Info mapper

A Publication on Surveys, Mapping, and Resource Information Technology

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# PHILIPPINE GEODETIC SURVEYING

## towards the Next Millennium


*Detail of Philippine map showing some of the geodetic control points or stations (red triangles) forming the Philippine Reference System of 1992.*

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## EDITORIAL

Very minimal to say the least is the current general level of awareness as regards geodetic surveying in the Philippines. Thus this issue of the *Infomapper* seeks mainly to introduce this significant field of surveying and to bring to the fore the role it plays in laying the crucial groundwork for the development programs of the government.

Geodetic surveying in the Philippines relies a great deal for its advancement on cooperative ventures with international/regional institutions, as well as private entities involved in surveying techniques, for updated technical knowledge and material aid.

The positive result of this is that the Philippines now enjoys a fairly significant level of progress in the conduct of geodetic surveys.

A notable example is the new geodetic control network known as Philippine Reference System 1992, which NAMRIA established with the use of state-of-the-art satellite surveying technology, the Global Positioning System (GPS). The new network was made possible through the geodetic survey component of the DENR Natural Resources Management and Development Project, with the assistance of the Australian government.

The agency is also set to implement the project on the establishment of an Integrated Geospatial Referencing Facility with foreign funding and technical support. The facility will consist of 15 continuously operating reference stations for GPS users.

Lack of financial and technical resources to jump-start noble objectives are Philippine realities that cannot be denied. Hopefully, the day will come when relevant projects on geodetic surveying, for example, will no longer bear the accompanying labels "foreign-assisted," "foreign-funded."

The Philippines still has a lot to catch up on to approximate the advancements in geodetic surveying of other countries. In terms of scientific researches, for example, it would be to the greater benefit of the nation to have more studies on unexplored areas in geodetic surveying, such as those on local geoid modeling. These researches are preferably those which the government should initiate by itself, or sponsor to ensure that the data gathered stays with us for our use rather than abroad with the project organizer or funding source. It would not hurt the nation to apportion part of its resources to this worthy undertaking. Support from the private sector is certainly just as welcome.

Other pressing concerns to further the development of geodetic surveying in the country include the need for greater access among geodetic surveying practitioners to relevant technology such as GPS which is very useful but quite expensive. Then there is the need for more locally-sponsored scholarships abroad. Incidentally, Philippine scholars would surely appreciate an updated school curriculum for geodetic engineering to avoid their having to take up in later training activities pertinent courses they could have taken up in school.

The country's own geodetic engineers and surveyors should themselves be credited for their concerted efforts to promote in the country the acquisition and application of technical and general knowledge on the relevant fields of land surveying and geomatics. The Circle of NAMRIA Geodetic Engineers, in particular, is the latest addition to the significant roster of nationwide groups of geodetic engineers of the Philippines. Among its foremost objectives at present is to work for the amendment of certain provisions of the implementing rules and regulations of Republic Act number 8560, or the new Geodetic Engineering Law. For one, the group deems that the law should provide for an appropriate mechanism for junior geodetic engineers to complete their Bachelor of Science degree.

Every new year affords especially the world's leaders with the opportunity to overcome all obstacles and really make things right, if not for this generation then for the next. The country's present administration gets this same opportunity as it enters its second year.

As one of the government offices tasked to work for the nation's development, NAMRIA is making use of whatever resources are available to do its share for the nation's development through, for example, better land surveys and map production. If and when its long pending modernization becomes a reality, the agency can do a lot more being in a much better position, equipment- and knowledgewise, "to help itself."

Infomapper

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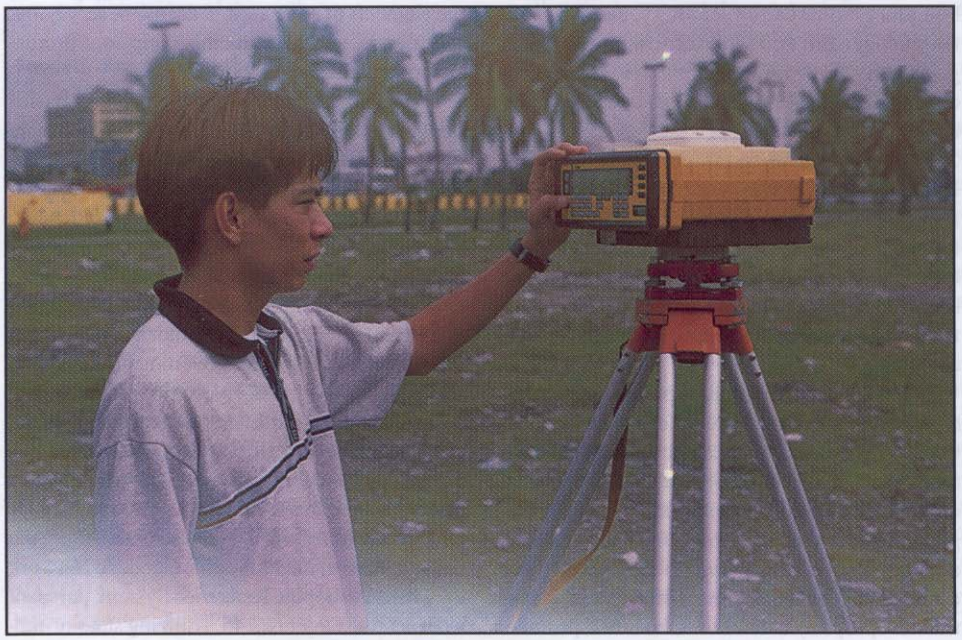
# Geodetic Surveying at a Glance

by Xenia R. Andres

*Surveying is a fundamental step to many human activities. It is a means of planning and laying out projects; preparing maps and plot plans in order to economize construction and effect cooperation; laying out industrial equipment; charting coastlines, navigable streams and lakes; and most of all, determining the property's area and the location of its boundaries. These are just a few examples of how geodetic surveying can help our life. It is but important to know more about it.*



*Operator switches on a Global Positioning System receiver.*

### Plane and Geodetic Surveying

Generally, surveys are classified into plane and geodetic. Plane surveying is that type of surveying in which the earth is considered to be a flat surface, and where distances and areas involved are of limited extent (less than about 10 square kilometers or 3.86 square miles) that the exact shape of the earth is disregarded. On the other hand, geodetic surveying is concerned with surveys of wide extent and large areas that take into account the spheroidal shape of the earth. These surveys require a high degree of precision and accuracy and are usually conducted by government agencies. Geodetic surveying provides control points to which other small surveys can be supported or connected.

### Geodesy as the Theoretical Foundation of Surveying

Surveying is based on the theoretical concepts of geodesy, the study of the size and shape of the earth and its gravity field. This is where geodetic surveying got its name mainly because this discipline deals with the measurement and representation of the earth, including its gravity field, in a three-dimensional and time-varying space.

Geodetic history began in ancient Greece, during the time of Thales of Miletus who philosophically thought that the earth was a disk-like body floating on an infinite ocean. Anaximander, another ancient philosopher, believed that the earth was cylindrical, with the axis oriented in the east-west direction. Many great thinkers during the ancient times tried to put forward their own views: that the earth floated on a finite, circumferential ocean and was held in space by compressed air; that the universe centered on *Hestia* or the central fire; and that the sun and the moon have diurnal motions. Among these thinkers, it is only Eratosthenes who can be properly called as the founder of geodesy because he was the first to determine the spherical earth's size by measuring the latitude difference between Alexandria and Aswan.

Somehow, philosophy and theology clouded the medieval era and little was known about the development of geodesy. The battle between reason and divine wisdom continued until the early 1600s when geodetic interests were renewed. Thereupon, Copernicus published his heliocentric theory; Leonardo da Vinci suggested the probability of **isostasy***; and Galileo formulated the first mechanical laws. Methods of experiments were also improved thereby making a progress in theories and hypotheses.

Algorithms and applications of triangulation to arc measurement were also introduced. Later on came the theory of gravity, differential and integral calculus, and the standardization of lengths.

The modern era saw the influx of technology, which revolutionized and opened many possibilities for geodesy. The invention of radio detection and ranging system (radar), electronic computers, electromagnetic distance measuring devices and artificial satellites only hastened the art of geodetic positioning. Surely, the development of microelectronics, acceleration sensing and direction-seeking devices as well as inertial navigation and positioning systems would moreover pave the way for the expansion of geodesy and its concepts.

As one sees, just as amino acids are the building blocks of proteins, mathematics, physics and computer science are the building blocks of geodesy.

Mathematical concepts, most especially those of algebra, analysis, geometry and statistics, are widely used in geodesy. As such, it is the firmest foundation of this discipline. Gravity gives importance to physics since gravity is the geometry of the space in which most geodetic observations are taken. And finally, computer systems that are useful in computing and analyzing data can only be taught through computer science.

Nonetheless, the theory of the propagation of electromagnetic waves, mechanics, **acoustics***, and the mechanics of **continuum*** and **rheology*** should also be considered.

*Editors' note: A term in bold type and marked with an asterisk (*) is defined in the Glossary of terms on page 16.*

### The Services of Geodetic Surveying

Principally, geodetic surveying is used for mapping or map-making purposes. We all know how essential maps are in the planning and design of construction projects, disaster prevention, relief operation, land survey and evaluation and many others. Maps are the bases for all types of special plans.

Other areas where the principles of geodetic surveying are employed include urban management, engineering projects, boundary demarcation, ecology, environmental management and land information system, geography, hydrography, space science, geology, **geophysics***, astronomy, oceanography and atmospheric science.

Very critical and important is the establishment of boundaries, whether international or intra-national. Many wars, for example, are fought over the possession and control of territory. The positioning and staking out of these boundaries are related to a geodetic network—a framework of points with known horizontal coordinates.

The locations of land-parcel based environmental data banks are likewise defined in terms of coordinates. These coordinates in turn are referred to a geodetic network. Environmental data banks give rise to benefits, serving as integrated information systems for, among others, demographic analysis, land-based taxes, land ownership records, land-use management, valuation and property assessment, and the optimization and management of social services.

Furthermore, by means of geodetic surveying, satellite tracking stations can be located, and the geometry of the earth's external gravity field determined for predicting the orbits of space vehicles.

Indeed, from mapping to navigation, conventional construction, physical and biological sciences, down to human and cultural resources; geodetic surveying continues to prove its worth both as a science and an art.

### Geodetic Practice and Profession

Aside from using a variety of measuring techniques and systems, geodetic practice requires geodetic professionals and technicians. As such, a true geodetic profession should possess the elements of education, a license in surveying, experience, and also membership in a professional organization.

Geodetic surveying therefore calls for honorable and dignified men and women who observe the highest standard of fairness, trustworthiness and honesty in the practice of their profession as embodied by their Code of Ethics.

### NAMRIA — The Government's Arm

In the Philippines, the National Mapping and Resource Information Authority (NAMRIA) is the principal arm of the government in geodetic surveying through its Hydrographic and Geodetic Surveys Department (formerly the Bureau of Coast and Geodetic Surveys). In this regard, the agency continues to provide geodetic controls that are used as basic references for land surveys and production of maps. It is also undertaking the densification of the Philippine Geodetic Network known as Philippine Reference System, pursuant to Executive Order No. 45. Utilizing state-of-the-art global positioning technology, this project aims to expedite the establishment of geodetic controls which also serve as basic reference points for geographic positions and elevations for various surveying, mapping, and engineering activities.

As a result, NAMRIA has continuously collected, stored and updated in its geodetic archives various information regarding geodetic stations throughout the country. The information gathered can be retrieved automatically for issuance to the public.

With geodetic surveying attaining modern dimensions, facing new tasks and furnished with the latest techniques and tools, the agency hopes to contribute more towards the country's development and security.

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*Surveyors calibrate their instrument prior to geodetic leveling work.*

# Geodetic Surveying Activities in NAMRIA and Their Relevance to National Development

by Engr. Randolf S. Vicente; DLUP, MSRS[1]

The conduct of geodetic surveys is part of the mandated functions of NAMRIA. This article aims to discuss the various geodetic surveying activities of the agency and their significance to national development. Among the topics included are the antecedents of geodetic surveying in the Philippines.

*Geodetic surveying is the branch of surveying in which the size and shape of the earth's surface is taken into consideration. It is distinguished from plane surveying by the fact that it takes into account the earth's curvature, usually necessitated by the large distances or areas covered. On the other hand, plane surveying is that branch of surveying in which the surface of the earth is considered a plane surface. The work under geodetic surveying requires the utmost refinement of methods and instruments: first, because allowing for the curvature of the earth is in itself a refinement; second, because small measurements have to be greatly expanded; third, because the magnitude of the work involves an accumulation of errors.*

The primary objective of geodetic surveying is to establish a basic geodetic control network that serves as the framework of all kinds of surveying and mapping. This framework shall also serve as the foundation for all mapping and charting activities including research.

The coordinates of points established through geodetic surveys are computed from certain initial datums (basic reference points). These include the horizontal datum which forms the basis for the computation of horizontal control surveys in which the earth's curvature is considered, and the vertical datum (or a geoid) to which elevations are referred.

There are two types of geodetic controls, namely, the horizontal and vertical controls. Horizontal controls are points with established geodetic (geographic) latitude and longitude while vertical controls provide elevation measurements above established **datum planes***. Horizontal and vertical controls are referred to an established geodetic datum. A geodetic datum of a country or region consists of five (5) elements, namely: (a) latitude of the first point; (b) longitude of the first point; (c) azimuth from the first point to the second point that defines the direction of the starting baseline (it may include the distance); (d) the **equatorial radius***; and (e) **polar radius*** of the adopted **ellipsoid***.

Traditionally, the fundamental operations of geodetic surveying are triangulation and precise leveling. These in turn require the determination of time, latitude, and azimuth; the determination of mean sea level; and knowledge of the figure and dimensions of the earth.

## Geodetic Surveying in the Philippines

The establishment of geodetic controls in the Philippines had its early beginnings since the transfer of sovereignty from Spain to the United States on September 10, 1898, by virtue of the Treaty of Paris. However, surveys made during that time were mostly approximations giving rise to uncertainties and problems, wherein descriptions made on land surveys could not very well satisfy the changing requirements of economic development. There were so many systems and the need for standards had already been recognized.

Extensive geodetic surveying in the country began in 1901 with the establishment of the Manila Field Station by the former United States Coast and Geodetic Survey (USCGS), the predecessor of the Bureau of Coast and Geodetic Survey (BCGS), which later became part of NAMRIA. The USCGS established the triangulation network of the Philippines using the Luzon datum as the reference. This datum is defined as the datum origin located in Marinduque by the geographic coordinates of the triangulation station "Balanacan." These coordinates are: latitude equal to 13° 33' 41.000"N, and longitude equal to 121° 52' 03.000"E. The azimuth from station Balanacan to triangulation station "Baltazar" (second point) is 9° 12' 37.000" and the distance is 37,680.90 meters. The back azimuth is 189° 11' 50.60" . The standard spheroid of the network is the Clarke's Spheroid of 1866 where the equatorial radius is 6,378,206.4 meters while the polar radius is 6,356,583.8 meters. The Balanacan-Baltazar line served as the initial baseline of all triangulation networks extensively established to all directions of the country spaced about 20 to 60 kilometers apart.

As a starting point of a geodetic datum, the latitude and longitude of the first point were observed astronomically using precise methods and instruments to obtain first-order precision. The azimuth of the line was also observed astronomically and its length was measured by first-order method.

In general, triangulation was confined to a relatively narrow strip of land along the coasts, as movement into the interior was quite difficult due to the rough and heavily timbered terrain and the lack of roads and trails. The matter of carrying out a general scheme of relatively large figures covering the full length of the archipelago, and from shore to shore across the channels was decided upon early. The arcs were established as chains of quadrilaterals or central-point figures so that the lengths of the sides can be computed through at least two different routes. This coordinating scheme of triangulation was needed to consolidate all of Philippine mapping.

Aside from triangulation, other methods of surveying were used. One was by "trilateration" wherein all sides of a triangle were measured. This method was adaptable in places where the use of the conventional instruments of triangulation would not be advantageous. The specification for attaining the required standards was more rigid in distance measurements.

Another approach was by traverse surveys, in case the method of triangulation did not warrant an economical means of providing the required control network. These were simply a series of stations where the directions and distances of the lines were determined according to the prescribed criteria. Although lacking in the usual geometric conditions readily obtained in triangulation, the traverse method was often advisable, especially with the use of Electronic Distance Measuring (EDM) equipment.

Other control points were established by satellite method (**Doppler principle***). However, Doppler observations in the country were undertaken mainly for research purposes rather than for surveying applications as reference stations. There are at present 59 Doppler stations established in the country: 32 by the former BCGS and 27 by private surveyors.

Vertical controls or "bench marks" were referred to vertical datum planes established by continuous observation on the fluctuation of tides over certain periods. For mean sea level, it was the mean of the hourly heights of tides during a period of nineteen years which covered a complete tidal cycle.

The basic network established by the BCGS was likewise used by other government agencies with surveying functions for their particular purposes. These agencies include, among others:

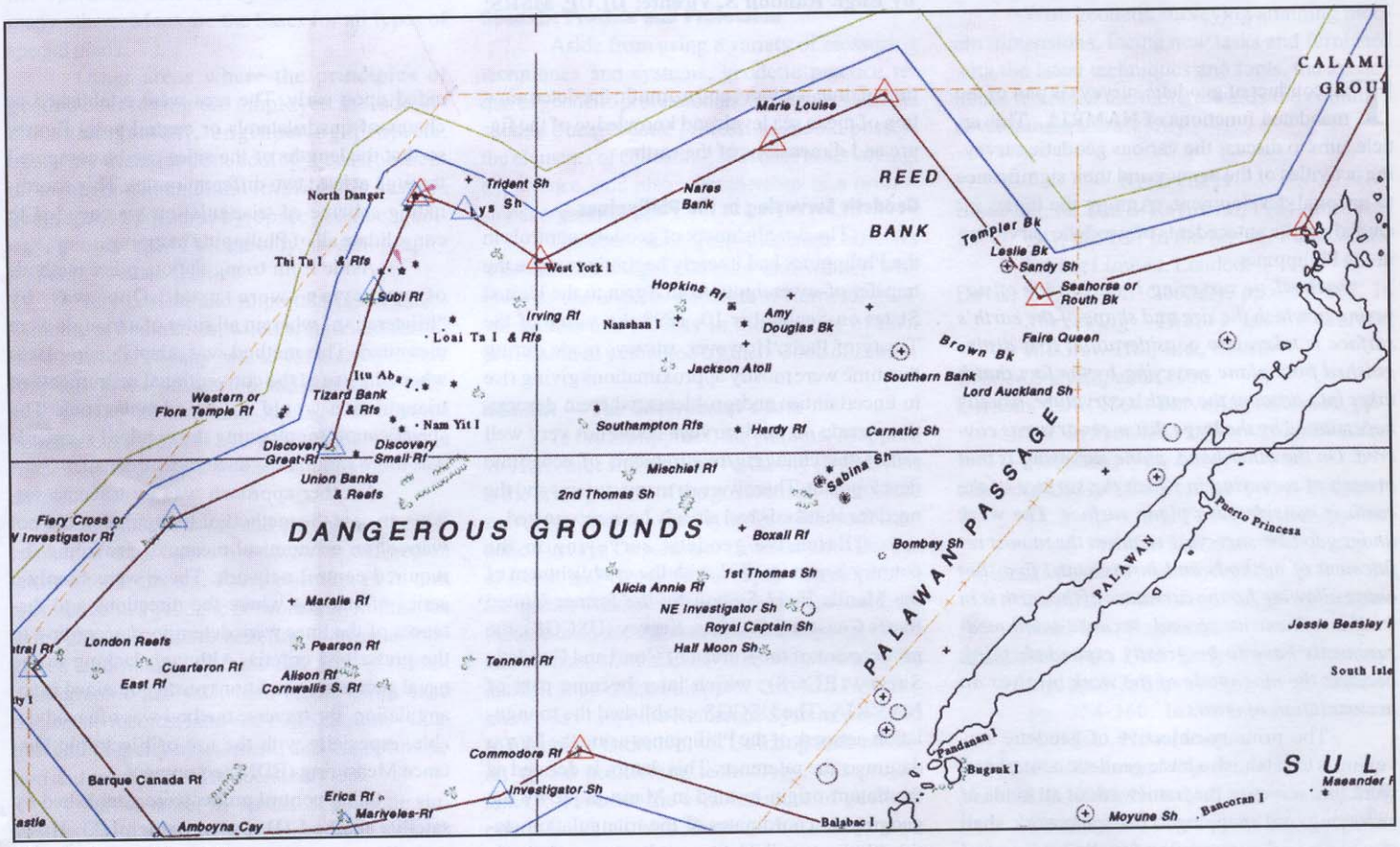
- Bureau of Lands (now the Lands Management Bureau or the Lands Management Services of the Department of Environment and Natural Resources

*... continued on page 15*

[1]*Geodetic Engineer Vicente has a Diploma in Land Use Planning, and a Master of Science degree in Remote Sensing. He is also the Chief of the Plans and Operations Division of NAMRIA.*

# *Freedom* over *Kalayaan*

by Maria Romina D. Pe Benito




The *Kalayaan* Island Group.

K. I. G. By now, these initials should already be familiar to a good number of Filipinos. Intensive media coverage has sparked the nation's interest in the matter of islands in the South China Sea, the *Kalayaan* Island Group included. These islands are presently the objects of serious contention especially among bordering littoral states.

With parties involved claiming rightful ownership over the disputed islands, the situation is understandably tense as each one keeps a watchful eye even over the slightest actuation of the other. A peaceful resolution of territorial disputes, even at some vague future time, is certainly more preferable than a full-blown conflict. Considering the sensitive issues involved this article merely attempts to take a cursory look at the country's own claim, especially over the KIG.

### 'Islands Philippines'

The Philippines prides itself on being an archipelago and strongly pushes the idea of cohesive unity for its scattered islands. The country subscribes to the archipelago doctrine whereby its group of more than 7,000 islands and islets are considered as one unit.

One needs only to refer to the Constitution for the country's assertion of ownership over its archipelagic domain. The earliest official definition of Philippine territory is found in Article I of the Philippine Constitution of 1935:

*The Philippines comprises all the territory ceded to the United States by the Treaty of Paris concluded between the United States and Spain on the tenth day of December, eighteen hundred and ninety eight, the limits of which are set forth in Article III of said treaty, together with all the islands embraced in the treaty concluded at Washington, between the United States and Spain on the seventh day of November, nineteen hundred, and in the treaty concluded between the United States and Great Britain on the second day of January, nineteen hundred and thirty, and all territory over which the present Government of the Philippine Islands exercises jurisdiction.*

The bases for the country's original claim to maritime boundaries were the Treaty of Paris and other pertinent treaties concluded by the United States during its regime in the Philippines.

Unlike the 1935 version, the definition of Philippine territory, as contained in a provision in the Philippine Constitution of 1973, features the absence of explicit reference to treaties, which gave way to an enumeration of territorial elements:

*The national territory comprises the Philippine archipelago, with all the islands and waters embraced therein, and all other territories belonging to the Philippines by historic right or legal title, including the territorial sea, the air space, the subsoil, the sea-bed, the insular shelves, and other submarine areas over which the Philippines has sovereignty or jurisdiction. The waters around, between, and connecting the islands of the archipelago, irrespective of their breadth and dimensions, form part of the internal waters of the Philippines.*

The nation's position, however, as regards its claim to maritime boundaries remained covered by the clause "all other territories belonging to the Philippines by historic right or legal title."

The 1987 version is largely similar to that of 1973 except for a new phraseology (highlighted below):

*The national territory comprises the Philippine archipelago, with all the islands and waters embraced therein, and all other territo-*

*ries over which the Philippines has sovereignty or jurisdiction, consisting of its terrestrial, fluvial, and aerial domains, including its territorial sea, the seabed, the subsoil, the insular shelves, and other submarine areas. The waters around, between, and connecting the islands of the archipelago, regardless of their breadth and dimensions, form part of the internal waters of the Philippines.*

The general consensus of the 1986 Constitutional Commission was that the new phraseology would not mean an abandonment of any unsettled Philippine claim to territories. The Commission deemed such matters as best left for judgment by the proper judicial body.

**A Bit of KIG History**

Philippine claim over the *Kalayaan* Island Group, has its roots in the demand made in 1947 by then Philippine Secretary of Foreign Affairs Carlos P. Garcia, over some islands in the island group known internationally as the Spratlys. The "New Southern Islands" were occupied by Japan during World War II.

Then there was the claim of ownership in 1956, through the issuance of a "notice to the world," of about 64,976 square nautical miles of territory in the South China Sea. The claim over "islands, sand cays, sand bars, coral reefs, and fishing ground" was made on the bases of rights of discovery and territorial occupation, by a Filipino navigator named Tomas Cloma, on his and his associates' behalf, and as a "citizen of the Philippines."

Tomas Cloma and its associates would mainly, "for and in consideration of the sum of ONE (P1.00) PESO, Philippine Currency, and their patriotism and love of country," waive "whatever and all rights and interests" to the island territory they named "Freedomland" in 1974, in favor of the Republic of the Philippines.

The occupation of Freedomland by Tomas Cloma and his group helped pave the way for the Philippine government's strong assertion of jurisdiction over several islands in the Spratlys. Among the major steps taken to confirm a legal claim was the formal request made in 1971 by the Philippine government for the immediate withdrawal of a Chinese garrison from *Itu Aba*, the largest island in the group. One of the legal bases for the demand was the legal title of the Philippines to the island group as a consequence of the occupation by Tomas Cloma.

The Philippines further solidified its claim over "the cluster of islands and islets in the South China Sea," which it called the *Kalayaan* Island Group, by virtue of Presidential Decree (PD) number 1596 which declares the KIG as part of Philippine territory. Issued in 1978 by then President Ferdinand E. Marcos, PD 1596 establishes the *Kalayaan* area as a distinct and separate municipality of Palawan province. Presidential Decree number 1599, also issued in 1978, in turn establishes the country's exclusive economic zone.

As early as 1976, the KIG had been shown in official maps and charts published by the Philippine government, through the former BCGS. NAMRIA, which now includes the former BCGS, publishes the country's official maps and charts.

At present, the Philippines maintains physical presence in eight islands in the KIG: *Pag-asa*, *Kota*, *Panata*, *Parola*, *Likas*, *Patag*, *Lawak*, and Rizal Reef. Certainly the nation's pursuit of its claim over the KIG is spurred on by its desire to uphold its sovereignty over areas it considers to be part of its territory. Then there are the economic and strategic considerations.

Philippine focus on the KIG has been heightened through recent years, following evidences of foreign intrusion into the area such as the construction of fortified facilities on Philippine-claimed land features in the South China Sea. Lately, the Philippine government is pushing for the adoption of a long-proposed regional code of conduct on the South China Sea, to govern the actions of claimants to the Spratly Islands. The Philippine government highly favors the diplomatic resolution of territorial disputes, through the holding of multilateral negotiations with Brunei, China, Malaysia, Taiwan and Vietnam. These are the five other littoral nations claiming the Spratlys either in whole or in part.

**RP Need for KIG: Present and Future**

Indeed, why pursue the KIG?

A successful claim by the Philippines over the KIG has a bearing on its economic survival. The existence of rich, both non-living and living resources in the area spells a lot of difference to the country. Its prevailing struggle with problems such as the perennially worsening poverty situation only serves to seriously derail its chances for full-scale development.

For one, the vast reserves of oil believed to be on the surrounding seas of the *Kalayaan* Islands would be more than adequate for the Philippines, for both domestic use and even export. There is also the significant contribution to national economy of marine fisheries production in the South China Sea. Then of course there are the invaluable livelihood opportunities for the country's fisherfolk and their dependents.

The strategic location of the KIG at the South China Sea happens to be an important passage say for commerce and military transport. The successful claimant over the KIG has the right to decide matters regarding the exploration and exploitation of resources in the area and the future use of the vital sea and air routes.

The implications are also clear as regards the Philippines' proximity to the KIG and the matter of national security. Consider the use of the islands by Japanese forces during World War II.

**Parting Shot**

Much ado over islands. To think that the present objects for conflict among the nations involved had lain dormant for many years, or apparently... It would seem that the whole world does not have enough serious problems that it welcomes the one brewing this time in the South China Sea.

In the case of the Philippines, the nation still has to overcome all its problems and difficulties. It especially seeks to alleviate the plight of its impoverished millions. This is perhaps one of its foremost considerations as it endeavors to secure control over the potential wealth of maritime resources in the KIG.

Cooler heads among all those concerned will hopefully prevail for the duration of efforts for the peaceful settlement of conflicting claims. They should, lest they themselves mar the bounties that are there. There are even far worse scenarios.

*Editors' note: Due to space constraints, we cannot publish the references for this article. Interested readers may avail of a copy of the list from the author or the editors of this publication.*

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Dorling Kindersley
(Egyptian Groma)

Surveying is a time-honored profession. It dates back from 5,000 years ago during the early Egyptian civilization. Even then, the science was of great importance and demand primarily because the construction of buildings as massive as the pyramids required an ability to measure angles and calculate long distances. Moreover, the yearly flooding brought about by the Nile River ruined the life-giving land's underlining boundary and area; as a result, the Egyptian surveyor called *harpedonapata* was indispensable and always called for.

Early surveying equipment like the Egyptian groma were of somewhat limited use but were apparently sufficient for flat terrain and a small range of angles. The groma consisted of stones hanging from sticks set at right angles to one another. Distant objects were marked out against the position of the stones in a horizontal plane.

Forerunners of our present-day surveying instruments were truly crude and unpolished, such as wooden poles, tied ropes, and grooves. With the passage of time, the devices gradually developed: each device an improvement from its predecessor. The lodestone, compass, **Gunter's chain***, telescope, transit and theodolite were later invented and electronic distance measuring devices were likewise introduced. Widespread nowadays is the use of global positioning satellite receivers, which are thought to be the ultimate in surveying instrumentation.

However, more specialized equipment and techniques are yet to be innovated and utilized in the future, especially with man's burning desire for knowledge and the advancement of science and technology.

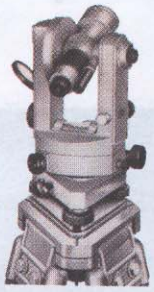
**Xenia R. Andres**

(**Source**: *"Egyptian Groma," Microsoft Encarta '97 Encyclopedia.)* *... continued on page 11*

PHOTO ESSAY


Electronic Level

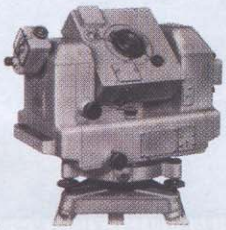
Engineer's Level



Theodolite Th3

Celestial Computer ARG 1

Universal Theodolite



Universal PhotoTheodolite

# URVEYING STRUMENTS WORLDWIDE 1900-2000

Binocular 8x30

Base Subtense Bar

Auto-Reduction Tacheometer

Theodolite for Tacheometry Type Tt

Engineer's Transit

Geodetic Level (Type IVb)

Alidade and Plane Table

Photo research/compilation and spread design: Nancy M. de Jesus

News

# NAMRIA Administrator calls for values-orientation at GEP convention

by Xenia R. Andres

*Administrator Liberato A. Manuel delivers his speech before members of Geodetic Engineers of the Philippines-National Capital Region. The convocation's theme was "Recognizing the Role of Geodetic Engineers in Solving Land Problems."*

Administrator Manuel exhorted the important role of geodetic and junior geodetic engineers in reducing land disputes, in his keynote speech during the 11th Annual Regional Convention and Election of Officers of the Geodetic Engineers of the Philippines-National Capital Region (GEP-NCR). This was held last 28 May 1999 at Camelot Hotel, Quezon City. He also called upon the members to reinforce their values-orientation in order to sustain their sense of community belonging and purpose, as well as the observance of truth in the practice of their profession.

In the same convention, Engineer Enrique A. Macaspac, Chief of the Geodesy and Geophysics Division was chosen as one of the directors in the GEP-NCR board, and Mr. Nazario B. Rivera as Representative of the junior geodetic engineers. On the other hand, POD Chief Randolf S. Vicente was duly elected as President of GEP-NCR West Chapter covering the cities of Makati, Pasay and Manila.

The Geodetic Engineers of the Philippines, Incorporated is a formal organization of geodetic engineering practitioners aimed at fostering the advancement of the knowledge and practice of geodetic engineering principles, and at the same time maintaining high ideals of integrity, learning, professional competence, public service and conduct. In its eleven years of existence, it continues to uphold the interests of the Filipino community by participating in the programs of the government such as shelter and urban development; maintenance and preservation of ecological balance; implementation of the Philippine Reference System '92, which will serve as the basic reference of all surveying and mapping activities in the country; and land titling registration systems. Most of NAMRIA's technical workforce are members of this association.

# PRS '92 updates

by Elinor C. delos Reyes

As of May 1999, a total of 1,329 geodetic control points (GCPs) or stations, which now comprise the Philippine Reference System of 1992 or PRS '92, have already been established by NAMRIA in different parts of the archipelago. PRS '92 becomes the common reference for all surveying and mapping activities in the country beginning Year 2000, pursuant to Executive Order No. 45, series of 1993.

PRS '92 was set up at a distance of five kilometers per station to ensure the accuracy of ground measurement and its accessibility to all users. About 1,700 old triangulation stations which were referenced to PRS '92 by mere computation and adjustment without a re-survey, also form part of the new network. The network consists of 330 first-order; 101 second-order; and the rest, third-order stations.

Utilizing the state-of-the-art GPS technology, the Geodetic and Geophysics Division of the Hydrographic and Geodetic Surveys Department (HGSD) of NAMRIA continues to undertake the densification of the network, providing at least two control points for every municipality. Likewise, NAMRIA exchanges geodetic station information with the DENR regional Lands Management Services (LMS). PRS '92 coordinates of these LMS stations were evaluated by the HGSD of NAMRIA and are now included in the NAMRIA geodetic database.

PRS '92 was established in 1989 in the country during the implementation of the DENR Natural Resources Management and Development Project or NRMDP. This new network is capable of supporting the surveying, mapping and information needs of the country for sustainable management and development of the environment and natural resources. It will soon be complemented by the establishment of the Integrated Geospatial Referencing Facility.

# NAMRIA undertakes CALABAR base mapping project

by Chester C. Nicolas

NAMRIA completed in May 1999 a total of 11 digital map sheets at 1:10,000 scale for the base mapping project covering municipalities of Cavite and urban fringe areas of Laguna Lake.

The urban large-scale maps will serve as economic indicators that will reflect the current state of development of a particular area in Cavite and Laguna Lake. The other outputs of this project will serve as basic inputs in various development activities of the government, the academic and scientific community, the private sector and the general public.

The maps were digitized based on 1997 aerial photographs. State-of-the-art photogrammetric equipment was utilized for the preparation of these maps. Planimetric features (road network, vegetation covers, buildings, houses, bridges, and rivers) were captured from aerial photographs using AutoCAD and DAT/EM digital mapping software, interfaced with the photogrammetric equipment. Through this equipment, errors from aerial photos were corrected and linear features were captured and converted into digital format. Captured data are stored in a format that can be manipulated with other GIS software.

# LCED pilots boundary demarcation of forestlands

by Cristina A. Montoya/Chester C. Nicolas

The Land Classification and Evaluation Department (LCED) of NAMRIA initiated in March 1999 a pilot project on the ground relocation/demarcation and monumenting of the specific boundaries/limits between forestlands/timberlands and alienable or disposable (A/D) lands. This is in preparation for the eventual nationwide implementation of the project by DENR where NAMRIA is expected to provide technical support.

The establishment/demarcation of boundaries/limits of forestlands is pursuant to Presidential Decree number 705, dated May 1975; Section 4, Article XII of the 1987 Philippine Constitution; and Section 4(a) of the Comprehensive Agrarian Reform Law (CARL) of 1988, as amended. The pilot area is Zamboanga del Sur.

At present, there are still no existing guidelines insofar as relocation/demarcation of boundaries/limits between forestlands/timberlands and A/D lands are concerned. Thus the pilot project aims to test interim procedures and techniques for improved operational effectiveness and efficiency of survey teams, apart from setting standards for future planning and programming purposes.

Surveys were conducted last March to April and September. Sites covered were portions of the boundaries of Pasonanca Watershed Reservation adjacent to Zamboanga City proper; and portions of forestlands/timberlands under LC Project number 5-L; and in Barangays Curuan, Quinipot and Buenavista specifically covering boundaries between A/D lands and Timberland Blocks I and K of LC Project number 5.

When finally implemented nationwide, among the expected benefits of the project are the following: (1) protection of the remaining forests and preservation of bio-diversity; (2) promotion of sustainable development; (3) more effective enforcement of laws, rules and regulations; (4) promotion of socio-economic activities/opportunities in the countryside; (5) facilitation of cadastral surveys and titling; and (6) prevention of illegal titling.

# NAMRIA conducts magnetic survey of Mindanao

by Elinor C. delos Reyes

NAMRIA has recently started the magnetic survey of Mindanao to gather information on the local variations of the earth's magnetism, particularly in Dipolog, Ozamiz, Mandulog, Cagayan de Oro, Gingoog, Nasipit, Tubod, Surigao, Carrascal, Tandag, Lianga, Mangagoy, Compostela, Cateel, Caraga, Mati, Gov. Generoso, Tagum and Davao.

The magnetic variation or magnetic declination that will be gathered from the field surveys will be used to update magnetic declination in nautical charts[1] and in topographic maps. Also through this project, an isogonic chart of the Philippines showing lines of equal magnetic declination or variations will likewise be produced. Magnetic data are highly useful for safety of air and sea navigation. They guide the pilot as to the position of his vehicle at sea or in the sky, relative to its true position. Data on the isogonic chart are regularly updated every five years.

Among other uses and/or applications of magnetic data are for the retracing of old property lines originally surveyed by compass bearings; geophysical prospecting for oil-bearing structures; the study and prediction of **radio*** propagation affecting communications and radio navigational aids; the study of **sunspot*** phenomena and auroral [**aurora***] and **ionospheric disturbances***; and the study of global **secular variation***.

Aside from undertaking magnetic surveys, NAMRIA maintains a primary magnetic observatory in Muntinlupa City and keeps records of 158 (magnetic) repeat stations established throughout the country. The agency also provides magnetic data to other countries such as Japan and Britain and these data are included in international publications.

[1]*This is shown in the form of a compass rose.*

# LGUs seek NAMRIA expertise in digital base mapping

by Floyd L. Lopez

Two local government units (LGUs) have tied up with NAMRIA in acquiring the necessary digital base map data. These are the province of Cavite and the city of Muntinlupa.

The two LGUs are in the process of strengthening their capability for local development planning, through the establishment of their own geographic information system to be used as basic tool for land use and socio-economic planning.

The provincial government of Cavite through its governor, Ramon "Bong" Revilla, Jr., signed a memorandum of agreement (MOA) with NAMRIA Administrator Liberato A. Manuel last 29 April 1999. Under the agreement, NAMRIA will provide 27 digital files in AutoCAD drawing format (*.dwg* ) for Cavite area, six pieces of zip disks for data storage, and reproductions of aerial photographs.

Meanwhile, the MOA between Muntinlupa City and NAMRIA was signed by Mayor Jaime Fresnedi and Administrator Manuel last 11 May 1999. Under the contract, NAMRIA will provide Muntinlupa with the latest digital data covering the latter's territorial boundary in suitable storage devices. It will also train city personnel on the various applications of digital data to planning and development efforts of the city of Muntinlupa.

The municipality of Sta. Rosa, Laguna, on the other hand, is also eyeing a possible tie-up with NAMRIA for technical assistance to beef up its geographic information system.

***Photo Essay*** *... from page 8*

Picture credits:

*De Leon Import & Export Corp., ODELCO Bldg. # 128 Kalayaan Ave., Diliman, Q.C.* [for data/illustrated brochures on surveying instruments]

*Information materials-*

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# HGSD undertakes GPS observation for the PICMP

by Elinor C. delos Reyes

The HGSD of NAMRIA, in coordination with the Philippine Institute of Volcanology and Seismology (PHIVOLCS) and Indiana University, conducted GPS observation last May to June 1999. This was done to monitor and gather information regarding crustal earth movement along the Philippine seismic zone for the Philippine Island Crustal Motion Project (PICMP). GPS observations for regional connections or tie-ups were simultaneously conducted in other nearby countries like Australia, Guam, Japan, and Taiwan. The PICMP is an initial undertaking of a long-term monitoring program, which aims to provide the local and international scientific community with data vital to the studies on future earthquake predictions and geophysical researches on plate movements, volcanology, etc. The project's objective is also to develop new approaches for natural hazard mitigation and the possibility of predicting earthquakes in the future, through the application of GPS and other highly precise and accurate surveying and geophysical equipment.

Aside from different government agencies such as NAMRIA and PHIVOLCS, the PICMP is being implemented also in cooperation with international universities like the University of Columbia and the University of South Australia. The PICMP started in May 1992 with the Earthquake Research Institute (ERI) of Tokyo University, Japan as the lead institution.

The latest GPS observations were conducted in Luzon and Marinduque. Areas in Luzon include Albay, Quezon Province, Pangasinan, La Union, Pampanga, Tarlac, Bulacan, and Nueva Ecija. Survey results conducted in these areas indicate that plate movement along the Philippine seismic zone is between two to four centimeters per year. Plate movement is caused by friction/stress between continental plates. It was also observed that plate movement/separation starts from Luzon up to Mindanao areas. These survey results conform with the different models developed by international geophysicists and scientists for their respective studies on plate tectonics, specifically on areas within the Pacific Region.

# Annual celebration of national statistics month held

by Maria Romina D. Pe Benito / Elinor C. delos Reyas

Philippine government offices observed the 10th National Statistics Month, with the theme "Statistical Research, Training and Education—Charting the Course for the New Millennium." This year's celebration was hosted by the Statistical Research and Training Center (SRTC). The SRTC, headed by Executive Director Gervacio G. Selda, Jr., led other participating agencies in launching the celebration at the Manila Hotel on October 1. The DENR, its bureaus and attached agencies, spearheaded some of the commemorative activities. These include the yearly ENR Statistical Quiz in the national and regional levels, held on October 25 at the Mines and Geosciences Bureau-DENR (MGB-DENR) in Quezon City. Two other equally important and well-received events were also held:


*Ambassador of Norway, Inga Magistad welcomes participants to the seminar on "National Information Infrastructure for Management of Marine Resources and Traffic at Sea.*

***Forum/Orientation on Technology of Spatial Data Collection and Analysis (14 October; Petrolab, MGB-DENR, Quezon City)***

This was sponsored by NAMRIA for the staff of the DENR, its bureaus and other attached agencies; non-governmental organizations; and local government units. The forum featured a series of technology presentations on mapping, surveying/charting, land classification, remote sensing, and GIS technology. The resource persons from the agency were Engr. Ana Marie R. Abante; Geodesy and Geophysics Division Chief, Engr. Enrique A. Macaspac; Supervising Remote Sensing Technologist Jesus L. Gerardo; Senior Remote Sensing Technologist Marvilyn P. Palaganas; and Information Systems Analyst Ernestine B. Gayban. A one-day exhibit of NAMRIA products was also set up for the forum. NAMRIA Administrator/ Undersecretary Liberato A. Manuel and DENR Assistant Secretary Sabado T. Batcagan were the officials present during the forum.

***Seminar on National Information Infrastructure for Management of Marine Resources and Traffic at Sea (19-20 October; Hotel Inter-Continental Manila, Makati City)***

This was sponsored by the Norwegian Trade Council (NTC) of the Royal Norwegian Embassy, in cooperation with NAMRIA; and attended by representatives from the national agencies, local government units, non-governmental organizations, the academe, shipping firms, and other entities involved in marine affairs. Highlights of the seminar were the presentations by resource persons from the Norwegian Hydrographic Service, several Norwegian companies, and NAMRIA. Among the speakers were Norwegian Hydrographic Service Director

*... continued on next page*

# 1st worldwide GIS Awareness Week marked

by Xenia R. Andres

The first worldwide awareness week for Geographic Information Systems (GIS) technology was celebrated last 15-19 November 1999. It was principally sponsored by the National Geographic Society; the Association of American Geographers; and the Environmental Systems Research Institute, Inc. The flagship celebration in the Philippines was spearheaded by the Southeast Asian Ministers of Education Organization (SEAMEO) Regional Center for Graduate Study and Research in Agriculture (SEARCA). Co-hosting the event were the International Rice Research Institute (IRRI); the Bureau of Soils and Water Management (BSWM); GEODATA Systems Technologies, Inc.; the University of the Philippines at Los Baños (UPLB); and NAMRIA. The weeklong activities comprised of GIS software demonstrations, video showing, exhibit viewing, and lectures on GIS applications such as forest land use planning and critical watershed management.

The opening ceremony was held at the SEARCA headquarters, Los Baños, Laguna. Assistant Director John SF. Fabic of the Information Management Department (IMD) gave the opening remarks in behalf of Administrator Manuel. "This occasion, modest as it is, will serve as a venue for minds to meet, learning to gain, and information to exchange," he said in his message.

The observance of GIS Day on November 19 culminated the event. It aimed to educate adults and children on the applications of geography and GIS technology. A symposium focusing on GIS organization, industrialization, issues and trends was conducted at the SEARCA Umali Auditorium. The speakers were Dr. Steve C. Godilano, a GIS specialist at IRRI; Ms. Frances N. Dayrit, executive vice-president of GEODATA; and Director Linda SD. Papa of NAMRIA. Present during the discussion were Dr. Percy E. Sajise, SEARCA director; Dr. Ruben D. Villareal, incoming SEARCA director; Dr. Wilfredo P. David, UPLB chancellor; Dr. William G. Padolina, Deputy Director of IRRI; members of the academe; the Los Baños science community; and delegates from both the public and the private sector.

That same day, the Philippine Geo-Informatics Society (PHILGIS) was founded, with Dir. Papa and Asst. Dir. Fabic as two of the 20 founding members. Roughly, the society's objectives are: (1) to share experiences and data; (2) to promote technological development and provide updates on it; (3) to recommend and formulate GIS policies; (4) to promote geomatics and professionalize GIS; and (5) to create a pool of GIS experts. The constitution and by-laws have yet to be drafted while a discussion meeting is scheduled for the third week of January next year.

For its part, NAMRIA, through IMD, conducted an orientation/briefing on basic GIS and map concepts as well as on the agency's products and services. The seminar was held last 17 and 18 November 1999 at the NAMRIA Lecture Hall. The resource persons during the two-day seminar were Supervising Cartographic Engineer Joaquin B. Borja, Jr.; Information Systems Analyst Claro P. Lopez III; Information Systems Analyst Eriberto N. Brillantes; and Information Officer, Engr. Lyndon John N. de Leon. NAMRIA has likewise signified its intent to host the GIS Day 2000 in Metro Manila.

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***Annual Celebration*** *... from page 12*

Frode Klepsvik; NAMRIA Plans and Operations Division Chief, Engr. Randolf S. Vicente; and NAMRIA Information Technology Officer Benjamin P. Balais.

The topics included mapping and charting the Philippines; managing a nation's hydrographic information; the impact of the United Nations Convention on the Law of the Sea; building a national infrastructure for marine information acquisition and management; the use of GIS in marine application development; seabed mapping; populating and managing databases for marine resource management; and vessel traffic management. There were also panel discussions, exhibits of relevant products and services by the two countries, and a press conference.

Key foreign and local officials present during the two-day seminar were Deputy Minister Harriet Berg of the Norwegian Ministry of Trade and Industry; Ambassador Inga Magistad of the Royal Norwegian Embassy; NAMRIA Administrator/Undersecretary Liberato A. Manuel; DENR OIC-Undersecretary for Legal Affairs Roseller S. de la Peña; NTC Regional Director Theis Ulriksen; and NTC Commercial Counsellor Morten Hoyum.

***Technical Paper*** *... from page 14*

veys since the satellite motion will not be needed, the Inmarsat can also be used as reference satellites in static surveying. The more synchronized the satellite systems are, the better they can be utilized for precise timing and higher accuracy.

This "augmentation" of capability should remedy present GPS deficiencies. The augmentation is seen as a marketable service, particularly since one transponder can be accessed by one ground station at a time. Aside from transmitting the integrity information of the GPS signals, the transponders will also considerably extend the coverage and capability of the GPS system by providing an additional ranging source, since each Inmarsat-3 transponder is equivalent to three orbiting satellites due to its geostationary position. This phase also includes the construction of ground-based monitoring stations and processing systems, which will relay confirmation of the integrity and accuracy of the GPS signals to users. Inmarsat's fourth-generation satellite, which is being designed to provide communications to small inexpensive terminals, is also being investigated for possible GNSS applications.

Other systems had also been developed such as the publicly accessible radio positioning systems. The following radio navigation systems mix are included under such initiative, namely: (a) Omega – a very low frequency continuous wave global terrestrial system; (b) Decca Navigator – a low frequency continuous wave terrestrial system; (c) European Geostationary Navigation Overlay System or EGNOS; and (d) other enhanced radio navigation systems.

### V. Conclusion

The term "hybrid" evolved in reference from mere biological life forms to something (as a power plant, vehicle, or electronic circuit) that has two different types of components performing essentially the same function. In the same line, position determination and fixing can now be achieved at a precision never made possible before with the advent of the GPS plus GLONASS technology. In fixing exact positions, the more reference points there are, the more exact the solution becomes.

It can be concluded therefore that the benefits of developing systems will signal the advent of the "GPS-GLONASS-INMARSAT-Other Systems" Hybrid.

TECHNICAL PAPER

# GPS-GLONASS: An Emerging Hybrid in Location Determination and Fixing

by Engr. Randolf S. Vicente (condensed for publication by Chester C. Nicolas)

## I. Introduction

The introduction of the Global Positioning System (GPS) in the country in the late 1980s through a bilateral assistance program with the Australian government has offered significant opportunities for obtaining highly precise locational data at relatively low cost. When the homogenous primary geodetic network was established by NAMRIA in the country under the "Philippine Reference System 1992" or "PRS '92," government and private agencies used GPS techniques to carry out their respective line functions.

Users of GPS, however, have encountered difficulties in surveying, land navigation, and feature coordinate tagging caused by temporary outage or loss of positioning as the receiver passes through obscured areas. Interference of satellite signals usually occurs when fixing is made near buildings, overhanging trees, and other related obstructions.

These are the reasons why various devices have been used to compensate for these disadvantages. When it comes to navigation, one simple way is the so-called "dead reckoning system." Another is the combination of GPS with the Inertial Navigation System (INS). Aside from its high cost and lack of field worthiness, the INS would become redundant for surveying if the Precision Code (P-code) is left unencrypted for a reasonable period. Perhaps, the most practical approach to this dilemma is to harmonize other positioning systems with the existing satellite-based positioning technology.

## II. GPS Harmonized with Global Navigation Satellite System (GLONASS)

Geopositioning techniques and technologies have undergone considerable evolution in recent years, as evidenced by the emergence of systems like the GLONASS, the Russian version of the United States' GPS. The nearly circular orbits with altitudes of 19,100 kilometers and a period of 11.25 hours are similar to GPS. It is composed of 24 orbiting satellites (including three active spares) equally spaced in three orbital planes with 64.8 degree nominal inclination. In contrast to GPS, the broadcast carrier frequencies are satellite-specific. All satellites transmit on two frequencies (L1 and L2) having a Course/Acquisition (C/A) and Precision (P) code on L1 and P code only on L2. This system has no intentional degradation of the C/A code accuracy nor encryption of the P code as in the case with the US-managed GPS constellation.

Other key characteristics of the GLONASS include the constellation's use of PZ-90 coordinate system; its non-operational, selective availability mode; and its horizontal accuracy of less 30 meters. (Source: *3S Navigation* [company])

Receivers had been built to track both GPS and GLONASS signals. Anyone acquainted with **avionics***, navigation, vehicle location, surveying, positioning, geodesy, precise timing, and so on, understands the great value of having additional satellites. If GPS and GLONASS are eventually used interchangeably at several meters and at 10-nanosecond (n), the impact will be far reaching. Resulting changes include systems reliability and accuracy, worldwide telecommunications synchronization, aircraft precision landings, and additional robustness for systems in general. The additional satellites would be of significant use in surveying applications.

In a normal survey environment, there are many obstructions that block satellite signals in certain portions of the sky. The GLONASS constellation will provide the same number of satellites that can be used in combination with the GPS satellites. Because of the similarity of the two satellites, it is possible to include the GLONASS measurements in a combined solution forming triple- and double- differences between satellite repairs. The main benefit to surveyors will be the increase in sky coverage, making it possible to measure lines that would have been otherwise obstructed. Also, the increase in number of measurements makes the kinematic [**kinematics***] method more viable than it is with just the GPS constellation. Kinematic surveys can be performed without the pre-survey initialization when five or more satellites are available and C/A code receivers are utilized. By the integration of the GLONASS, kinematic surveys can proceed even after cycle slips have been experienced. On-the-fly kinematic surveying using inexpensive C/A code receiver could be used for other land surveying tasks, such as boundary, topographic, hydrographic, and construction surveys.

The value of having both GPS and GLONASS harmonized includes: (a) a composite contribution of 48-satellite availability; (b) the desirability of using either or both systems interchangeably; (c) good geometric dilution of precision; (d) strong satellite configuration; and (e) information denied by the GPS will be provided so that full combined system capability is maintained.

## III. Prospects of Combined GPS-GLONASS Technology

NAMRIA is one of the government agencies that acquired such sophisticated surveying equipment, primarily for the purpose of demarcating the permanent limits of forest boundaries. Considering the biophysical condition of the area to be surveyed, not to mention the thick canopy cover within forestlands, NAMRIA opted for the acquisition of GPS-GLONASS receivers. Results reveal that these receivers are far better to use than the GPS receiver alone. Consequently, the time and the cost in carrying out the agency's surveying activities would be minimized.

NAMRIA will be putting up an Integrated Geospatial Referencing Facility (IGRF), a network of permanent, continuously operating satellite-based survey stations that are capable of providing users with real-time post-processing parameters for correction purposes. It is expected that the IGRF would also be capable of tracking GLONASS signals as well as mixing existing geopositioning systems to support the activities of the agency as well as other users of these technologies.

## IV. Systems Mix

The number of civilian users of GPS is three times more than the number of military users, and the ratio is rapidly increasing. Recognizing that Europe will lose a good opportunity for a multibillion market and because GPS and GLONASS are both under military control within their respective countries, the European nations have deemed it best to design and build "a wholly civil European Global Navigation Satellite System (GNSS1), to be followed by a next-generation (potentially stand-alone) system, the GNSS2."

GNSS1 will use four (4) third-generation **I**nternational **Mar**itime **Sat**ellites (Inmarsat-3) to augment the existing GPS and GLONASS constellations. These satellites will provide correction signals for GPS and GLONASS. In addition to increasing the effective coverage of GPS and GLONASS and being useful in kinematic sur -

... *continued on page 13*

*Geodetic Surveying Activities ... from page 5*

[DENR]) for cadastral and parcellary surveys;

- Department of Agrarian Reform (DAR) for photo control surveys in line with their thematic (suitability) mapping;
- Bureau of Mines (now the Mines and Geosciences Bureau of DENR) for universal land surveys and geological mapping;
- Bureau of Soils (now the Bureau of Soils and Water Management of the Department of Agriculture) for soil and land use mapping;
- Ministry of Public Highways (now the Department of Public Works and Highways) for their engineering surveys, planning and design; and
- Armed Forces of the Philippines Mapping Center (now the MIG-18) for their surveying and mapping activities.

The geodetic control network established by the BCGS was subsequently densified by the former Bureau of Lands. Later there were the difficulties in expanding the triangulation network particularly inland because of difficult terrain; and the growing need for a suitable geodetic framework for integrated surveying and mapping in the country, which the existing network could not provide. Thus, a new network was established in 1989-1992 by NAMRIA through a bilateral assistance program with the Australian government. This new network was installed using the satellite-based Global Positioning System (GPS) approach. It was called the "Philippine Reference System of 1992" or "PRS '92."

**Geodetic Surveying Activities in NAMRIA**

By virtue of Executive Order number 192 issued in 1987, the functions of the former BCGS of the Department of National Defense were integrated with three other agencies to form NAMRIA. These agencies were the National Cartography Authority under the Office of the President; the Natural Resources Management Center of DENR; and the Land Classification Teams of the former Bureau of Forest Development, now the Forest Management Bureau of DENR. Upon its creation, NAMRIA assumed the maintenance, including the densification, of the national geodetic network. This is to support various surveying and mapping activities of the government.

The establishment of a geodetic network is a painstaking job considering the difficulties to be encountered in its execution. Despite these hardships and predicaments, the agency carried out various relevant projects, having in mind their importance to meet the scientific needs and commercial demands of the country.

NAMRIA undertook support activities in connection with the devastating natural calamities that hit the country. First, the physical monitoring surveys (**topographic*** and hydrographic) on eleven river systems around Mt. Pinatubo which provided inputs to the rehabilitation efforts in 1992 and 1998 of the government in the lahar-devastated areas. Second, the delineation of a permanent six-kilometer danger zone around the Mayon Volcano. The agency established 40 GPS monuments that serve as markers of the said danger zone. Third, the establishment of **photo control points*** necessary for the mapping in 1994 of earthquake-stricken areas, covering municipalities around Lingayen Gulf from Dagupan City to San Fernando City in La Union.

The agency also undertook geodetic surveys in support of its various large-scale mapping activities, primarily on the installation of ground photo control points. Among the significant accomplishments of the agency was the establishment of "PRS '92." One of the key result areas of this project was Executive Order number 45, which states that PRS '92 shall serve as the ac reference system for all mapping and surveying activities in the country by the Year 2000. As of 30 June 1999, there are 1,331 stations established under this new framework. Since then, the agency has densified the primary network in some areas of the country just to provide basic reference points to both government and private surveyors. The agency has also established 131 surveyed basepoints out of the 143 base points of the proposed new baselines, which are essential in defining the maritime zones including the exclusive economic zone. NAMRIA is currently pursuing the densification of the geodetic network and is establishing project controls for hydrographic/oceanographic surveys, photogrammetric mapping, and forest boundary surveys.

One of the pressing concerns in survey management is the preservation and care of survey records and technical data. For this purpose, a computerized geodetic records system was developed and is currently being maintained by NAMRIA. This enables users to acquire geodetic information and/or request for certification within a few minutes. It also facilitates flexibility in updating the records.

Under the NAMRIA Medium-Term Public Investment Plan (MTPIP) for the years 2000-2004, the agency has programmed the following projects, such as: (a) densification of control points per Executive Order number 45, series of 1992; (b) geodetic surveys in support of hydrographic or oceanographic charting, large-scale mapping, and relocation/demarcation of forest boundaries; (c) delimitation of municipal waters and other activities in support of the implementation of the Fisheries Code; (d) establishment of an Integrated Geospatial Referencing Facility; (e) research and development on the determination of the datum shift and other parameters; (f) evaluation of emerging surveying/positioning techniques to simplify methods; (g) population and enhancement of the geodetic control database; (h) manpower development to meet the challenges of an ever changing world considering the trend in development of geodetic surveying; and (i) professionalization of the geodetic engineering practice in the agency in order to cope with near-future requirements for reliable geographical data.

Under the new management of NAMRIA, geodetic surveying activities are geared towards accelerating the execution of geodetic control surveys. Another goal is to provide adequate main and subsidiary control points of all surveying and mapping activities in the country, utilizing modern positioning equipment, human intelligence, hard work and dedication.

**Relevance to National Development**

The first step in the optimal exploitation of one's available resources is the determination of how much are available and their location. Further, one should also know where they can be found in abundance in contrast to where they are rarefied. From this first step, it then becomes possible to rate the resources in terms of yield per unit of area, quality of yield, sustainability of production and so on; constantly expanding the methods by which resources can be tallied for immediate utilization, rehabilitation, recovery or conservation.

In this cybernetic age, however, wherein information abound and can be relayed at lightning speeds in forms and media which used to exist only in science fiction, the revitalization of resource management is easier said than done. Resources can be lost overnight without a means of near real-time monitoring and assessment, such as a geographic information system, and without a means of measuring exact areas and positions, such as geodetic survey.

Essentially, the value of geodetic surveying can be viewed as an input to a production process. The outputs of this process as spatial information products have the attribute of spatial compatibility. This allows users of the information products, besides those responsible for their initial production, to combine and integrate information products independent of the original purpose for which the information was produced. Further, a consistent and homogenous geodetic reference system makes land information congruent. The demand for such compatibility generates a stream of benefits attributable to the geodetic reference system. Benefits occur only if the demand exists for the product obtained from its use.

Nowadays, NAMRIA takes its place among the leading government agencies with aspirations to make significant reforms in its traditional activities in the field of geodetic surveying. Under its MTPIP for 2000-2004, its concern is focused on the supply of geographically referenced information to contribute in the major programs and projects of the national government, specifically on sustainable management of the country's vast water and land resources.

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Maps and charts serve as inputs to national and local development. If maps and charts are to be used for planning exercises, then planners should have precise spatial references. In such an undertaking, highly compatible data and/or reliable maps from orderly surveys are of primary importance. This holds true in land and water resources management, administration and investment. For local land use planning and development, the local government units should have at least reliable maps for such a purpose. Among the efforts of the national government that had been supported by NAMRIA are the following: (a) land use planning and development; (b) environment and natural resource planning and management; (c) land distribution and human settlement; (d) disaster mitigation and emergency response; (e) engineering design and infrastructure development; (f) town/city planning; and (g) formulation of development objectives and policies.

**Epilogue**

At the inception of every new administration in the Philippine government, one invariably hears and reads about the introduction of invigorated resource management and the promise of increased productivity and earnings. It is worth noting, however, that it is only during this administration that this promise is being reiterated in the context of improved resource management through the modernization of NAMRIA, the country's central resource mapping agency.

Resources in the large scale include land, vegetation, fishing grounds and an exclusive economic zone where there may be fossil fuel reserves and ore deposits, among others. These are the basic elements being mapped out and monitored by NAMRIA today at a smaller scale and only in selected areas of priority on account of budgetary constraints. These are also the areas of concern that will be the subject of scientific scrutiny and real-time mapping by the future NAMRIA, that is envisioned to be replete in professional manpower, state-of-the-art equipment, and budgetary resources.

It must be taken to heart that without constantly updated knowledge of the quantity of one's resources, where they might be found and in what condition or state, there can be no realistic planning for exploitation or conservation. Without planning, successful management will not be possible, and finally, without successful management, increased productivity and earnings would forever remain a frustrating illusion.

*Editors' note: Due to space constraints, we cannot publish the references for this article. Interested readers may avail of a copy of the list from the author or the editors of this publication.*

## Glossary

- **Acoustics** – science of sound, including its production, transmission and effects.
- **Aurora** – luminous phenomenon which appears in the high atmosphere, mainly in high latitudes, in the form of rays, arcs, bands, draperies or corona.
- **Avionics** – electronics designed for use in aerospace vehicles.
- **Continuum** – a coherent whole characterized as a collection, sequence, or progression of values or elements varying by minute degrees.
- **Datum plane** – an arbitrarily assumed level or curved surface, every element of which is normal to the plumb line.
- **Doppler principle** – [or Doppler effect; named after Christian J. *Doppler* (1803-53), Austrian mathematician and physicist] variation of transmitted electromagnetic radiation frequency caused by the relative motion between an emitter and a receiver. As applied to satellite positioning, the principle refers to the change or frequency with which the radio signal (electromagnetic wave) from the satellite, as given source or emitter, reaches the GPS receiving antenna as receiver; when the source and the receiver are in motion with respect to each other.
- **Ellipsoid** – a geometrical figure used in geodesy to most nearly approximate the shape of the earth.
- **Equatorial radius** – the semi-major axis of the reference ellipsoid.
- **Geophysics** – the study of the physical characteristics and properties of the earth.
- **Gunter's chain** – a chain 66 feet long divided into 100 parts or links. Each link is equal to 0.66 foot or 7.92 inches and made of heavy wires connected by loops and three connecting rings with end handles.
- **Ionospheric disturbance** – a sudden outburst of ultraviolet light from the sun, known as solar flare, producing abnormally high ionization in the region of the D-layer of the ionosphere. The result is a sudden increase in radio wave absorption, with particular severity in the upper medium and lower high frequencies.
- **Isostasy** – a condition of approximate equilibrium in the outer part of the earth, such that the gravitational effect of masses extending above the surface of the geoid in continental areas is approximately counterbalanced by a deficiency of density in the material beneath those masses; while the effect of deficiency of density in the ocean waters is counterbalanced by an excess of density in the material under the oceans.
- **Kinematics** – a branch of dynamics that deals with aspects of motion apart from considerations of mass and force
- **Photo control points** – points of known positions that are clearly identifiable on photographic images to provide a way of correcting the geometry of the photographs so that objects in the photographs match their actual locations in the ground.
- **Polar radius** – the semi-minor axis of the reference ellipsoid.
- **Radio** – communication by electromagnetic waves, without a connecting wire.
- **Rheology** – the study of the deformation and flow of matter.
- **Secular variation** – the slow changes experienced by the main magnetic field of the earth.
- **Sunspot** – any of the dark spots sometimes seen at the surface of the sun caused by storms within the sun; and believed to have some connection with magnetic disturbances on earth.
- **Topographic survey** – a type of survey performed in order to determine the relative horizontal and vertical positions of existing natural and man-made features on a tract of land.

*Sources:*
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