backup Facility

One of the major components of the Project is to establish the NGDC to house the NCSD. The NGDC will also house the major facilities, both hardware and software for analysis and dissemination of the database. A Backup System will be established at the Department of Environment and Natural Resources (DENR) for security reasons. The main feature of the NGDC is to upgrade the current equipment of NAMRIA, both hardware and software, to meet the technical requirements of the project.

The development of the NSDI and the NCSD is now being carried out in many countries. For economies that have already established these GIS backbones, their users as well as producers of the datasets are now reaping the benefits.



Tide Stations in the Philippines

by Rene G. Eclarino[1]

NAMRIA's mandate with regard to oceanographic surveying primarily focuses on the physical aspects of oceanography that dwell mainly on ocean parameters such as tides, current, temperature, salinity, and depth. Data collection is however not limited to the physical characteristics, but likewise explores other marine-related data in the course of a combined hydrographic and oceanographic surveying operation. The office has a long history in tidal observation.

Primary tide stations, where continuous tidal observation in the country are conducted, are mostly located in strategic coastal areas. These areas are scattered in the different seaports of industrial and economic convergence such as Manila, San Fernando, and Legaspi in Luzon; Cebu in the Visayas; Davao and Surigao in Mindanao. To date there are 10 primary tide stations in the Philippines with existing tide house structure and tide gauge equipment. Mean values of datum planes are derived from the operation of these primary tide stations. Such values include mean sea level (MSL) and mean lower low water (MLLW) which serve as the respective bases for ground elevation, bathymetry, and nautical charting purposes. They likewise serve as references for analyzing data from secondary and subordinate locations where short-period tidal observation exists.

History of the Establishment of Tidal Stations in the Philippines

The work of conducting tidal observation in the Philippines is now over a century old. It began shortly with the establishment of a sub-office then known as the Manila Field Station of the United States Coast and Geodetic Survey (USC&GS) in 1901, which was then located at the *Intendencia* building of the Walled City of Intramuros.

In 1902, the first primary tide station was established in Manila with the first observation records mainly kept in the archives of then USC&GS. Tidal observation continued to be conducted across the country with the establishment of a tide gauge in Iloilo, Panay in 1903. The Cebu primary tide station was set up in 1935.

By 1950, the office then called the Bureau of Coast and Geodetic Survey (BCGS), which was created to replace the Manila Field Station under Act No. 222, was already under Filipino operation. This came about after the turnover of the total supervision by USC&GS to the Philippine government. In 1952, the Bureau acquired a tide-predicting machine (**Figure 1**) from Liverpool, England, which could take into account 32 tidal components. Six tidal stations were being maintained and these were located in Manila, Cebu, Davao, Legaspi, San Fernando in La Union, and Jolo. The first *Tide and Current Tables* was published in 1953 under Filipino leadership. Prior to this, preparation and printing were being done in Washington D.C., USA.

Figure 1. *Doodson-ledge tide predicting machine from Liverpool, England*
Source: Library, CGSD

In 1969, computer-aided tidal predictions replaced the use of the 32-component predicting machine (which still exists presently in the present office) with that of an electronic computer, IBM 360/30. By 1972, additional computers such as the FACOM 230/20 were being used for all predictions including manuscript preparation.

In 1986, with Phase I of the ASEAN-Australia Marine Project (Tides and Tidal Phenomena-Regional Ocean Dynamics), BCGS started to use the digital type of tide gauges with models such as EMS 16 (cartridge type) and ENDECO pressure sensor type. The office also undertook the establishment of more tide stations. Nearing the completion of Phase II of the project in 1990, four additional tide stations were already in existence, three of which became primary stations in the same year, namely, Surigao, San Jose in Mindoro, and Port Irene in Cagayan. In 1994, the Puerto Princesa tide station became a primary tide station. The year 1996 saw the dismantling of the Jolo tide gauge due to security matters and equipment malfunction. It was relocated to Zamboanga in 2002. In 2001, the tide station in Real, Quezon became a primary tide station.

To date, the processes of tidal analysis and prediction have come a long way with the use of modern PCs and software programs such as those being used in Australia, Japan, and the US. The Philippine tide station has remained the same in terms of setup, structure, and instrumentation. It still yields good data results.

In addition, the collaboration and exchange of oceanographic data with both local and foreign entities continue to be given high regard by the present Coast and Geodetic Survey Department (CGSD) of NAMRIA. In the advent of the present technologies, it will no longer be farfetched that NAMRIA's oceanographic data will soon be made available to the Internet community in the present millennium.

Tides

The tidal stations maintained by the NAMRIA CGSD are primarily aimed at measuring tides. *Tides*, which refer to the periodic rise and fall of the sea-surface level, vary mainly in accordance with the changes in position of the moon and sun relative to the earth. Vertical water-level measurements are made using special equipment known as *tide gauges*. Tidal records for analog tide gauges are registered as simple sine curves in hard copy medium known as *marigram*. Tide monitoring is carried out in long periods of observation to determine the MSL and the MLLW which serve as the bases for land- and water-datum level respectively. A period of 19 years is generally considered as constituting a full cycle of tide during which the more important variations in tides would have undergone a complete cycle (*Marmer*, 1927) and hence, the datum level would be more precise.

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[1]*Chief, Oceanography Division, Coast and Geodetic Survey Department*

Tide...

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Tide Prediction

Continuous actual tidal observations made possible through the maintenance of the tidal stations are very important in the analysis for the computation of tide prediction. Predictions from primary tide stations are derived from 60 harmonic constants using mathematical analysis computed and updated from long years of observation. Tide prediction at secondary stations is derived from 36 harmonic constants calculated from short-period observations. These are then collated in the *Tide and Current Table*s which are published yearly by NAMRIA.

Tidal Leveling

Tide stations are annually inspected and checked for proper equipment operation and data accuracy. During annual inspection, tidal leveling is conducted to determine water-level datum shift with regard to land elevations. *Tidal leveling*, which is the process of taking vertical measurements of ground points known as tidal benchmarks, is then carried out to connect the benchmarks to a water-level datum plane. These measurements are then connected to the zero datum of the tide gauge referred to a mean water-level reference to define the elevations of points on the ground.

Through these measurements, shifts in water-level datum or ground-level change can be determined which could be analyzed as either sea-level rise or ground subsidence. The present datum in each of the tide stations is referred to a fixed zero level of a tide staff or simply called *tide pole*, which was initially determined when the station was first established. These are only arbitrary levels which vary in each of the tide stations depending on how the tide staff was set up. The following lists the original years of establishment of the zero-level tide staff in determining the datum plane of references: Manila-1901; Cebu-1935; Davao, Legaspi, Jolo, San Fernando-1947; Surigao, Port Irene, San Jose-1986; Palawan-1990; and Real-1995.

Levels of the current tide staff/pole in each of the tide stations may differ during annual inspection and re-leveling from the original setup but the discrepancy is always corrected to refer back to the original zero level. These corrections are necessary to maintain the fixed reference level for the analysis of the observed tidal data for quality control and more importantly in monitoring the datum plane for control references.

Importance of Tide Stations

The establishment and maintenance of tidal stations serve various purposes both for government and non-government institutions, educational and research facilities, local coastal residents, as well as the general public. Benefits provided include the following: (1) actual tidal information for various activities (i.e., research, planning, navigation, charting, and coastal infrastructure design); (2) data on daily occurrences of either high or low tide for coastal activities; (3) basis in determining datum planes for ground elevation and charting references; (4) data inputs for tide prediction; (5) additional information on flooding scenarios; (6) inputs for weather forecasting; and (7) data inputs for storm surges and tsunami studies.

Related Issues on Sea-Level Scenarios

Aside from monitoring high and low tides, tidal observation can very well be a source of inputs to other activities such as land subsidence monitoring, and coastal erosion and tsunami studies. Ground movement as in land subsidence can be manifested as a sea-level rise through analysis of long tidal observations. Tide gauge connected to a telemetry system for real-time tide monitoring is very important instrumentation for tsunami analysis.

Among the 10 primary tide stations in the Philippines, only the Legaspi Tide Station is equipped with telemetry capability, which monitors tidal measurement in real-time mode. In collaboration with the Pacific Tsunami Warning Center (PTWC), based in Hawaii, the telemetry system was installed sometime in 1993 at the station. A special coupling device was attached to the tide gauge of NAMRIA to translate the tidal measurement to the telemetry system, which then transmits the data to PTWC. Locally, personnel from the Philippine Institute of Volcanology and Seismology (PHIVOLCS) closely collaborate with the tide observer of NAMRIA for tidal observation and monitor the operation of the telemetry. PTWC personnel supervise the maintenance of the telemetry instrumentation setup.

A number of Philippine tide stations are registered in the network of tide stations under the Global Ocean Sea Level System for worldwide tidal scientific studies. Being a member of the International Oceanographic Commission, the Philippines sends yearly tidal data to this program as part of the country's commitment to various oceanographic surveying activities.

Tide Station Characteristics

There are 10 primary tide stations established and maintained in the different coastal areas of the country. Each consists of a simple tide house structure of concrete and wooden materials measuring about 1.5 meters square in floor area and about 2.5 meters in height. This type usually houses the analog type of tide gauge due to the numerous mechanisms and setup features of the equipment. Some digital-type tide gauges such as the Aanderaa pressure sensor type are housed in just small boxes attached to existing pier structures. Other digital-type tide gauges such as the wave and tide gauge (WTG) models are just fastened to pier piles below the surface of the water and do not require casings. Three tide stations to date are equipped with digital tide gauges, six stations with analog-type tide gauges, and one station with both digital- and analog-type tide gauges (**Figure 2**).

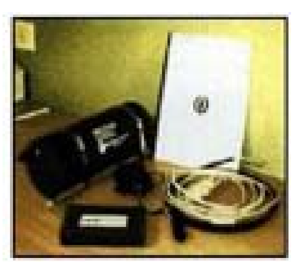
Figure 2. *Types of tide gauge models currently in use in the different primary tide stations*

Analog-type tide gauges

Leupold Stevens chart recording model coupled to a digital converter EMS 16 cartridge recorder

A.O.T.T. float type Marigram recorder

Digital-type tide gauge



WTG-904 series 3, wave and tide recorder, InterOcean

List of the various features of the country's existing primary tide stations

Tide Station Location – Original Year Established	Present Type of Tide Gauge	Type of Tide – Mean Tide Range	Highest Tide Observed – Date Recorded	Lowest Tide Observed – Date Recorded
(1) South Harbor, Manila – 1947	Analog tide gauge (AOTT model) – operational	Mixed diurnal and semi-diurnal – 0.758 meter	4.0 meters above zero tide staff – 04 July 2000	1.16 meters above zero tide staff – 26 January 1952
(2) Poro Point, San Fernando, La Union – 1947	Digital tide gauge (WTG model) – non-operational (Operation was suspended due to instrumentation problems but its resumption this year is planned.)	Diurnal – 0.39 meter	2.37 meters above zero tide staff – 22 June 1985	➢ 0.66 meter – 14 December 1989 ➢ 0.58 meter – 16 January 1949
(3) Old pier of Port Irene in *Barangay* Casambalangan in the town of Sta. Ana, Cagayan – 1987	Analog tide gauge (Leupold & Stevens model) – operational	Semi-diurnal – 0.918 meter	3.64 meters – 31 July 1996	1.28 meters – 22 December 1991
(4) Wharf in *Barangay* Ungos town of Real in Quezon – 1995	Digital tide gauge (WTG model) – operational	Semi-diurnal – 1.354 meters	3.33 meters – 09 February 2001	0.81 meter – 26 November 2003
(5) Pier in *Barangay* Caminawit in San Jose Occidental, Mindoro – 1986	Analog tide gauge (Leupold & Stevens model) – operational	Mixed diurnal and semi-diurnal – 0.800 meter	2.86 meters – 31 July 1996	0.62 meter – 01 January 1991
(6) Pier I near the Cebu Port Authority building, Cebu City – 1935	Analog tide gauge (AOTT model) – operational	Mixed diurnal and semi-diurnal with diurnal dominance – 1.023 meters	3.25 meters – 13 July 1987	0.36 meter – 29 January 1983
(7) Surigao Port, Surigao City, Surigao del Norte – 1986	Analog tide gauge (Leupold & Stevens model) – operational	Mixed tide – 0.781 meter	3.46 meters – 23 & 24 July 1998	1.26 meters – 01 January 1991
(8) Sasa Wharf, Davao City – 1947	(Temporary) Portable digital tide gauge (WTG model) – operational	Semi-diurnal – 1.305 meters	3.47 meters – 27 September 1988	0.40 meter – 13 December 1958
(9) Puerto Princesa Port in Puerto Princesa City, Palawan – 1990	(Temporary) Portable digital tide gauge (WTG model) – operational	Mixed diurnal and semi-diurnal – 0.917 meter	3.09 meters – 24 November 1991	0.66 meter – 08 January 1993
(10) Legaspi Pier in Legaspi City, Albay – 1947	Analog tide gauge (AOTT model) – operational	Semi-diurnal – 1.156 meters	2.92 meters – 26 September 1988	0.15 meter – 19 January 1969

Tide observers who are hired in the local area for advantageous reasons oversee maintenance, operation, housekeeping, security of the station, as well as monitoring of data acquisition. They are also responsible for sending the data to the main office on a monthly basis.

Future Locations of Additional Tide Stations

The Philippines being an archipelago, the present number of tide stations in the country are not sufficient to provide adequate tidal information for its entire coastline. The densification of our tide station network is therefore greatly required, considering the varied tidal behavior of our waters that should be fully understood.

The need for the densification of the Philippine tide gauge network in the near future would suggest the establishment of additional tide stations in many coastal areas such as the following which are initial priorities: Eastern Mindanao, Eastern Samar, Masbate coast Northeastern Luzon, Northwestern Luzon, Southwestern Negros, West coast of Zambales, Western Palawan, and Zamboanga. The above locations are deemed necessary since most parts of the country lack tidal information, especially within the internal waters which are largely used for navigation. The outer coastlines are likewise very long and tidal characteristics may not be defined very well by the existing tide stations as they are spaced too far apart from one another.

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Port Irene
San Fernando
Manila
Mariveles

Tide Stations of the Philippines

Upgrading and Optimizing the Philippine Geodetic Infrastructure (PGI): Strategic Options toward Medium-Term Plan Formulation[1]

by Randolf S. Vicente[2]

Since the dawn of civilization, the processes of measuring and mapping one's domain or jurisdiction have continuously persisted up to the present. The management of natural and economic resources has become increasingly dependent on the availability of precise and consistent geographic information. The methods and techniques for measuring, processing, analyzing, presenting, and disseminating resource data/information have changed radically in recent years. The underlying issues on ambiguous locations, distances, areas, and other related statistics, however, have remained the same throughout.

Modern society turned out to be progressively more dependent on geographically-based datasets. These datasets allow locations, distances, areas and other related statistics to be reliably measured and calculated. A geodetic system, commonly known as the *"standard spatial reference system,"* provides the foundation of any geographically-based dataset. It involves a combination of factors such as *ellipsoid, geoid, datum, coordinate system, and projection* that identify a point on a sphere in a two- or three-dimensional representation.

The Philippines is currently adopting the Philippine Reference System of 1992 (PRS92) as the standard reference system for all surveys and mapping activities. This is pursuant to Executive Order (EO) number 45, as amended by EO numbers 280 and 321. PRS92 is an upgraded version of the old Philippine Geodetic Network (PGN) which was established by then USC&GS in 1901. The responsibility of establishing and maintaining the PGN was assumed by NAMRIA CGSD (formerly BCGS of the Department of National Defense or DND) in 1987 by virtue of EO number 192. The PGN, particularly the horizontal control network, served as the reference or tie points for cadastral surveys by the then Bureau of Lands (now the Lands Management Bureau or LMB of DENR, and those projects administered by other government agencies such as the Department of Land Reform (formerly the Department of Agrarian Reform), the Department of Public Works and Highways, DND, among others.

The existing reference system is characterized by technical, operational, legal/policy, and institutional inadequacies. As the industry becomes bigger and bigger, the present system does not anymore cater to the needs and demands of the user community. In response to this, a Strategic Plan, designed to upgrade and optimize the PGI, must be drawn to address such inadequacies as well as the current and emerging issues. It shall cover all the elements of a geodetic infrastructure in addition to the traditional definition and scope of a geodetic network.

Current and Emerging Issues

Surveying, mapping, and the use of geographic information are currently the areas of intense activity. Numerous projects and research efforts are being actively pursued nationwide as well as worldwide to upgrade the existing geodetic networks, modernize field and office operations, reinvent institutional arrangements, pool organizational resources, and satisfy user needs. Appropriate options vis-à-vis local situations, however, cannot be ascertained without knowing and understanding the real issues and drivers towards system improvement.

There is indeed a serious backlog in the implementation of PRS92. This was revealed by the results of the Stakeholders' Conference on PRS92, held on 15 August 2003 at the New Army Officers' Clubhouse in Fort Bonifacio, Taguig City; as well as the Focus Group Discussions on PRS92 which were organized by NAMRIA in collaboration with LMB, and held from 22 February to 02 March 2004 in the cities of Baguio, Cebu, Davao, and Manila. More specifically, the issues and problems include: (a) Inadequate funds (less priority); (b) Inadequate implementing structure, mechanisms, and strategies; (c) Inadequate policies and guidelines; (d) Non-compliant implementing units; (e) Insufficient qualified manpower complement/inadequate training; (f) Doubtful set of transformation parameters; and (g) Implications of the adoption of PRS92 on the existing land titling and registration system.

The design and specification of a national geodetic infrastructure should take into consideration the above-cited issues and problems. Parallel to this, it is also important that emerging issues and the drivers for improvement of the current system be defined in order to put in place an efficient and ideal geodetic infrastructure that caters to the needs of the government, the user-community, and other major stakeholders. These emerging issues include the following: (a) Changing role and needs of the government; (b) Expanding user-community and their future requirements; (c) Role of the private sector, academe, accredited professional organizations or groups, and other stakeholders; (d) Malpractices in geodetic surveying; (e) Human resource incapacity; (f) Investment/cost recovery; (g) Datum shift (geodetic to geocentric and vice versa); (h) Migration to business systems automation; (i) Operation of the national spatial data infrastructure; (j) Accommodation of technology innovations (e.g., data portal and real-time positioning); (k) Maintenance of the network of ground marks; and (l) Inefficiency in geodetic data and information management.

The Future Ideal State

The definition of vision and mission would involve the statement of the future scenario, having the geodetic infrastructure play the role of an *enabler* in ensuring the availability of precise and consistent geographic information. As such, the vision may be stated as, ***"an efficient and modern national geodetic infrastructure***

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[1]The article was based on the draft Strategic Plan presented by the author on 06-08 June 2005 during the Land Management Sector Conference conducted by the Lands Management Bureau (LMB) in collaboration with the Land Administration and Management Program-Project Management Office and the DENR-Comprehensive Agrarian Reform Program Secretariat. This was held at the Executive Plaza Hotel, along Mabini Street, Malate, Manila. According to the author, the article does not necessarily represent the views of NAMRIA or LMB.

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which underpins and sustains national, regional, and local socioeconomic development and decision making."

In order to attain this vision, the mission should be, ***"to ensure the availability of an efficient and modern national geodetic infrastructure that will allow accessibility to quality geodetic data and information which will facilitate consistent integration of all surveys and maps."***

EO number 321 specifies, among others, a transition period for the adoption of PRS92 until the year 2010. With such a directive, a strategy must be planned in order to meet this deadline. This also means that the planning horizon should be within a medium term (i.e., CY 2005-2010). It is therefore imperative that a strategic goal be defined to conform to the said time-bounded Order. With reference to the issues and drivers mentioned earlier, the strategic goal can therefore be declared as, ***"a modern and complete geodetic infrastructure that provides a three-dimensional position of points, ensures efficient data and information management, increases understanding and ensures active participation of major stakeholders based on an accepted geodetic reference and on legal, institutional, and intellectual frameworks."***

With the recognition and declaration of PRS92 as one of the top priority programs under the Medium-Term Philippine Development Plan (FY 2005-2010), it is possible to attain the aforementioned goal. Such a condition, however, would greatly depend on the manner by which the infrastructure is conceived, communicated, and implemented by all the major stakeholders and beneficiaries and the amount/magnitude of resources that will be mobilized. Everyone should likewise take note and understand that the Order does not only call for the establishment of control points, but also the integration of all technical surveys and maps as well.

The PGI: Nature and Desired Outcomes

The Strategic Plan is expected to cover the development of the national geodetic infrastructure. The Plan should not only include the geodetic network *per se* but it must subsume the other related elements as enumerated herein. The implementation of PRS92 will no longer focus merely on the densification of geodetic control points and integration of surveys and maps but also on its appurtenant elements geared towards an improved geodetic service delivery to the public.

The PGI should comprise the six key elements briefly described below.

(a) Geodetic Network – Being the fundamental basis of the infrastructure, it must include the strengthening of the existing horizontal control network, the revitalization of the vertical and gravity networks, and the establishment of new and upgrading of selected primary tide stations.

(b) Reference Framework – The framework comprises the definition of the size and shape of the earth, geodetic datum and vertical datum, map projections, transformations between datums and projections, and the geoid model.

(c) Data and Associated Information – This element includes the field survey data/records, results of computations/adjustments, and information service delivery systems.

(d) Intellectual – This comprises the network design, methods and procedures on how to migrate from the existing geodetic system to the internationally recognized reference frame/system, and the knowledge base of professionals and users.

(e) Legal – This encompasses the legislative measures as the bases for the adoption of the infrastructure and relevant regulations, guidelines, standards, and technical specifications.

(f) Institutional – This involves the role and responsibilities of stakeholders, appropriate structure, functional and job analyses, capacity building, creation of prototypes, action planning, and other related organizational arrangements required to deliver the infrastructure.

The present definition of the PGN and the implementation of PRS92 do not include some aspects of item "**c**" and disregarded items from "**d**" to "**f**."

The PGI is envisioned to play a major role as the new utility for precise positioning on a real-time basis. It will facilitate easy and simple integration of previously disparate datasets and is expected to be an inherent part of a global datum and spatial infrastructure that will accommodate the effects of regional crustal deformation (geodynamics), as well as the measurement and monitoring of global changes in climate/temperature and sea levels.

Under the PGI, all positioning activities will be integrated into a common national datum. Geoid models will be developed to eliminate the artificial split of horizontal coordinates and elevations. A common vertical datum will be defined to meet the most precise vertical reference requirements of users. There will also be a higher emphasis on the maintenance of the first- and second-order base stations of the geodetic network, which is the fundamental element of the infrastructure.

High-quality receivers now have the capability to collect and integrate data from GPS, with the augmentation of the Galileo and Global Navigation Satellite System. Thus the major satellite-based positioning systems under the PGI will be these systems. Common user real-time kinematic broadcast systems, enabled by active geodetic stations, will be installed in selected priority strategic sites. Integration shall be made involving new and emerging satellite-based positioning units, such as GPS cell phones, watches, electronic maps, vehicle navigation fleet management, alarm systems, and other units used in monitoring animal and human movements.

Once the PGI is put in place, the role of the government will be to focus more on the management of and coordination through the geodetic reference infrastructure. Human resources will be developed at the highest level of knowledge and skill to achieve wide recognition. The user-community is foreseen to become much broader as it will involve the government, private, academic/research, and professional organizations/groups as contributors to the infrastructure. Their common objective must be to work in a coordinative interaction to optimize the benefits from individual actions. This is done through the creation of and compliance to international and national policies, standards, operating procedures, and strategic plans. The government sector shall be working with users to ensure that their business and service objectives are facilitated through timely delivery of any changes/modifications, upgrades, and refinements to the geodetic infrastructure.

Strategic Options

With a time frame of five years, the Strategic Plan shall be designed based on the six elements of the PGI. In order to define the medium-term objectives in a programmatic form, the PGI can be divided into five major components, such as: (a) Physical and Survey; (b) Data and Information Management; (c) Prototype; (d) Information, Education and Communication (IEC) ; and (e) Infrastructure Management. The details about these components are shown in **Table 1**.

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Upgrading...
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The component activities shown in the table are designed to address the issues mentioned earlier, consistent with the elements of the PGI.[3]

The implementation of the Strategic Plan will involve all major stakeholders from the government, private and academic/research sectors, and professional organizations/groups. The government agency with the primary responsibility is DENR. Two units of the department which play the major roles in geodetic survey works are NAMRIA and LMB, including the Lands Management Services (LMS) of the regional offices of DENR. The Field Network Survey Parties of the various regional offices under LMS will play a critical role in the implementation of the first and second components.

The private sector will be involved in the installation of physical markers and other facilities, as well as in field observations/measurements and adjustments. Selected players from the academic sector will be involved in the design of the reference framework and in the various, myriad, and significant research requirements for the infrastructure. The design of the most appropriate geodetic network shall also include the participation of the Mines and Geosciences Bureau (MGB) of DENR and PHIVOLCS under the Department of Science and Technology.

The local government units, down to the *barangay* level, should be actively involved. They may assume responsibility in the establishment and maintenance of the physical markers and facilities, and more importantly, in providing counterpart funds. Professional organizations or groups will take part in advocacy or IEC campaigns, technical and ethical standards, and quality assurance requirements for an efficient infrastructure.

Appropriate operational, administrative, and financial arrangements and incentives between and among the stakeholders shall be made and adopted to ensure that the required legal framework will be institutionalized to back up the attainment of the medium-term goal and objectives.

The most important stakeholders in this undertaking will be the Donors. With the limited financial resources of the government, outsourcing of funds and technical assistance becomes the necessary option. It is therefore imperative for the agency with primary responsibility to facilitate the outsourcing of funds from donor countries/agencies having interest in this area. Financial augmentation should likewise be made within DENR, i.e., NAMRIA, LMB/LMS, Forest Management Bureau (FMB)/Services, MGB, Parks and Wildlife Bureau, Coastal and Marine Management Office, Comprehensive Agrarian Reform Program-Secretariat, and other government-owned and -controlled agencies or corporations involved in positioning, surveying, mapping, and use of geographic information. Augmentation may also come in the form of collaboration with local and international research institutions and/or bodies implementing a worldwide geodetic campaign.

The development of the infrastructure will be implemented through the adoption of common prioritization approaches such as: (a) all at once,

Table 1. Particulars on the Five Major Components of PGI

COMPONENT	ACTIVITIES	OBJECTIVES	OUTCOMES
1. Physical and Survey	• Installation of physical markers and facilities • Measurement/ observation and recording • Maintenance of physical markers and facilities	To establish a modern and complete geodetic network and keep quality records of all measurements/ observations	A modern geodetic network and complete quality measurement/ observation records
2. Data and Information Management	• Data adjustment and analysis • Development and operation of Geodetic Network Information Systems (GNISs) • Improvement of data/information archival system as well as accessibility and dissemination mechanisms	To develop and institutionalize an efficient system for geodetic data and information management	An efficient system for data and information management
3. Prototype	• Execution of connection surveys • Derivation of local transformation and projection parameters, geoid, ellipsoid/spheroid • Integration of data and maps • Establishment of active geodetic stations • Development of On-line Positioning User Services (OPUS)	To test the efficiency of the prototype infrastructure with due regard to all elements	Sensible programs and policy recommendations
4. Information, Education, and Communication	• Information campaign • Education and training • Communication drive	To increase the awareness and achieve better understanding of all stakeholders about the role/value of and benefits from the infrastructure, and to professionalize the practice of geodetic surveying	Increase in awareness and better understanding of the infrastructure and an institutionalized Code of Ethics for all recognized practitioners
5. Infrastructure Management	• Planning and coordination • Monitoring and evaluation • Policy and standards development • Research and development	To ensure that activities are carried out efficiently and that component objectives and outcomes are achieved promptly	Infrastructure efficiently administered/ sustained and a well-developed Transition Plan

[3] *The timeframe, milestones, sub-activities, outputs, targets, budgetary requirements, as well as cost-benefit analysis were not included in this article due to space constraints.*

(b) phased by geographic region, (c) phased by program, and (d) on demand. The decision and management approach as to the most appropriate option to be adopted shall be clearly defined and discussed in detail under the Implementation Plan. Nonetheless, the execution of the most appropriate scheme shall depend greatly on the capacities of the government agencies concerned, the needs of the wider user community, and the anticipated risks.

Risk Factors and Management Interventions

The purpose of presenting this section is to identify the major risks associated with the implementation of the Strategic Plan. Risk factors and the corresponding management interventions are described in **Table 2**.

By and Beyond Year 2010

If options will be adopted by the year 2010, a modern and complete geodetic network is expected to have been in place; better data and information management schemes have already been established; and a law will have been passed and approved for the adoption of the appropriate reference framework, including policies and guidelines on data/map integration and real-time positioning. Fundamental datasets will have been integrated into the new reference framework and precise positions will have already included the vertical component. With the completion of the prototype on active geodetic stations, appropriate mechanisms and procedures may be drawn for nationwide installation and operation of at least 25 continuously operating reference stations. Stakeholders will have gained an understanding and increased their participation for the sustainability of the infrastructure. The *User Manual for Transformation/Conversion* will have become available nationwide. With the infrastructure efficiently administered, adequate standards and procedures as well as best practices will have been documented. Additional responsibilities of the government will have included network maintenance, data storage, electronic dissemination, spectrum management, among others.

Beyond the year 2010, it is anticipated that there will be more active participation and greater contributions by the wider user-community. Other thematic maps which have been integrated will have been easily made as tools and made

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Table 2. Risk Factors and Management Intervention[4]

RISK FACTOR	DESCRIPTION	MANAGEMENT INTERVENTION
1. Adequacy of Funding	• Significant risks to funding the development of the infrastructure include the changes in government policy and departmental priorities	• As a core service, document the benefits and deliver advice to the government to define the role/value of and benefits from the geodetic infrastructure • Outsourcing and getting counterpart funds
2. Adequacy of Human Resources	• Inadequacy of skilled staff to assess technologies and trends, develop new processes, as well as manage the infrastructure contributes to the failure of the infrastructure	• Formulate a human resources development policy and program that recognizes the skills required to manage the infrastructure • Outsourcing funds for human resource development wherever appropriate. • Pool existing local experts as consultants
3. Failure of Private Service Providers	• Failure to fulfill contracts of the private sector who will be involved in the implementation of the Plan; also their low productivity and failure to retain technical competency and to meet standards	• There should be accreditation of providers to ensure their financial viability and technical competency to carry out the work • Require providers to carry out professional and public-liability insurance • Develop performance monitoring and operate a contract management system
4. Organizational Failure	• The lead agency is expected to successfully manage the infrastructure through technical development and design, standard setting, purchasing of data or service providers, and quality control. Failure in these areas will create risks in terms of level, quality, and appropriateness of the infrastructure that will be developed.	• Develop audit standards and policies to ensure appropriate requirements • Initiate independent reviews of the infrastructure to ensure that user requirements are met • Develop the structure, processes, and skills to ensure required capacity of the lead agency and other collaborating players
5. Technological Failure	• Computer technology and satellite-based positioning make up the significant drivers for the development of the new infrastructure. Risks may come in the form of the failure of the satellite-based positioning system, replacement of the existing technologies by new ones that cannot be accommodated in the system, and technical malfunctions in data management.	• Develop a system that is technology-independent • Keep abreast of new technologies and implement policies and standard operating procedures to ensure their accommodation in the current system • Search, study, and implement/adopt alternative technological augmentation strategies
6. Legal/Policy Failure	• The development of the infrastructure requires legislation and policy directives for adoption of the upgraded reference framework. Without the law and the necessary policy issuances, the PGI will not gain nationwide recognition by all sectors affected.	• Ensure that the required legislation is passed and policy directives are adequately provided • Specific guidelines should be issued to manage the impact of the new reference framework on the existing titling and registration system
7. Users' Knowledge, Responsive-ness, and Acceptability	• The development of the infrastructure is based on the assumption that the user community will adopt it. The risk may include the non-utilization of the new and upgraded system and the continuance of the use and maintenance of the old incompatible framework, technology, and legacy systems.	• Create and solicit greater user inputs to ensure that appropriate infrastructure is developed to meet their needs. • Educate users to ensure that they understand the role/value of and benefits from the new infrastructure.
8. Availability and Reliability of Baseline Data for Network Design	• The design of the most appropriate horizontal and vertical control networks will depend on the availability and reliability of baseline data. Failure to recover old geodetic control points will have a negative impact on the design of the new geodetic network.	• Incorporate in the program a massive monument recovery campaign involving old geodetic control points • Thorough assessment of reliability/quality of recovered points • Involve the survey and mapping practitioners, especially those who are engaged in geodetic surveying
9. Appropriate Organizational Structure	• The implementation of the project as well as the management of the new infrastructure require a sound organizational set up. Without the proper structure, the goal and objectives may not be achieved.	• Design and organize a core group composed of competent managers and technical staff (from the central, regional, and field units) to manage the infrastructure • The structure should facilitate smooth vertical and horizontal coordination among all units including other major players and users
10. Sustainability of the PGI	• The development of the new infrastructure is not an end by itself but a continuing process of delivery of services and maintenance of the system. Without viable strategies on infrastructure sustainability, all efforts will become futile.	• Develop a policy strategy to ensure sustainability of the PGI • A well-conceived Transition Plan should be well-documented at the earliest opportunity and made a part of the public advocacy or IEC campaign.

[4]*Author's note: Risk factors are not arranged chronologically.*

News

The Geodetic Engineers of the Philippines (GEP), Incorporated held its 31st Annual National Directorate Meeting and Convention which had for its theme "Re-engineering the Philippine Land Administration and Management System towards a Strong Republic" at the Tagaytay International Convention Center in Tagaytay City on 16-18 June 2005. Shown in this photo is the ceremonial ribbon-cutting for the Geomatics Exposition 2005, a parallel event. This was led by DENR Undersecretary Manuel D. Gerochi and NAMRIA Administrator Diony A. Ventura. Looking on are Engr. Pedro Noble (in pink shirt), Regional Technical Director, LMS, DENR-Region V; Engr. Alfredo D. Antonio (in blue shirt), GEP National President; Engr. Benjamin Mindajao (in gray shirt), Member, Professional Regulatory Board for Geodetic Engineering, Professional Regulation Commission; Engr. Restituto Bautista (in white shirt), past National President, GEP; and Engr. Randolf S. Vicente, NAMRIA Plans and Operations Chief, GEP National Public Relations Officer, and Convention Chairman (extreme right).✦

PRS92 task group undertakes pilot project

by Nicandro P. Parayno[2]

The NAMRIA PRS92 technical working group on research, development, and extension chaired by Mapping Department Director Jose Galo P. Isada, Jr. conducted last December a pilot project in the municipalities of Bacarra and Pasuquin in Ilocos Norte. The activity aimed to determine the local/regional transformation parameters to integrate survey and maps to PRS92.

The pilot project involved four major activities, namely: (1) Densification, (2) Data gathering, (3) Reconnaissance and recovery survey, and (4) Re-observation and establishment of new positions for cadastral project controls in PRS92.

Preliminary cadastral data were gathered from the Land Management Sector office of DENR Region I in San Fernando, La Union. The gathered information included a municipal boundary index map, a municipal index control map, and project control description sheets with coordinates in the old system of Bureau of Lands Location Monuments, Municipal Boundary Monuments, and *Barangay* Boundary Monuments for Bacarra and Pasuquin. Together with large-scale planimetric maps from NAMRIA, the information were used in identifying controls and locating possible sites for the recovery survey as initial assessment of the selected pilot area.

During the conduct of the recovery survey of cadastral project controls for the pilot sites, a sufficient number of well-distributed control monuments were chosen from the municipal index control map to determine the true relationship between the local and the PRS92-related global datum. The number, distribution, and stability of the recovered points and the adopted transformation technique determined the achievable accuracy of the local transformation. The activity was undertaken in coordination with the respective DENR provincial and community ENR local offices. Their assistance fast-tracked the recovery survey especially on points that were already disturbed and were difficult to locate.

With the availability of recovered controls, new positions in PRS92 were obtained using high-accuracy survey grade GPS equipment. The static method was used with an observation time of 15 minutes per point with more than six satellites available. Global datum positions were attained at third order accuracy for the local datum recovered points and the local survey network recomputed in terms of the global datum.

Initial results of the pilot project show that consistent relative shifting in coordinates based on the old reference system occurs with an average magnitude of 2 and 20 meters, with respect to easting and northing. An initial set of local transformation parameters for the area was also computed and used for the remaining project controls. The latter were not recovered and served as "check points." An additional set of cadastral project controls was recovered and observed on 19 April 2005. The second set will be used to compute for the final transformation parameters applicable for the area.

The process adopted and the initial result of the pilot project were presented during the training on "Data Transformation, Survey, and Map Integration to PRS92," which was conducted on 23-25 May 2005.✦

[2]*Engineer IV, Photogrammetry Division, Mapping Department*

EPS for management of environmental data

by Jaime P. Mallare[1]

NAMRIA and the Environmental Management Bureau (EMB) of DENR, Region III, have forged a partnership to develop an Environmental Profiling System (EPS) for the region. The undertaking is in support of the bureau's effort to actively pursue sustained and systematic environmental governance to guarantee a clean and healthy environment for the Central Luzon Region.

The EPS is envisioned to provide a facility for the efficient management of environmental data and an effective statistical system at the EMB regional office. The EPS will provide adequate data support for decision making and policy formulation. It is designed to organize the tremendous amount of data that is being generated by the current system in the region. This will make data presentation simple and coherent to users within and outside DENR.

The project focuses on the formulation of a GIS-based environmental profile for Region III. It will utilize the data gathered from the processing of Environmental Compliance Certificate applications under the Environmental Impact Statement System, air- and water-quality monitoring activities, solid-waste management, and monitoring of toxic and hazardous materials. The system will also provide tools and utilities for the delineation of airshed areas.

The project has already completed the mapping and plotting of Environmentally Critical Areas, solid-waste management sites, and other different thematic maps such as those dealing with air and water quality and airshed areas.

A series of on-the-job-trainings was also conducted for EMB Region III personnel. The trainees, using their own data, got firsthand experience of the concepts of GIS and in the process built their own geographical databases. They were also able to design and develop the linkage between GIS and the database management system.

A major long-term goal of the project is to institutionalize the EPS. This requires recruiting more agency partners and publishing environmental plans on the Web using GIS. Other long-term goals include increasing Internet usage for building up and publishing planning and EMB documents, collaborating with constituents, increasing partnerships with other environmental organizations, and modernizing environmental data management to support interactive access while maintaining traditional paper outputs.

The institutionalization of the EPS within EMB promises to change the way the bureau uses GIS in support of environmental planning and management. The EPS is envisioned to foster the government-to-government and government-to-citizen data and services interchange. This happens to be the critical component of the management plan of the present administration.*

NAMRIA-JICA ENC project completed

by Alberto B. Sta. Ana[2]

The NAMRIA-Japan International Cooperation Agency (JICA) Electronic Navigational Chart (ENC) Project was completed on 14 June 2005. The Japanese Government grant-in-aid project which started in year 2000 was aimed at modernizing nautical charting in the Philippines through the development of ENCs. The ENCs supplement the tools for safe navigation used by mariners.

The project produced four published small-scale and six published large-scale ENCs. The small-scale ENCs cover Central Mindanao, Central Visayas, Northern Luzon, and the Sulu Sea area. The large-scale ENCs cover Batangas Harbor, Cebu Harbor, Manila Harbor, Manila to Cavite, Port Olongapo and its vicinity, and Subic Bay. All cited ENCs have already been updated except for Batangas Harbor, Cebu Harbor, Port Olongapo and its vicinity, and Subic Bay. Chart features such as aids and dangers to navigation, changes in coastline, and conditions affecting safe navigation were validated as to their existence and the correctness of their geographic coordinates.

Awareness seminars on ENC for stakeholders were also conducted in Batangas, Cebu, Manila, and Subic. Each seminar featured an actual demonstration of the ENC technology onboard a motor launch. Attendees were mostly from the academe, fishing industries, government agencies, shipping lines, and yacht owners. NAMRIA also provided lectures on ENC upon the request of the Philippine Coast Guard and the Philippine Navy.

During the five-year period, JICA facilitated the transfer of technology by providing hardware and software, personnel training, and technical experts to establish and develop an ENC system in NAMRIA.

The project acquired for NAMRIA a plotter and a scanner, computers, GPS receivers, printers, SevenCs software package, a dKart Inspector, and GPS- processing software. The SevenCs software package consisted of five modules for ENC-compilation, quality assurance, and creating and testing an exchange set on an Electronic Chart Display Information System format; while the dKart Inspector was for independent quality assurance.

Japanese experts provided technical assistance to the project. They conducted an in-house training for NAMRIA technical staff, some of whom were also sent to Japan for trainings in hydrographic survey, ENC management, and ENC production. NAMRIA and JICA personnel also visited the hydrographic offices of Australia, Indonesia, Japan, Malaysia, Singapore, and South Korea to exchange ideas and information on the respective experiences in ENC production of these countries.

The original time frame for the project was three years, from June 2000 to June 2003. Six months before it ended, a Japan Evaluation Mission Team was dispatched to assess the status and progess of the project. Members of the team together with their NAMRIA counterparts recommended a two-year extension, from June 2003 to June 2005, to complete all the target outputs of the project.*

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Updates on the Standard Seamless Digital Topographic Database

by Ma. Mercedes M. Manoos[1]

Workshop held at Sulô Hotel in December 2004

Now one year in operation, the technical working group (TWG) on standard seamless digital topographic database is continuing with its efforts to promote the need for standardization in the creation of digital topographic databases. The need for standardization and the creation of the TWG came about as a result of the following reasons: (a) Unreliability of data sources; (b) Problems on positional accuracy; (c) Non-standard parameters for transformation, conversion, and projection; (d) Use of different software and platforms; (e) Proliferation of base maps; (f) Difficulties in geo-referencing and/or rubber sheeting of digital raster graphics; and (g) Difficulties in creating a "seamless" digital topographic database. The creation of the TWG on 07 May 2004 was spearheaded by the NAMRIA Information Management Department (IMD).

The TWG has the following tasks: (a) to evaluate and review the features and performance of software packages used by various NAMRIA departments, in terms of addressing the issues on the creation of a seamless database for 1:50,000-scale topographic maps; (b) to validate findings and existing procedures on the creation of a seamless database for 1:50,000-scale topographic maps documented by various NAMRIA departments, and make appropriate recommendations; (c) to formulate and recommend standards, guidelines, and policies based on validated findings and procedures for adoption by all NAMRIA departments in the generation of digital spatial data; and (d) to conduct IEC and consultation activities in relation to the formulated standards and policies.

The TWG has so far conducted 11 meetings and 4 workshops. All of the technical meetings and workshops were held in NAMRIA except the last workshop which was held at Sulô Hotel. This workshop held on 16 December 2004 served as a consultation assembly with the GIS community or users of geographic information, both in government and private sectors with the members of the IATFGI making up most of the participants. In this workshop, the draft Administrative Order (AO) prescribing the *Guidelines for the Creation of a Standard Seamless Digital Topographic Database from 1:50,000-Scale Topographic Maps* was thoroughly discussed. The draft Volume I of the *Manual of Standards for the Creation of a Seamless Digital Topographic Database* was also distributed to the participants for review. Further revisions on the AO and the manual are being continually made by the TWG through weekly meetings in time for their approval within this year.

Documentation of findings on evaluating the different georeferencing procedures of concerned NAMRIA departments was also completed by the TWG last year. Actual ground validation of georeferenced maps was postponed, however, due to time and budgetary constraints.

The TWG is chaired by Plans and Operations Division (POD) Chief, Randolf S. Vicente and co-chaired by Database Management Division(DMD)/IMD Chief, Bobby A. Crisostomo. Its members are composed of representatives from the departments of Coast and Geodetic Survey, Information Management, Mapping, Remote Sensing and Resource Data Analysis; the Development Studies and Standards Office; and the POD. The DMD/IMD acts as TWG secretariat.

Tide Stations...

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Future Visions

Indeed there are very important benefits to operating additional tide stations considering the archipelagic nature of the Philippines. Tide gauge data is very important not only for hydrography but for other areas of research and more importantly in support of technical and scientific applications.

Operating additional tide stations, moreover, is very timely in the light of the recent Indian Ocean tsunami tragedy. It will be for the benefit of the country if we will be able to establish more tide gauge-telemetry systems as part of the PTWC network in the Pacific. In the eastern Philippine side, the tide stations in Sta. Ana in Cagayan and Surigao City would be very strategic parts of the PTWC network. Also it will be to our advantage if a tide station can be established at Borongan in Samar and along the eastern Mindanao side possibly in Bislig. Providing telemetry systems for the tide stations in Davao City and Zamboanga will be valuable to address tidal issues in the southern part of the Philippines. The San Fernando and San Jose tide stations will likewise be very important for the western Philippine side and the western side of Palawan.

Lastly, the additional tide stations established will play a very vital role in the implementation of the new Philippine reference system (PRS92) for the vertical component requirement of our geodetic control network. Comprehensive tidal information would be required as an input in developing a more appropriate geoid model for the Philippines.

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The Significance of Forest Cover Statistics

by Elpidio B. Gelera Jr.[1]

The Philippines is geographically located within a typhoon belt. For this reason, it is susceptible to weather- and water-related disasters such as the Ormoc Flood in 1991 and the recent inundation in Nueva Ecija caused by Typhoon "Winnie." These and similar occurrences have claimed countless lives and properties. "*Force majeure*"… "fortuitous event"... "act of God"… are phrases used to describe these destructive natural phenomena, which are implied as being beyond the capability of man to prevent or control. Nonetheless, every time one of these calamities occurs, people are quick to blame the government. In particular, DENR is the usual scapegoat of people who are quick to point to its supposed failure to protect our forests. The positive implication of this kind of thinking is the awareness of people as to how essential the forest trees are in maintaining the ecological balance. Nevertheless, the people should still be properly informed that the government does not close its eyes on the matter.

For effective planning, and sustainable development and management of the forestry sector, it is important to have a reliable set of forest cover data as basis. The last nationwide forest resources inventory in the Philippines was conducted through the RP-German Forest Resources Inventory (FRI) Project of the DENR FMB from 1982 to 1988. The project revealed an estimated forest cover of the country of 6.46 million hectares or 21.5 percent of the total land area covering both forestlands and Alienable and Disposable (A & D) lands. Considering, however, the significant changes that had already taken place from 1988 to 2003, these data are now deemed impractical since they no longer reflect the present condition of the country's forests. Recognizing the pressing need for an updated forest inventory, former DENR Secretary Elisea G. Gozun directed FMB and NAMRIA to undertake a joint project utilizing the LANDSAT ETM images of 2002 and 2003 acquired by NAMRIA through a National Commission of Indigenous Peoples-related project.

The Forest Cover Statistics Project started in the latter part of 2003 with FMB assuming the responsibility of modifying the National FRI forest categories into new classifications, taking into consideration international forest resources definitions and data reporting. NAMRIA, on the other hand, was tasked to undertake image interpretation, mapping, and statistics generations. The area estimation was based on the interpretation of a total of 40 satellite scenes covering the entire country and mostly taken in 2002 and 2003. Maps for the 16 administrative regions involving 79 provinces and the National Capital Region (NCR) were prepared showing the forest cover at the time the satellite imageries were taken. They consist of 79 provincial land cover maps.

The activities involved in this endeavor include acquisition of LANDSAT ETM images, a consultative meeting between FMB and NAMRIA, geo-referencing, image processing, scanning and digitization of different thematic maps, image interpretations, preliminary mapping, statistics generation, accuracy assessment, map editing, and map layouting with the final map layout prepared at 1:100,000 scale.

The result, reflected in **Table 1**, is the total forest area estimated at 7.17 million hectares or 24 % of the total land area of the country which is 30 million hectares.

As shown in the table, about 6.5 million hectares or 22% of the total land area are found in forestlands while 646,817 million or 2.19% are located in A & D lands. The open forest in the forestland is the largest in terms of area accounting for 3.6 million hectares or 12.12% of the total land area. Second largest is the closed forest at 2.5 million hectares or 8.45%. In a broad context, a *closed forest* is a formation where trees cover more than 40% of the ground and do not have a continuous dense grass layer and may have been logged over one or more times. These are actually the areas logged over by timber license agreement holders including those portions that were affected by timber poaching. An *open forest* is a formation with discontinuous tree layers having a coverage area of at least 10% and less than 40% which is either managed or unmanaged. Included are forest areas that have not been logged over and logged-over areas with vegetation that have reached the *closed canopy stage*. A forest has attained this stage when the treetops or crowns are in close contact, creating a shaded forest interior.

The forested area in A & D lands accounts for 646,849 hectares or 2.19%. Under A & D lands, the open forest comprises the largest at 452,055 hectares or 1.53% while the closed forest covers 65,039 hectares. These areas could be former forestlands that have been classified as A & D lands, with some parts subjected to logging due to the presence of timber licensees in the 1970s. *Mangrove forests* refer to communities of trees thriving in mangrove areas. In 1988, mangrove forests were estimated at 139,100 hectares while in 2003, they covered 247,362 hectares. There is an increase of mangrove forest cover of 78% from 1988 to 2003. The increase may be attributed to reforestation efforts and the policy of banning the cutting of mangrove species. Plantation forests are products of reforestations and other tree-planting activities. They account for 281,764 hectares in forestland and 47,814 hectares in A & D lands or 0.95% and 0.16% of the total forest area, respectively.

...continued on next page

Forest Type	Forest Area			
	Forestland		A & D	
	Area	% to Total Land Area	Area	% to Total Land Area
Total	6,521,548	22.08	646,852	2.19
Closed Forest	2,495,833	8.45	65,039	0.22
Open Forest	3,578,526	12.12	452,062	1.53
Mangrove	165,425	0.56	81,937	0.28
Plantation	281,764	0.95	47,814	0.16

Table 1. *Forest area (in hectares) by land classification*

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The Significance...
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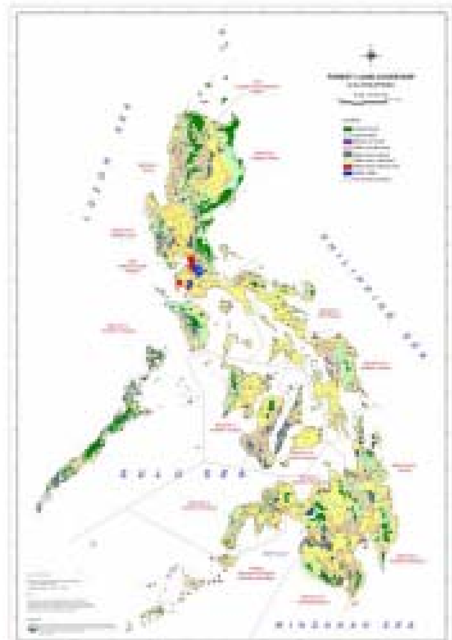
As analyzed by the Remote Sensing and Resource Data Analysis Department, there was an increase in the total forest area from 6.46 million hectares in 1988 to 7.17 million hectares in 2003 or an increment of about 700,000 hectares or 11%. This is an increase of forest area of 47,000 hectares per year from 1988 to 2003. It is worth noting that the increase can be attributed to the development of forests in A & D lands which accounts for 77% of the total increase in forest area. In addition, the logging moratorium in several areas of the country and the intensive forest protection program involving the participation of the people resulted in the preservation of the existing forests. The involvement of the communities and the private sector in protecting their lands is a contributory factor in the preservation of the natural forests, as confirmed by the figures showing that 70% of the forest area in A & D lands is open forest.

The increase in forest cover as compared to the result of the last forest inventory is a positive sign in the government's efforts to rejuvenate our forests. We, however, also have to consider the fact that the reported rate of deforestation in the Philippines is about 1.4% annually. If this trend continues, it is estimated that all virgin forests will disappear by the year 2010 (*Encarta Reference Library*, 2004). With only a little forest area left, the country could be likened to a kingdom without a fortress. It would be vulnerable to the arrows of heavy monsoon rains and the barrage of tidal waves on its shores. Soil erosion and flooding may consequently occur which is why it is important that our existing forests should be maintained and protected. Permanent forest



Map showing the present forest cover of the Philippines

boundaries should also be established so that activities in these areas can be well regulated and illegal logging could be minimized, if not prevented.

The proper implementation of laws in protecting our remaining forests complements the endeavors extended to restore and increase the remaining forest. Success in the cause of forest protection can be achieved with everyone's strict adherence to the relevant rules and regulations. The vigilance of the community is also very much required. All sectors need to work hand in hand.•

Upgrading...
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available. As the establishment of other active geodetic stations progresses, the need for ground markers will have become progressively less. The synergy of global positioning and communications technology will have made this facility possible. The ability to precisely locate a position in a three-dimensional aspect will then be as easy as telling the time. The infrastructure will thus become an intrinsic part of a global geodetic network and a solution to worldwide changes and challenges.

What lies ahead is the decision of whether to go "geocentric" or to adopt a new "geodetic" datum, say, *PGI2010*. Ideas and options addressing these future challenges should be incorporated in the Transition Plan.•

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