Note

Modernisation of the Hydrographic Service of Uruguay

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The Servicio de Oceanografía, Hidrografía y Meteorología (SOHMA) is the National Naval Service of Uruguay, created on 15 May 1916. Since then, its main activities have been:

- The execution of Hydrographic Surveying
- The preparation and maintenance of Nautical Charts and Publications
- The establishment of national policies on Aids to Navigation.

Background

Since its establishment, SOHMA has been using ships adapted to conduct hydrographic surveys. In 1930 the first hydrographic ship was built in the shipyards of Matagorda, Cadiz, Spain. This ship was called *Captain Miranda* and started executing hydrographic surveys that constituted the base of Uruguayan nautical cartography.

In the nineteen seventies the ship was modified and assigned a new role, as the Navy Training School Ship, an activity that it continues to perform today with pride, visiting different ports worldwide as an ambassador, carrying on board young navy personnel on training missions. Since then the country has lost the capacity of having a dedicated ship to conduct hydrographic surveys, returning to ships of opportunity that have been adapted to execute this important activity.

In February 1997, as a result of an accident that occurred to a tanker in the proximity of the entrance to the Río de la Plata, which resulted in significant material damage to the marine environment, the Navy decided to establish a Project that would allow the modernisation and enhancement of hydrographic activities in the area of its responsibility. The project was given the name: 'Hydrographic Surveying of Shallow Waters and the Continental Shelf.

This ambitious Project would also contribute to the necessary scientific research that Uruguay could use in the establishment of the outer edge of the continental shelf, within the framework of the United Nations Convention of the Law of the Seas (UNCLOS), specifically referred to in article 76.

The Project

When the goals of the Project were in the definition phase, it was recalled that a paper had been presented by the present Director of the IHB, Captain Hugo Gorziglia, in September of 1999, during a Seminar held at the International Maritime Academy (IMA), Trieste, Italy, on **'The modern administration of a Hydrographic**

Service'. The presentation gave strong emphasis to the importance of reaching a balanced growth of the following four fundamental components: Infrastructure, Human Resources, Technology and Budget. The balanced growth of these four elements was carefully considered by SOHMA as it was felt that it would lead towards a successful development, and SOHMA would obtain the necessary strengthening and modernisation of the hydrographic and cartographic activities that Uruguay urgently needed. Moreover, Uruguay would take care of the demand for support needed by the increasing fluvial-maritime activities, a fundamental requirement of the railway and highway network and the national development.

The main objectives to be emphasised were identified and decided upon were as follows:

- To provide safety of navigation for the sea-lanes entering the Río de la Plata and terminal harbours in the area.
- To compile the necessary scientific information for the application of Art. 76 of UNCLOS, to establish the outer edge of the Continental Shelf in the zone of interest of Uruguay.

The main tasks to face and fulfill the Objectives drawn up consisted primarily of hydrographic activities in the area.

In order to accomplish the first objective, an ambitious goal was outlined that was to execute hydrographic surveying with the latest generation technology throughout which, special **'Safe Water Lanes'** were identified, that would connect the high seas with the ports of the Zone, assuring the non-existence of obstacles to navigation. The width of the lanes would be six nautical miles, being increased in some sections according to the particular characteristics of the area, with a 100% coverage of the sea bottom overall (Figure 1).

The second objective defined, among other works, emphasised the execution of oceanic bathymetry up to 350 miles from the Base Lines by profiles that will permit the determination of the location of the foot of the Continental Slope.

The Navy, having decided upon these activities, had to provide the human, material, technical and scientific requirements necessary to support, in a timely manner, the long chain of modifications and advances that were planned.

The first activity was centered on the acquisition of a ship that would allow the execution of the hydrographic tasks as planned. During late 1997 and early 1998

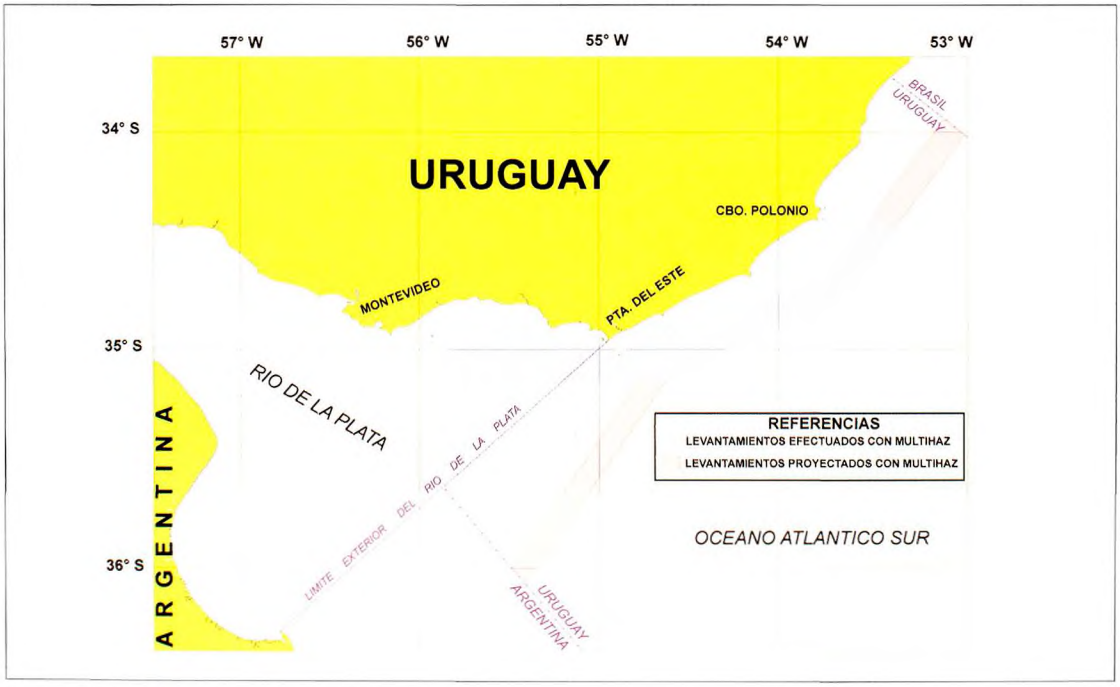


Figure 1: 'Safe Water Lanes'.

Figure 2: Rou Oyarvide.

the Navy searched for that platform, and after analysing several alternatives, identified a German ship that was to be decommissioned, which covered the identified needs and could be adapted quickly to the requirements of its new activity.

In parallel with the search for a ship, sources of support, at a national as well as an international level were investigated, seeking the support of different national and international organisations, that could contribute in different ways.

At the same time it was necessary to equip the ship with the necessary scientific instruments for the execution of the hydrographic surveying according to specifications. To this end invaluable aid was provided by the International Maritime Academy (IMA), Trieste, Italy, and the International Hydrographic Organization (IHO) which facilitated the submission of a project to the European Union that was designed to equip the ship with the necessary instruments for the execution of the hydrographic tasks planned.

This project was named: '*Safety of Navigation in the Rio de la Plata and its Access Routes*' The project was mainly co-financed at the international level, by the Ministry of Foreign Affairs of Italy, the European Union, and the International Maritime Academy in Trieste.

The project, contemplated the provision of all necessary instruments for the hydrographic tasks, and also anticipated an important training activity in IMA, which reinforced the hydrographic and nautical cartographic capabilities of the officers of SOHMA.

The project was extended with the provision of a launch, totally equipped for hydrographic tasks in restricted waters, that is the necessary complement for the ship that cannot operate in such areas.

In September 1998, after negotiations with the Ministry of Defense and the German Navy, the Uruguayan flag was raised on the '*Rou Oyarvide*' (ex *Hellgoland*), in the Port of Wilhemshaven (Figure 2).

The ship has the capability that ships dedicated to the hydrographic task require. It size allows it to conduct, without any problem, the assigned activities in the planned operational areas of the River de la Plata and the South Atlantic Ocean.

During September and October 1998 all the necessary work for the installation of the hydrographic equipment was made, in addition to the necessary work to put the ship in operation. After a short period of commissioning and familiarisation with the ship, the *Rou Oyarvide* departed from Germany on 7 November, arriving at the Port of Montevideo on 8 December, with its new classification as a hydrographic ship.

The hydrographic launch *Trieste* (Figure 3) arrived at Montevideo in March 2001, with the same instrumentation as the *Oyarvide*, together with a side scan sonar that can operate from either of the two vessels.

In the manner described above all the technology, training and infrastructure necessary for the hydrographic data acquisition at sea, was completed together with the preparation of the infrastructure at SOHMA, necessary to adapt its facilities, and the training of its personnel for the processing of the data collected with the new technology, and its later distribution of paper, digital and electronic nautical charts.

Figure 3: Hydrographic launch 'Trieste'.

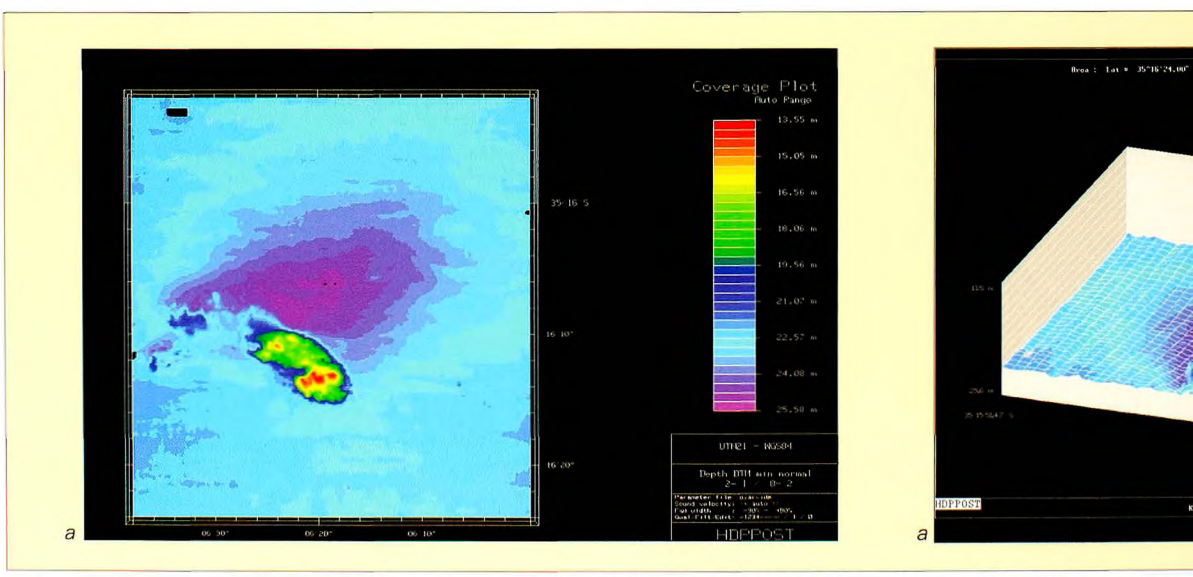
SOHMA Today and the Hydrographic Activity

a) Hydrographic survey and data processing

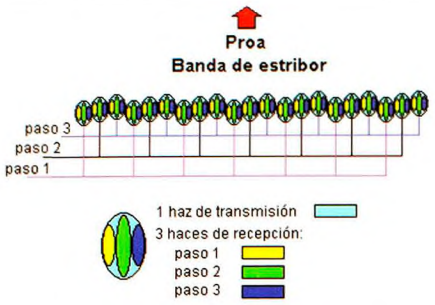
For bathymetric data collection there are two 180 KHz ELAC Multibeam Echosounders Systems of identical characteristics, one installed in the *Rou Oyarvide* and the other in the *Trieste*. These Systems use the beam formation principle in transmission and reception, and are classified as mid water systems according to their maximum range, which is 650 metres of depth.

For the acquisition of the data on both platforms the Hydrostar Online Elac software is used. The data is captured in the *.dat format. By entering the CTD data collected in the working area or SVP, the sound speed correction is made.

For the calibration that must be made in the field in order to adjust the theoretical values of the different sensors with respect to the reference point of the boat, Elac software HDPPost is used. This tool makes it possible to calibrate the roll, pitch and heading of



a) Images obtained from multibeam system in the occasion of survey San Jorge obstruction and b) Images obtained from multibeam



Sistema de haces en transmisión y recepción

Technical Data:

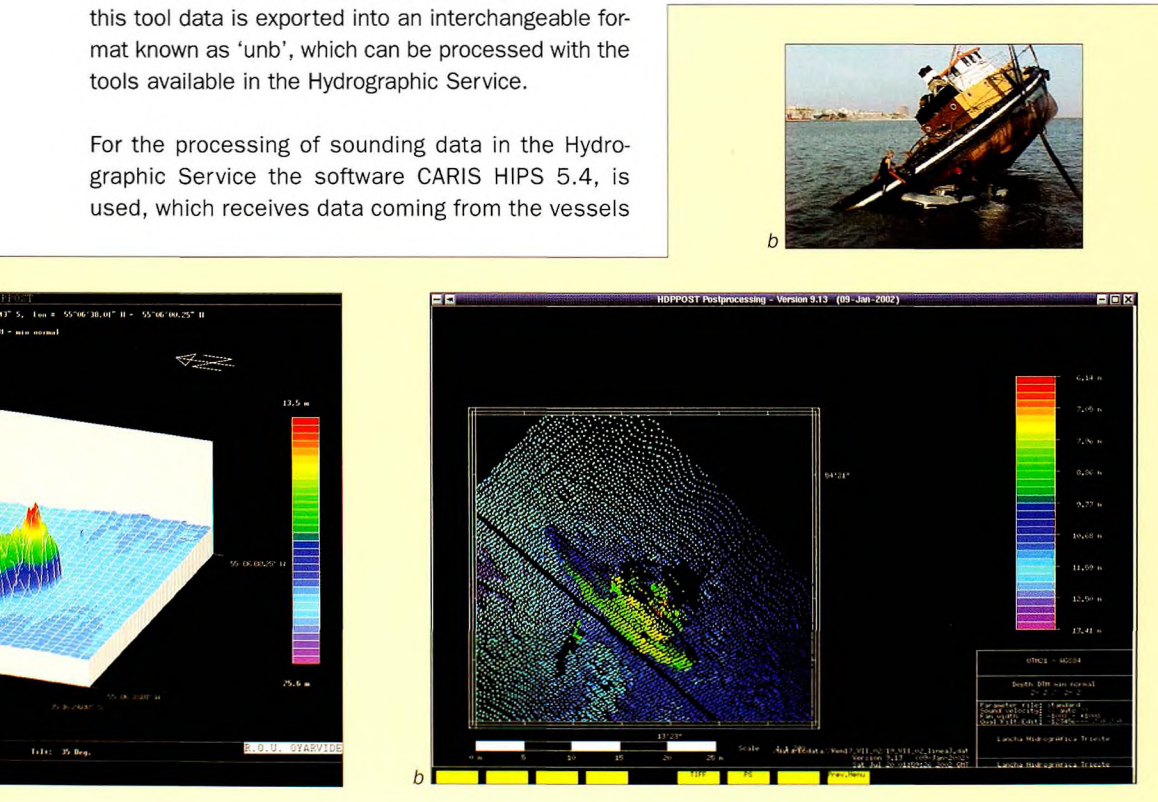
- Frequency 180 KHz
- Pulse length 0,15; 0,3; 1 y 3 ms.
- Side lobe suppression > 36 db
- Number of beams 120 (fewer selectable)
- Beam sector 150º
- Transducer array size (without housing) 255 x 180 mm.

the transducers with respect to the chosen reference point in the boat, as well as the delay in navigation with respect to the position obtained by GPS. With this tool data is exported into an interchangeable format known as 'unb', which can be processed with the tools available in the Hydrographic Service.

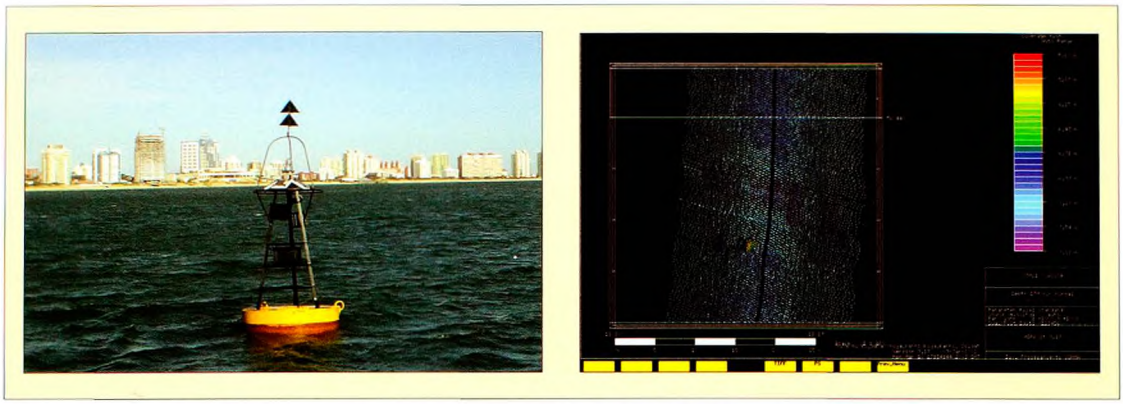
For the processing of sounding data in the Hydrographic Service the software CARIS HIPS 5.4, is used, which receives data coming from the vessels in the 'unb' format. With the same software the following actions are executed: control of the compensation conducted in the field by the motion sensor; tidal data applied; bathymetric information processed line by line and in the module, by subset, or by depth areas, quality control of the survey by means of three-dimensional models. Finally different products can be generated, as for example, the sounding selection, which is sent to the CARIS GIS or CARIS HOME module, to be used in the preparation of the paper charts or S57 cells.

The Side Scan Sonar is a Geo Acoustic system, operating on 100 and 500 KHz. frequencies. This System uses GeoProLC software a complete hardware and software portable system for digital acquisition side scan sonar, with which recording, reproduction, generation of images in different formats, processing and analysis of targets take place. It also works on the Macintosh operating system.

For the topographic survey tasks the GPS RTK Leica SR530 system is used. This GPS system tracks the C/A code in L1 and the P code in L2 to



system in the occasion of the rescue of a tugboat sunk in the Port of Montevideo in June 2002.



Sunken buoy recovered after detection by using multibeam system at the approaches to Montevideo Harbour (Means depth = 7 metres).

reconstruct the carrier phase. When activating the AntiSpoofing, the receiver changes to a patented auxiliary tracking technique of the P code, which provides measurements of complete phase in L2 and also pseudo ranges in L2.

Connected to a radius MODEM, the receiver can be used to conduct RTK operations, reaching coordinates with a precision of up to one centimetre.

Measurements can also be made later to be processed in cabinet by means of the SkiPro software version 3,0 of Leica. By means of this tool different survey methods can be processed, such as, the Static, Quick Static or Kinematics' modes. Leveling trials with the RTK method are also being made, which in the near future may be employed to apply real time tidal data to the survey, without the need of using a tide gauge.

b) Nautical cartography

For computer assisted nautical chart production SOHMA has used the 'CARIS GIS' software since 1999. The incorporation of this tool required the training of the personnel, mainly young people, who incorporated this technology without great difficulty. This was a long process, that did not simply consist of 'drawing' of the chart, but in the continuous search for the best way to include data from digital and paper sources.

With regard to the digital sources, the problem was to manage file formats coming from different surveys and post-processing software. This difficulty, as it was envisaged, also appeared in relation with information coming from other institutions, such as the port authority, private companies or the Army Geographic Service, the national authority in the production of topographic maps.

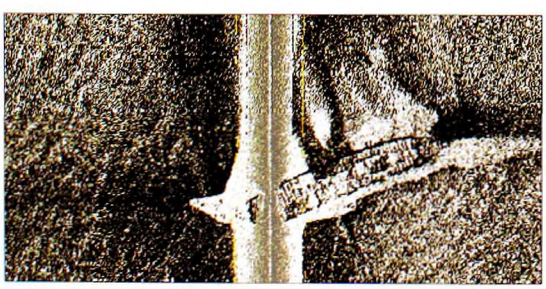
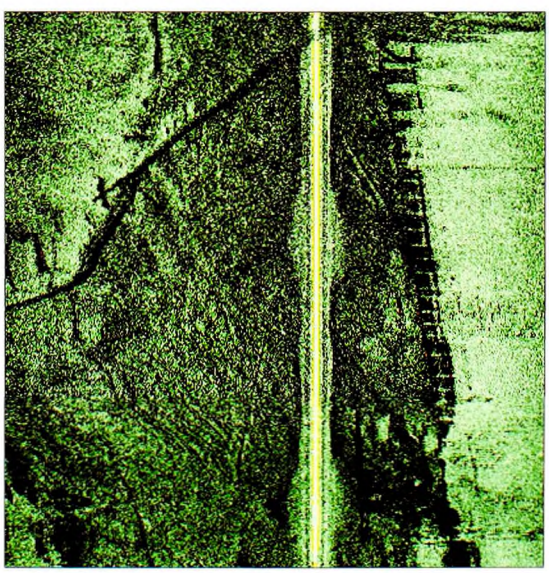
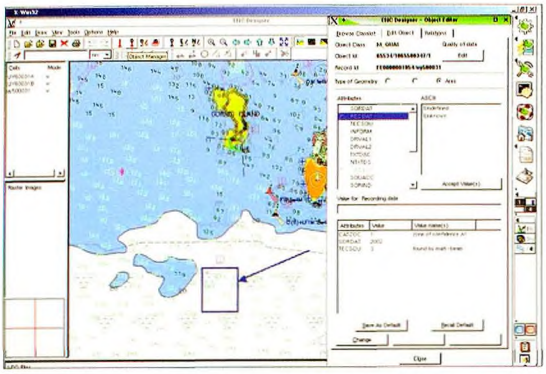


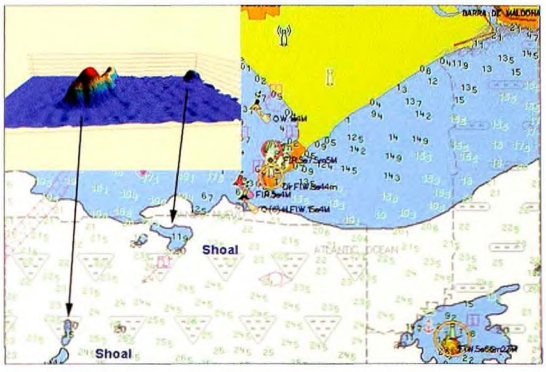
Image from sunken ship detection by side scan sonar operation at Fray Bentos road (Means depth = 10 metres).



An image obtained by means of the side scan sonar in the Port of Montevideo.



M_QUAL and CATZOC use in UY500031 cell (Multibeam survey of Punta del Este).



Shoals surveyed by multibeam system allows better representation in ENC (Punta del Este).

As regard to sources on paper, the work consisted in producing a vector image from a scanned image using the SOHMA CAD. Problems such as the dimensions of existing scanners used by commercial companies, the most convenient resolution to use (balancing the dimensions of the generated *.tif file and the clearness of the image), the georeferencing process, the acceptable differences between the registers, etc., were issues to solve.

In our false belief that "now it is easy to erase and to redraw", the aesthetic aspect caused many backs and forth, generating delays in the processes.

Finally in May of 2001 the first nautical chart was totally produced by digital means.

Another challenge consisted in obtaining a CARIS output format file able to be handled by the commercial printing companies, in order to make the colour separation and preparation of films for later use in offset printing, considering that SOHMA does not have printing facilities. At this stage SOHMA is using PDF files generated through Acrobat Distiller, with excellent results. Also and parallel with the acquisition of the technology by the local companies, SOHMA is in the initial test stage for CTP (Computer to Plate) impression, with the intention to avoid one phase and to go directly from the PDF file to the plate.

Our Cartographic Plan consists of 28 charts and 17 inserted plans. At the moment SOHMA has digitised 50% of the plan, keeping a very clear and strict policy as regard to two points of vital importance in the process of the Electronic Nautical Chart. They are the transformation of horizontal datum to WGS-84 and the verification item by item of all the sources used for the construction of the editions in force, with the corresponding updating of their history files, giving special attention to the precision in the compilation of the different sources. The need for a new compilation of the information has been faced in those cases in which the present methods offer better possibilities, re-measuring with GPS in RTK or DGPS mode in some cases the information to be used, fundamentally, in the port or anchorage charts.

Coping with these problems has slowed down SOHMA production, but it provides great confidence to know that charts, and especially the ENCs, will give to the mariner the greatest possible security.

In that respect, the first steps towards the production of ENCs were made in 2003. Test licenses for the edition and navigation were obtained to confirm the capacity to produce a cell following the standard S-57 of the IHO. The ENC was based on the digital file of the latest edition of the paper chart of the main tourist port and anchorage of the east coast: Nautical Chart Nº 31 'Bahia de Maldonado e Isla de Lobos', which includes two plans: Puerto de Punta del Este y Punta Ballena.

Four months later cells of the approach, port and berthing areas were ready. This experience had its validation at sea including the berthing areas. Later these cells were provided to the hydrographic ship to complete the tests, serving their final report as a feedback to validate the procedures.

With this practical experience and after obtaining the required resources, on the job training was held at the United Kingdom Hydrographic Office

(UKHO) at the end of 2004, helping to reaffirm the concepts and to establish cooperation links. Also it was possible to meet the personnel of the RENC (IC-ENC) that operates there, being able to observe their validation and harmonisation procedures which are of great importance to be able to comply with the WEND principles.

In August 2004 a CARIS HOM license together with the associated training at SOHMA were acquired. Seven months later a license of Dkart Inspector was bought to be able to validate the cells with software provided by a company different from that executing the editing process. Until now SOHMA has finalised four cells and is taking action to establish the mechanisms for the commercialisation of these new products.

Conclusions

This project has demonstrated the importance of modernising and improving hydrographic services in the national interest and that such a process is clearly possible.

It is important to find the support and understanding of national authorities to which the contribution and collaboration of the international community should be added. SOHMA highlights this as having been the fundamental element for the success of the project.

The present challenge of SOHMA is to sustain and keep updated the Hydrographic and Cartographic capacity level reached, as it is considered to be of great benefit for the maritime and fluvial activities in the region, providing safer access routes to Ports, through the provision of products that contribute to the development of international hydrography.

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