Infomapper

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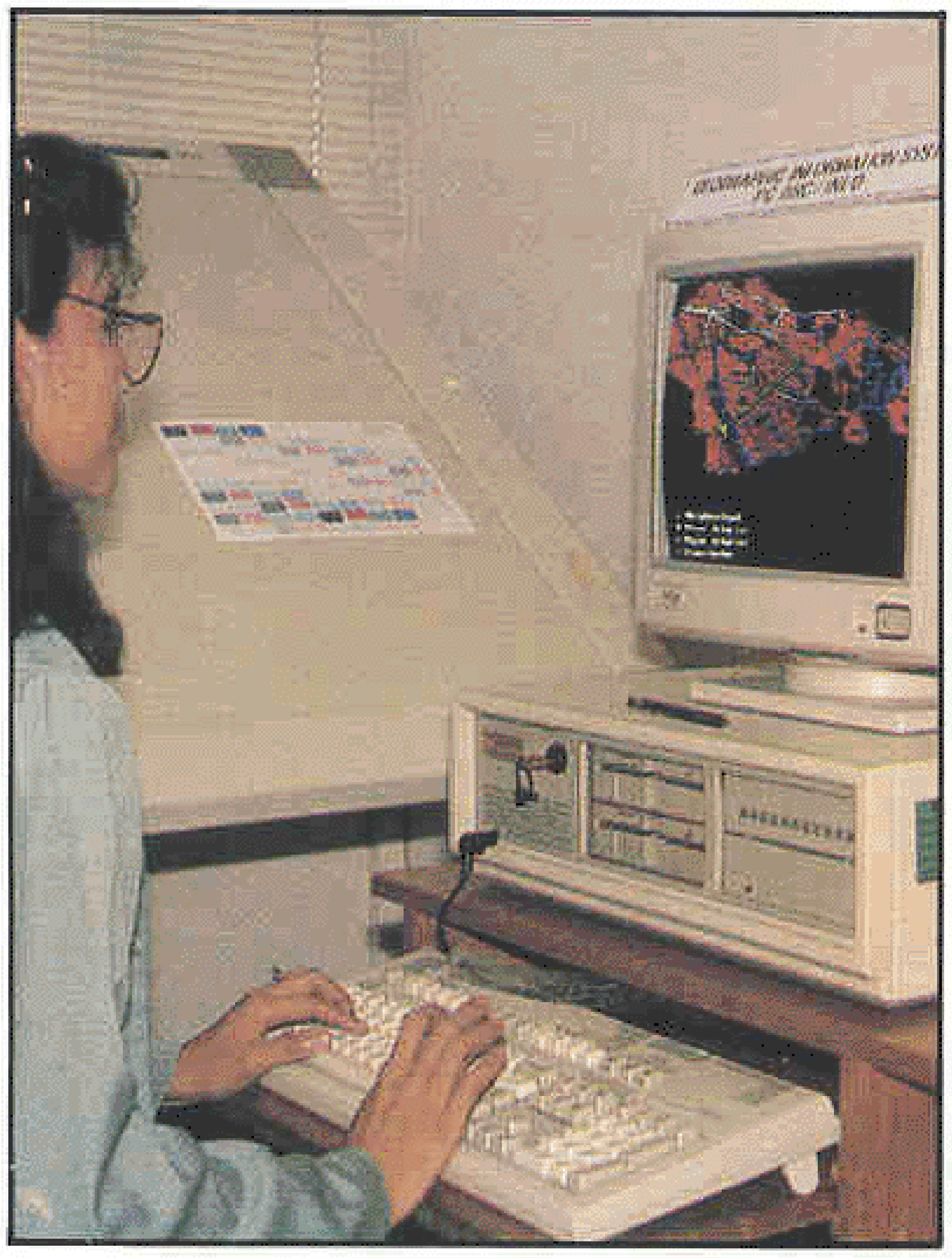
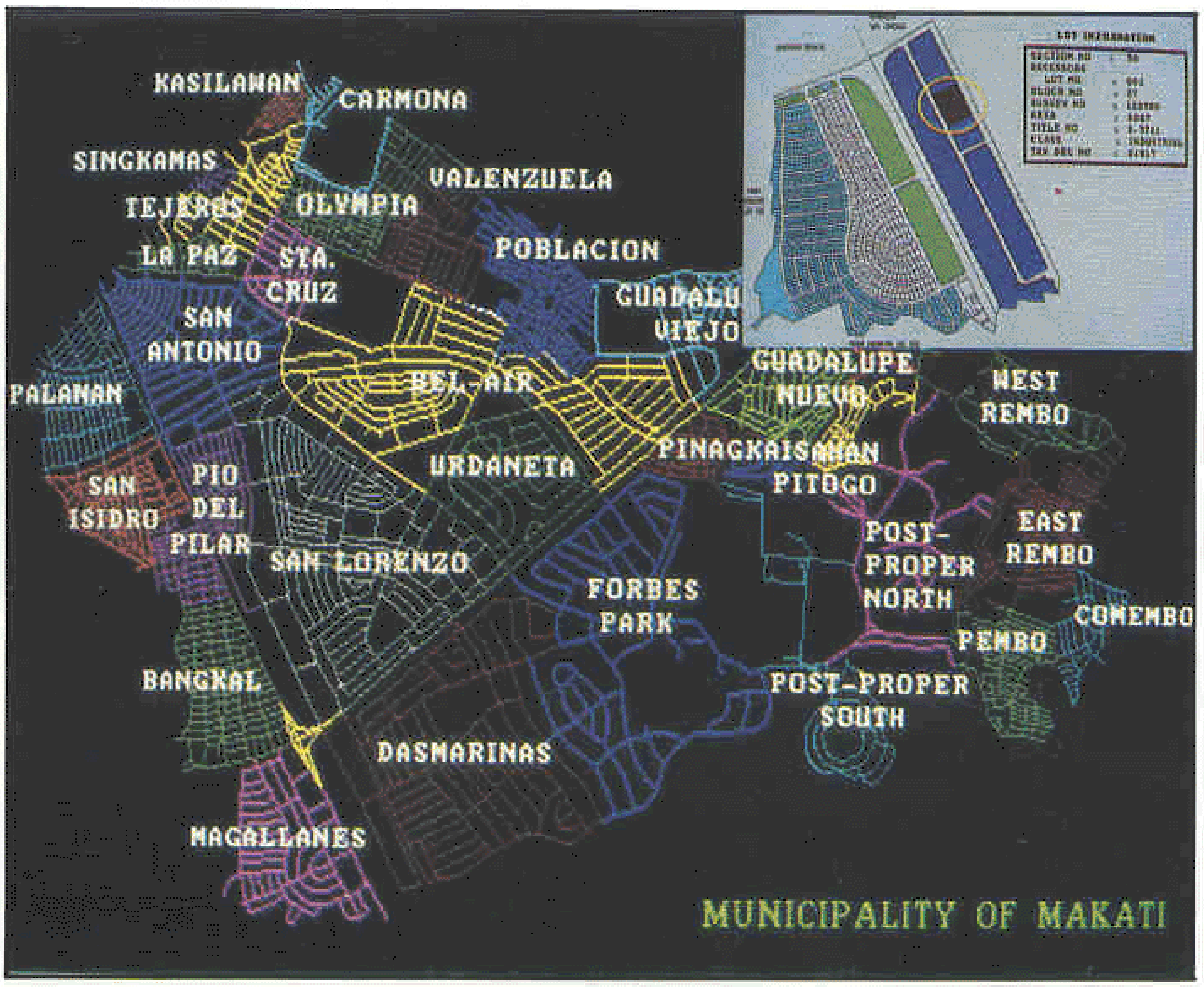
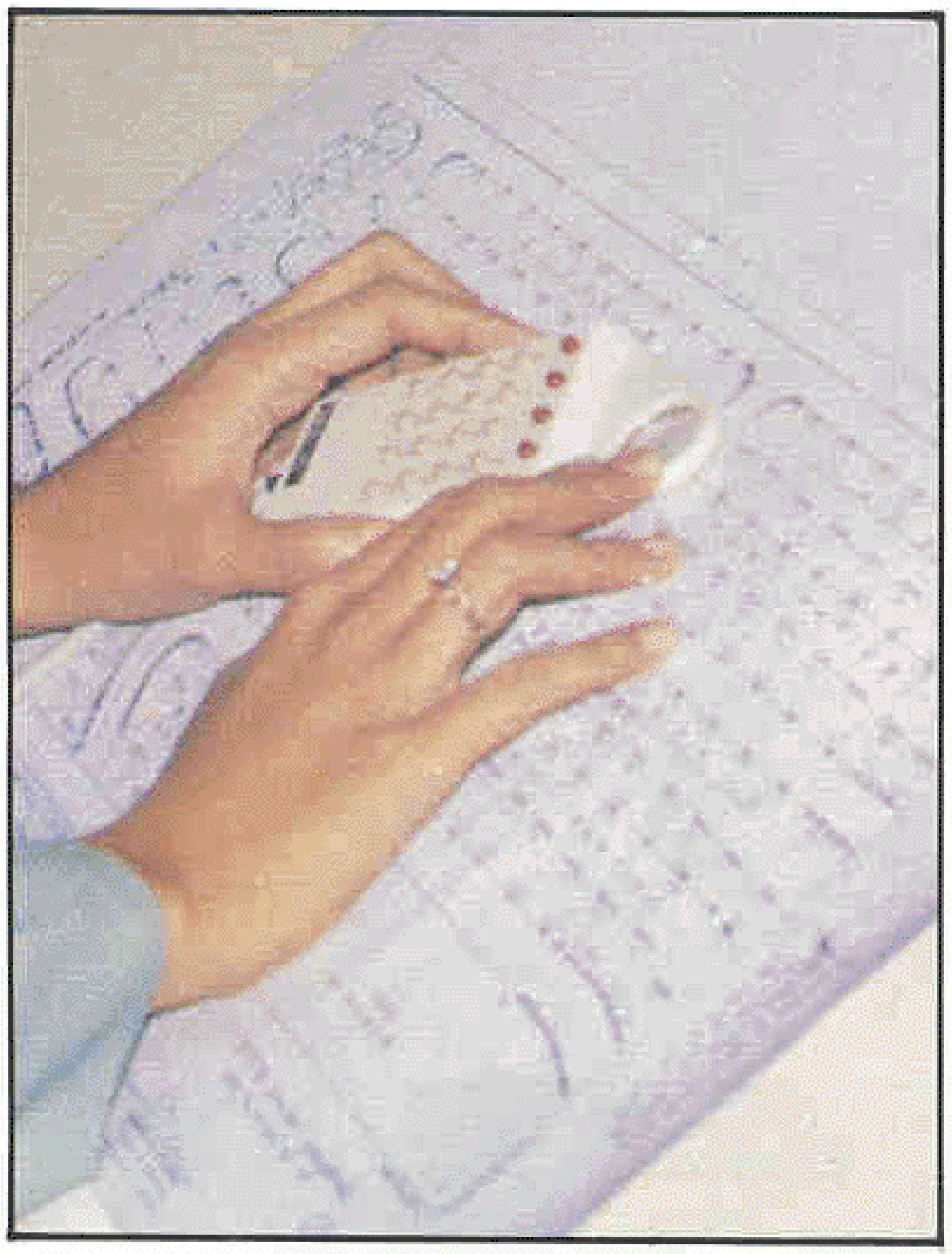
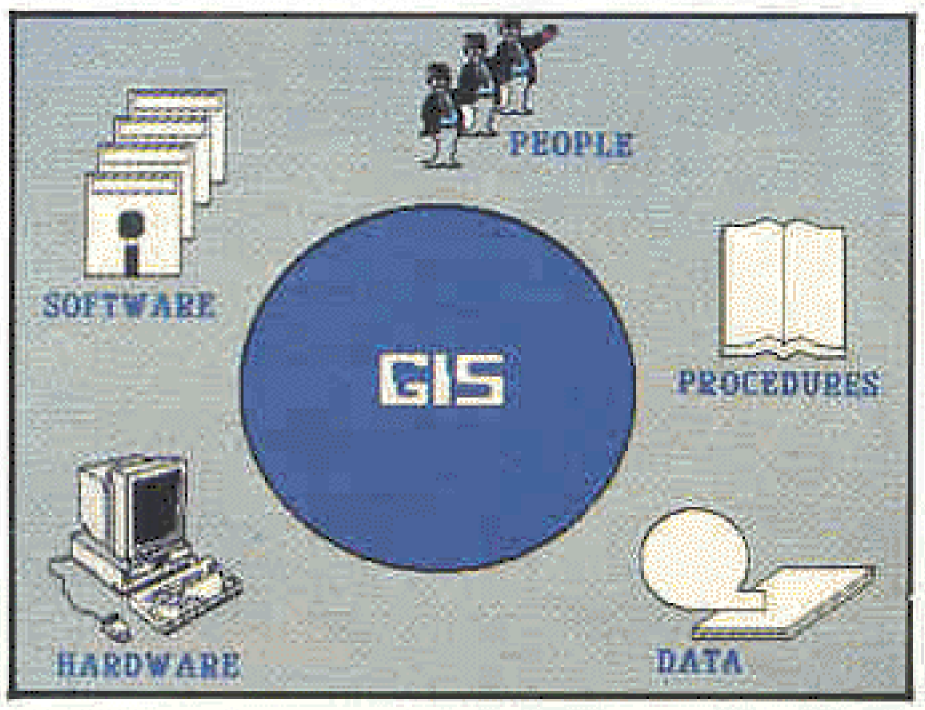
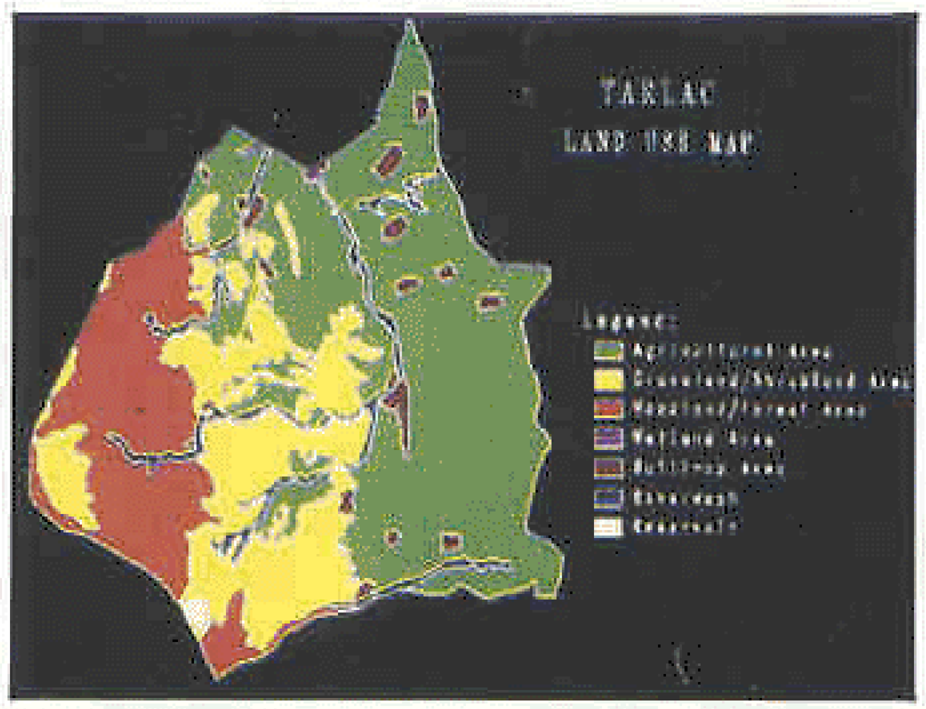
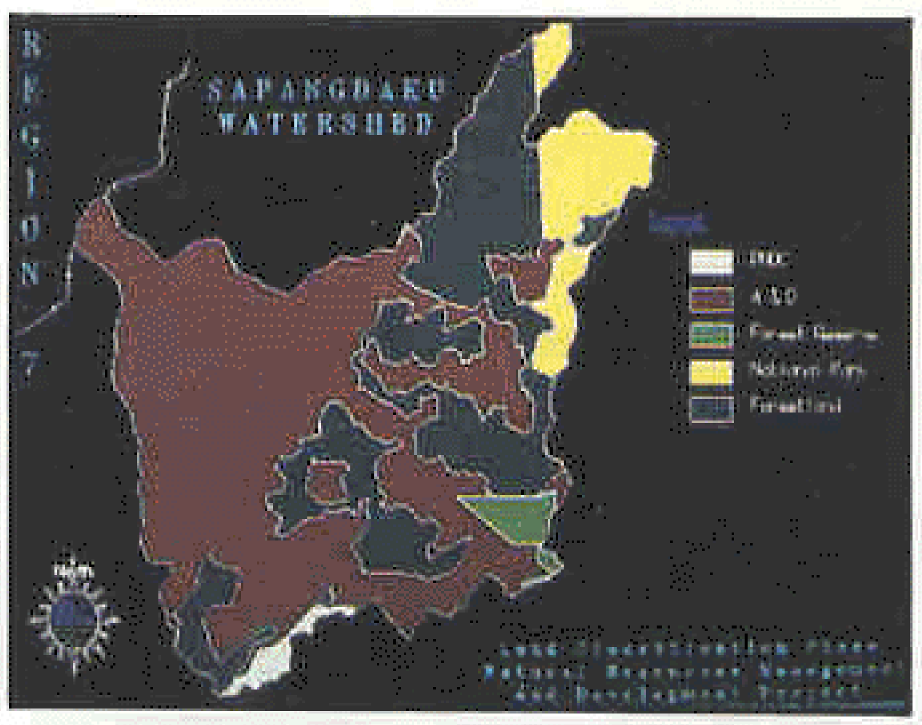


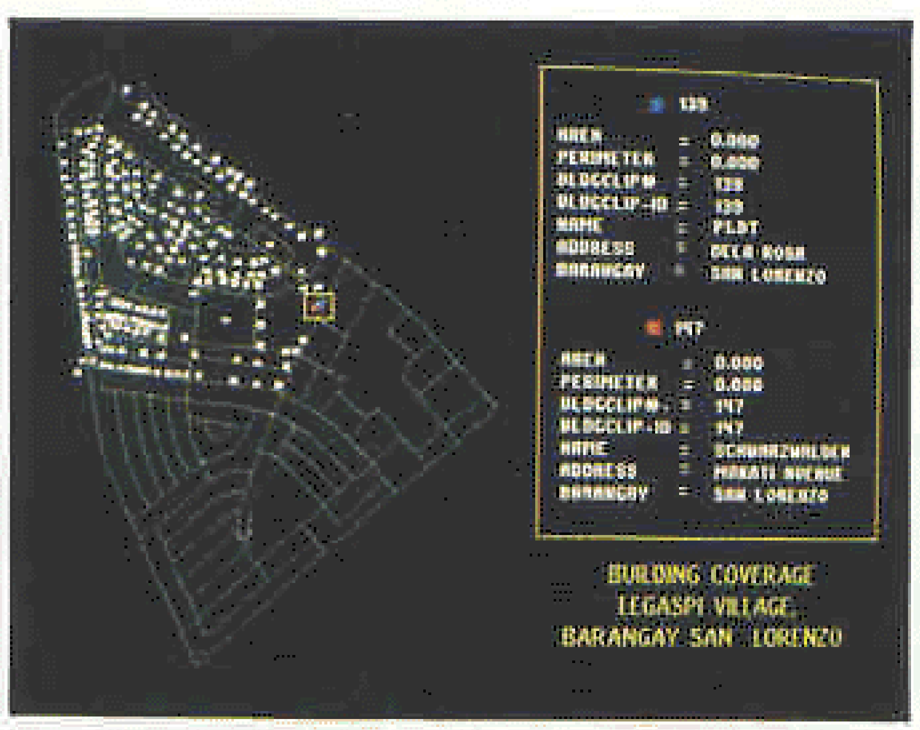




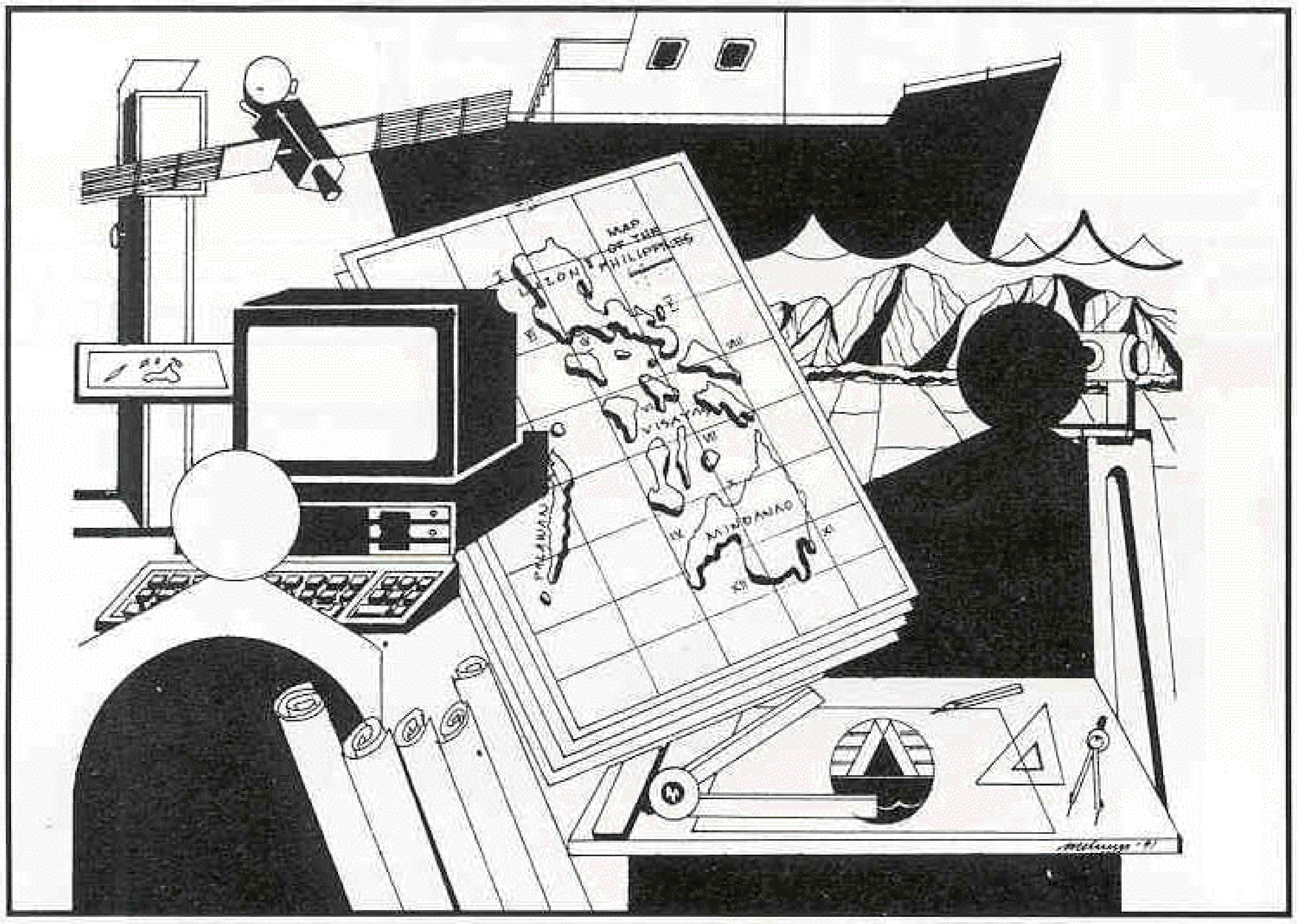








GIS - A Breakthrough in ENR Mapping



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Editorial

This is the decade of increased environmental awareness in the Philippines. While advanced countries are now aggressively implementing measures to mitigate the deleterious effects of industrial pollution, unabated population increase and unscrupulous exploitation of natural wealth, the Philippines has yet to fully grasp the significance of conserving our natural resources and of preserving an undefiled environment. Rapid deforestation, illegal fishing, destruction of our coral reefs and other marine resources continue to intensify.

In the early 80s, environmental groups and concerned individuals in the private sector took an active role in disseminating facts and figures showing the deteriorating condition of our environment. Government policy, more pronounced in the late 80s than at other times, has been moving towards a concerted effort to arrest the destruction of the nation's natural wealth through legislation and a more active pursuit of a conservation and environment protection program.

For its part, the Department of Environment and Natural Resources in 1991 is implementing an intensive Information, Education and Communication Program to make the public aware of its various conservation and environment projects. The National Mapping and Resource Information Authority, an attached agency of the department, has followed this initiative and has updated its information dissemination program. One of the program's activities is the publication of the **Infomapper Quarterly**, a technical publication that contains information vital to policy/decision makers, natural resource managers, researchers and map users in general.

The Infomapper Quarterly aims to enlighten concerned map users and the general public about the various processes that are involved in the preparation of maps. State-of-the-art and technological innovations in surveying, remote sensing, mapping and information management as applied to various projects of NAMRIA will be discussed by competent technical personnel who have had substantial first-hand experience in these fields.

While maps have been used by the natural resources manager, social scientist, businessman, student and the ordinary man on the street, little is known about the research, analysis and production that go into the preparation of a map. This is due to a dearth of relevant information materials and the absence of an integrated program to disseminate the information to interested users.

With the Infomapper Quarterly, the NAMRIA seeks to fill in this information need. This publication will adequately explain these technologies in layman's terms. Maps as vital tools in the wise utilization and management of our natural resources will also be discussed. Other environment and natural resources data here and abroad will also be featured as materials become available.

The initial issue is proof of time well spent. The articles within these pages were meticulously edited, rewritten and translated into terms which can be easily understood by the publication's target audience.

It is hoped that with the Infomapper Quarterly, the public will be made aware of various technologies involved in the generation of maps and in the efficient protection of the environment and conservation of our natural resources; thus, they will be encouraged to contribute to the government's efforts towards their wise utilization, conservation and management. ●

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Global Positioning System - An Introduction

Perhaps two of the least obvious, but nonetheless important, requisites to national development are mapping and surveying. It is a sad fact that maps and charts are not readily perceived to be the essential instruments for planning and decision-making that they are.

Realizing the need for a more organized system of map and chart production, government through the NAMRIA and industry are cooperating in the various stages of a total surveying and mapping program. In surveying and mapping large areas, it is necessary to establish a grid of **horizontal and vertical control stations*** which will serve as a reference for all surveying and mapping operations to ensure a coherent product.

The existing old **geodetic control network*** in the Philippines comprised of narrow chains of coastal triangulation extending from **Luzon Datum*** in Balanacan, Marinduque. This control network was established by the US Coast and Geodetic Survey during the period 1903-1946 primarily for the provision of controls for hydrographic survey and charting. Further development of the network to encompass inland regions was limited and it was not feasible to use conventional surveying techniques due to the nature of the terrain. The establishment of the first-order Philippine Geodetic Control Network through the Australian - RP Natural Resources Management and Development Project (NRMDP) using the Global Positioning System (GPS) will achieve this objective.

The Navigation Satellite Timing and Ranging Global Positioning System (NAVSTAR/GPS) is a state-of-the-art **satellite*** surveying technology. It is a space-based radio positioning system that operates on two **L- Band frequencies*** of 1575.42 MHZ (L1) and 1227.6 MHZ (L2).

Presently, the system consists of 18 satellites (which will eventually increase to 24) in six different **orbital planes*** orbiting the earth every 12 hours at an altitude of 20,200 km. and with an inclination of approximately 63 degrees to the equator.

The satellites are arranged such that a minimum of four will be in view to a user anytime, anywhere in the world. The constellation of satellites are tracked from known earth stations to determine the satellite orbits, which will then be transmitted to satellites for later transmission to the user.

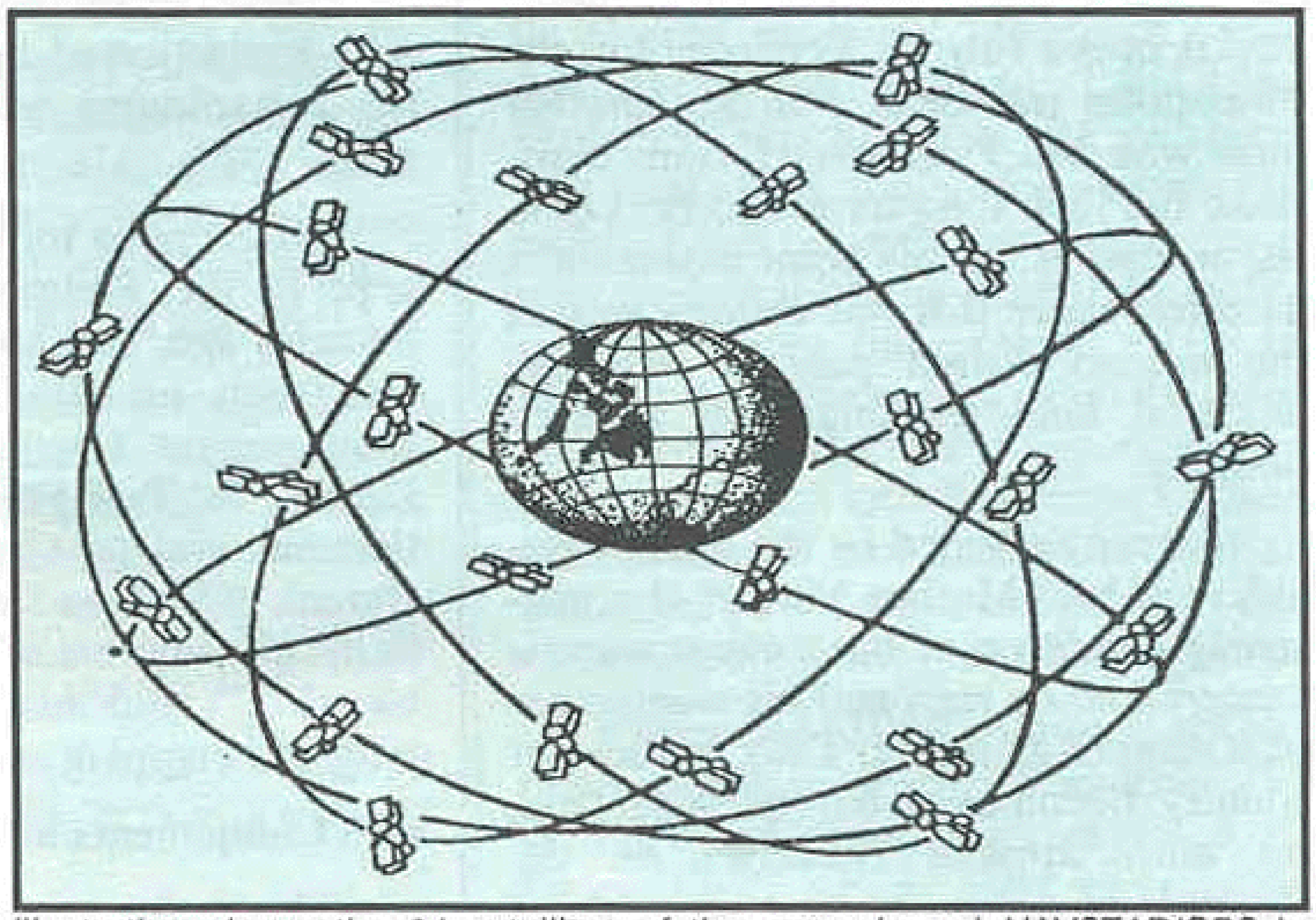


Illustration shows the 24 satellites of the space-based NAVSTAR/GPS in orbit.

The GPS system consists of three major segments:

Space Segment - this constitutes the satellites in space which transmit signals together with their modulated navigation message.

Control Segment - ground-based monitor/control stations that track the satellites and update their signals.

User Segment - receivers that passively acquire the satellite signals and interrogate them to obtain positioning and navigation information. This segment also includes software for the reduction and analysis of observed data (e.g. Trimble Model 4000 SLD GPS Surveyor).

Like its predecessor, the TRANSIT Doppler System, GPS shifts the scene of surveying operation from ground-to-ground measurement to ground-to-sky. The major difference of GPS from TRANSIT lies in accuracy and speed of operation. There are more satellites in the GPS constellation allowing continuous tracking, whereas with TRANSIT there may be ninety (90) minutes between observations. GPS satellite orbits are much higher than TRANSIT orbits, so they are less affected by local gravity anomalies. They use higher frequencies, reducing the effect of **ionospheric propagation delays***.

The conventional ways of establishing ground control points are through **triangulation***, **traverse*** and **trilateration***. These methods require about three to four days utilizing about four personnel to establish a single ground control point, while using the GPS receiver requires only one person and an hour of observation to do the same job. Because intervisibility between stations is not required, there is no need for time-consuming traversing and the extensive cutting of trees that accompany conventional surveys.

Another advantage of the GPS is that it is equivalent to a **theodolite***, an **electronic distance meter (EDM)***, and a **levelling instrument***, since it acquires precise and accurate three dimensional (x,y,h, i.e., latitude, longitude, height) ground control positions. These are just a few of the many advantages in using this state-of-the-art technology (GPS) in conducting surveys.

GPS instruments have a wide range of applications not only in geodetic control surveys but also in land surveying, topographic mapping, nautical charting, photo control, boundary and cadastral surveys, positioning offshore structures, mineral explorations and control surveys for large-scale engineering works like harbors, highways, railroads, pipelines and irrigation projects.

Certainly, the advent of the GPS has revolutionized surveying technology. Acquisition of these GPS receivers will greatly improve the mapping and surveying capabilities of NAMRIA. ●

By: Lt.(j.g.) Hernando R. Raposas, CGSD

* *Terms in bold type and marked with asterisks are defined in the Glossary of Terms on page 15.*

GIS - A Breakthrough in ENR Mapping

Still reeling from the catastrophic effects of the July 16, 1990 temblor, the Philippines was dealt with yet another blow with Mt. Pinatubo's furious emissions and their long-term effects. Looking around us, at this point in time, it is hard to believe that this country was, in the not so distant past, a rich and beautiful land teeming with nature's bounties.

Already ravaged by the unappeaseable wrath of Mother Nature, the worsening condition of our environment is exacerbated by man and his wanton exploitation of its riches. Thus, before our country becomes a barren wasteland, we must appoint ourselves as the stewards of nature to stem the tide of destruction and preserve it for our children and those of generations to come.

Geographic Information Systems

The need for more effective methods of protecting and caring for the environment and natural resources (ENR) is being realized today more than ever, with information playing a vital role in ENR planning and decision-making. This is answered with the advent of computer and other innovative information technologies such as *Geographic Information Systems or GIS*.

GIS can best be described as a computer-based technology which integrates textual or attribute data and geographic information from various sources into a system which makes it possible to store, retrieve, analyze, manipulate, and present these data for different user purposes.

GIS Through the Years

The precursor of GIS in the 1960s and 1970s was the overlaying of resource maps on light tables to identify common attributes of the different map layers. This was later adapted to computer technology through a grid-cell or **raster*** system.

During the late 70s, rapid advancements in computer technology as well as in surveying, photogrammetry, and remote sensing paved the way for the linking of spatial information obtained from these different fields into a multi-purpose system.

The 80s saw the emergence of GIS as a sophisticated information technology for resource assessment and planning.

GIS is not a totally unheard of concept in the Philippines. One or two decades ago, various government agencies such as the Natural Resources Management Center (NRMC) of the DENR, the Task Forces on Human Settlements and on Cartography, and the Bureau of Soils and Water Management have already made use of a raster-based GIS and map overlays for planning and mapping activities.

GIS Components and Structure

The major components of GIS as we know it today are computer hardware, software, and human resources/ organizations.

A. *Hardware*

Previously requiring larger computer systems such as mainframes and minicomputers, GIS now works on microcomputers (PCs) and workstations. A typical set-up consists of a Central Processing Unit (CPU) as the brain of the system; input devices such as keyboards, **digitizers*** and **scanners***; primary and secondary storage devices such as disk drive units, high capacity hard disks and floppy disks for storing data and programs, tape drive units and magnetic tapes for storing additional data; and output/display devices such as video display units or monochrome and colour monitors, line printers, plotters, and film recorders.

B. *Software*

GIS software consists of technical modules which enable the system to perform the following functions:

1. Data Input - refers to the conversion of data from maps, field observations, satellite images, and aerial photographs into compatible digital form. It includes *data capture* which involves a mixture of manual and automatic digitizing operations; *data cleaning*, and *editing*; and *geometric correction* which involves the maintenance of geometric consistency between all data planes included in the database.

2. Data Storage and Database Management - concerns the structure and handling of the data in the computer and how they are assessed and perceived by the system user.

3. Data Analysis, Processing and Manipulation - typical operations include the overlaying of different thematic maps; computation of areas and distances; obtaining statistical data on attributes; changing legends, scale and projection of maps; creation of 3-D perspective views of certain areas using elevation data, etc.

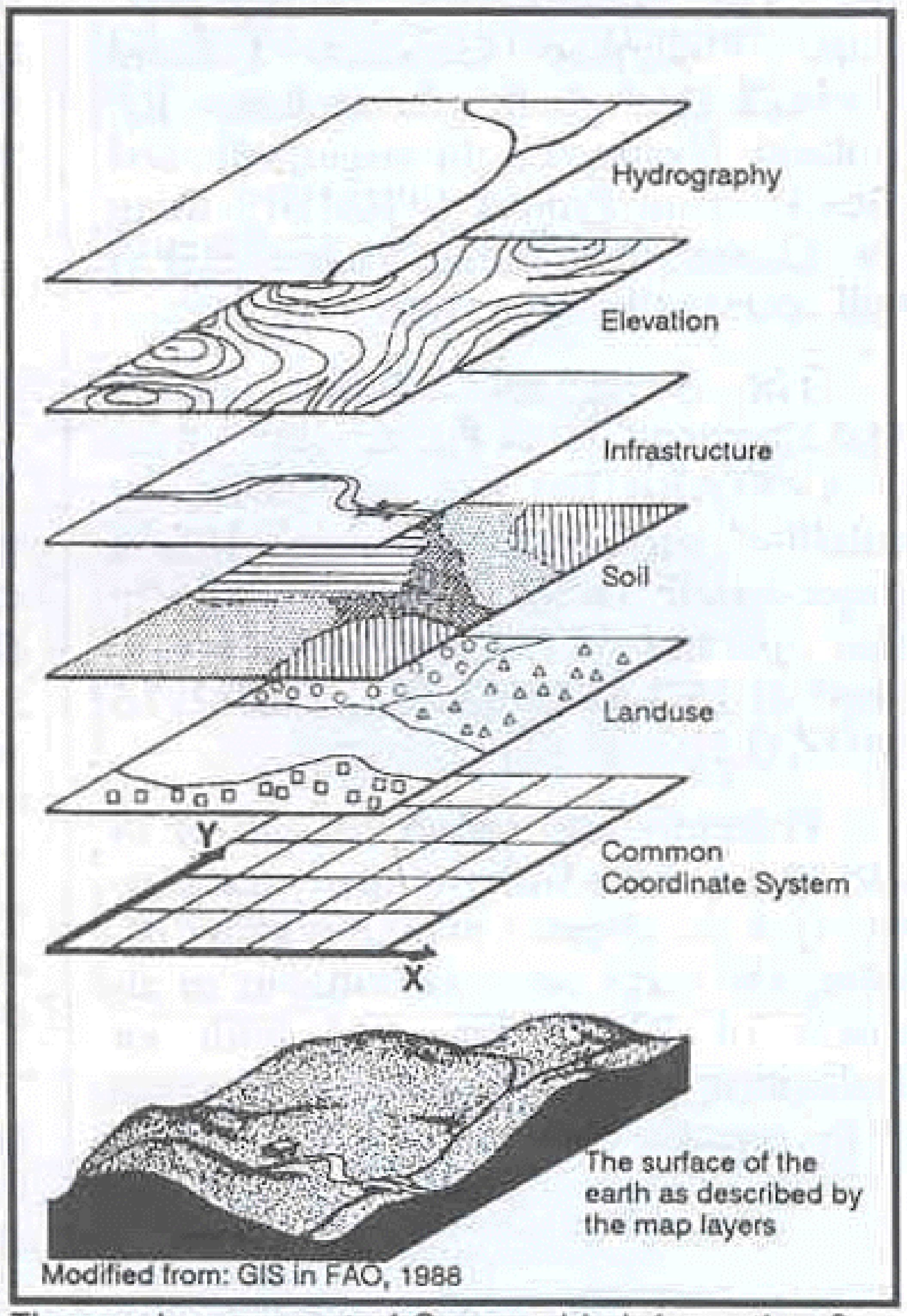
4. Data Output and Presentation - consists of the ways in which the system presents the information to the users through visual displays (soft copies) and printed maps and reports (hard copies).

5. User Interface - a function which handles user queries through features such as menu-driven command systems, icons, multi-windows, online help messages, mouse pointers, etc.

Some of the more popular commercial GIS software used locally are PC ARC/Info, TYDAC/SPANS, CRIES, and RASTA, among others.

C. *Human Resources/ Organizations*

With the increasing availability of sophisticated hardware and software, one tends to overlook the human resources aspect which is vital to the



The overlay concept of Geographic Information System.

operation of the system. It is important to know and understand the information requirements of potential users, and to ensure adequate staff training, planning, organization, and supervision to maintain the integrity of outputs.

General Characteristics and Capabilities

GIS may be considered as a revolutionary technology for the simple reason that it can provide, at a single glance, different forms of information about specific locations. Conventional ENR management methods require the manual comparison and combination of attribute data (in the form of statistics or written text contained in tables or lists) with geographic data (from maps or satellite images) to discover relationships between a certain geographic location and its particular attributes or characteristics. This would normally mean sifting through sheaf upon sheaf of documents and records, poring over kilometric statistical tables and lugging voluminous map sheets from libraries to work areas and vice-versa in order to obtain ENR information for a specific purpose.

While GIS does not guarantee the total elimination of this tedious paper chase, it can assure the user that there are lesser chances of him going through the same backbreaking process should these information be needed once more, but this time for another purpose. This is because GIS utilizes computers to store different types of data from different sources, converts them into a consistent internal format and scale within the system, and integrates them to produce entirely new information according to the desired use.

GIS also facilitates the ENR manager's use of various types of information since it can "convert maps into a computer-usable digital format and allow the simultaneous manipulation of both the geographic spatial data and related attribute data" (GIS in FAO, 1988). Thus, a combination of maps and their corresponding tabulated attributes are more rapidly produced.

The use of GIS has opened up new avenues in the field of mapping. It allows data operations and manipulations not previously possible and feasible to do. One important operation possible with GIS is *overlaying*. In overlaying, the real world is portrayed by a series of layers representing various aspects of reality. GIS overlays or arranges these layers containing various types of information (i.e., topography, soil types, roads, rivers, vegetation) on top of each other to produce a new map which integrates all the features found in the individual layers. Another important function associated with GIS is the generation of *buffer or proximity zones* around certain features of interest in a map such as streets, barangays, etc.

GIS can be used for the calculation of area which in effect reduces or even eliminates the use of manual overlays and planimetric procedures.

Thus, GIS is capable of answering the following types of questions:

1. What is the total area within a 30 km. radius of Volcano P that is settled? (buffer, calculation)

2. What areas of land in Bgy. K are A & D and susceptible to soil erosion? (overlaying)

3. Identify the total number and exact location of business establishments engaged in X line of business within 20 km. of Main Street B.

The flexibility of the system is also manifested in its capability for *spatial analysis* of resource data. Apart from the identification of nature's attributes, it also describes these in terms of their position and relation to a known coordinate system, and in terms of *topology* (the position of an object in relation to another which is unaffected by changes in an object's shape or size). The analysis of spatial relationships is important because an accumulation of unrelated digital data is worthless without any form of referencing.

GIS also functions as a means of integrating and updating/revising maps made of different scales, projections, or legends.

Applications

The international scientific community has found multifarious applications of GIS in natural resources management and planning, geographic data collection and production, resource allocation, route and flow optimization, facility and asset inventory, map and chart publishing, site location planning, and many others.

The Philippines has not lagged behind in the application of GIS. Among other public and private organizations using this technology, the NAMRIA is one that has found this information system useful in many of its undertakings.

One of NAMRIA's projects utilizing this system is the "Research on the Application of GIS to Land-based Statistics" which makes use of spatial and statistical data for monitoring building and business permits, tax mapping, and establishing street information systems. Under this project, a GIS for Makati was developed, and its major outputs are: a query and report generation system for lots, buildings, business establishments and streets; plotted tax maps and street maps classified by type of jurisdiction and type of accessibility.

Other NAMRIA projects utilizing this technology are the "Determination of Suitable Upland Agricultural Areas Using GIS" which aims to produce maps showing the conditions and suitability of upland areas for agriculture, agroforestry, and other farming purposes and the "Application of GIS to Soil Erosion Susceptibility Mapping" whose objective is to analyze through GIS erosion-susceptible lands in Palawan.

NAMRIA is also involved in the Natural Resources Management and Development Project (NRMDP), an Australian-assisted project whose primary goal is to contribute to better economic and social conditions through the improved management of natural resources and land utilization. One of the project's sub-components, the Natural Resources Management Information System (NRMIS), illustrates the effective use of GIS in creating a model under which the flow, dissemination, quality, and effectiveness of resource information in the DENR is improved.

The project is implementing an Integrated Resource Management Process Pilot (IRMPP) on two watershed areas in Regions 2 & 7 respectively. The IRMPP is divided into the following phases: a) Land Classification Phase; b) Resource Use Framework Planning Phase; c) Subclassification Phase; and d) Resource Use Priority Planning Phase. The staff is now on the third phase. A downstream project for the nationwide establishment of the NRMIS is also being designed. As of 1990, the NRMIS has already completed a preliminary database design, converted satellite data to PC ARC/INFO, conducted GIS training courses in Manila, and sent some of its

To p. 14 GIS - A Breakthrough ...

Synthetic Aperture Radar, a Flexible Way

The July 16 earthquake which focused the attention of the world on the Philippines may now be just a vague memory to most people, but its effects are difficult to ignore. Suddenly, people have become conscious of earthquakes and the severity of the aftermath. Literally, the earth moved. Its surface and structure was altered, its "face" changed. Another disaster of such magnitude will be, to say the least, tragic.

The government, realizing the enormity of the disaster, has taken active steps towards recovery through its Earthquake Rehabilitation Program. NAMRIA, as an attached agency of the Department of Environment and Natural Resources (DENR), has been tasked to assess the extent of damage not only to properties but to the environment in general. One of the activities being undertaken towards this goal is the conduct of aerial photography of the stricken areas.

Being a tropical country, the Philippine skies are consistently cloud-covered, making it difficult for remote sensing systems such as Landsat and SPOT satellites to collect timely data sets of high quality. This is where the Synthetic Aperture Radar (SAR), which has been included as a component to NAMRIAS's P15,000,000.00 Aerial Photography Project, comes in.

Certeza Aerophoto Systems, Incorporated, a local affiliate of Intera Technologies Ltd., of Canada won the contract to undertake the survey of 9.3 hectares in Luzon, the hardest hit area. Intera will utilize the STAR-I Synthetic Aperture Radar System. STAR-I is the only commercial digital airborne synthetic aperture radar system in the world and has been operational since 1983. It is a lightweight, digital, fully-focused X-Band SAR carried in a twin prop-jet Cessna Conquest aircraft.

Data collection using SAR is carried out by imaging a swath to one side of the aircraft, called a "side-looking" mode, while flying at approximately 9,000 meters above sea level. During acquisition, SAR data are recorded on board the aircraft in digital form using High Density Digital Tapes or HDDT, while being displayed in real time on dry silver paper. Using the real time display, the radar operator monitors the image quality in flight and makes changes to the mission plan if so required. The data then are later transcribed into computer compatible tapes (CCTs). From these, analogue or digital products are created.

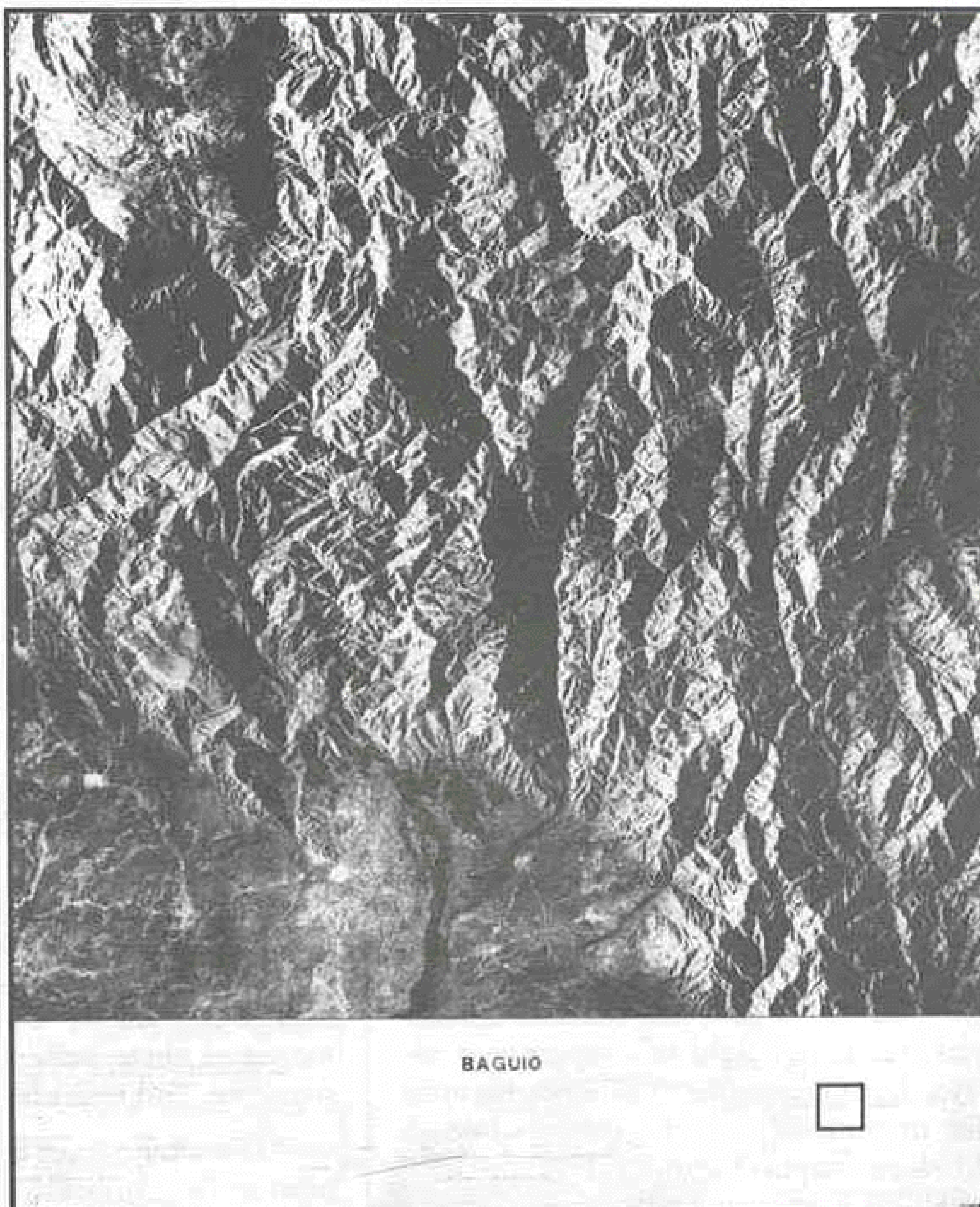
STAR-I data may be carried in two modes: standard **resolution*** and high resolution. Standard resolution allows data acquisition over a large area in a cost-effective manner at a lower resolution level using a wider swath. The high resolution mode provides increased resolution, but using a narrower swath, thus having more flight lines.

Several flight lines can be digitally assembled in a mosaic to show a regional view of the area. The large area covered by a mosaic allows regional analysis of geological structure and provides a base map for organizing other information required in the early phases of an evaluation. One advantage of SAR data is its flexibility to be combined with other sensors such as aeromagnetics and satellite imagery because of its digital format. This combination provides a more complete picture of the structure governing earthquake activity in the surveyed area.

Radar* data have been used for over two decades to provide detailed information on land surface features. Because of the high sun angle in tropical areas, optical (visible) sensors (satellite and airborne) are restricted by limited shadow causing the terrain to appear "flat". SAR solves this impediment through its "side-looking" radar which creates artificial shadowing, enabling the detection of faults, strikes and subtle geologic structures otherwise not obvious or even visible in other data sets due to high sun angles.

The primary effect of damage from earthquake activity is ground shaking. The farther an area is from the fault zone, the lesser the degree and length of shaking. Loosely compacted, water-saturated sediments, specially in landfills, have a tendency to liquefy during earth-quakes. This results in the loss of cohesion, which in turn causes **subsidence***, fracturing and/or horizontal sliding of ground surface material. This is common in very steep, rugged and heavily vegetated mountainous areas with moderate to high annual rainfall. These areas are susceptible to landslides, rock falls and mud-flows, occurences that are common with earthquake-related faulting.

Through the use of SAR imagery, surface fracture lineaments which may

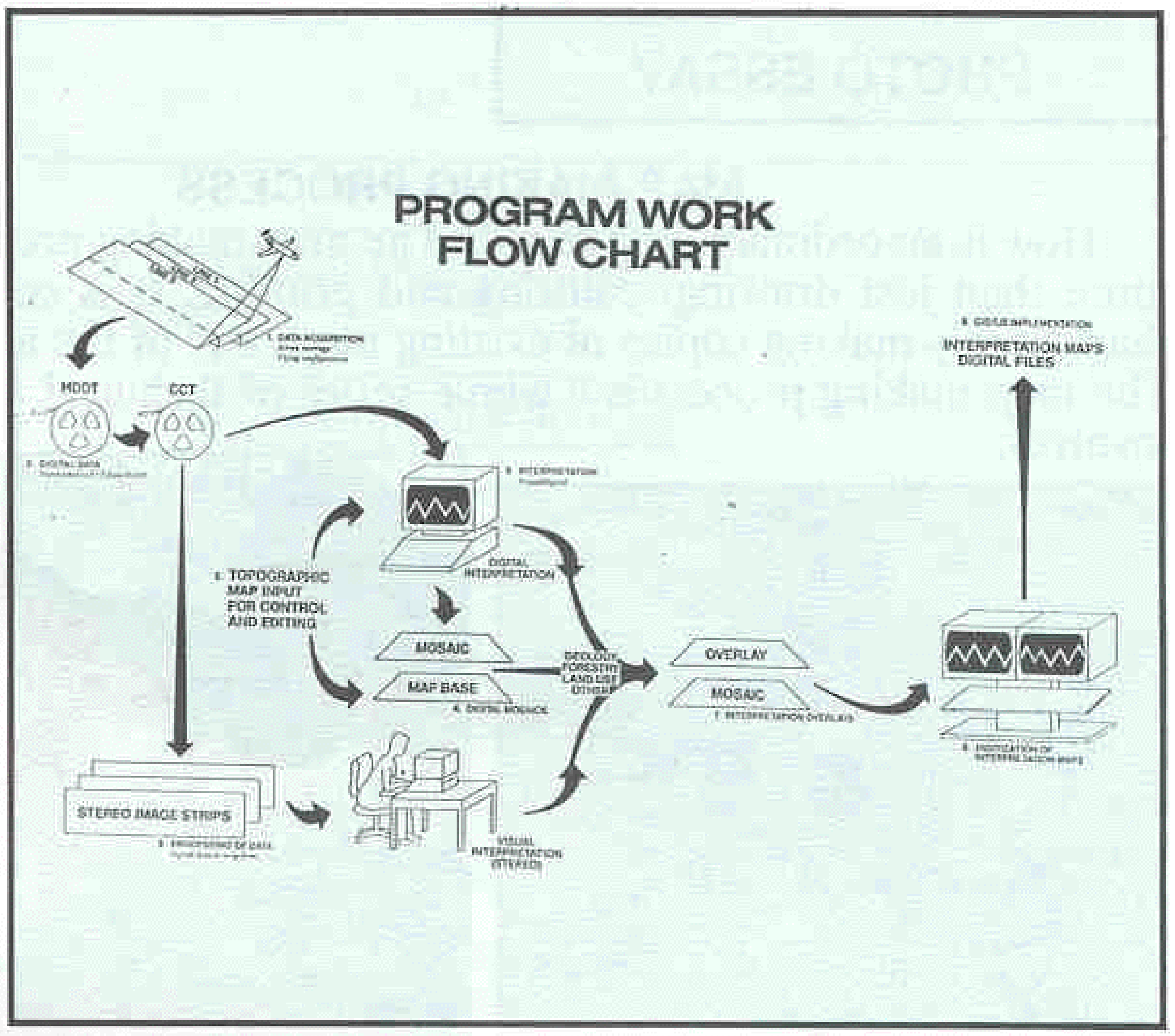


Mosaic of high resolution SAR digital image of Baguio City showing structural features such as faults and fracture lineaments.

be expressive of near surface extensions related to deeper seated faults may be effectively interpreted and evaluated. Areas of unconsolidated alluvial and unstable landfill may also be identified. Though the sources of earthquakes are deep, surficial extensional features along with ground checking can identify areas hazardous to human habitation and activities. Using SAR imagery interpretation, the following surficial expressions indicative of faulting related to earthquake activity can be identified:

1. Local slumping and land scours;
2. Rock falls, rock and soil slides;
3. Mudflows through liquefaction of muds on high slopes;
4. Large scale sand boil features;
5. Lateral spreading of stream course or increase in stream gradient; and
6. Offsets in lithologic units, geologic structures, geomorphic landforms and cultural features such as roads, railroad tracks, and others.

Intera has developed its radar imaging capability to produce higher resolution imagery which allows for more versatility in the enlargement of the digital radar data. Thus, radar imagery is not only useful as a tool for damage assessment, but also as a tool for planning and redevelopment in regions with unstable structure.



As of April this year, the project has been 100% accomplished with the survey of the damaged 9.3 hectares in the Luzon area. Mosaics, which are necessary in the construction of a base map and allow the analysis of geologic structures and other information for evaluation have also been partially delivered. ●

By: Jocelyn P. Salud, IMD

JICA, NAMRIA Embark on 3-year Cooperative Project

The Japan International Cooperation Agency (JICA) and the NAMRIA drew the blueprint of a joint project entitled the "Mini-Project- Type Technical Cooperation on Hydrographic Surveying and Nautical Charting in the Republic of the Philippines," or simply, the JICA-NAMRIA Project.

Before the inception of the Project, Japan has been giving assistance to the Coast and Geodetic Surveys Department (CGSD) of NAMRIA through experts, group training courses in hydrographic surveying, nautical charting and equipment. From such undertakings, the CGSD personnel have benefited immensely, but because of the scarcity of modern equipment, they have had little opportunity to apply what they have learned. In July 1989, during a seminar on "Hydrographic Surveys and Tide and Tidal Currents" held at the CGSD, it was keenly felt that an On-the Job-Type Training should subsequently be conducted to substantiate the transfer of technology. Thus, the project was conceived by the Government of the Republic of the Philippines and proposed to the Government of Japan.

In response to the Philippines' request, a series of meetings was held last year by the resident representative of JICA in the Philippines and a visiting team of Japanese experts with officials of the CGSD. The discussions crystallized into the 3- year period of cooperation between the two governments from May 1, 1991 to April 30, 1994.

The highlight of the project is the development of human resources in the field of hydrography by imparting modern techniques in hydrographic surveying and nautical charting to the CGSD personnel. This will be done through the production of updated nautical charts of the port of Puerto Princesa and its approaches. These are located near the international shipping route off Palawan Island and used as a shelter from typhoons. Updated large-scale nautical charts with more accurate bathymetric and other information obtainable from modern survey equipment and techniques will become available. This will greatly contribute to navigational safety measures for vessels, as well as economize shipping operations in harmony with the Philippine Master Plan on Maritime Safety.

Japan will provide at its own expense machinery, equipment and other materials, and the training of one or two Filipino counterpart staff in Japan annually. The Philippines, for its part, will provide land, transportation and other facilities for the use of the experts, meet running expenses necessary for the implementation of the projects, assign counterparts, and other measures.

The project was officially started with the arrival on July 15 of four Japanese experts in hydrographic surveying. Repairs have been done on the Puerto Princesa pier and harbor surveys were made as preliminary activities. The RPS Arinya, one of the three hydrographic survey vessels of the CGSD will be utilized.

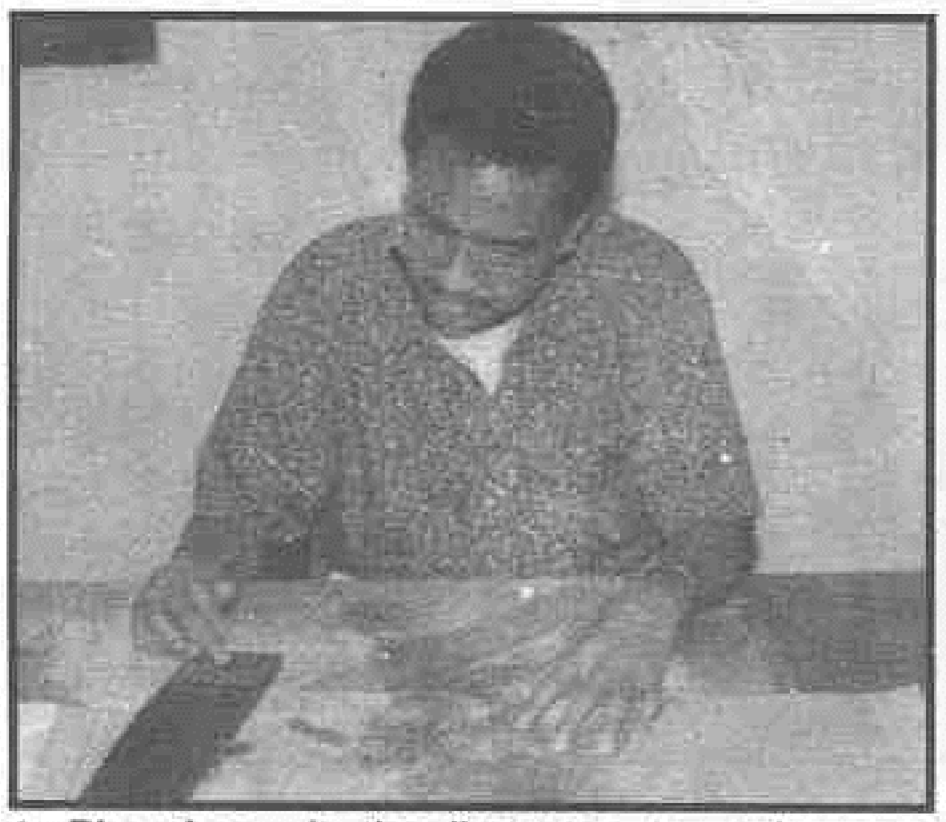
Through this project, a new era of good relation between the hydrographic authorities of the two countries is envisioned, as well as the enhancement of the capabilities of the CGSD personnel as they put into practice the technical know-how that will be transferred through Japanese experts and group training courses. ●

PHOTO ESSAY

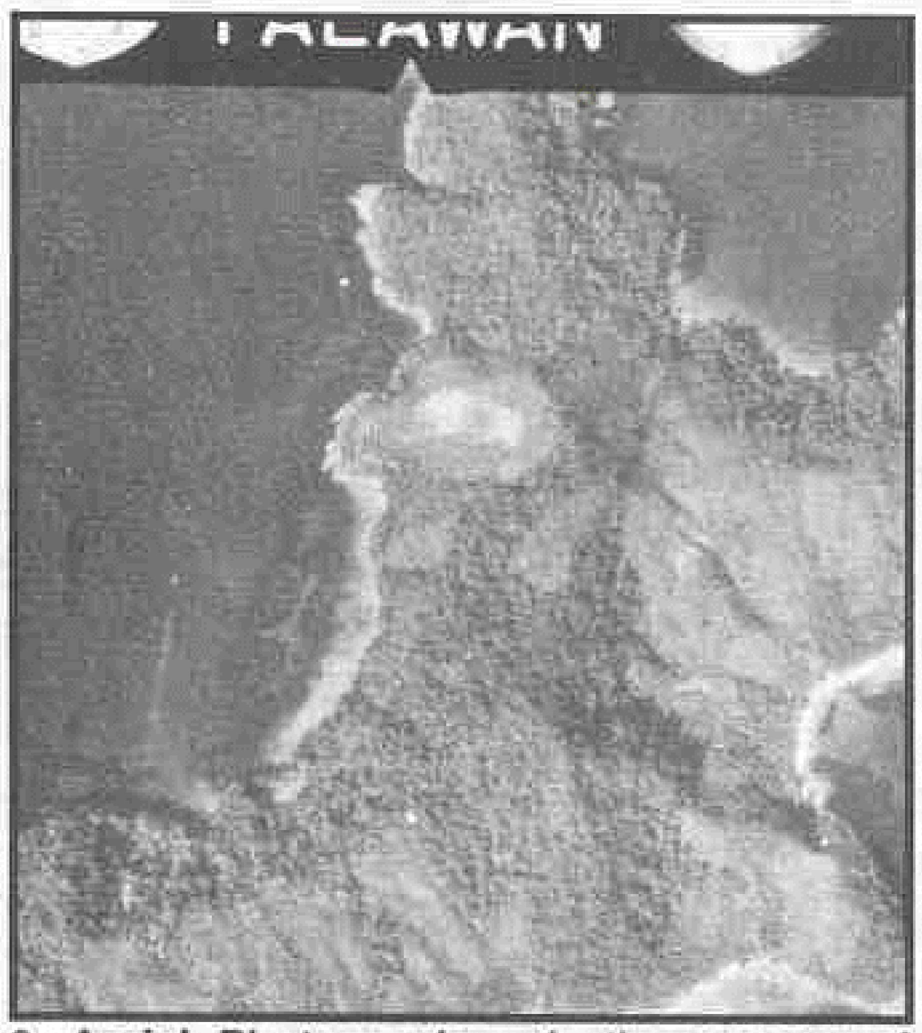
Topographic Map-

MAP-MAKING PROCESS

How is an ordinary map made? The map-making process involves more than just drawing, coloring and printing. It is so much more than merely making copies of existing maps and of the actual terrain. The map-making process is a whole series of technical activities that involves:



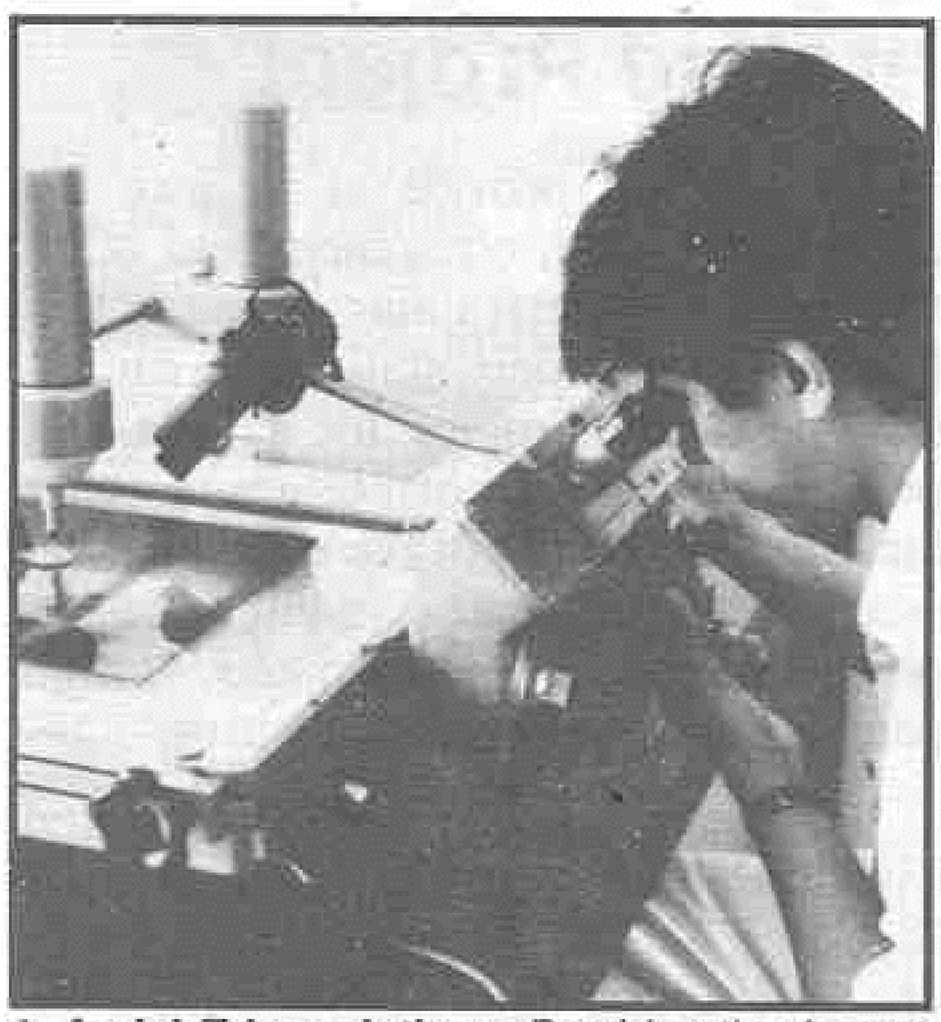
1. **Planning** - Is the first step towards map-making. It takes into consideration.the area to be mapped, the method(s) to be used, the size and scale of the map, the accuracy desired, the details to be shown, the cost involved, the length of time to finish the map, the prospective users and other relevant information.



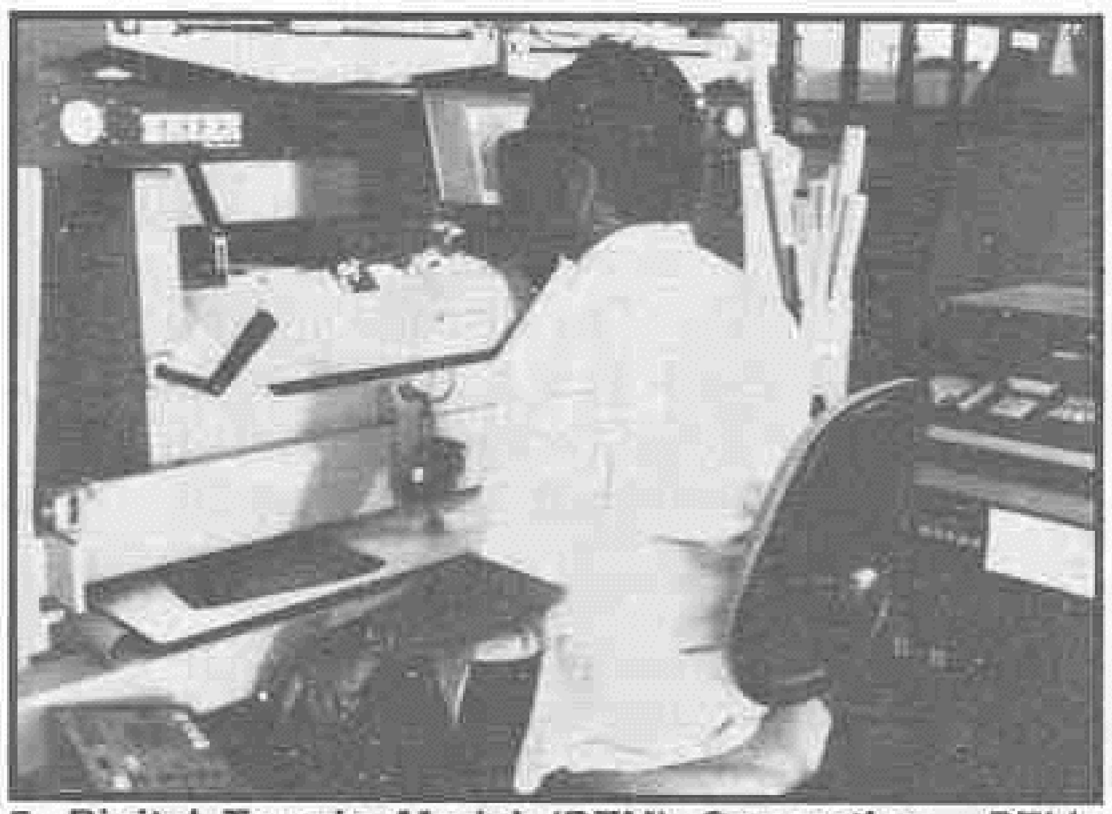
2. **Aerial Photography** - is the process of taking photographs of an area to be mapped from an airplane flying along straight parallel courses called flight lines. These lines are spaced at such a distance that pictures taken at short intervals completely cover the area in a manner suitable for mapping purposes.

3. **Control Survey** - Aerial photographs, being flat representations of the terrain, have to undergo control survey. Control survey involves the determination of the horizontal position (location) and the elevation of a systematically distributed set of points. These points, identifiable in the photographs, are determined using ground survey methods.

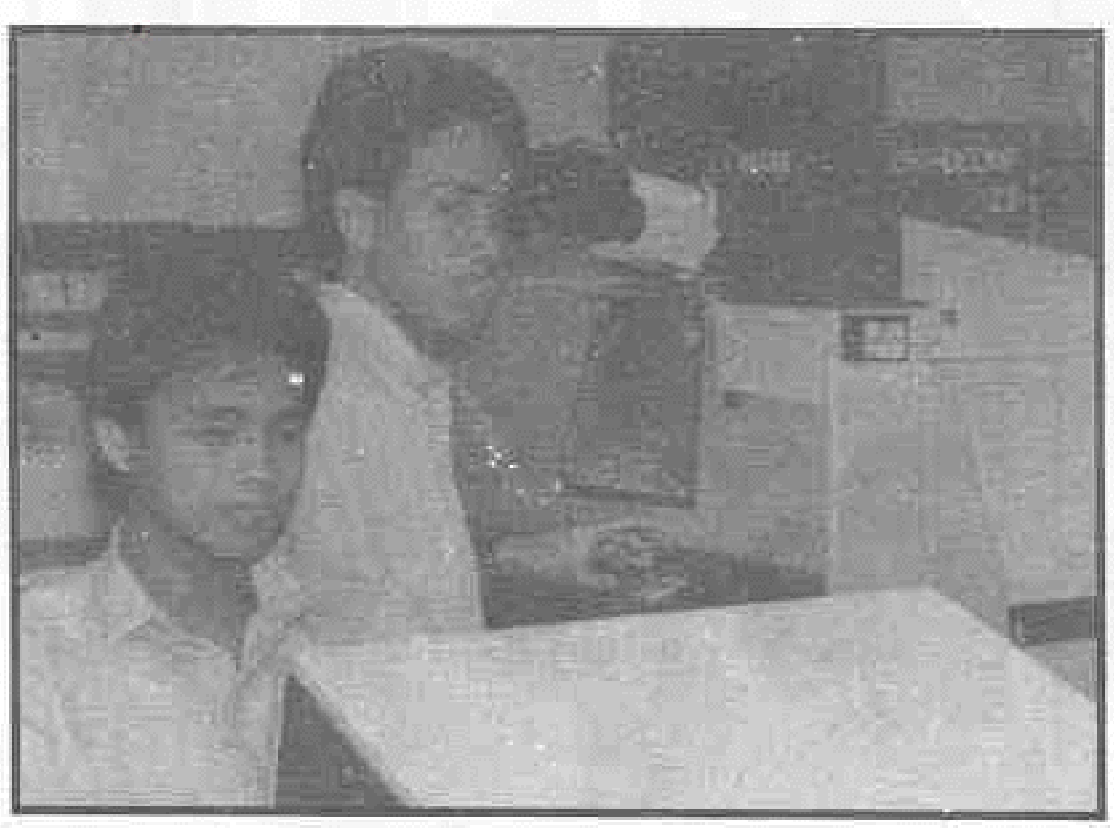
Grcund survey is the act or operation of making measurements for determining the relative positions of points on, above, or beneath the earth's surface.



4. **Aerial Triangulation** - Provides the fastest way of densifying control points. It is done mathematically with the use of computers and software programs. All models are corrected since during the exposure photographs may have been tilted or shifted relative to the ground. This is due to the inability of the pilot to keep the plane steady and on course. The process provides the adjusted coordinates on model points needed in the preparation of the map sheet where the actual drawing takes place.



5. **Digital Terrain Model (DTM) Generation** - DTMs are numerical representations of the terrain containing the X, Y, and Z coordinates of a dense network of points, hence showing a three-dimensional (3D) model. The DTMs are processed using computers to generate automatic contour lines and 3D models, as well as automatically drive the orthoprojector during scanning.

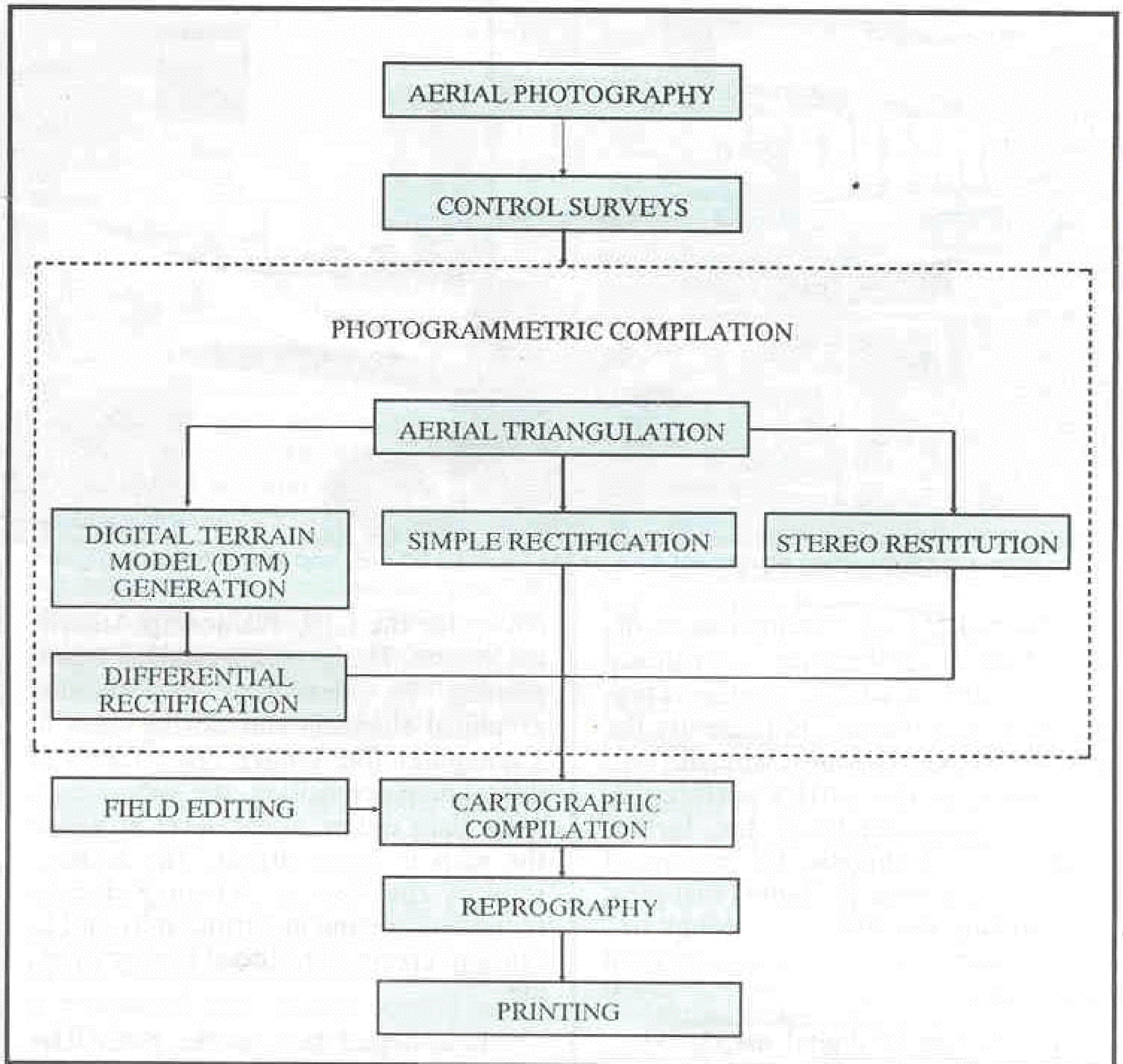


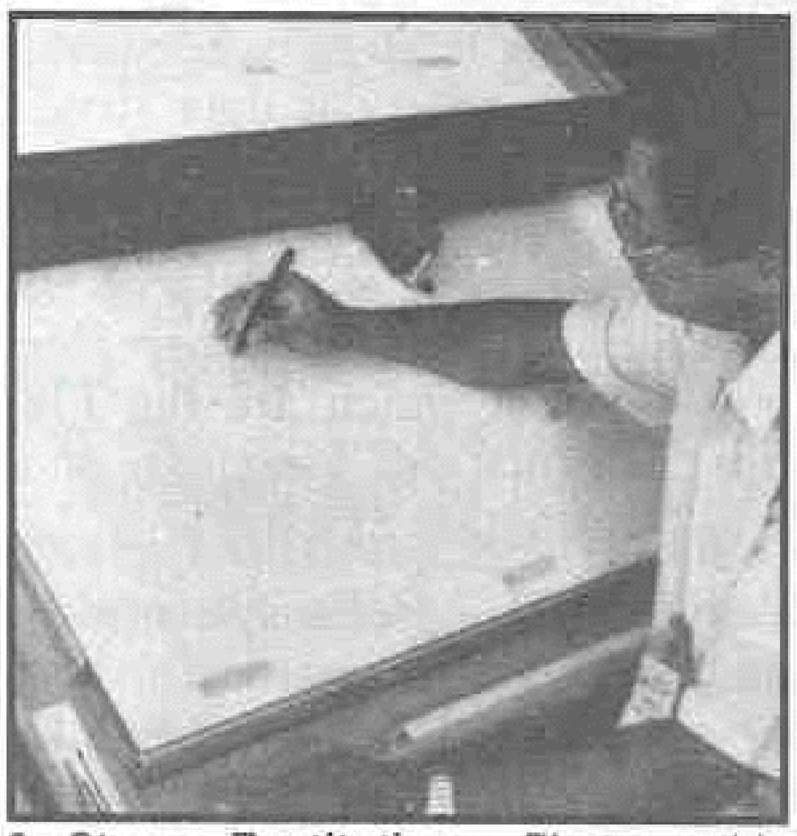
6. **Differential Rectification** - Rectification is the process of projecting a photographic image to a horizontal plane in order to remove displacements due to tilt.

Differential rectification is used when the differences in area are relatively large. It entails the production of a photograph wherein the effects of tilt and relief displacement, which are inherent qualities of an ordinary aerial photo, are eliminated. The result is an orthogonally or vertically projected photograph having the qualities of a planimetric map. Contours and other map information are added to complete the topographic map.

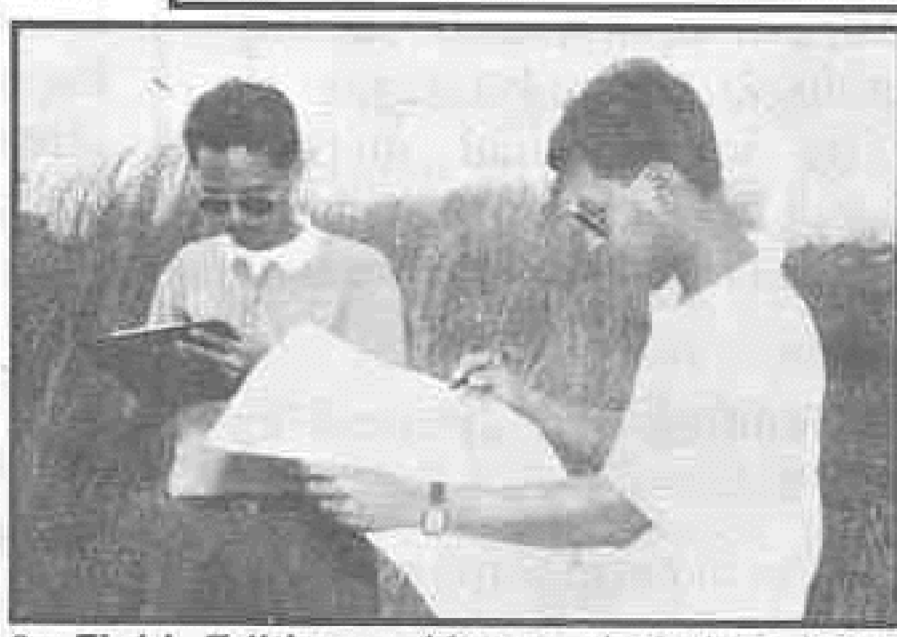
making Process

7. **Simple Rectification** - This is used for project areas which are flat or where the differences in elevations are relatively small. It provides a very rapid means of producing a photo map for development planning and for other purposes in which accuracy of measurements is not of primary importance. The output is called a rectified photograph.





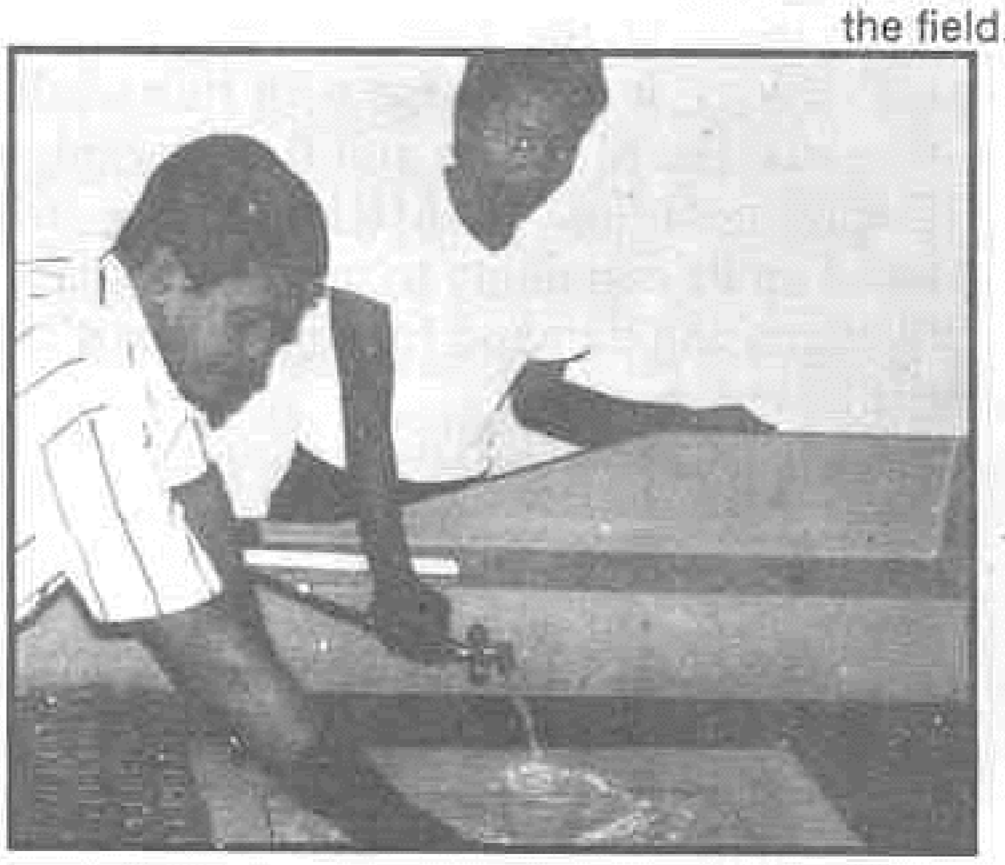
8. **Stereo Restitution** - Photographic details are captured or transferred onto the map through the use of stereoplotters to graphically represent the terrain. Stereoplotters are used for plotting a map by observing an overlapping pair of aerial photos. Planimetric features are represented by appropriate lines, symbols and annotations while relief is represented by contour lines and spot heights. The output is called the map manuscript.



9. **Field Editing** - After a draft has been made, accuracy of the map manuscript is double-checked through field editing. Survey teams go to the area for a verification of hydrographic, vegetative and actual features, especially those of doubtful interpretation.

This is the process of checking the completeness and accuracy of the map manuscript in the field.

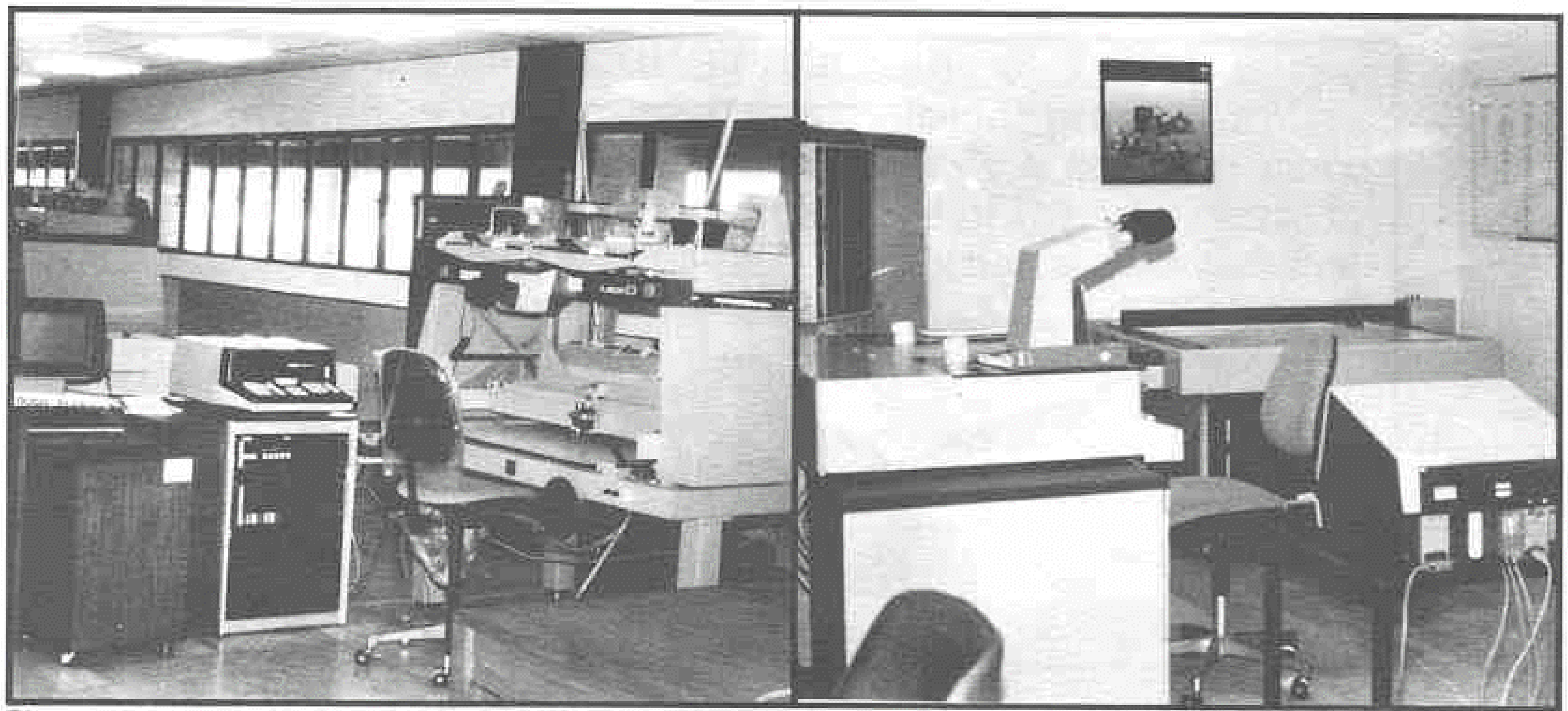
10. **Cartographic Compilation** - This process deals with transforming the compiled manuscript into a format that is cartographically and scientifically comformable, as well as aesthetically acceptable and understandable. It includes such steps as map sheet lay-out, editing, scribing, names placement, masking and color separation. Outputs are called map reproducibles.



11. **Reprography** - This involves the enlargement or reduction of map reproducibles using the camera technique and contact printer for reproduction at equal scales. It includes platemaking for input to final printing.

12. **Printing** - Reproduction of the map in multiple copies for distribution.

Planimap - An Initial Step Towards Digital Mapping



Photos show digital mapping equipment such as the Planicart E3 (left) and the Orthocomp (right).

The digital map - defined as an organized set of cartographic data stored on computer readable media representing a map image - is presently the most flexible and the most versatile representation of the earth's surface because of its availability for further processing and analysis. Its process of production, known as digital mapping, is alternately referred to as computer-assisted mapping or computer-assisted cartography.

The history of digital map production covers several decades. The production of maps with computer assistance met initial success in the 1950s. During the mid-1970s, significant application of the technique in actual map production took place. With the advent of relatively affordable computer hardware in the 1980s, computer-assisted mapping for large scale projects not only became practical but economical as well. Today, in support of the rapid advancement in the technology of Geographic Information Systems (GIS) and other geographically referenced data bases, digital mapping has already received and continues to receive extensive usage and acceptance in the international mapping community.

With the proven success of digital cartography and in the pursuit of solutions to effectively deliver correct and updated map information to the public, NAMRIA took a small but very significant step towards digital map production. The Mapping and Reprography Department of NAMRIA acquired the ZEISS program PLANIMAP as part of its software updating for the C100 Planicomp Analytical System. The program enables digital plotting by measuring and coding graphical elements and storing them in a computer file. Unlike other forms of digital map acquisition, the system captures data online at the level at which the map is being drawn. The method reduces the loss of accuracy due to secondary tracing in cartography and to random errors introduced during printing.

It is hoped that as the NAMRIA acquires more computer-assisted mapping technology, the advantages experienced by international mapping institutions will likewise be experienced by the Authority. Some of these advantages are:

1) rapid editing and dynamic updating of map data;

2) reduction in cartographic work;

3) flexible output possibilities, e.g. display, fine drawing, quick plots, etc.; and

4) integration of additional information with relative ease, such as natural resource surveys and utilities and facilities data.

Unfortunately, the system has not yet been ideally set-up. A severe limitation of the current set-up is the lack of an interactive graphical station for editing which should consist of a cartographic digitizer, an interactive visual display and an appropriate software to support it. The progress of plotting is checked by simultaneous graphical output on a digital tracing table. Editing is performed by using the tracing table to digitize the erroneous point and a search program to locate the object containing the transmitted point. The operator is thus limited to simple corrections on the position of points, lines and polygons. Functions such as object shifting and rotation, relative movement of a group of objects, cleaning, enhancement and edge matching are likewise not supported by the existing editing program.

Another disadvantage of the system is the data structure at which the map details are stored. Data storage is based on a simple data structure called the "line-map" model which stores points, lines and objects as strings of coordinates. While this is already adequate for mapping purposes, the data structure can not be used conveniently for spatial information analysis. It still can not properly support geo-referenced data bases requiring digital topographic bases, examples of which are the FIS (Facilities Information Systems) and LIS (Land Information Systems).

However, a comprehensive updating of photogrammetric instruments has already been planned and approved. In the proposed environment, the use of the software will be more ideal and most of the problems initially encountered will be eliminated.

PLANIMAP, the software for digital mapping currently being used, is still far from being the solution to NAMRIA's problems in map production. As crude as its stage of utilization may be, it nevertheless serves as a sufficient introduction to computer- assisted mapping. It also marks the initial step of the Authority in the direction of digital cartography. Finally, with the rapid advancement in the field of information technology, it is likewise with this small step that the Mapping and Reprography Department of NAMRIA hopes to build up its capability to meet the rapidly increasing demand for digital maps in the future. ●

By: Roberto R. Clerigo, MRD

Tides in the Philippines

The word "tide" refers to the periodic rise and fall of sea water associated with the gravitational attraction of the moon and sun acting upon a rotating earth. This is characterized by the gradual advance and recession of water at the shorelines, due to which a horizontal movement of water called *tidal streams* results.

The direction of the current reverses according to the rising and falling of tides. The inflow of water towards a locality is called *flood* and the outflow is called *ebb*. The magnitude of the current tends to be minimum when both tidal extremes are about to occur while the maximum current occurs within the period of falling and rising tides.

Without the effects of other factors such as wind, temperature, and density variation, tides are consistent mobilizers of current that continuously circulate water around the globe, enhance nutrient exchange and mixing, and minimize pollution, among many others. Tide characteristics of Philipine waters have varied cycles: from *diurnal* (one tide cycle a day), *semidiurnal* (twice), to a *composite* (mixed diurnal and semidiurnal) tidal regime. The locality of Lingayen Gulf (La Union) is diurnal while the rest of the Philippine west coast is composite with diurnal dominance. The eastern, southern, and interior Philippine waters are composite with semidiurnal dominance and with an isolated diurnal dominance at the localities of Pangutaran Group of Islands including Jolo (Sulu Arch.) and Surigao Strait.

The fortnightly modulation of tides is influenced by the phase of the moon. The maximum tidal range is attained one to two days after the full moon and new moon *(spring tide)* while the minimum range *(neap tide)* is observed when the moon is at its quadrature (e.g. first and last quarter).

The seasonal sea level variation in the Philippines is strongly affected by the monsoon. During the **southwest monsoon***. (June-August), it is usually noted that the mean sea level is generally above the annual mean (averagely +10 cm.) with the maximum sea level noted in Manila (+19 cm. for 1986). This is the reason why there are tidal floodings in some low lying areas even during normal days within this period. On the other hand, during the **northeast monsoon*** (October - December) it is the opposite and the effect is extended to the month of February by the easterly winds. This will eventually result in exposed shoals that are hazardous to sea crafts.

The normal tide oscillation is mostly distorted by the occurence of a storm. The tropical depression in itself can cause the water level to rise accordingly with the decrease of the atmospheric pressure *(storm surge)*. For every decrease of 1 millibar (1 hpa) in atmospheric pressure below the mean atmospheric pressure, there is a corresponding 1 centimeter rise in water level (Heaps, 1967). This phenomenon, commonly known as *inverse barometer effect*, can perturb the sea level above the normal tide.

The most critical instance for the **estuarine*** and coastal areas is the occurrence of a typhoon coinciding with the highest level of spring tide. With the induced blow of a strong wind and the atmospheric depression brought about by the storm, the mass of water that has accumulated can smash coastal areas and can bring unimaginable damage due to overflooding.

This incident was noted when a typhoon struck Cagayan on 23 October 1987. Water level in the locality rose up to 1.20 meters above the normal tide. It should be borne in mind that the recorded water level is a response inside the stilling well of the tide gauge in which the kinetic energy of the current and the potential energy due to the spontaneous change in water level is minimized. It could be extrapolated therefore that the actual water level could be higher than that of the recorded level. The surge was likewise sensed even down to the latitude of Surigao and the damage was not limited only to the coastal areas but to the offshore and inland communities as well.

The potential harm brought by a calamity like this can be minimized by the proper understanding of tides. The NAMRIA has monitored and studied tides and has published Tide and Current Tables to help coastal and maritime communities.

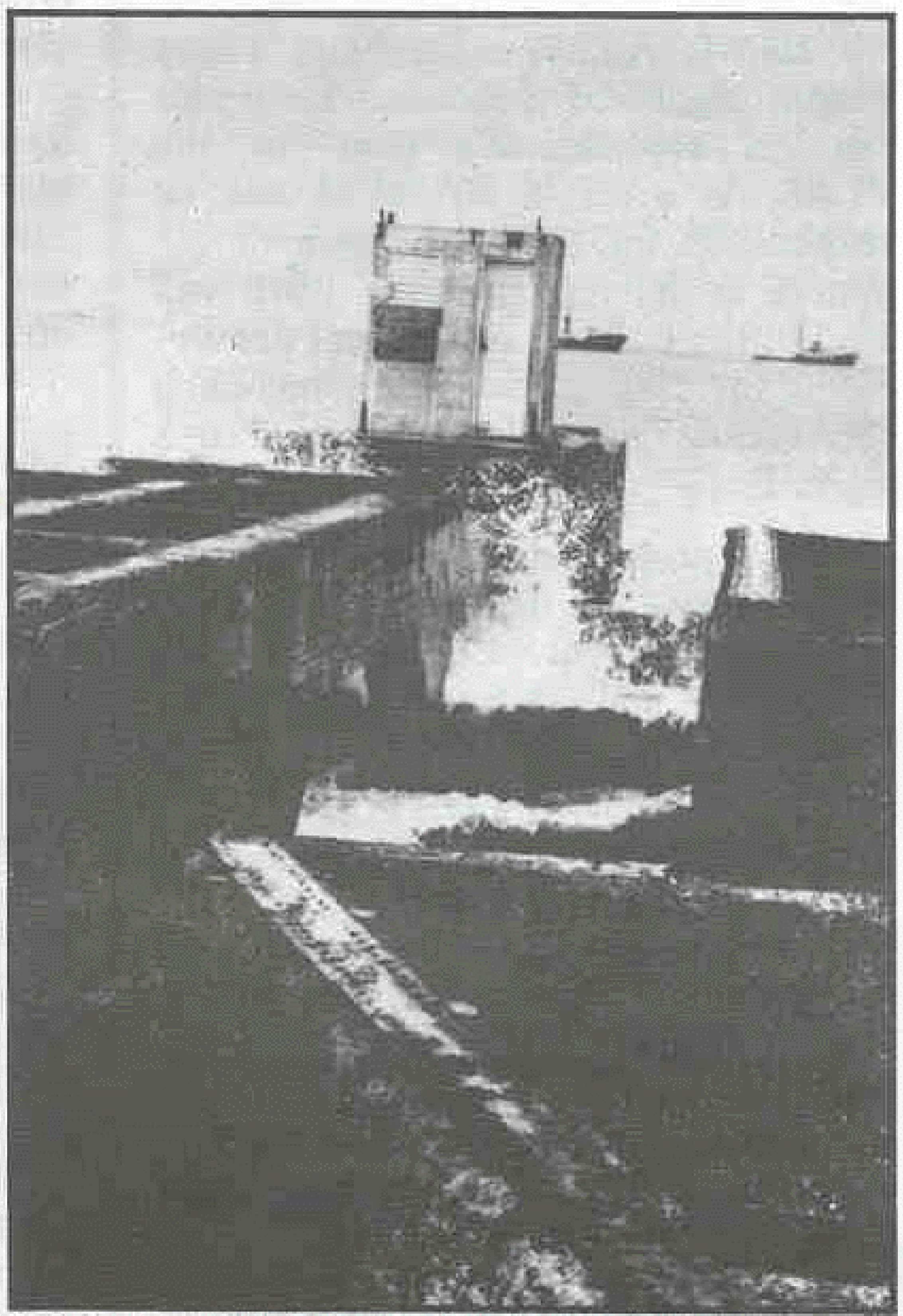
Tides, being periodic in nature, can be predicted. The Tide and Current Tables contain predicted tides and currents of about 270 stations intended to help people anticipate the beneficial and disastrous effects of tides on navigation, the considerable effects of storms to tide and sea level, and many others. Furthermore, it contains astronomical information such as solar and lunar characteristics to supplement tidal information.

Knowledge of tides is very helpful in legally defining tidelands; demarcating sea-land boundaries; establishing nautical chart datum and other tidal data such as Mean Lower Low Water (MLLW), Mean Sea Level (MSL), etc.; coastal engineering; and resource management. If knowledge in tidal dynamics is harnessed properly, tides can be a good source of energy, food production, transport, and recreation. ●

By: Lt. (j.g.) Steve S. Abalayan, CGSD

Reference:

Heaps, N.S. Storm Surges. Oceanography and Marine Biology - An Annual Review, 5, pp. 11-47, 1967.



The rise and fall of sea level and other tidal data are observed by NAMRIA through tide stations distributed in major Philippine ports.

NAMRIA develops Public Land Application Systems for LMB

The NAMRIA and the Land Management Bureau (LMB) concluded the Land Management Development Project in June 1990. The project came out with the Public Land Application System (PLAS), a computerized system that will facilitate the access of information for public land applications such as free patents, homesteads, sales, and leases among others. It contains data on application (number, term, date, purpose, status), lot (project number, area, location, present land use), and applicant (name, address).

The system is designed to monitor the status and whereabouts of application in the DENR Regional Offices where the PLAS will be implemented and maintained. The LMB Central Office which was the site of the pilot test will now become the central depository of all applications nationwide. The PLAS will also be used by the Statistical Reporting System of LMB and the DENR Planning Services for monitoring and evaluation services.

DENR Assistant Secretary Elisea Gozun organized a meeting to formulate an implementing plan for the PLAS. As a result, NAMRIA will be responsible for the installation of the system in the regions while LMB will lead in the training of regional personnel on the usage of the system including the coding instructions using PLAS Form 1.

The project started in 1986 as a joint effort of the then Natural Resources Management Center and the Bureau of Lands. After the government reorganization, the project was turned over to the NAMRIA and LMB. ●

CONTRIBUTIONS

The National Surveys, Mapping, and Resource Information Technology Quarterly (Infomapper) is accepting contributions for its forthcoming issues. Manuscripts should be typed, double-spaced and must indicate the author's name, position, and office/home addresses. Photographs and illustrations with captions are also welcome.

The Editors reserve the right to edit materials submitted. ●

Levelling survey of earthquake-stricken areas completed

The CGSD has completed its report on the results of the levelling survey conducted in Barangay Sabangan in Binmaley, Pangasinan; Barangay Narvacan in Agoo, La Union; Barangays Alaska, Sta. Lucia, Samara and Sto. Rosario in Aringay, La Union, and Dagupan City. The survey was conducted to determine any vertical shift of landmass caused by the July 16, 1990 earthquake in these areas.

Results of the preliminary survey showed that these earthquake-stricken areas are still above mean sea level. La Union and Pangasinan have 0.76 meter mean high tide and areas in these provinces with 0.76 meter or less elevation will be prone to flood particularly if high tide coincides with heavy rains.

Bench marks* established in the area during previous surveys by the former Bureau of Coast and Geodetic Survey (BCGS) were located and survey teams used these as reference points in checking the elevations of these earthquake-stricken areas.

Bench marks are placed on permanent objects to serve as datum or reference level for tidal observations or in surveying. Since these marks have defined elevations based from mean sea level or other datum, their vertical displacement or movement due to earthquake would indicate probable landmass or tectonic movements in the area.

Results of the survey in Dagupan City indicated that two bench marks have sunk. These are: the bench mark located at the City Hall that has sunk by about 15 centimeters from its old elevation of 1.632 meters to 1.482 meters, and the bench mark situated at the east bridge across Dantol River along Fernandez Avenue that has sunk by about 8.4 centimeters from its old elevation of 3.257 meters to 3.173 meters. An analysis of the results confirmed reports that these areas have sunk.


A CGSD team surveys a river in Dagupan City, Pangasinan to determine bench mark level changes after the July earthquake.

In contrast, bench marks located in barangays Mayombo, Tambac and Bolosan, east of Dagupan City, have risen from about 3 to 13 centimeters and the bench marks in barangay Lucao, south of Dagupan City, have also risen to about 10 centimeters.

In La Union , the Damortis-Aringay road with a length of 9 kilometers sunk from 10 to 15 centimeters.

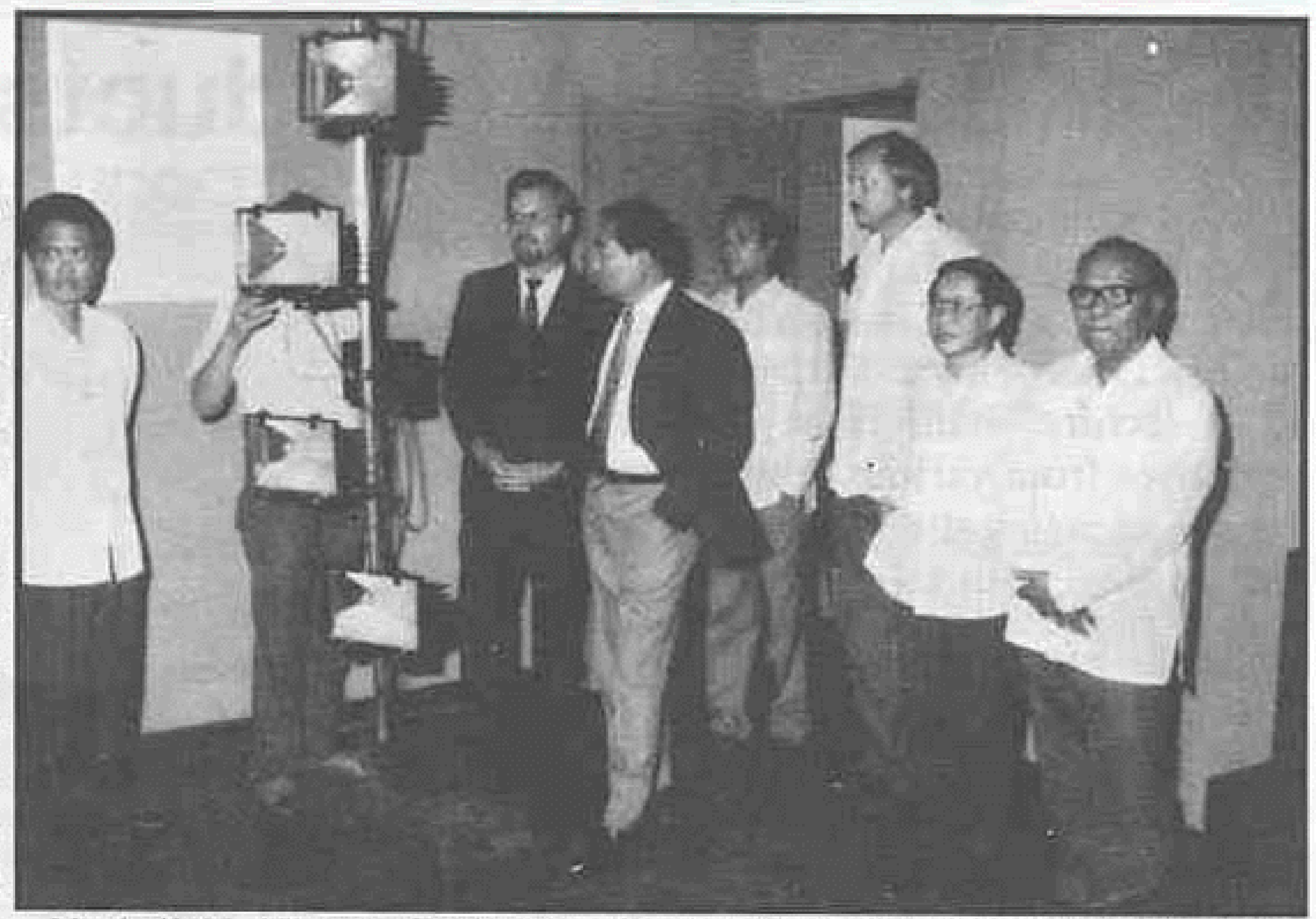
Likewise, in Lingayen, old bench marks near the shore were observed to have sunk by 20 centimeters. In the inner areas near the poblacion, minimal vertical shifting was observed.

Findings of the survey showed that the July 16, 1990 earthquake has caused vertical shifting of landmass in some areas in La Union, Dagupan and Pangasinan.

In the report, the level line in Dagupan City and Agoo, La Union was recommended to be connected to **first-order level lines*** and/or to the tide gauge at San Fernando, La Union, as the entire Pangasinan-La Union area was affected by subsidence and **liquefaction***. Connecting the level lines to the **Mean Sea Level (MSL)*** at San Fernando is the best way to ascertain the actual elevation of the affected areas. A copy of the report was submitted to the DENR for information and guidance. ●

By: Lt.(j.g.) Hernan Raposas, CGSD

Reprographic process camera installed at NAMRIA



Mr. Leifold, Klimsch Technician (partly hidden by camera lamp), shows operating mechanism of the repro camera to guests and NAMRIA officials.

The NAMRIA received last 16 April 1991 a KLIMSCH REPROGRAFIKA P (reprographic process camera) valued at P2.7 M from the government of the Federal Republic of Germany (FRG) through the German Assistance for Technical Cooperation (GTZ).

The reprographic process camera was installed at the Reprography and Printing Division of the Mapping and Reprography Department of NAMRIA in connection with the National Cartography Center Project (NCCP), a joint undertaking between the governments of the FRG through GTZ and the Republic of the Philippines through NAMRIA. Among the FRG's contributions for the project is the provision of technical equipment to NAMRIA.

The KLIMSCH REPROGRAFIKA P will augment NAMRIA's map making facilities in establishing self-reliance in the continuous production of updated maps. The reprographic camera which is a computer-assisted high precision equipment has the capability to perform various reprographic processes such as halftone, line and screen work needed for map production. It is a special darkroom camera in horizontal construction used for industrial reproduction and reprodrafting. The camera is equipped with electronic digital control for automatic sizing and focusing as well as for exposure.

Under the NCCP, NAMRIA has already received various photogrammetric and printing equipment. These equipment are now operational and have been producing orthophoto and topographic maps covering areas in Ilocos, Sorsogon, Cebu City, Bicol, among others at 1:50,000 and 1:250,000 scale. The project will be completed by June 1992.

Present during the installation were Conrad Capell, Counselor from the German Embassy, NAMRIA Administrator Jose G. Solis together with Helmut Muenzing, head of the German Advisory Group of the NCCP, Project director Rodolfo Villanueva, NAMRIA Director for Mapping and Reprography Department Jose Galo P. Isada and other NAMRIA officials. ●

DORIS beacon project in NAMRIA

The Philippines through the NAMRIA became the 22nd member nation to participate in the Determination Orbitography for Radio Integrated System (DORIS) beacon project. The DORIS orbitography beacon was installed at the NAMRIA premises on 5 April 1991.

The DORIS project is an international network of transmitter beacons that carries geodetic and geophysical data of a satellite station receiving feeds from 38 other such stations around the world. The beacon transmits to the SPOT 2 satellite information allowing very precise orbit determination and accurate determination of reference points.

The heart of the DORIS system is a radio receiver that accurately measures the carrier frequency of incoming signals. The system has two main functions: 1) it determines satellite positions to within 10 cm. and 2) it serves as a high-precision absolute or relative location system allowing a wealth of applications demanding accurate location measurements for a long period of time and is free of local environmental constraints.

The powerful beacon is very essential to NAMRIA's geodetic surveys. DORIS's absolute location accuracy improves the accuracy of existing geodesy networks, tying regional **geodetic datums*** into a worldwide geodetic reference system. It demarcates maritime frontiers in a single reference system, tying islands into a worldwide geodetic reference system. It also facilitates geometric corrections to support satellite remote sensing imagery.

The DORIS project will also be of great benefit to the practice and application of seismology, geodynamics and volcanology (concerning volcanic eruptions, tectonic faults, landslides).

In seismology, DORIS can be used to study displacements associated with seismic events and pre-and-post-event deformation on the ground. In geodynamics, DORIS can be utilized to study the movements of **lithospheric plates*** in regions of high **seismicity*** and, on a broader scale, it monitors the drifting and internal deformation of **tectonic plates***. In volcanology, DORIS will be used to measure surface deformations between eruptions.

The DORIS integrated satellite-based orbit determination and radio positioning system was designed and developed by the Centre National d'Etudes Spaciales, French Space Agency (CNES), Groupe de Recherche de Geodesie Spatiale (GRGS) and the French National Geographical Institute (IGN) to meet new needs in precision orbit determination and high accuracy beacon location.

As host of the 39th beacon, the Philippines, through NAMRIA now has access to highly valuable scientific data. A cooperative venture between the Philippines and the IGN is expected through NAMRIA's involvement in the project.

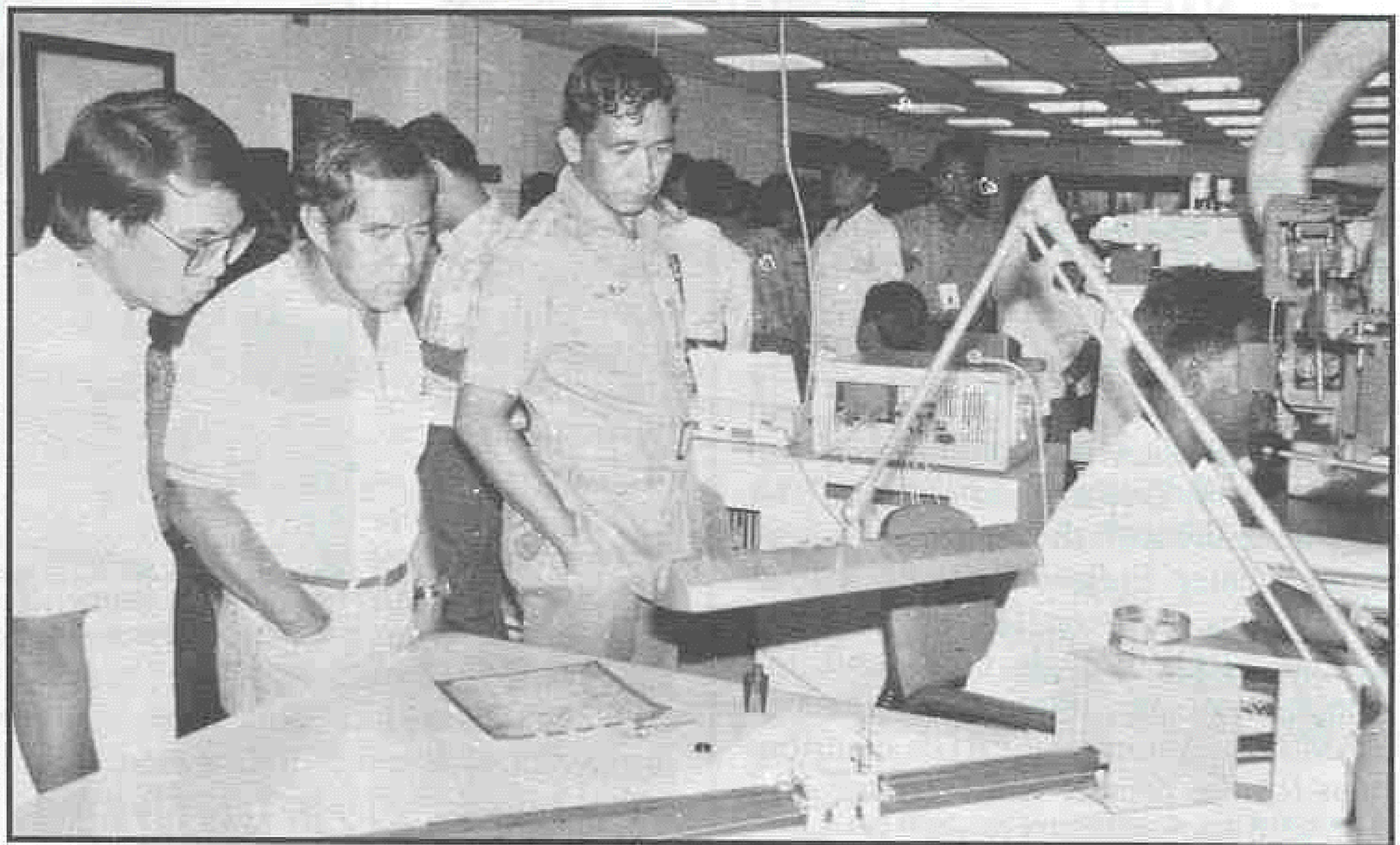
The French Ambassador to the Philippines Olivier Gaussot; NAMRIA Deputy Administrator for Surveys and Mapping Ananias A. Batilaran, Jr.; DORIS beacon maintenance Director Michael Lansman and French embassy Counsellor for Cultural and Scientific Affairs Dominique d'Ollone were present during the inauguration of the DORIS project. ●

NAMRIA conducts Technical Forum

A technical forum on Map-making Processes and Map Uses was conducted by the IMD in coordination with the MRD last July 2 1991 at the NAMRIA lecture hall. Forty-five representatives from various government and private agencies attended the occasion.

It was the second of a series of technical fora to be conducted for the National Capital Region by the NAMRIA. The first forum was held on August 31, 1990 with the theme "Information Campaign on NAMRIA Products and Services".

The participants of the map-making forum were briefed on map production processes, standards & specifications and map uses. A storyboard on Map-making Processes was shown to supplement the presentations.



Participants of the second NAMRIA Technical Forum view several photogrammetric equipment during a tour of NAMRIA mapping facilities held on July 2, 1991.

Administrator Jose G. Solis and MRD Asst. Director Ponciano Ciceron responded to questions raised, such as how often are the maps updated, how the data are verified and how the public can avail of these maps.

Representatives of various agencies expressed their appreciation of the possible utilization of NAMRIA products and services in their agencies' respective undertakings. Linkages and possible joint ventures were also identified.

This series of technical fora is part of a larger endeavor: that of conducting a Regional Information Campaign throughout the country. Through the technical forum, the NAMRIA expects to inform a larger segment of the concerned general public on the available ENR data/information in different forms at NAMRIA, and in the long run, pave the way for more prudent utilization of the country's natural resources using ENR information.

The Information Campaign project is jointly undertaken by the Information Services Division and the Media Production Division of the IMD. ●

From p. 4 GIS - A Breakthrough ...

staff to an ARC/INFO course in Australia.

Aside from trainings and workshops, GIS software and hardware exhibits are also conducted from time to time in the Philippines to keep users abreast of the latest developments in the field.

Even as this article extolls the powers of GIS for ENR monitoring, like any other system, it also has its limitations. It is therefore important to remind enthusiastic GIS first-timers that this system is not a cure-all for resource management problems. One cannot just plug it in and expect instant success. One has to identify the user's needs before carefully designing an appropriate system for the organization. Also, the high cost of GIS pre-empts the users from focusing on their long-term requirements before actually setting up the GIS facility.

Some of the more common misconceptions about GIS are: that it can magically transform low quality data inputs into accurate data outputs; that paper-based data is easily converted into digital files; and that it can replace other mapping techniques. In reality, the quality of your GIS output data is only as good as that of your inputs. It takes experience and intensive training to be able to effectively operationalize a GIS, as well as skill and patience in transforming maps and tables into a GIS-generated map. Finally, GIS is not meant to supplant all other ENR management techniques, but rather, to supplement them.

GIS is here, and it has proven its worth in various Philippine applications. It only remains for those in the ENR sector to decide on the most appropriate applications of this powerful technology. As we move into an increasingly automated society, the role of GIS in ENR management is expected to be more significant in the years to come. ●

By: Charmaine C. Aviquivil, IMD

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TECHNICAL REPORT

Mapping of Shallow Reef Areas in Support of Hydrographic Surveys (Puerto Galera)

INTRODUCTION

Periodic survey and monitoring studies of shallow reef areas are necessary in obtaining updated data and information to support coastal zone management programs. One of the major tools used in such studies is the application of remote sensing technology which has been utilized for several years in the assessment of marine resources. Using satellite imagery data for shallow reef status evaluation of an area makes it convenient and accurate to monitor reef conditions which if done conventionally can be very expensive, time-consuming, and difficult to complete.

This paper reports on the evaluation/interpretation of SPOT satellite imagery which was validated by actual field survey for the monitoring and inventory of physiographic condition of selected shallow reef areas. Digital processing techniques for thematic mapping of coral reefs similar to those used by R. T. Biña et al (1978) were used. For this project, the physical features of the reef areas in Puerto Galera, Oriental Mindoro and vicinities were mapped and categorized.

The project aims to complement the information contained in existing hydrographic maps and nautical charts of shallow water areas such as coral reefs, shoals and coastal areas in selected sites through digital analysis of remote sensing data (SPOT, in particular).

PROJECT SITE DESCRIPTION

The area is located at approximately between 13° 30' latitude and 121° 05' longitude, northern part of Oriental Mindoro within the vicinity of Puerto Galera.

The area is considered as a tourist spot and ship anchorage for people and cargo because of its many surrounding islands which give natural protection against strong waves and wind currents generated by strong typhoons. The northwestern portion faces the Verde Island passage which has a canal/gully at the center and is used as a passage for shipping. Isolated patches of mangrove vegetation, mostly dominated by bacauan species, were also recognized.

METHODOLOGY

A. Ground Truth

Prior to detailed surveys of the selected site, information based on aerial photographs, topographic maps and other secondary data were gathered and utilized to assess existing conditions and to determine probable sampling sites. Three stations were marked and plotted on a 1:10,000 scale base map.

Ground surveys were carried out in selected areas aboard a motorized banca. Following location of points, shallow water reconnaissańce and skin dives were done. Line transects of 30 meters were used on narrow reef flats, **time-sled transects*** for extensive reef flats, and surface reconnaissance for extensive shallow reef areas. Data gathered included substrate type, **percent bottom cover,*** predominant coral types, conspicuous flora and fauna, bottom profile and other physiographic features.

Depth of penetration of multispectral satellite data was classified into three (3) types: 0-3 m., 3-5 m., and 9-12 meters. The instrument used for this study was the Japanese **transit/stadia*** for measuring the distance of shallow reef areas from the shorelines. The tide table was also utilized to determine water level during a specific time of day (high or low tide).

NAMRIA technical personnel used booties to protect their feet against sea urchin, toxic organisms, and rubble as well as surface diving equipment such as snorkel, diving masks, and flippers. For the collection of underwater samples, two divers from the vicinity contracted by NAMRIA for manual diving used improvised diving masks and flippers.

Hydrographic information was derived by using the 1989 Tide Table produced by NAMRIA's Coast and Geodetic Survey Department (CGSD).

B. Digital Analysis

An imagery of Puerto Galera was extracted from **computer compatible tapes (CCTs)*** of SPOT scene K-304, J-323 taken on May 20, 1987. The imagery was displayed on a TV monitor screen at scale 1:50,000.

Digital analyses and processing were performed with the use of the MicroBRIAN processing system, a microcomputer-based set of interactive analysis programs with various processing and analytical functions. Results of the digital **classification*** were also displayed on the TV screen in the form of thematic maps and printed with the use of a Tektroniks Inkjet Printer.

IMAGE PROCESSING

Prior to classification, various pre-processing operations have been applied to the image:

a. Image enhancement - spectral values stretching of each **band*** to enhance underwater features of interest such as bottom cover types, marine vegetation, reef formation, etc.

b. Image cleaning - despiking or smoothing was done to remove the spikes or noisy **pixels*** (homogenized spectral values).

c. Image stratification - unnecessary components in the image were removed by spectral and spatial stratification to save computing time and avoid inaccurate labeling.

DEPTH OF PENETRATION AND BAND ZONE MAPPING

For underwater features, the same bottom type in different depth locations could have different spectral signatures (the unique spectral **reflectance*** or emission response from a particular object). In this case, **band zone mapping*** proved to be the best **algorithm*** (digital analysis program) to undertake. It was done by scanning in deep water to determine the level of background signals or Deep Water Theme (DWT) where there are no bottom reflected signals.

The obtained signal values were then used to create the band zones :

Zone 1 channel 1 above the DWT others within:
Zone 2 channel 1 and 2 above the DWT Channels 3 &4 within; and
Zone 3 channel 1, 2 and 3 above the DWT channels, 3 &4 within.

Depth data from a nautical chart of the area were then correlated to get estimates of the depth from zero level to the bottom of each band zone and the resulting images were then calibrated:

Zone 1 --- 0-3 meters depth;
Zone 2 --- 3-5 meters depth; and
Zone 3 --- 9-12 meters depth.

CLASSIFICATION

Each band zone was then digitally classified by utilizing the supervised classification routine which uses the nearest neighbor classifying algorithm whereby a pixel is assigned to a class whose spectral value has the shortest distance to a spectral class. Each spectral class derived from the clustering procedure was then assigned to a bottom type category. The synthesized classes were color-coded showing variation in bottom cover within a given depth-range.

RESULTS AND DISCUSSION

A. Ground Truth

The field survey at Puerto Galera was conducted in October 1989. Three selected sites were determined and two triangulation points were located by the CGSD. One station was established and monumented on the ground. Snorkeling by NAMRIA technical staff was done in shallow reef areas, while manual diving was performed by two local divers in deeper areas. Collected fresh specimen of coral, seagrass, and algae were properly identified with depth, time and reference points plotted on a hydrographic map.

Physical features were classified on SPOT imagery and properly validated via ground verification, which is the process by which data acquired through sensors are checked for accuracy through field surveys.

B. Digital Analysis

Based on the supervised digital classification, ten major physical features were identified and given color codes: 1) Coarse sand = cream; 2) Soft sticky mud = gray; 3) Fine gravel = brown (associated with seagrass); 4) Rocks = brown yellow; 5) Fine gravel = yellow brown; 6) Coarse sand = purple; 7) Mangroves = dark green; 8) Fine gravel and coral (black corals) = violet; 9) Deep sea portion = peach; and 10) Land = red.

CONCLUSION

The digital analysis of SPOT satellite data was found to be applicable to the mapping of the physiographic features of Puerto Galera Shallow Reef areas. This method could be useful in planning extensive ground surveys and establishing survey stations. The information derived from similar studies can provide data needed for hydrographic surveys in updating nautical charts of unsurveyed shoals, and coral reefs. ●

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Reference:

Biña, R. T., Carpenter, K., Zacher W., Jara, R., and Lim, J.B. Coral Reef Mapping Using Landsat Data: Follow-up Studies. NRMC Research Monograph No. 3, 1978, pp.2-4

GLOSSARY

The following terms appear or are related to terms in the various articles in this issue:

Algorithm - the precise series of commands programmed into a computer to enable it to perform a specific function.

Band - A wavelength interval in the electromagnetic spectrum.

Band zone map - a thematic map of band zone categories showing areas in which the band signals (recorded reflected energy of an earth feature) in each channel show a particular type of earth feature such as bottom cover types.

Bench mark - a permanent, stable object containing a marked point of known elevation with respect to a datum, used as a reference level for water level observations or as a control point for levelling.

Classification - the process of assigning individual pixels of a digital image to categories, generally on the basis of spectral reflectance.

Computer Compatible Tape (CCT) - a magnetic tape which contains the data used to produce an image.

Digital data - data recorded, stored, processed, or displayed in binary form.

Digitizer - a device used to convert data stored or represented in non-digital form into digital.

Electronic Distance Meter (EDM) - a distance-measuring instrument utilizing electromagnetic waves.

Estuarine - pertaining to an estuary or a passage, such as the mouth of a river or lake where the tide meets the river current.

First-order level line - a line of level consisting of bench marks connected by first-order levelling.

Geodetic control network - a network consisting of stable, identifiable markers which are tied together by extremely accurate observations. This is the basis by which all other lower-order controls are derived.

Geodetic Datum - a reference surface which forms the basis for the computation of horizontal control surveys in which the curvature of the earth is considered.

Horizontal control stations - stations with known horizontal positions such as triangulation, traverse, and GPS stations.

Ionospheric propagation delay - the delay in transmitting signals from satellite to receivers (antenna) due to the effects of the ionosphere. The ionosphere consists of the outer layers of the earth's atmosphere containing electrons and ions.

L-Band frequency - one of the letter designations commonly used for micro-wave band (390 MHZ - 1550 MHZ). This designation has no official international standing.

Levelling instrument - surveying instrument used in determining difference of elevations between two points.

Liquefaction - the process that transforms the behavior of water-saturated deposits from solid to liquid.

Lithospheric plate - the rigid outermost layer of the earth.

Luzon Datum - the datum or reference system where the existing geodetic control network of the Philippines was tied.

Mean Sea Level (MSL) - the average height of the sea surface for all tide stages over a 19-year period usually determined from hourly height readings.

Northeast monsoon - a season characterized by light, northeasterly trade winds.

Orbital plane - the path of satellites around the earth.

Percent bottom cover - the relative percentage of a bottom cover type per unit of an area measurement (e.g., 30% of a 1.0 square meter area).

Pixel - picture element; smallest spatial unit addressable by a device.

Plotter - automatic drafting machine which can convert and plot GIS map data to a precise drawing of any required scale.

Radar - a remote sensor which transmits its own energy signal that is reflected off the target and back to the sensor when it is recorded.

Reflectance - a measure of the ability of a body (usually the surface of an earth feature) to reflect incoming light or sound. The reflectance of a surface depends on its type , the wavelength of the illumination, and viewing angles.

Resolution - refers to the ability of a sensor to detect the smallest unit of space, time, and wavelength of an earth feature.

Satellite - a man-made object launched into space to orbit the earth for scientific purposes.

Scanner - any electronic device which records an image in digital form along a predetermined path.

Seismicity - the likelihood of an area being subject to earthquakes.

Southwest monsoon - a season characterized by strong southwesterly winds accompanied by heavy rainfall.

Stadia - a surveying instrument used for measuring approximate distances and differences in elevation.

Subsidence - the sinking of a particular land area with respect to a reference plane or datum.

Tectonic plate - one of the large, rigid, mobile fragments of the lithosphere at whose boundaries occur spreading centers, transform faults and subduction zones.

Theodolite - a precision surveying instrument used in measuring horizontal and vertical angles.

Time sled transects - utilized for coverage of extensive reef flats, lagoon areas and areas between transects and bounce dive points. This method employs a two-diver sled format in a straight line by a motor boat between two fixed points. To orient the data spatially along the transect, the motor boat travels at a constant speed and time. This is recorded during data collection. The sled is manuevered close to the bottom and depth is recorded with a submersible depth gauge.

Transit - an instrument used in determining areas, angular displacements of boundaries and actual position of land or tracts of land.

Traverse - a method used for horizontal control surveys in which a series of horizontal distances and directions are observed to connect points whose positions are to be determined.

Triangulation - a method for extending horizontal control for topographic and similar surveys which require observations of triangular figures whose angles are measured and whose sides are determined by trigonometric computations.

Trilateration - a method used for horizontal control surveys based exclusively on measured horizontal distances.

Vertical control stations - stations with known elevations such as bench marks. These are based on the mean sea level datum derived from long observations of tides. ●

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