Infomapper

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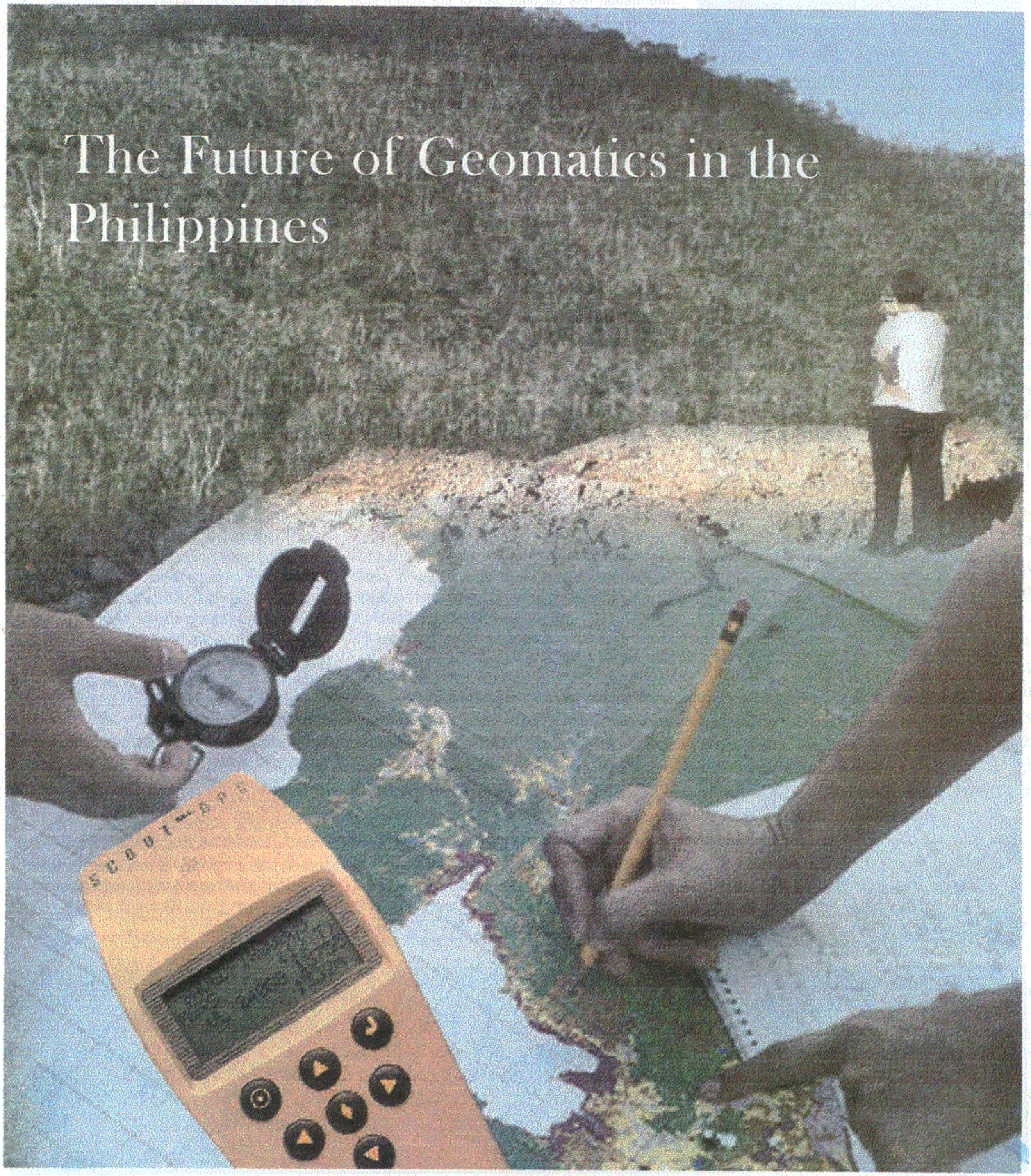

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Contributions

The *Infomapper* is accepting contributions for its forthcoming issues. Manuscripts should be typed and double-spaced. Please include the author's name, position and office/ home address. Photographs and illustrations with captions are also welcome. The editors reserve the right to edit materials submitted.

Editorial

We recognize the fact that geographic information now plays a critical role in making decisions for social and economic development. Time was when geographic information was synonymous with environment and resource management. Now, geographic information has become part of the information economy. Information infrastructures and highways are being built all over the world around geographic information.

In the Philippines, the formulation of a framework plan for the National Geographic Information Infrastructure (NGII) is being carried out by NAMRIA and the Inter-Agency Task Force on Geographic Information (IATFGI) through the assistance of The World Bank. The NGII will provide a distributed network of geographic databases. It aims for efficiency thereby maximizing government's return on investment in data holdings. In other words, NGII hopes to provide better access to geographic information collected and maintained by the various government offices.

It is a fact that there is a wealth of geographic information in government resulting from performing both regular mandates and special activities. Likewise, non-governmental organizations and other specially-tasked groups generate resource information. All these range from general survey statistics to more specialized and specific geographic information databases. While NGII will ensure compliance by data producers, ***data sharing*** may still be a sensitive issue, much more a problem, among government agencies. Consequenctly, the adverse effects may find their way into data transfer and distribution.

Ideally, data sharing in government should follow the general "*principle of transparency of public documents*" wherein anybody may request access to government records or documents either for free or for a fee. However, because of the complex nature of the bureaucracy, compounded by the people's attitudes, perceptions, "traditional" practices and even loose policies regarding data ownership and release, this is not simply so.

For example, on one hand, the psyche of associating information with power tends people to hold on to their data. On the other extreme, others simply ignore the value attached to the data. Sometimes, data custodians release information to users based on their own individual discretions and personal preferences. Such situations are apparently deplorable and basically demonstrate the need for a corporate data management mechanism wherein data should ultimately be collated under the custody of the agency as a corporate resource and not end up in the hands of the consultants or inside the drawers of the individual data producers/ collectors.

Here, we see a need to increase awareness in government in general and data custodians in particular about the concept of geographic information as a public resource that should be managed in a corporate perspective (not necessarily centrally) and shared with various users from all sectors of society. Value-adding is one meaningful result of data sharing as base information or fundamental datasets are updated as they are passed on from one user through another.

Data sharing will also emphasize the value of cooperation, joint undertakings and co-building of geographic information databases such that the cost of data acquisition and production can be shared as well. Cost-effectiveness means a lot in terms of eliminating data redundancies and duplications on one hand and focusing on data quality on the other. For instance, instead of working alone, agencies can work together on a particular project and co-build geographic information databases. To illustrate further, potential stakeholders could forge a cooperative agreement in updating fundamental datasets, e.g., topographic (base) maps of a particular local government area, by sharing resources in acquiring and processing aerial photographs or satellite images, integrating them and generating digital geographic information databases.

Now, how can we lay claim to future state-of-the-art geomatics in our country and support the government's bid to leapfrog the Philippines to become Asia's IT hub in the 21st century if data producers, custodians and users themselves within the government (and even in the private sector) are still snail-paced in appreciating the value of data sharing and cooperation? Attitudes have to change. Admittedly, we get better and better at planning and addressing the technical tasks, but as an industry, we need to do the same on the change management and people side. If it needs to be funded, then its costs should be included in the business plans.

Our own NGII shall eventually become a node in the seamless global geographic information infrastructure network. We indeed need to learn from the efforts of some countries that have already established their own geographic information infrastructures and treasured the value of resource sharing and cooperation. After all, ours is a global information economy where competition is stiff among international players. We play in the same arena. We cannot afford to lose, let alone, not play again.

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InfoDev/World Bank-NAMRIA/IATFGI:

Towards a Framework for Managing Geographic Information in the Philippines

by Xenia R. Andres

In the management of data stored in a geographic information system or GIS, there are many issues to consider. In what scales and how precise are the base maps? What data are commonly obtainable? Indeed, one cannot escape from dealing with various problems regarding data: their availability and currency; exchange; maintenance; flow and sharing; conversion and standardization; and data pricing and copyrighting.

It is very fortunate that in the Philippines, there is the IATFGI. This 82-member GIS advisory committee was created in 1993 through the initiative of NAMRIA in coordination with the National Statistical Coordination Board. At present, NAMRIA acts as its secretariat. The IATFGI aims to institutionalize a permanent coordinative mechanism, design standards, and draft policies for the efficient exchange of GIS data among agencies.

If data are to be shared and exchanged, however, data must be standardized. This is precisely what NAMRIA had in mind when it submitted in 1996 a proposal to the World Bank Organization. The proposal was entitled "The Establishment of a Technical, Operational, and Legal Framework for the Management of Geographic Information in the Philippines." In 1998, the World Bank's Information for Development Program (*InfoDev*) expressed its willingness to fund the proposal. The necessary grant for the implementation of the proposal was provided in the following year.

The project was conceptualized in order to provide appropriate technical and financial support mechanisms for the activities of the IATFGI. Its specific objectives include: (1) to develop a functional/organizational framework for the management of geographic information in the Philippines, which will eventually propose for an institution or body that solely serves this purpose; (2) to develop and document geographic information data standards in consonance with local requirements and existing international models; (3) to study and propose policies on data exchange and other general applications of geographic information; and (4) to propose marketing and copyrighting policies and practical procedures for digital products. With the project, NAMRIA looks forward to permanently setting up the appropriate technical, operational and legal framework that could be utilized in managing geographic information in the country. The established structures and procedures would enable the agency to adequately serve the spatial requirements of its clients and most especially, the Philippine government.

With nationally accepted data standards, there is a great chance that the exchange of digital data among various sectors in the country would be smooth. Resources in geographic information development would also be efficiently and effectively allocated. In addition, there would be an institutional structure responsible for managing this kind of information. The use of Philippine data may well be extended to globally relevant projects.

Documented standards, proposed policies, and an institutionalized framework for an efficient geographic information management systems are the expected outputs of the project. The advantages, however, will merely be experienced when the model and standards have been formed, put into operation, and generally accepted by the agencies.

A preliminary manual on standard GIS data classification and codes with regard to socio-economics; agricultural, environment and natural resources; lands and survey; and infrastructure and utilities has been submitted to World Bank as part of the proponent's commitment to provide a quarterly report on the progress of the project. As the activity nears its completion date of December 2000, the challenge looms for agencies to share data and information as well as to acknowledge and accommodate requests. This is because information has no effect unless it is broadly shared or, in this case, matched with an effort to develop them.

A year after the completion of the undertaking, a post-assessment period will be undertaken to determine whether the outputs have been implemented and accepted by the agencies as a whole.

Without a doubt, the moment has arrived for GIS frameworks in the Philippines. The task is undeniably Herculean, but in the long run, the hard work returns a thousand fold. With this undertaking, the country hopes to be a bright example for other nations that are still to develop their own GIS policies.

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The Role of the Bureau of Coast and Geodetic Survey in the 100 Years of Mapping and Surveying by the Philippine Government

by: Maria Romina dR. Pe Benito

"O'er waves, o'er land we bravely onward go, to chart the deep and map the High and Low."—
Inscription in circa 1954 mural at the entrance of the old BCGS building in Manila.

Fifty-four years ago on July 4, the Republic of the Philippines was inaugurated amidst, according to historian Gregorio F. Zaide, "the cheers of 300,000 people, the ringing of church bells, and the salute of guns." The lowering of the American flag during the Independence Day rites at the Luneta by United States High Commissioner Paul V. McNutt marked the withdrawal and surrender of "all rights of possession, supervision, jurisdiction, control, or sovereignty" of the United States of America in and over the territory and people of the Philippines.

The Filipinization of the government covered the former Bureau of Coast and Geodetic Survey (BCGS) whose operation, supervision and control were turned over to the Philippine Government by the United States Coast and Geodetic Survey (USCGS) also on 04 July 1946. Complete withdrawal, nevertheless, of USCGS technical supervision and material aid would not come about until four years later.

During 48 years of the American Occupation, Filipinos were afforded the necessary training to undertake for themselves the land and water surveys of the islands to provide the data for maps and charts. Prior to the American period, said activities were undertaken by the Spanish colonial government. The reaping of the fruits of this education for the Philippines will very soon come to a full circle. Mapping and surveying under the umbrella of the Philippine government reaches its first centennial year in 2001.

In commemoration of the forthcoming centennial celebration, this article focuses the spotlight on one of the four mapping agencies that were merged to form the National Mapping and Resource Information Authority, the BCGS. The BCGS happened to be the earliest established bureau in the country which laid the foundation for Philippine mapping and surveying.

A. Prewar office of the BCGS on Engineer Island, Manila harbor

Prior to 1901

The Philippines was mapped by conquering nations as part of efforts to stake their claims in and also facilitate exploration and occupancy of the archipelagic territory. When it was America's turn after Spain to occupy the Philippines in 1898, as its newly ceded territory by virtue of the Treaty of Paris, one of the foremost items on its agenda was the acquisition of current and accurate charts of Philippine waters.

The American occupation forces had a so-called inheritance from the Spaniards of nautical information reportedly fully comprised in a set of 136 Spanish charts of various dates and statistics in the *Derotero del Archipelago Filipino* or Spanish Coast Pilot last published in 1879. Still one reference material pinpoints to 110 charts as the total production, after infrequent operation for nearly a century, of the *Comisión Hydrográphica Española*—the Spanish counterpart based in Madrid of the USCGS. There were also some British-made charts, notably the circa 1882 ones made by the British Admiralty but which covered only surveys conducted in Palawan, the Sulu Archipelago, and Sulu Sea. Incidentally, prior to the assumption by the USCGS of the job of map-making in January 1901, most of the maps on the Philippines were made and printed by either the United States army or navy owing to the Filipino-American hostilities (1899-1901).

The USCGS in the Philippines

The Early Years: 1900-1910

The USCGS is described in one reference material as being "one of the oldest and most respected scientific organizations in the [United States] Federal Government." With its "fine reputation for accuracy and thoroughness," according to another source, the USCGS was certainly well able to take on the task of charting over 7,000 islands. It was the serious objective of this first technical bureau of the Federal Government to come up with comprehensive and reliable results.

At least one historical document on the BCGS gives as the date of its establishment, i.e., in terms of organization of office and field personnel, as December 1900. This date in another reference is said to be the date of arrival of the pioneering American staff complement of six officers and five technicians. Still another historical reference limits the early establishment period of the sub-office of the USCGS in the Philippines as from 1901 to 1910, during which time the surveys of a reconnaissance nature were said to have been conducted out of the urgent requirement for charts by the new leaders.

Beginning January 1901, the BCGS, then known as the Manila Field Station (MFS) and housed in the old *Intendencia* building in the Walled City of Intramuros, conducted basic land and water surveys and gathered surveying and mapping data. The results of these surveys were mostly shipped to the United States for processing, evaluation and the preparation of needed charts and maps. A processing office for survey records in Manila was reportedly set up in 1906. For many years before the second world war (1939-1945), the surveying and charting of the Philippine Islands was carried on under a joint agreement for the division of expenditures between the respective governments of the United States and the Philippine Islands. With its already growing number of survey activities, the MFS was made a bureau of the Philippine Government on 01 July 1902.

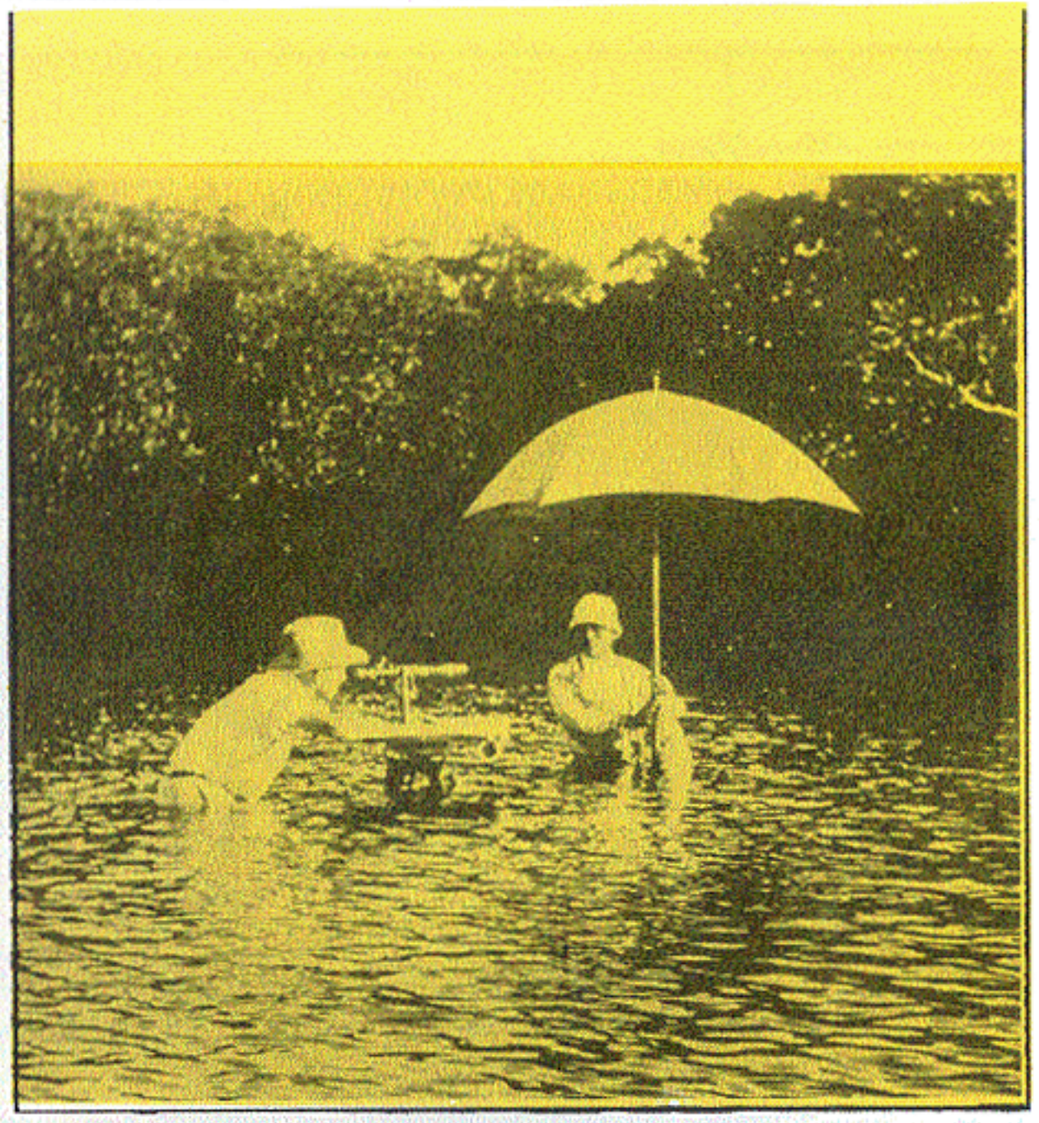
Other than the vast area of more than 14,000 miles of coast to be covered for surveying, the initial efforts of the USCGS were made even more daunting in view of generally prevailing unsettled conditions such as during the time of the insurrection. For one, the field work conducted by the first ever field party to reach the Philippines was said to have been confined to the vicinity of garrisoned posts. Moreover, survey teams had to contend with grave transporta-

tion problems especially in the early days when to travel by land mostly meant through carabao or horse-pulled vehicles while water travel was mostly by small boats. Other factors also hampering the progress of operations included language barriers, the heat, pests, severe typhoons, poor sanitation, and tropical diseases such as malaria.

The need of the BCGS to address the work impediment caused by the lack of small boats suitable for survey work, led to the purchase in 1901 of a small wooden steamer S.S. VITALIANA (renamed RESEARCH) by the Insular Government. In the same year, the steamer PATHFINDER arrived in the Philippine Islands where it was assigned by the Washington office. The other survey vessels which followed in 1905 were the FATHOMER, ROMBLON and MARINDUQUE. Various survey parties especially during the first decade also made use of hired steam launches such as the *Amelia*, *Filipinas*, *Comillas*, *Morven*, *Evening Star* and *Teresa*.

Employing the help of Filipinos in BCGS field and office work was a serious option of the USCGS. This in the face of the difficulty cited in an article by a former USCGS official, "in enticing persons from the States to duty in subordinate positions in a hot climate so far from home and at the small salaries then prevalent in the Government service." The USCGS resorted to the albeit slow training of a staff of native seamen and workers to ultimately replace the American civilians brought from the States in the reproduction plant, cartographic division, computing section and other specialized branches of the organization. One reference mentions the apprenticeship as draftsmen of Filipino employees of the USCGS as early as 1903. Several references also indicate that especially within the period 1905 to 1915, Filipinos were already serving as crew members of survey vessels, together with a reported existing survey group of 27 American officers, 12 mates and ship engineers, and 11 recorders for the conduct of hydrographic and topographic surveys of the more settled central islands.

Other milestone events of the bureau during the period were in 1901, the enactment of the US Philippine Commission Act, number 222, which placed the BCGS and other offices under the executive control of the Department of Commerce and Police, one of the former departments of the Philippine Government; in 1902, the establishment of a primary tide station in Manila; in 1903, the installation of a tide **gage*** at Iloilo; in 1906, the organization of the bureau into four divisions (i.e., computing, nautical, chart construction, correspondence and property); and in 1908, the creation of a geographic section to compile and publish a series of 17 maps mostly at 1:200,000 scale.



B. Planetable surveying in the Philippines

Making Great Strides: 1911-1940

After hurdling initial adjustments and difficulties, the BCGS was in this period on a much smoother course for its surveying and mapping operations. Triangulation operations of the bureau alone were vigorously pursued and culminated in the publication between 1926 and 1930 of the *Triangulation of the City of Manila* and the two-volume *Triangulation of the Philippine Islands*. The only serious temporary drawback to BCGS survey work was caused by US participation in World War I in 1918. Still according to one reference, "a comprehensive survey of the entire Philippine Archipelago approached completion in the years leading up to World War II and the Japanese occupation."

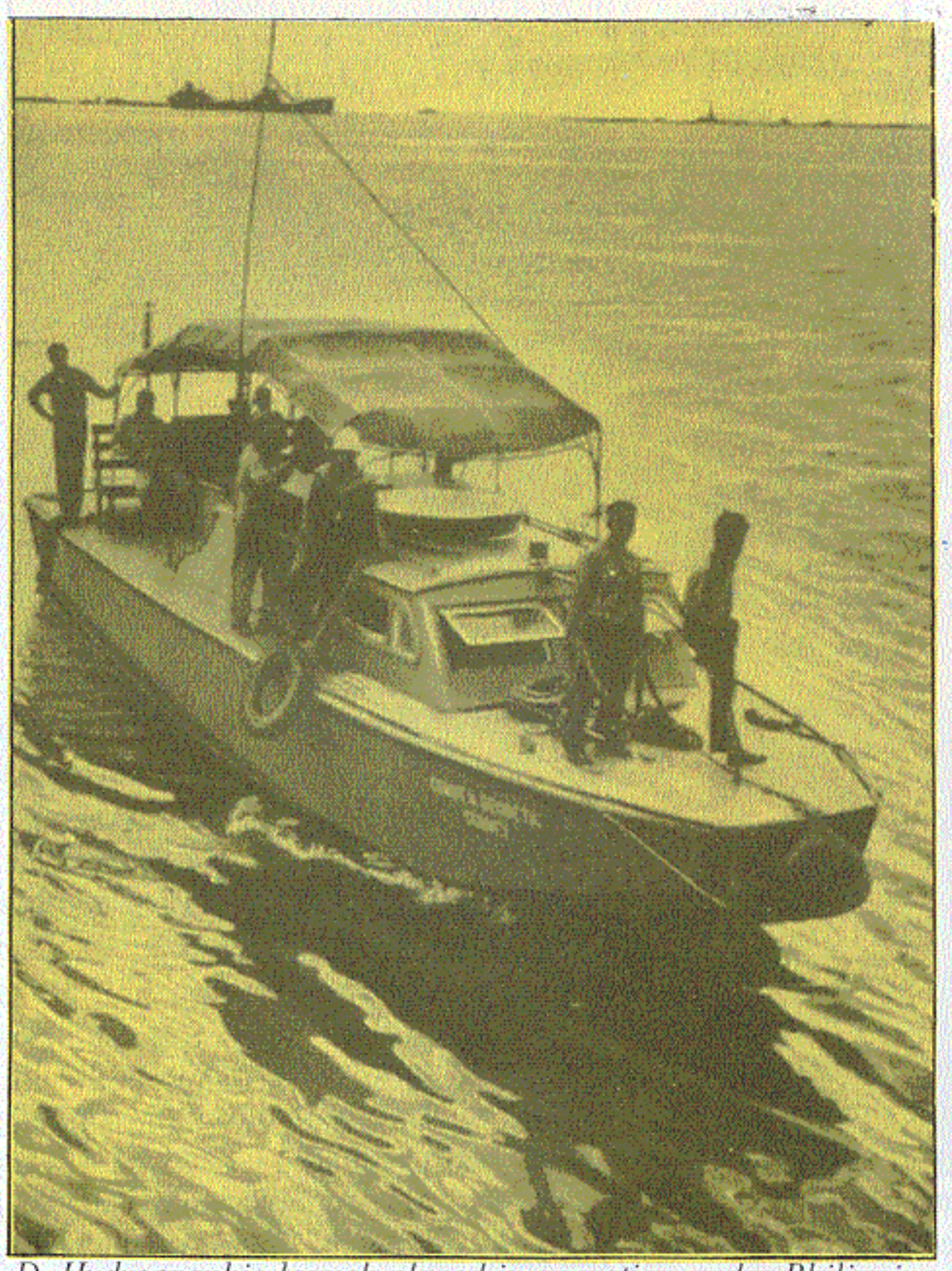
With notable improvements already made in the Philippine educational system,[1] * the planned nationalization of the BCGS in 1946[2] led to the passage in February 1938 of a special act of the US Congress, which allowed six qualified Filipino engineers to become the cadets to form a future corps of field officers who would take over the work of undertaking coast and geodetic surveys of the islands. Under American officers, these cadets were given specialized training aboardship and in the office. The selection in 1939 of an unidentified Filipino employee as assistant director of the bureau was also in preparation for the impending transfer of all responsibilities from the United States to the Philippine Government. Incidentally, the BCGS was placed under the Department of National Defense through Executive Order number 230, dated 01 November 1939 of former President Manuel L. Quezon.

From 1930 until 1941, there was a marked decrease in the field work outputs due to reduced available survey vessels as a result of significant appropriation cuts made by both the Insular and Federal Governments after 1930. This was not the case with the office of the BCGS which experienced a surge in demand especially for charts and maps because of the gold-mining boom in the islands, the impending world war, and the work of some of the Philippine bureaus in the fields such as the census and soil surveys.

Milestone events during the period include: the adoption of the Luzon Datum as basis for Philippine surveys in 1911; publication in two volumes of a new edition of *Sailing Directions*, Part I in 1918 and Part II in 1919; the addition to the bureau in 1920 and operation in 1922 of the photolithographic [**photolithography***] division for the local printing of charts and maps of the Philippines; in 1924, the completion of a large-scale magnetic survey at repeat stations originally occupied in 1912; in 1926, the conduct of a current survey by the FATHOMER in San Bernardino Strait which made possible predictions of the unusual type of currents in that passage; in 1935, the establishment of a primary

Editor's note: Terms in bold type and marked with a fixed star (*) are defined in page 16.
**Endnotes for the article may be found on p.7.*

C. Survey party starting for Badoc Island on the west coast of Luzon.



D. Hydrographic launch placed in operation under Philippine Rehabilitation Program

tidal station in Cebu and the reduction of the American office staff from six to three; in 1936, conversion of the old Administration Building on Engineer Island in Manila harbor into a suitable office and reproduction plant for the BCGS; and in 1939, publication in Washington of a new edition of *The Philippine Islands Coast Pilot* after field revisions made in 1937 and 1938.

The War and Rehabilitation Years: 1941-1950

At the outbreak of the war in the Philippines, sometime in December 1941, the BCGS for a while was able to render extensive technical services, which included assisting the Armed Forces in supplying charts, maps and other materials required for war operations. The fatal bombing raid, however, on Manila during the Japanese invasion, also in December 1941, put a stop to the survey and mapping operations of the bureau and caused the death of its American director, Comdr. George D. Cowie. Also a casualty of the war was another USCGS commissioned officer, Lt. Joseph W. Stirni, who was first imprisoned in the University of Santo Tomas internment camp and later killed while being transported to Japan as a prisoner of war in 1945. Destroyed during the war were the Manila office and reproduction plant, all vessels, survey instruments, equipment, and reports, including important geodetic data pertaining to the islands and particularly to northern Luzon.

After liberation in 1945, a new personnel setup made up mostly of the readily located surviving, pre-war Filipino employees of the BCGS initiated the reestablishment of the Survey office, with the invaluable assistance of Major Glenn Moore, a USCGS Officer on duty with the US Army in Manila. With acquired equipment and requested monetary appropriations, including ships and auxiliary survey vessels from the US Army and the Philippine Government, the bureau was able to resume coast survey operations from temporary headquarters at a make-shift office in a **quonset hut*** located on the Malacañang Palace grounds. Again, through the assistance of the aforementioned American officer, the bureau was later able to acquire the modern O'Racca building (and compound), formerly a Japanese candy factory located in Binondo, Manila, to serve as its own office headquarters. Even with the loss of very recent surveys, what facilitated reconstitution of destroyed materials was the recovery of a great deal of vital data and information in existing copies say of Philippine charts from various sources, including those on file in the Washington office before the war.

USCGS commitment to participate in the rehabilitation of the BCGS was made official through the US Congress passed-Philippine Rehabilitation Act of 1946, an agreement between the United States and the Republic of the Philippines. Through the terms of this agreement, as implemented through the Philippine Rehabilitation Program, the USCGS was authorized to continue until June 30, 1950 the survey operations in the Philippines which were conducted prior to December 7, 1941. From 1947 to 1950, which was the official time frame for the program, the USCGS trained, supervised and assisted in the establishment of a counterpart Philippine organization.

By July 1, 1950, the organized, trained and equipped Philippine Coast and Geodetic Survey, which was patterned after its American counterpart and headed by its first ever Filipino director, Captain Andres O. Hizon, was already suitable to carry on the duties and functions undertaken by the USCGS during the years 1901 to 1941. Furthermore, a total of 49 Filipino trainees, carefully selected from engineering graduates of Philippine colleges and pre-war technical employees, were able to undergo intensive in-service training in various aspects of surveying and mapping activities in the Philippines and in the United States. They eventually composed the bureau's commissioned corps of field officers and key technicians.

The survey vessels of the bureau were the AGL ORCHID, AGL TULIP, TL-3 ALBER, and C-456 which were later renamed respectively FATHOMER, PATHFINDER, RESEARCH and COWIE. Completed in November 1950 was the construction of the magnetic observatory at Muntinlupa, Rizal which replaced the one maintained by the Jesuit Fathers in Antipolo, Rizal before the war and destroyed by the Japanese. Initial international representation of the Philippine Coast and Geodetic Survey was made through Director Hizon in the 8th Assembly of the International Union of Geodesy and Geophysics at Oslo, Norway in 1948.

The BCGS on its Own: 1951-1986

The next 36 years witnessed the steady growth in breadth and strength of the BCGS as it solely assumed the responsibilities of the USCGS. In the course of its long period of independence, the BCGS, still under the Department of National Defense, strove to maintain the high standards established by its predecessor. This despite the constant problem of limited budget allocation for the bureau's maintenance and operating expenditures, especially for essential projects; including the development of its manpower and procurement of technical materials. The BCGS resorted to undertaking priority projects that can only be supported by its limited appropriation. The bureau also relied on the assistance of international/regional institutions, as well as private entities for funding and technical support.

As the operational activities of the office expanded through the years, the BCGS sent out trainees abroad under various training programs in order to keep abreast with modern develop-

E. The old BCGS office in Binondo, Manila

ments in surveying and mapping. The bureau participated as well in national and international scientific meetings and conferences. It also held active membership in the International Hydrographic Bureau (now the International Hydrographic Organization), the International Union of Geodesy and Geophysics, among others. As of 1986, the BCGS was under the *Ministry* of National Defense.

Historical highlights of the BCGS for the period include reestablishment of the printing of local maps in 1951; acquisition in 1951-1952 of the 30-component tide-predicting machine; initiation of an extensive vertical control of the Philippines in 1952; adoption of photogrammetric methods in 1953; in 1957, de-commissioning of the rank of the BCGS officers; in 1957-1958, participation of the BCGS in the International Geophysical Year Program in the fields of geomagnetism [**geomagnetic***] and **oceanography***; in 1958, restoration by Congress of the commissioned rank of the officers; acquisition of modern photogrammetric equipment in 1962-1963; in 1963, 1964 and 1969, acquisition through donation by the Australian Government, of the modern survey ships, namely, RPS ARINYA, RPS ARLUNYA, and RPS ATYIMBA (under the Southeast Asia Treaty Organization Economic Assistance Program for the Philippines); in 1966, opening of the Cebu map sales unit in Cebu City; in 1970, addition of physical oceanography to the functions of the bureau; in 1973, absorption by the BCGS of the pertinent functions of the former Board of Technical Surveys and Maps during the national government reorganization as a result of martial law; in 1974, the designation of the bureau as chair-agency of the National Committee to Coordinate and Standardize Surveying and Mapping Activities in the Philippines; in 1977, inauguration in the bureau and subsequent operation, with the assistance of the United Nations Development Programme (UNDP), of the Map Production Center; in 1982, completion of the UNDP "Expanded Assistance to Central Map Production" project from which the bureau acquired adequate technical capabilities in the production of charts and maps; and in 1984, integration of topographic mapping functions of the BCGS with that of the former National Cartographic Authority.

Merging into NAMRIA: 1987-present

The change in administration as a result of the EDSA Revolution of 1986 resulted in still another reorganization of the national government in 1987. By virtue of Executive Order number 192, the BCGS, then nearing its 86th year, was merged with three other agencies performing related functions to form NAMRIA - and attached to the DENR. The objective was to integrate the expertise and resources in surveying and mapping

The BCGS, deemed abolished, lost its powers and autonomy and became known as the Coast and Geodetic Survey Department (CGSD) of NAMRIA. Even with a retained commissioned service and enlisted personnel for coast and geodetic survey work, the BCGS lost more than half especially of its original number of technical personnel. Having initiated the basic land and water surveys of the country, it still, however, performs to date its old functions.

Other than the basically maritime-oriented activities, the CGSD is now also involved in environmental concerns, ocean energy development, infrastructure support, including disaster mitigation undertakings. The department, with assistance from the Australian government, was instrumental in introducing the use of GPS (geographic positioning satellites) in the establishment of a new geodetic control network in the country. It is presently completing the new network known as Philippine Reference System 1992 or PRS'92. It is also completing the survey of the whole maritime territory of the country, including the Exclusive Economic Zone, in accordance with the United Nations Convention on the Law of the Sea. The department now makes use of NAMRIA's two new state-of-the-art survey vessels named after former BCGS directors—the BRP HYDROGRAPHER PRESBITERO and the BRP HYDROGRAPHER VENTURA. The 12-year quest of the previous directors of the BCGS culminated in the acquisition of these two vessels under the leadership of present director, Commodore Renato B. Feir. It also started to automate in 1984 the production and updating of nautical charts, with the assistance of the Japan International Cooperation Agency. With acquisition of necessary computers and training of personnel, production of electronic navigational charts was started in 1997. A modernized NAMRIA through a still pending bill would mean for the CGSD, upgraded equipment and facilities as well as human resource development. With enhanced capabilities, the department would then be able to at least produce up-to-date nautical charts which are reference materials needed in planning, policy-formulation and decision making.

If walls could speak... The old BCGS building in Manila still stands, an edifice surviving war, time and the elements. Gazing into its empty and dusty rooms, the energy, the vitality characterizing the old BCGS are hardly brought to mind. It is a historical landmark, nonetheless, that serves to remind the present generation that the spirit of the BCGS lives on in the present CGSD; and that if not for the BCGS and its mentor the USCGS, then there would be no Philippine mapping and surveying.

ENDNOTES

[1]*Filipino literacy significantly increased during the American regime largely as a result of great encouragement given by Americans to Filipinos to avail of public schooling and to learn the English language.*

[2]*By virtue of the Philippine Legislature-approved Tydings-McDuffie Act, which provided for the proclamation of Philippine Independence in 1946 after a ten-year Commonwealth, transition period.*

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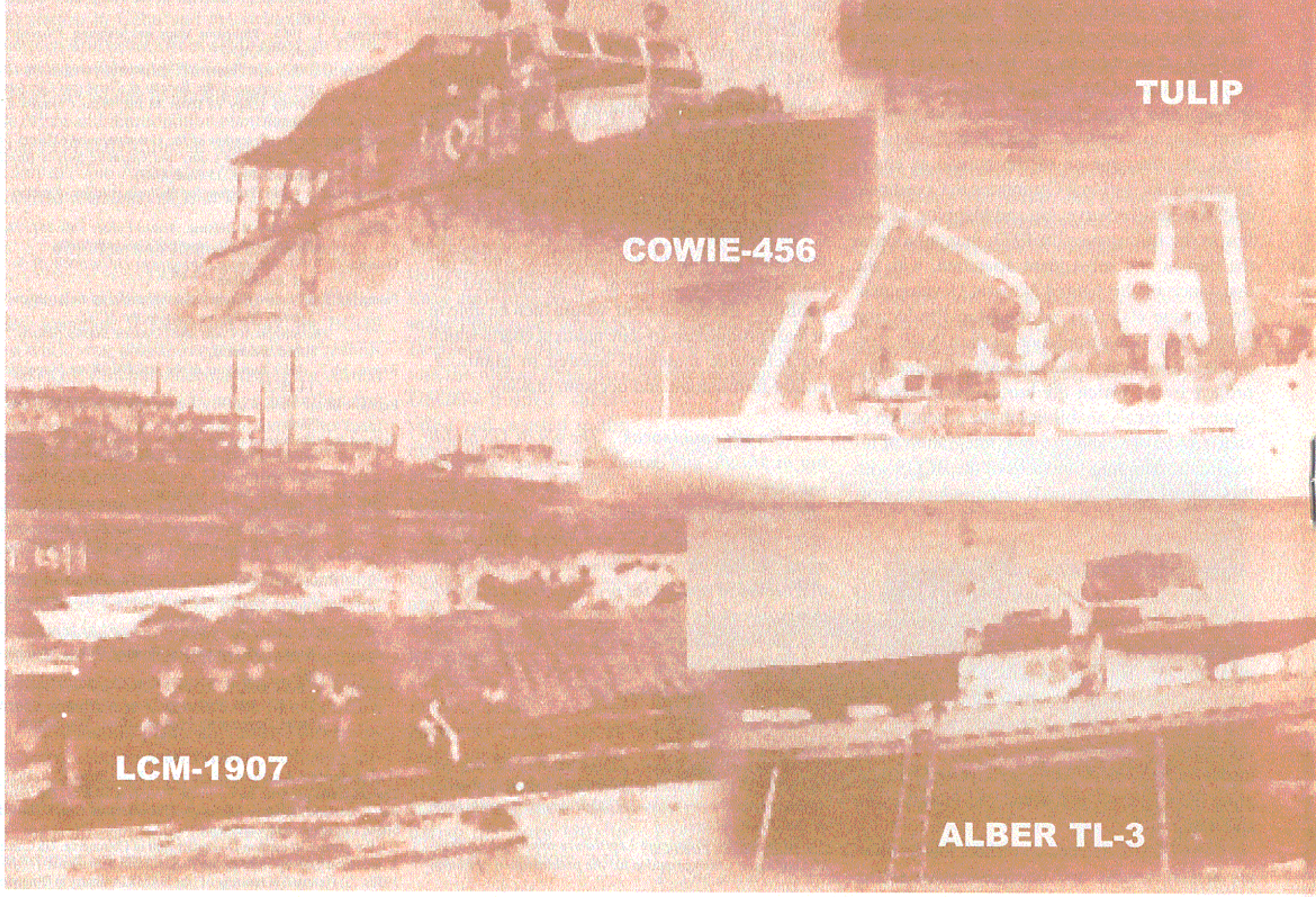
Picture Credits

(1) For picture A & pictures w/ captions B & C-- Deily, E. A.,1957. The coast and geodetic survey in the Philippine islands. *The Journal: Coast and Geodetic Survey (Sesquicentennial Issue).* United States Department of Commerce.
(2) For picture w/ caption D--Department of Commerce, US Coast & Geodetic Survey. *Philippine Rehabilitation Program (1947-1950).* (3) Picture E is courtesy of the NAMRIA library in Binondo

The survey vessels of NAMRIA

Hydrographic/oceanographic surveying in the Philippines has truly come a long way: from the establishment of the Manila Field Station of the United States Coast and Geodetic Survey in 1900 to the merging of the Bureau of Coast and Geodetic Survey with other agencies to form NAMRIA in 1987. Before, small steamers were used to chart our waters. With advancements in science and information technology, however, and the increasing demand for reliable information, there are now more sophisticated watercraft that are utilized especially in the survey of vital sea routes. In order to address NAMRIA's task of providing reliable ocean resource information, the agency is presently using multidisciplinary vessels equipped with state-of-the-art hydrographic and oceanographic equipment. These ships will enable the agency to map the nation's water territory as well as its Exclusive Economic Zone.

This spread features some of the vessels used in surveying Philippine waters to commemorate the forthcoming centennial celebration of mapping and surveying in the nation. A warm salute to NAMRIA's small but heroic fleet, past and present!



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News

NAMRIA launches DENR banner program

The DENR launched its banner program entitled, "Delineation and Establishment of Permanent Forestline Boundaries," on 12 May 2000 in Carranglan, Nueva Ecija with department Secretary Antonio H. Cerilles leading the ceremony. The launching was highlighted with the conduct of an on-the-job training for 57 participants who are from the Land Evaluation Parties (LEPs) and selected NAMRIA personnel.

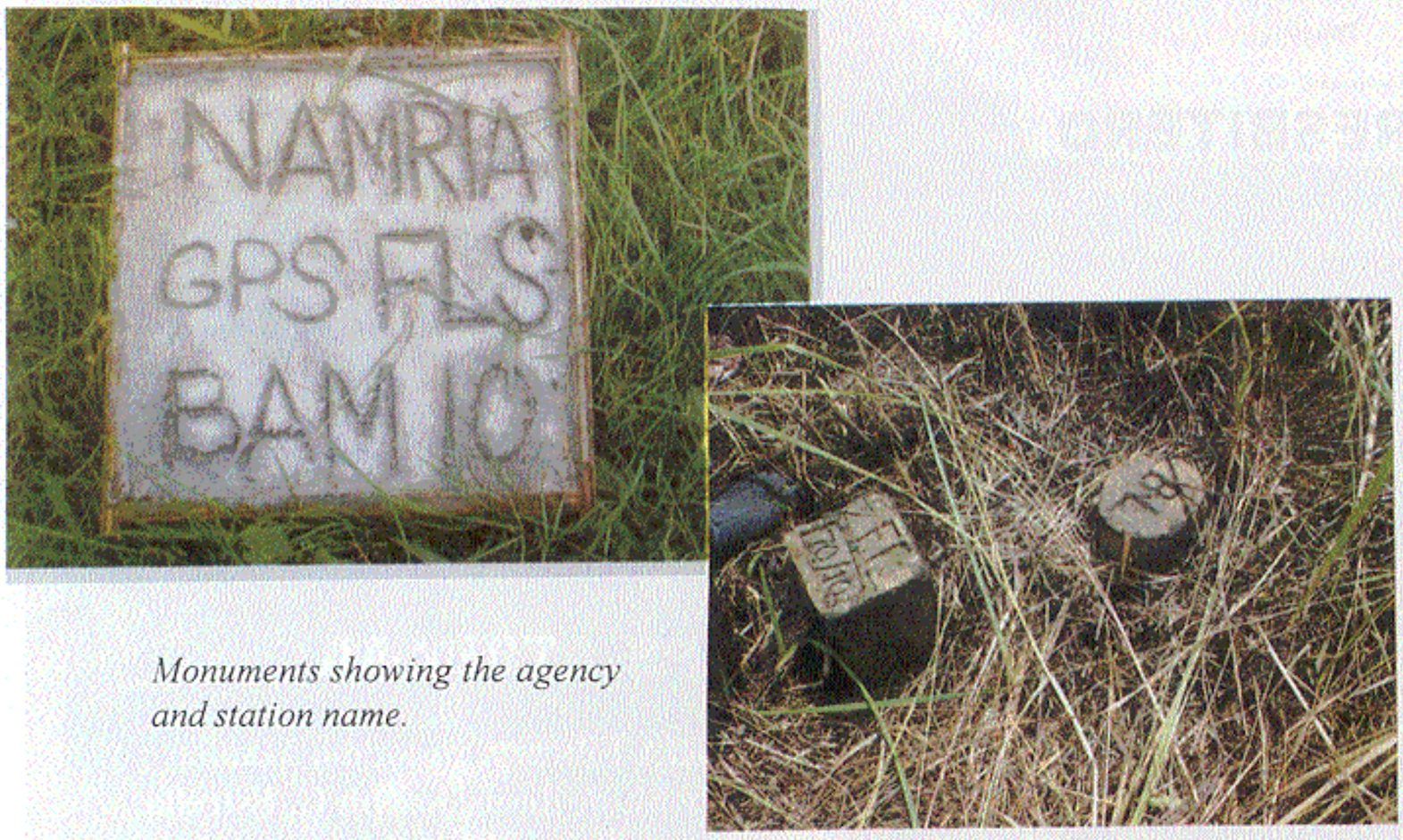
The launching marked the start of DENR Secretary Cerilles' desire to clearly mark on maps as well as on ground the specific limits of forestland, without which the government's problems on squatting, encroachment, fake and illegal titling in the forestlands, among others, will be unresolved.

The project's target for CY 2000 is to delineate a 500-kilometer forest boundary line in Nueva Vizcaya. Out of the target, a total of 68.16 kilometers have been surveyed during the first fieldwork undertaken by the training participants who formed nine survey teams. The fieldwork was an integrated activity of the training course. The survey covered the following barangays of Nueva Vizcaya: Sawmill, Nagbitin, Kumunal, Bangaan, Wacal, Masoc, Magsaysay, Busilac, Sta. Cruz, Careb, Aggub, Bascaran and Pogonsino.

The implementation of the banner program is in response to the urgent need for reliable data on forestland boundaries which are critical inputs to policy makers, planners and project implementors in their efforts to bring about pertinent laws and policies on management and administration of our environment and prudent utilization of the country's natural resources. The activity is also in compliance with Section 4, Article XII of the Philippine Constitution which stipulates, "The Congress shall, as soon as possible, determine by law the specific limits of forestlands and national parks, marking clearly their boundaries on the ground..."

Other legal bases of the undertaking are the following: Section 17 of the Presidential Decree No. 705 likewise known as the Revised Forestry Code of the Philippines which cites the need for established forestland boundaries in the country; Section 1826 of Republic Act No. 3092 of 1961 which seeks among others, the regulation of setting apart forest reserves permanently; and Department Administrative Order No. 31 series of 1998 which provides the guidelines for the implementation of the banner program.

◆**Nancy D. Vasquez/Concepcion A. Bringas**



Monuments showing the agency and station name.

GDRTAG projects bared

The Geomatics Development Research and Technical Advisory Group (GDRTAG) of NAMRIA is set to embark on various projects aimed at developing technical standards and methodologies on mapping, surveying, nautical charting, remote sensing and information management. The GDRTAG, through its research and development projects, endeavors to support the agency in solving operational concerns in order to strengthen its capabilities and services.

For this year, seven projects on remote sensing and information management will be undertaken. These projects with its project leaders are the following: The Use of Airborne Synthetic Aperture Radar (AIRSAR) and Master Data in Mapping Floristic and Structural Types in Selected Pacific Rim II Study Sites, Marvilyn P. Palaganas; Digital Reconciliation of Forest Cover Maps, Alma SM. Arquero; Application of Remote Sensing and GIS Bathymetric Mapping and Total Suspended Sediments Monitoring of Lingayen Gulf, Fay F. Mancebo: Classification of Forest Cover Using L-Band SAR Data, Raul T. Magabo; Development of a Prototype Internet/Intranet-based Digital Data Browser System, Sunday R. Lingad; Development of a Prototype Graphical User Interface-based Image Processing System, Joselito T. Reasol; and Comprehensive Client/Market Assessment, Lyndon John N. de Leon.

Other projects on mapping, surveying and remote sensing that are in the pipeline include: Digital Photogrammetric Approach to Base Map Updating Using Multi-Spectral Satellite and Radar Imageries; Standard Symbols and Specification for Topographic Maps at Scale 1:50,000; Electronic Navigational Charting; Global Positioning System Reobservation of Geodetic Control Points in Leyte; Integration of Remote Sensing and GIS in Urban Growth Detection; and, Land and Marine Cover Mapping in Lingayen Gulf Using Spot Multi-Spectral Satellite Data.

Administrator Isidro S. Fajardo has expressed funding support for these projects.

◆ **Benjamin T. de Leon**

NAMRIA implements Information Technology Plan

Administrator Isidro S. Fajardo (5th from left) and Geodata President Alberto L. Morales (4th from left) ink a memorandum of agreement for the implementation of NAMRIA's Information Technology Strategic Plan. Witnessing the signing are (from left) NAMRIA Deputy Administrator Ricardo T. Biña, Information Management Department (IMD) Director Linda SD. Papa, Geodata Executive Vice-President Francisca N. Dayrit,IMD Asst. Dir. John SF. Fabic, Geodata Director Rolando C. Lazaro and Deputy Administrator Evangeline C. Cruzado.

NAMRIA will soon start its Information Technology Strategic Plan (ITSP) Project with the recent award to Geodata Systems Technologies Inc. for the implementation of the project. The ITSP includes the acquisition of hardware, software and network to strengthen the present capability of the agency. An information network will be set-up to facilitate smooth transfer and exchange of geographic-based data within the organization. The infrastructure will cover the networking of the CGSD in Binondo, Manila to the NAMRIA Central Office in Fort Bonifacio, Makati City. An internet connection and a web site will also be installed to serve as an on-line and on-demand querying tool for NAMRIA's products and services. This will make NAMRIA a secondary service provider wherein on-line and on-demand querying capability for the agency's products and services will be enhanced.

Administrator Isidro S. Fajardo, announced that the ITSP will enable the agency to be web-based in keeping with President Joseph E. Estrada's call for national government agencies to be accessible through the internet. The ITSP project implementor, Administrator Fajardo explained, "will also put in place the appropriate data and system management policies, procedures, standards and appropriate hardware and software that will propel the agency to the forefront of the information age." The award to Geodata came after an open bidding and a rigorous technical evaluation.

◆ **Concepcion A. Bringas/Geodata**

NAMRIA draws corporate plan

NAMRIA has drawn a Corporate Strategic Plan (CSP) in response to the current demands and problems regarding the management of geospatial information in the country. The CSP is the blueprint for the development of geomatics industry in the Philippines which takes into consideration the multiple concerns of both the government and the private sector.

Under the CSP, NAMRIA will be spearheading a nationwide geospatial information acquisition and mapping in three strategic aspects, namely: corporate; business; and functional. The corporate aspect describes the agency's over-all direction in terms of its attitude toward growth and business management in order to achieve a balanced portfolio of its products and services. The business aspect, meanwhile, emphasizes the improvement of the agency's competitiveness in the specific industry or market segment served. The functional strategy, on the other hand, is primarily concerned with the maximization of available resources.

The CSP is in line with President Joseph E. Estrada's platform of fostering growth with equity as embodied in the Medium-Term Philippine Development Plan of 1999-2004.

◆ **Randolf S. Vicente/ Eugene S. Pascual**

JAFTA-NAMRIA ties rekindled

The ties between the Japan Forest Technical Association (JAFTA) and NAMRIA are rekindled with the continuation of the Information System Development Project for the Management of Tropical Forest (ISDPMTF). The ISPDMTF is a project commissioned to JAFTA by the Japanese Ministry of Agriculture, Forestry, and Fisheries. It aims to provide the Philippines and other Asian countries in the tropics with useful data for the planning and management of tropical forests. The project uses remote sensing technology, especially digital data processing, to investigate basic information on land use and forest distribution, among others, in order to provide the countries concerned with resource analysis for the formulation of a wide area forest management plan.

The project subsumes three processes, namely: (1) Wide Area Tropical Forest Resources Survey; (2) Development of Tropical Forest Management Planning Information Service System; and (3) Development of Tropical Forest Resources Analysis Technology.

The first process involves the study and analysis of land use and other information using LANDSAT data. Using the information obtained in the first procedure, a forest management information system will be developed. The data will be presented in terms of forest types or forest distribution category for the preparation of a management plan.

The last process entails identifying the potential condition of areas and classifying the forest suitability by analyzing information provided by satellite data, ground truth data, and other secondary data.

The ISDPTMF was implemented in the whole of Luzon and Visayas in 1993 until 1996, except for areas not covered by satellite. The first phase was conducted in the island of Palawan and a portion of Mindoro. The second phase was carried out in 1994 covering Northern Luzon except for the western part. The third phase in 1995 took into account Southern Luzon excluding Romblon Islands. The fourth phase covered the Visayas Region except the southern portion. Among the outputs of the study were digital and hard copies of thematic maps, specifically Land Use/Forest Type Maps, at the scale of 1:100,000 with the

turn to page 13

14th regional MSO opened

The NAMRIA has opened a sales outlet in San Fernando, Pampanga last 21 August 2000 to service the city as well as Region III's maps and other geographic data requirements. The new map sales office (MSO) is located at the DENR compound in MacArthur Highway, Baliti.

With the opening of the map sales office in San Fernando, local demands for NAMRIA products will be met immediately. This is the agency's 14th regional MSO, bringing the total number of offices to 16. The major outlets are located in Binondo, Manila and Fort Bonifacio, Makati.

NAMRIA also opened in 03 October 2000 a map sales branch in the DENR main office in Visayas Avenue, Diliman, Quezon City.

◆ **Elinor C. delos Reyes**

Administrator Isidro S. Fajardo and DENR Undersecretary for Policy and Technical Services Ramon JP. Paje cut the ceremonial ribbon during the inauguration of NAMRIA's map sales office at the DENR Central Office. Looking on from left are NAMRIA Deputy Administrator Evangeline C. Cruzado, DENR Director for Financial Management Service Erlinda P. Meram and National Statistics Coordination Board Secretary General Romulo A. Virola.

NAMRIA digitizes chart for BFAR

The CGSD of NAMRIA has digitized Chart No. 4722 covering the Sulu Archipelago at the scale of 1:407, 000. The digitized chart shows the boundary limits of the 15-kilometer allowable fishing zone for each municipal water.

The Bureau of Fisheries and Aquatic Resources (BFAR) sought the technical assistance of NAMRIA following a meeting with Secretary for Flagship Project Robert N. Aventajado, local government officials and fishing boat operators which cited the need to delineate the municipal water boundaries of the archipelago. By delineating the municipal water boundaries, the area of jurisdiction and the responsibilities of each municipality with regards to fishing activities will also be determined.

The delineation was based on Republic Act No. 8550 known as the Philippine Fisheries Code of 1998. The digitized copy of Chart No. 4722 was transmitted to BFAR for presentation to the local officials of Mindanao.

◆**Rosalino C. delos Reyes**

NAMRIA submits guideline for delineation of municipal water boundaries

The NAMRIA has submitted the final draft guideline for delineating municipal waters to DENR Secretary Antonio H. Cerilles for his approval and subsequently, the issuance of a DENR Administrative Order. The guideline aims to standardize the procedure in delineating/delimiting municipal waters in a manner that is fair and equitable to all concerned. NAMRIA prepared the first draft which was reviewed and revised by an inter-agency group which included NAMRIA, DENR, Department of Agriculture-BFAR and the Department of Interior and Local Government-Philippine National Police Maritime Group.

The delineation of municipal waters will clarify the geographic extent of the city or municipality's taxation or revenue-generating powers, its law enforcement jurisdiction, resource allocation and general management powers.

The guideline introduces the Enrique A. Macaspac Concentric Circles Method of Determining an Equidistance Line in Boundary Delimitation. It includes a technical annex on how to draw municipal waters. The procedure will enable a municipality to delineate its own municipal waters, delimit the boundaries with its neighbors and check the boundaries of its municipal waters as drawn by other municipalities. In the delineation of municipal waters, normal baselines, straight baselines, archipelagic baselines or a combination of these baselines may be used.

To date, the guideline has been applied in the delineation of municipal waters of the coastal towns of the provinces of Masbate and Davao Oriental and around the Davao Gulf. It has also been used in checking the municipal waters of the municipalities of Magdiwang and Banton, both of the province of Romblon, which delineated their own municipal waters. The guideline has also been shared with the coastal municipalities of the province of Bohol, some of which completed the delineation of their municipal waters and just recently, with the coastal towns around Butuan Bay in the province of Agusan del Norte and Sapian Bay in the province of Capiz.

NAMRIA is currently delineating the municipal waters of municipalities which have requested the agency for assistance and is providing resource speakers to institutions and local government units conducting seminar-workshops on delineation of municipal waters.

◆ **Concepcion A. Bringas/**

Enrique A. Macaspac

NAMRIA attends China Remote Sensing workshop

Ms. Marvilyn P. Palaganas, officer-in-charge of the NAMRIA National Remote Sensing Center (NRSC), represented the Philippines in a remote sensing workshop held in Panzhihua City, China on 20-22 July 2000. The Association of Southeast Asian Nations (ASEAN)-China Workshop on Remote Sensing Cooperation was primarily organized to discuss possible areas of collaboration between ASEAN countries and China in the field of remote sensing. It was also aimed at being a catalyst for further action between ASEAN countries and China in various space technology areas such as satellite meteorology, satellite communications, satellite technology, and space science.

In her country presentation, Ms. Palaganas reported that remote sensing activities are continuously undertaken by NRSC/NAMRIA in support of the various developmental plans of the Philippine government. These activities include the updating of forest cover maps; delineation and relocation of forest boundary lines; sustainable land management; and mangrove inventory. She also said that research and development projects are on-going, such as updating of topographic maps using remote sensing data; use of remote sensing and GIS to model deforestation dynamics; and use of polarimetric SAR in coastal and land cover mapping, soil moisture, geologic and volcanic studies.

In an address delivered for him by Ms. Salmah Kasim, Chairman Nik Nasruddin Mahmood of the ASEAN Sub-Committee on Space Technology Applications (SCOSA) stressed the fact that a much more concerted effort is required in order to enhance the remote sensing capability of the region. Deputy Director Zheng Lizhong of the National Remote Sensing Center of China (NRSCC) also cited the importance of remote sensing and its various successes in the area of space technology. Parallel activities are likewise being undertaken to lay a good foundation for data exchange and cooperation in the Asia-Pacific region.

At the end of the workshop, it was decided that the following fields of remote sensing applications should be given priority concern: a) forest fire management; b) flood prediction, monitoring and assessment; c) water resource management; and d) agriculture.

The three-day conference brought together other ASEAN member countries, namely: Brunei Darussalam; Cambodia; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Singapore; Thailand; and Vietnam. Their country report presentations reflected the present remote sensing activities in their respective countries.

◆ **Chester C. Nicolas**

UKHO officials visit CGSD

Two officials from the United Kingdom Hydrographic Office (UKHO) visited the Coast and Geodetic Surveys Department (CGSD) last 18 July 2000 in order to observe the nautical charting activities of the agency and explore possible areas of collaboration. The visitors were Mr. Allan Shaw, head of the UKHO Hydrographic Center and Mr. Adrian Halliwell, head of Chart Branch 7. Administrator Isidro S. Fajardo together with Commodore Renato B. Feir and other CGSD staff welcomed the officials.

During the visit, the UKHO officials noted that the coverage of the country's nautical charting scheme can still be improved. The UKHO expressed support in enhancing the country's nautical charting coverage by providing technical assistance to NAMRIA. UKHO also publishes nautical charts covering the Philippine waters for the use of international seafarers. For their part, Administrator Fajardo and Commodore Feir pledged that the department will do its best to improve and increase the production of nautical charts of the Philippines as well as provide other data and services to the maritime community.

The officials also had a tour of NAMRIA facilities at the head office before they left for Singapore on 20 July 2000.

◆ **Rosalino C. delos Reyes**

RSRDAD-NRSC work on Lingayen project

The Lingayen Gulf Coastal Area Management Commission (LGCAMC) has approved the undertaking of a NAMRIA project called The Application of Remote Sensing and GIS in the Land and Marine Cover Mapping of Lingayen Gulf, Pangasinan which was submitted by the Remote Sensing and Resource Data Analysis Department (RSRDAD) and the NRSC. The approval came after the project was presented by Ms. Fay F. Mancebo, project leader, to the executive committee chaired by DENR Regional Director Victor J. Ancheta in its 41st regular meeting on 26 July 2000 in San Fernando, La Union.

The project, which will be implemented this year, will cover 18 municipalities, among them Sta. Cruz; Bolinao; Alaminos; San Carlos; Camiling; Mt. Lamat; Bugallon; Dagupan City; Lingayen; San Jose; Cuyapo; San Nicolas; and Binalonan.

The LGCAMC will finalize the approved resolution which will include a stipulation on project funding amounting to roughly P854, 000.00 and the signing of a memorandum of agreement among concerned agencies.

Also present during the project presentation were RSRDAD Assistant Director Jose C. Cabanayan, Jr. and Mr. Rey Quadernal.

◆ **Benjamin T. de Leon**

JAFTA-NAMRIA ...

from page 11

corresponding statistics by watershed unit compiled in a Forest Register Book.

This year, the project will be implemented in the northwestern part of Luzon; the eastern portion of Mindoro including the three islands of Romblon; and the southern portion of Visayas.

Administrator Isidro S. Fajardo and Director Virgilio F. Basa warmly received the JAFTA expert team composed of Kiyoshi Mochizuko, Yukio Wada, Kei Suzuki, and Dr. Krishna K. Mishra during their courtesy call last 05 September 2000.

◆ **Jesus S. Medenilla**

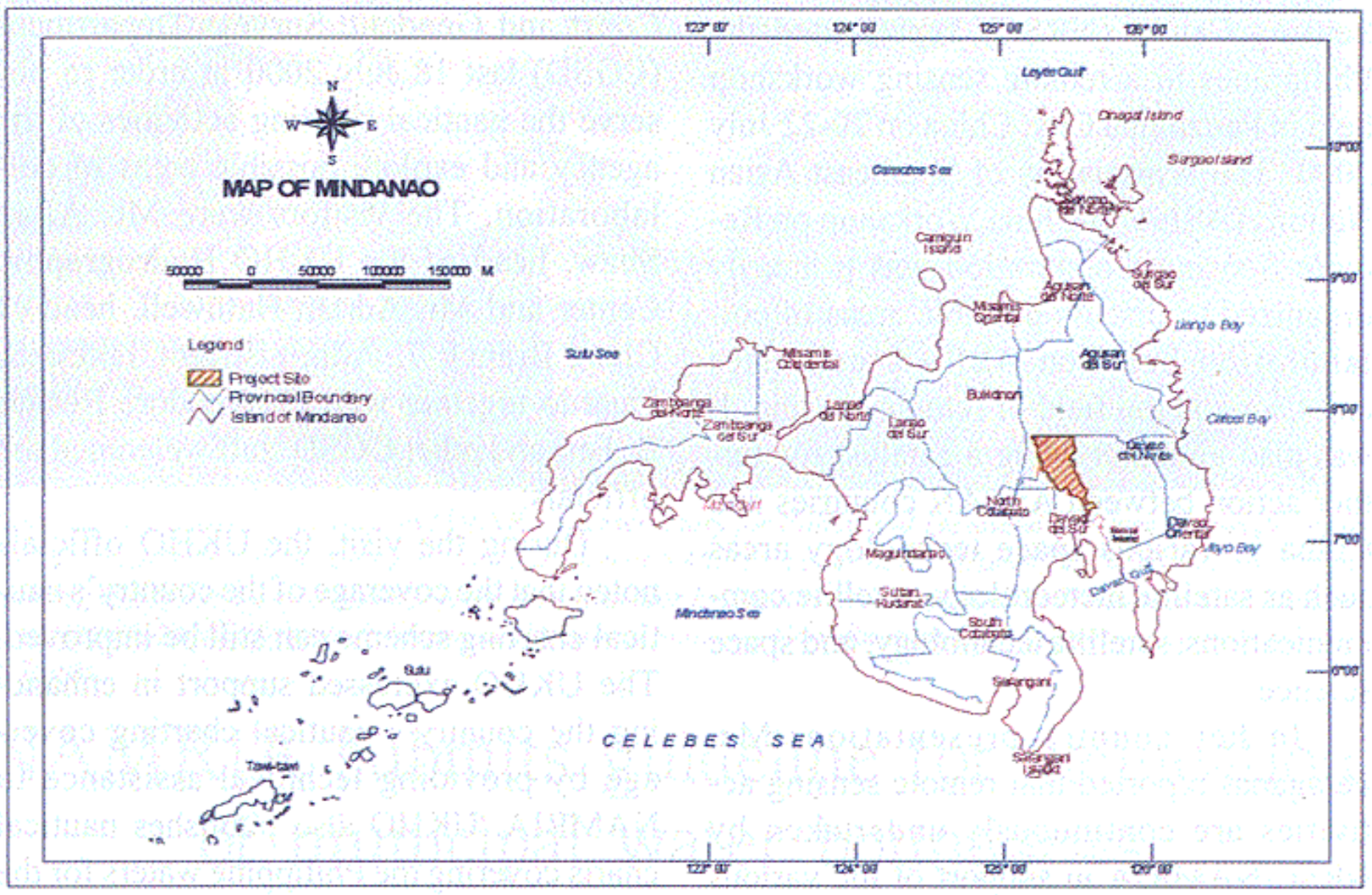
Technical Paper*

GIS-assisted Mapping of Identified Critical Watershed

By: Josephine O. Ferrer, Noel C. Daus, and Cornelio S. Tolentino[1]

I. INTRODUCTION

About 70 percent of the Philippines' total land area are watersheds. Watersheds are found in some 419 river basins throughout the archipelago and are regarded as major freshwater sources besides lakes. There are 343 independent principal river basins with areas of at least 40 square kilometers (sq km) each, covering a total of 199,637 sq km or 60 percent of the country's total land area. Twenty of these are accounted as major river basins; Tagum-Libuganon is one. The basins are sustained by more than 400 watersheds, of which 117 are proclaimed and 17 are critical. These watersheds are often forest resources protected for their ecological value and some are part of declared integrated protected areas.



II. PROJECT OBJECTIVES

The general objective of the study is to determine and predict soil erosion and fire occurrence hazard levels that are naturally or artificially present in the study area. It also aims to provide updated digital databases for reference/record in the formulation of preventive and rehabilitative measures for sustainable development. Specifically, the project aims to establish baseline information for the development and management of the watershed; to generate digital databases of all available information for critical watersheds; to conduct GIS analysis to identify areas potential to soil erosion; and to predict areas which are prone to fire incidence.

III. METHODOLOGY

A. Selection and Description of Study Area

The Libuganon Watershed, a major catchment area under the jurisdiction of Davao del Norte, was selected as the study. It was chosen from the list of priority watersheds provided by the Forest Management Bureau of the DENR. These watersheds are considered as priority areas based on their critical status in supporting an existing or proposed major electric, irrigation, or domestic supply project and as being potential sources of water in and outside the national integrated protected areas.

The Libuganon Watershed, with the Libuganon River as its main drainage channel, stretches from the mountain of Agusan del Sur to Davao Gulf of Davao del Norte. It lies between 8° and 00 minutes to 7° and 20 minutes latitude to 125° and 30 minutes to 125° and 45 minutes longitude. The watershed, which is presently being managed by the DENR-Community Environment and Natural Resources Office at Panabo, Davao del Norte, embraces the municipalities of Talaingod, Kapalong, Sto. Tomas, Dujali, Carmen, Asuncion, and Tagum City, covering an approximate area of 126,663 hectares. It has no distinct dry and wet/rainy season.

The watershed is likewise found within the cancelled Timber License Agreement of five logging companies, namely: Alcantara and Son, Incorporated; Sta. Ines Melale Corporation; Aguinaldo Development Corporation; T.H. Valderama; and E.P. Dacudao.

B. Secondary Data Collection/Research

This involved the gathering of secondary data which include existing maps (slope, land cover, soil, watershed boundary, etc.) and several publications regarding the watershed area.

C. Preliminary Interpretation and Mapping

This procedure entailed base mapping using the 1:50,000 topographic maps and the visual interpretation of SPOT satellite data taken in 1998. Topographic map sheet numbers 4141-IV; 4142-II; 4142-III; 4142-IV; 4143-III; 4143-IV; 4043-I; and 4043-II at a scale of 1:50,000 were used as bases for the road and river/drainage system. Topographic map Series 752 was also used for the temporary delineation of the watershed boundary. Since only the southern portion

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**A digest of the original copy submitted to NAMRIA's Media Production Division. A copy of the original paper may be requested from the authors of the report or the editors of this publication.*

[1] *Ms. Ferrer, Mr. Daus and Mr. Tolentino are Senior Remote Sensing Technologist, Remote Sensing Technologist II and Engineer III, respectively, of NAMRIA's GIS Applications Division.*

of the watershed was covered by the satellite image, the 1988 Land Cover Map was taken into account. The Land Use Map from the Bureau of Soils and Water Management was also overlaid to present a more detailed classification of the agricultural areas.

D. Coordination, Data Collection and Reconnaissance Survey

The following activities were conducted in this particular phase: (a) courtesy calls to concerned agencies and local officials who have direct jurisdiction over the study area; (b) reconnaissance and field checking of the land cover interpretation; (c) checking and gathering of maps and other necessary documents; and (d) interviews with local residents regarding practices around the watershed area. A handheld GPS instrument guided ground verification. Photos were also taken during the field visit. All initial corrections were eventually indicated on the base maps.

E. Data Evaluation and Processing

Base maps were re-mapped and edited based on corrections derived from the field. Data input, editing, cleaning and attribute entry of the secondary data acquired in the field were undertaken. The boundary lines served as the points for digitization. In the editing, cleaning and attribute entry portions, the lines and the generated polygons were classified according to their characteristics. These activities were all done using PC ARC/INFO.

F. Spatial Analysis

Prior to the generation of the Soil Erosion Susceptibility Map and the Fire Risk Map, a decision matrix model was designed using the following thematic maps: Soil, Slope, Land Cover and River System buffered at five meters on both sides. Since majority of the areas fall within the clay loam soil type, only the Slope and Land Cover maps were taken into the matrix. The buffer generated along the river had a high risk in soil erosion. Using the PC ARC/INFO Overlay commands, the thematic maps were integrated and analyzed.

G. Final Map and Report Preparation

The finalization of map layouts, generation of statistics, and plotting/printing were carried out using PC ARCVIEW software. All activities conducted for this particular study were documented using Microsoft office programs.

H. Reproduction of Final Output

The project prepared and printed a map layout in bond size at the scale of 1:50,000. Digital files and hard copies are readily available at the GIS Applications Division, RSRDAD-NAMRIA.

IV. RESULTS AND DISCUSSION

A. Base Map

The created base map encompassed the watershed boundary, the main river system and its tributaries, and the updated road network stretching over the study area. The Libuganon Watershed's drainage length totaled to 17,459.4 kilometers.

B. Land Cover Map

The vegetation of the upper portion of the watershed is classified mostly as mature trees with an open and closed canopy. A cultivated area mixed with brush land and grasslands are found on the part of Talaingod, while the rest consisted of fishpond, open lands and cultivated/agricultural lands.

B. Slope Map

The topography of the project area ranged from flat to severely sloping, with slope ranging from *0 to 3%* for Dujali, Carmen and Tagum City; *3 to 18%* for Asuncion and Sto. Tomas and *18 to above 50%* for Talaingod and Kapalong.

C. Soil Map

The Municipality of Kapalong and the upper part of Talaingod occupy the Undifferentiated Mountain Soil, which is very significant in the mountain fringes. Camansa Sandy Clay Loam lies in the lower part of Talaingod, which fills the gently sloping and undulating to hilly portion as well as the mountainous area. Sto. Tomas, Asuncion, Dujali and part of Carmen are characterized by San Manuel Silty Clay Loam within the level and nearly level broad alluvial terrace landscape along rivers and creeks. The City of Tagum is in Cabangan Clay Loam area.

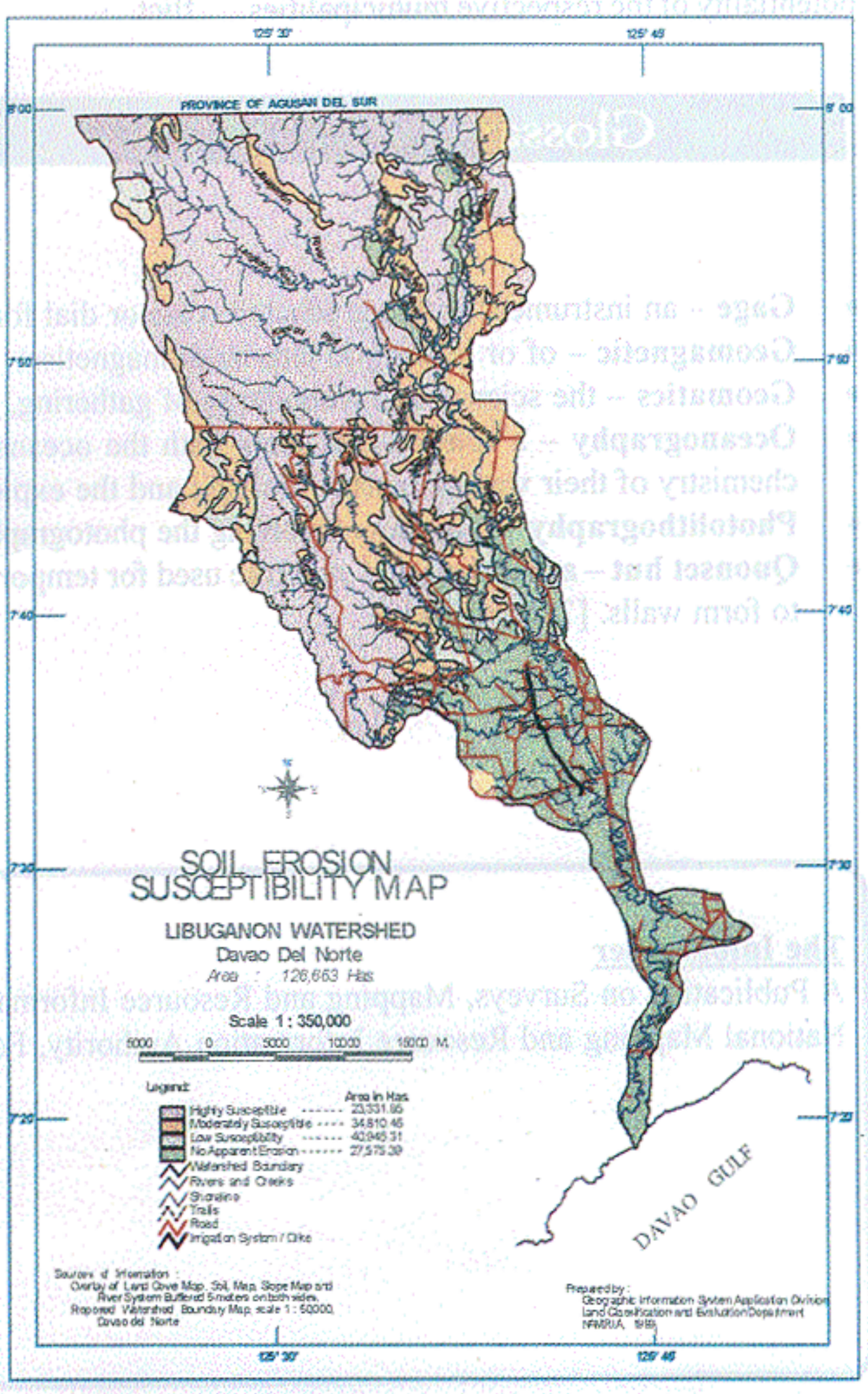
D. Land Classification Map

Of the total land area of the Municipality of Kapalong, 77 percent is Forestland/Timberland and 23 percent is Alienable/Disposable (A/D) while the Municipality of Talaingod has 92 percent Forestland/Timberland and eight percent A/D. The rest are classified as A/D areas.

E. Elevation Map

The watershed comprised mostly of areas *above 100 meters* elevation specifically within the municipalities of Talaingod and Kapalong. The highest elevation of *1,500 meters above sea level* was found in Kapalong. Areas with an elevation of *100 meters and below* were observed to be covered by agricultural crops and fishponds converted from mangroves.

Topographic height or land configuration can be legibly presented in a three-dimensional form using the generated digital



elevation model. This model, however, cannot be properly generated for the Libuganon watershed due to lack of data in the middle part of the area.

F. Soil Erosion Susceptibility

Of the total land area of Kapalong, 78 percent is highly susceptible to erosion; 18 percent has no apparent erosion; three percent has low susceptibility and one percent is moderately susceptible. The Municipality of Talaingod, meanwhile, is 62 percent highly susceptible; 31 percent moderately susceptible; five percent has low susceptibility; and two percent has no apparent erosion. The rest has no apparent soil erosion with a little percentage on high susceptibility.

G. Fire Risk Potential

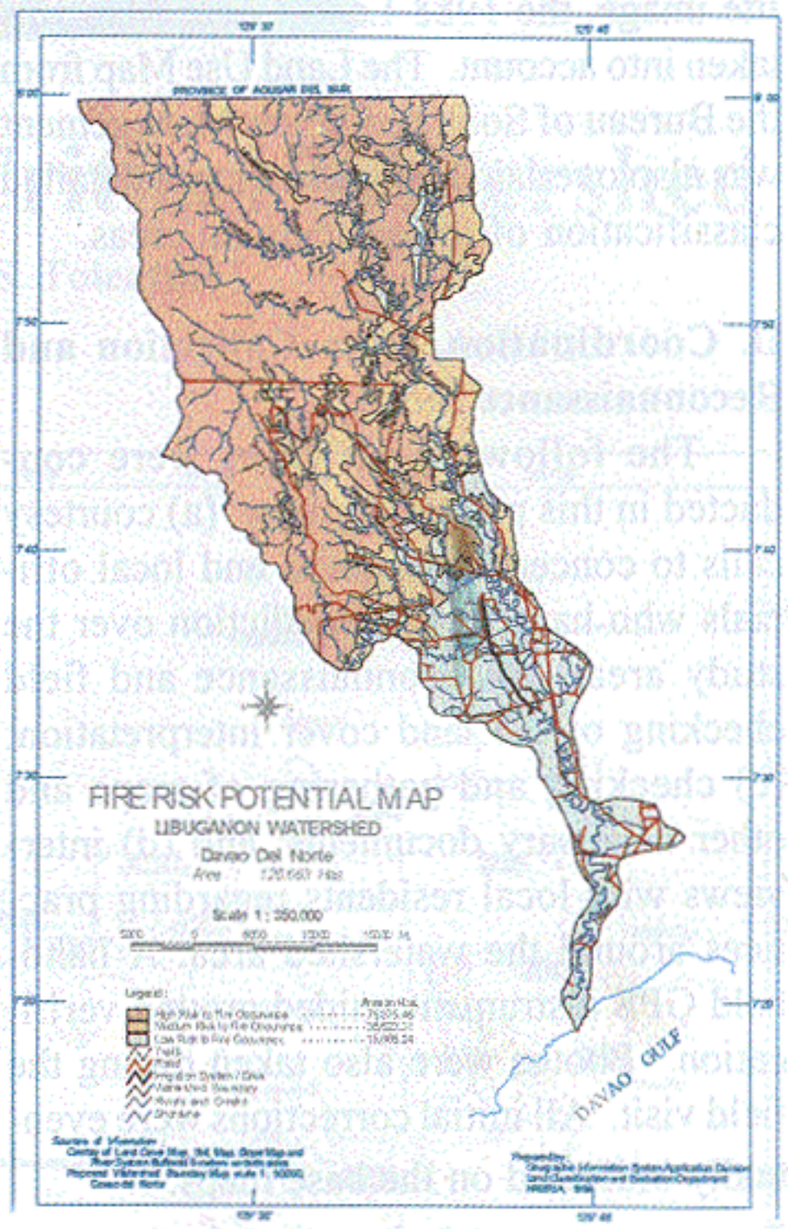
It was found out in the project modeling that the municipalities of Kapalong and Talaingod are more prone to fire occurrences because of their terrain and vegetation. They occupy 77 percent of the total land area of the watershed compared to the other municipalities. Table 3 shows the fire potentiality of the respective municipalities.

H. Drainage Characteristics

The Libuganon River has a length of 171,258.85 meters. Eight rivers, Simong; Suaong; Suwaon; Pipisan; Kapugui; Langitang; Maguimon; and Kapalong, to be exact, comprised the secondary and tertiary tributaries and were computed to have a total length of 985,989.08 meters.

V. RECOMMENDATIONS

The DENR is gradually shifting its management approach from a political to a watershed unit; that is, from the forest to the coast. The field and local officers in Region XI expressed their ultimate desire for the services we can provide as the central agency for surveying and mapping in the Philippines. We must therefore play our role efficiently and continue producing baseline information for our critical watersheds; information that are vital to address not only the pressing environmental concerns of timber poaching, slash and burn farming, flash floods, watershed boundary delineation, etc. but also the inadequacy of alternative livelihood to upland dwellers; peace and order situation; and political conflict.



Glossary

- **Gage** – an instrument with a graduated scale or dial for measuring or indicating quantity.
- **Geomagnetic** – of or relating to terrestrial magnetism.
- **Geomatics** – the science and technology of gathering, analyzing, interpreting, distributing and using geographic information.
- **Oceanography** – a science that deals with the oceans and includes the delimitation of their extent and depth, the physics and chemistry of their waters, marine biology, and the exploitation of their resources.
- **Photolithography** – a process involving the photographic transfer of a pattern to a surface for etching.
- **Quonset hut** – a prefabricated structure used for temporary army barracks. It has a cylindrical roof of corrugated iron curving down to form walls. [*Trademark*]

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