

Mexican Hydrographic Office: Serving the Navy and Improving Intermodal Transportation

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Background

The Mexican Navy has been conducting hydrography since the mid-1900s. Evolving from a small office to a larger, more formal organization in 1960, the Department of Astronomy, Geodesy and Hydrography became responsible for all hydrographic surveying and nautical cartography along the Mexican coasts, not only for the Navy but for the general public. The Navy has the responsibility for safety of navigation and the production of “official” nautical charts in Mexico’s national waters. In 1971, the Naval Hydrographic program became the Department of Hydrography which was part of the General Directorate of Oceanography. As the Naval Hydrographic Department continued to grow, in 1977 it became the Directorate of Hydrography under the General Directorate of Naval Oceanography.

New technologies not only increase the capabilities of the Hydrographic Office, but also the workload of its people. As such, in 2001 a Hydrography and Cartography Deputy General Directorate (DIGADHICAR) was created with a command separate from Oceanography. Major changes and rapid development of new technologies in hydrography require the need for more specialized officers in the hydrographic field. For the Mexican HO, this has meant sending junior officers to different allied countries through agreements between navies to train the next generation of hydrographers.

Because of its growing economy, Hydrography has become more important not only for the Navy but for all of Mexico. In 1998, this was recognized when the Navy High Command decided to acquire new equipment and software, and start the transition from paper to digital nautical chart products and services. The current Federal Government Administration of President Fox was quick to recognize how important Hydrography is in terms of improving multi-modal transportation and economic development for Mexico.

In 2002, Mexico became the newest member of the IHO, and brings a renewed commitment to the international community with respect to hydrography and safety of navigation within Mexican waters, as well as the MesoAmerican region.

Organization

Within the Mexican Navy, the Hydrography and Cartography Deputy General Directorate (DIGADHICAR) is under the Research and Development General Directorate. DIGADHICAR has two main offices:

1. Directorate of Meteorology is in charge of managing the Navy’s Maritime Meteorological Network, and for data analysis. It is also responsible for providing forecasts for Naval operations and civil forecasts in case of major weather events or natural disasters.

2. The Directorate of Hydrography and Water Levels is in charge of surveying, charting the Mexican territorial sea and EEZ, and for creating the Navy’s GIS and services to support naval operations. It has two offices:

- a) Water Levels and Publications is in charge of managing the Navy’s Water Level Network, data analysis and tide predictions for hydrographic operations. It is also responsible for safety of navigation and the edition and printing of all aids to navigation such as notice to mariners, sailing directions, astronomic navigation tables, and paper charts.
- b) Hydrography and Cartography is in charge of the planning and execution of the hydrographic operations and production of charts. It also manages the hydrographic database, as well as building and supporting the Navy’s GIS and services.

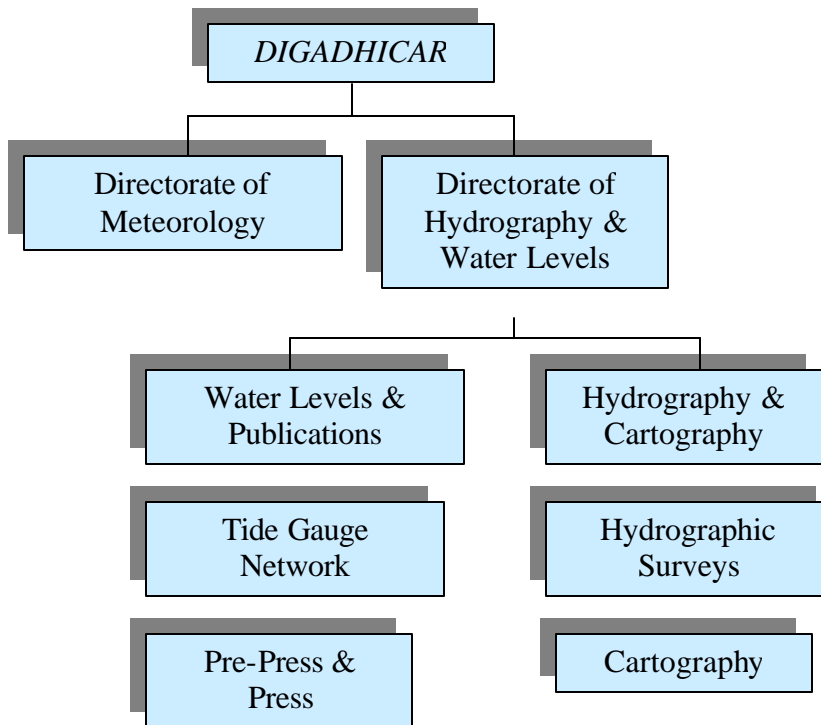


Fig. 1. Mexican Hydrographic Office Organization

Hydrographic Surveys

DIGADHICAR has two Teams (called “brigades”) each with fifteen elements to conduct hydrographic surveys. These teams are assigned to each coast:

- Gulf of Mexico and Caribbean Sea Oceanographic Institute,
- Pacific Oceanographic Institute.

All of the planning and logistics are conducted at the Directorate of Hydrography and Water Levels in Mexico City. The two teams perform field work in four major areas:

- Geodetic Control (horizontal and vertical).
- Baseline survey & traverse (if needed).
- Differential Leveling and Tide Gauge Installation.
- Bathymetric Survey and post processing.

The equipment used in survey operations includes single-beam echo sounders, DGPS, laptop computers, paper plotters, tide gauges (bubble pressure and pressure digital), two launches, and other ancillary equipment required to accomplish the job. Currently, we have four Oceanographic ships being used for medium and deep water surveys. In addition, Navy ships of opportunity are often used.



Fig.2. A Hydrographic brigade preparing for survey operations

Currently, there is a project to purchase multi-beam echo sounding systems (MBES) in the near future. The plan is to install MBES on board two Oceanographic Navy Ships and the purchase of four Hydrographic Survey Launches (HSL) with all the necessary equipment.

For the HSLs, there are several design options. One of the most interesting prototypes is a fiber glass launch no longer than 32', trailer enabled, less than one meter draught, water jet propulsion, with a crew of no more than 4 people. We also plan to take advantage from the experiences of the Canadian Hydrographic Service (CHS) and U.S. Naval Oceanographic Office (NAVOCEANO) design considerations. DIGADHICAR has a cooperative agreement with the NAVOCEANO through the Hydrographic Cooperation Program (HYCOOP) that will enable us to install equipment on board some of our boats, as well as to increase our hydrographic capabilities.

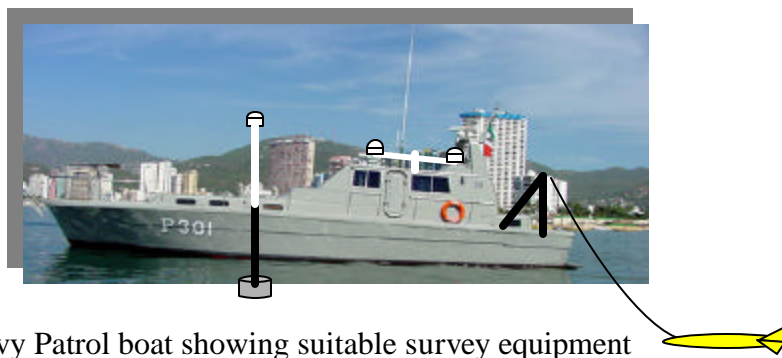


Fig.3. Navy Patrol boat showing suitable survey equipment

Major challenges associated with producing hydrographic data

Mexico has more than 12,000 km of coastline. Since Mexico's territorial waters and EEZ combined, have almost the same size as the land area, many national economic activities are related to the sea. Thus, Hydrography has become a key factor in Mexico's national development.

In 1998, the DIGADHICAR had limited resources to conduct its work properly. The problems at that time included insufficient skilled personnel, the cartographic equipment was very old, and producing charts was primarily an artistic and hand-crafted process. Also, cartographers had almost no experience with computers. This situation would create a bottleneck in the production process. Although we made three hydrographic surveys a year, we were only able to produce one new chart in the same amount of time. In addition, some authorities were not aware of hydrography and its fundamental roll in the Nation's development. As a result, the budget was small.

Fortunately, the situation has changed. Today, the Mexican policy is now aimed toward increasing coastal development. As such, DIGADHICAR is responding to these new challenges. Even with a limited budget, a modernization plan has been instituted to produce a full range of hydrographic products and services. This includes the production of large scale charts for major ports to coastal charts for all Mexican national waters. To do this requires several steps:

- create a modern hydrographic department
- enable the transition from paper to digital
- build the database infrastructure
- and the most important part, one year of training in cartography/hydrography

As part of this overall effort, DIGADHICAR made the decision to purchase *CARIS* software, install desktop computers in a local network, acquire an image setter, and setup a huge new offset printer (for paper chart production).

Digital Production System

The production line was designed to receive data from two different sources: digital data from the hydrographic surveys (using *CARIS HIPS* and *Hypack*, Coastal Oceanographics) and scanned data from already existing paper charts. These data goes to three desktop PCs where *CARIS SAMI* is used to vectorize the scanned paper charts. *CARIS Editor* is used to make a new chart from the survey field chart (cleaned field sheet) or update an already existing chart. It is also used for organizing the data on a GIS basis.

Once a chart has been vectorized, the files are processed by a server computer in order to make the color separation for the image setter, and to produce four films (one for each basic color). These films are then "transported" onto steel plates for offset printing. This is done with a large format offset printer (Man Roland 900) capable of producing 12,000 sheets per hour.

The same vectorized data are also processed by three PCs where personal trained in *CARIS HOM* build the S-57 ENC's. We are also investigating the possibility of producing Raster charts in the Maptech/BSB file format using *CARIS BSB* software. However, this option has been limited to a

few tests within the Navy. In the near future, DIGADHICAR expects to enter into an agreement with Maptech in order to produce “official” raster nautical charts (RNCs) of Mexican waters.

In summary, the Mexican HO has a complete production line of *CARIS* software, including *CARIS HIPS*, *CARIS GIS*, *CARIS Tools*, *CARIS BSB*, *CARIS HOM*. We are also currently building a hydrographic database under *Oracle 8i* for internal data management. In the future, there are plans to establish an Internet web site whereby charts could be ordered and downloaded online.

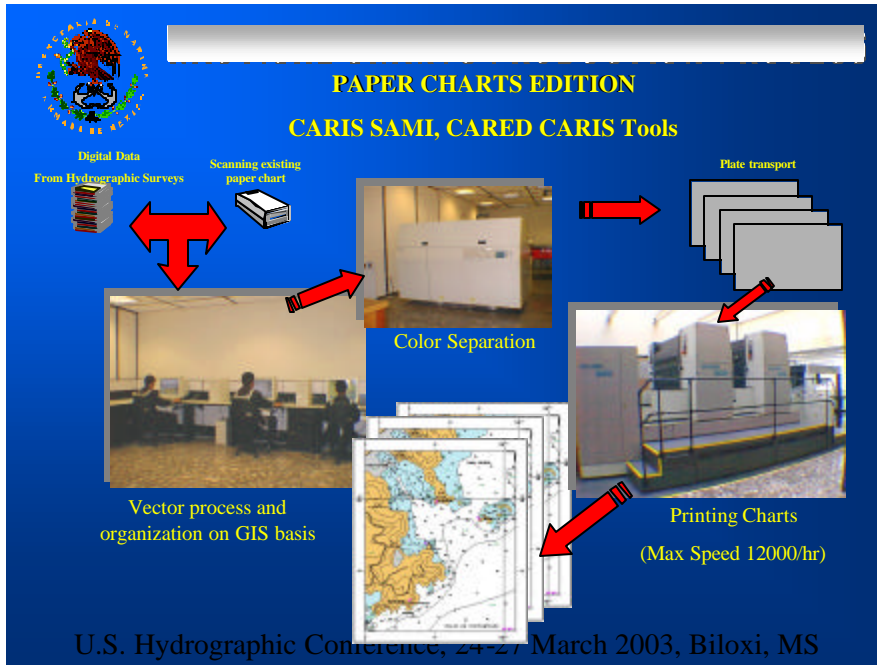


Fig.4. Flow diagram showing paper charts production process.

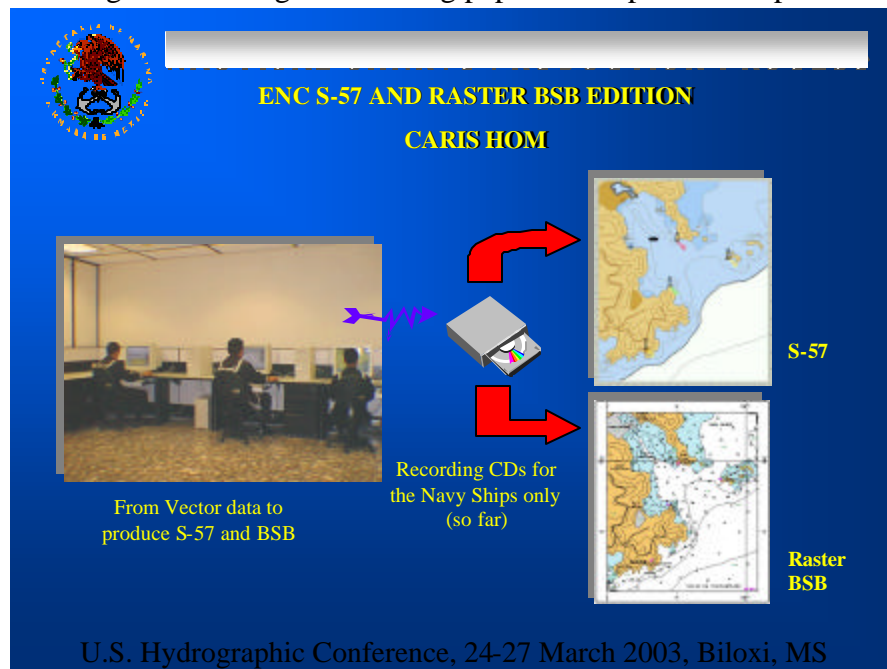


Fig.5. Chart production in digital formats.

Chart Production Status

We currently have more than 100 paper charts at different scales. Our goal is to achieve a mosaic of 408 charts along both coasts in order to achieve full coverage of Mexican waters. We are in the process of vectorizing those 100 paper charts and producing S-57 ENC data from existing paper charts and from new surveys. To date, we have produced over 20 S-57 ENCs. They include:

- 11 Proximity Charts (1:30,000 to 1:50,000)
- 10 Harbor and Berthing (1:10 000 to 1:30 000)
- one for the whole country and the EEZ (1:3,000,000).

National Plan for Nautical Cartography

Under the National Plan for Nautical Cartography, there are:

- five Regional Charts (1: 1,600,000, 1:1,700,000 and 1:1,200,000)
- 12 Approaches Charts (1:750,000 to 1:600 000)
- four Coastal Charts with 26 more planned (1:250,000 to 1:200,000)
- 60 Proximities, Harbors and Berthing Charts with 201 more planned (1:30,000 and larger).

There is also a plan to produce a full mosaic of coastal charts at a scale 1:100,000. Currently, there are eight charts with 92 more planned.

The Nautical Cartography National Plan, also includes two major projects of the Federal Government:

1. Plan Puebla – Panama has the objective to increase the human and ecological richness of the MesoAmerican region framed by sustainable development and keeping the cultural diversity. One of the Mesoamerican initiatives is to establish the promotion of the physical integration of the region to facilitate the transit of people and merchandise by lowering the transportation costs. A key focus for a multi-modal transportation integration is to improve port facilities for commercial shipping and tourist/cruise ship industry. For both, hydrography will play a very important roll. At the same time, the Central American Maritime Transportation Commission (COCATRAM) is establishing a hydrographic project in the Central American region in order to enable new navigational charts to increase the maritime transportation and help in economic development for the region. Both the Plan Puebla – Panama and the COCATRAM Hydrographic Project are related. In this regard, the International Hydrographic Bureau (IHB) has requested Mexico to play a key roll as an advisor in order to assist other MesoAmerican nations in creating national hydrographic capabilities.

2. The Escalera Nautica Project has the objective to develop the Baja California peninsula and the north western states on the Sea of Cortes, focusing toward the tourism market (e.g., yachting, sport fishing, and cruise liners). There are four Mexican states involved in this development: Baja California, Baja California Sur, Sonora, and Sinaloa. These states together with the private sector and local authorities, are planning and working to achieve sustainable development of the region. For instance, there is a potential market of up to 12,000 boats and yachts visiting the Baja California peninsula per year. This represents a major opportunity for improving economic and social development of this region. In response, DIGADHICAR plans to produce 100 new charts at different scales for this region.

Finally, in conjunction with the National Cartographic Plan, a mosaic of one hundred charts at 1:100,000 scale will be produced. Currently, there are eight have been produced.

Data Distribution

The challenge does not finish after accomplishing the 408 nautical charts. There is also a need for distribution and updating services for the civilian end user. In this matter there are several alternatives that DIGADHICAR is considering.

1. Navy Chart Server

The Navy is analyzing the possibility to establish a web site as a “Chart Server”. Powered by CARIS, it would facilitate the sale and distribution of nautical charts (paper and ENC). Eventually, other nautical products and services such as Tide Tables, Notice to Mariners and chart updates, Sailing Directions could also be added.

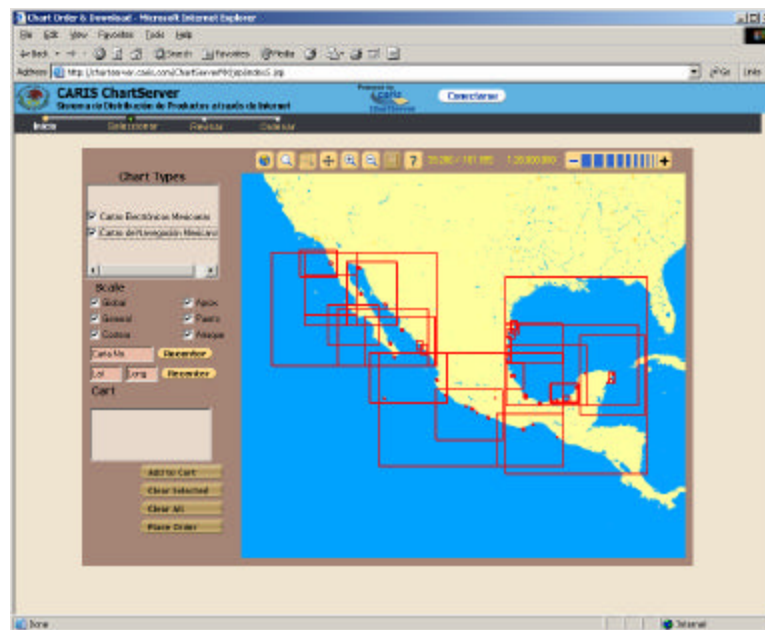


Fig.5. CARIS Chart Server prototype for DIGADHICAR

2. Establishing a RENC

Another alternative being considered is to establish a RENC under the IHO WEND concept. It would be accomplished in conjunction with the new MesoAmerican and Caribbean Sea Hydrographic Commission (MACHC). The idea is to join efforts between countries in the region to facilitate the distribution and servicing of nautical charts. One approach could be to establish a RENC similar to what has been done in Europe (e.g., PRIMAR Stravanger or the UK HO International Centre for ENC (ICE). Another approach would to establish a so-called “Virtual RENC” within the region. These and other possibilities are being analyzed by the MACHC – Electronic Chart Working Group. Regardless which alternative is chosen, Mexico would expect that it would be complementary with its Navy Chart Server.

Lessons learned by Mexico

During the past four years the Mexican Navy Hydrographic Office (DIGADHICAR) has been rapidly evolving. Sometimes we went faster than we expected. Change is good, but it has its inconveniences. Ideally, you need to learn at the same pace as changes occur. Also, it is important to adapt your organization to new requirements. In the process of changing and evolving we have learned the following lessons:

1. A Hydrographic Office must adapt to the new needs and challenges of the digital age.
2. Transition from paper to digital is not an easy step. Also, it takes time.
3. A problem is not solved buying “off the shelf” commercial software. More important is investing a fair amount of time and money in TRAINING.
4. Beginning with the installation of software and proper training, for an HO to accomplish actual S-57 production takes at least one year.
5. Build your data base infrastructure before you start getting multibeam data and producing ENC's.
6. In planning for a chart distribution and updating service, decide on the best option based on your reality. Do not simply copy a foreign concept. It could be good for others, but maybe not as good for your own needs.

Serving our Nation's Needs

Our Hydrographic Office was created to serve both the civilian world for safety of navigation and in support of naval operations. For the Navy, the Hydrographic Office is not only producing nautical charts, notice to mariners and sailing directions to the Navy, but also has started creating the Navy's GIS and services to cover all aspects of spatial information. This is being done to provide the Navy Command with the best available information required for decision making in tasks against terrorism, drugs smuggling, piracy and any other illegal activity in Mexican waters.

In the civilian world our participation goes beyond the traditional role of providing safety of navigation. For Mexico, hydrographic information is a key factor for improving Intermodal Transportation and contributing to our National development. In particular,

1. Tourism
2. Shipping
3. Fisheries
4. Oil Industry
5. Coastal Zone Management
6. Port Authorities
7. Environmental Protection

As an integral component of maritime development, Electronic Navigational Charts will become the highways of Mexico at sea.