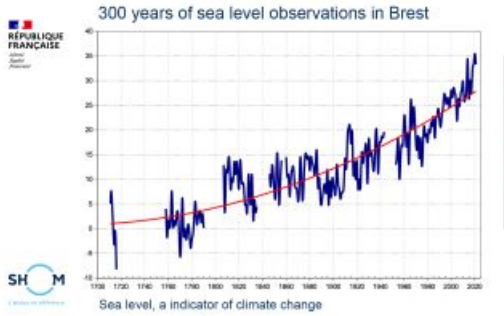
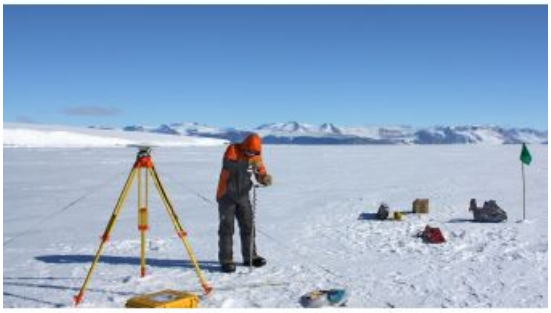
FROM NAUTICAL CHARTS TO MARINE SPATIAL DATA

Preparing for sea-level rise thanks to hydrography





In many places around the world, data clearly shows a rise in sea level. In low-lying coastal areas, even small increases when coupled with high tides and storm surges can have devastating consequences. Hydrography can provide a range of technological and data solutions for monitoring changes, pinpointing vulnerable areas and preparing for the future. Digital data standards developed by the IHO can also help to tackle the large quantity of ocean data generated.

Sea-level rise coupled with extreme weather events can have far-reaching effects, such as altering coastlines, impacting offshore energy infrastructure and displacing populations. However, not everywhere around the globe will be impacted to the same extent or at the same speed. Many factors determine tides and sea level: the gravitational pull of the sun and the moon, but also the shape and texture of the seabed, which in some cases can magnify the height of tides and waves.

Hydrographic products and services support all activities associated with the oceans, seas and inland waterways and can help to address these challenges. Hydrographic surveys collect data on a variety of ocean parameters, including depth (bathymetry), tides and sea level. To integrate this data from different geographic sources, different disciplines and different devices and to ensure it is interoperable, robust international standards are needed. As a result, the standards and frameworks developed by the IHO for navigation are being expanded to cover other applications.

From nautical charts to marine spatial data infrastructure

The provision of hydrographic information has expanded from feeding just nautical charts and services to a much broader range of activities. The digitalization of this information allows hydrographers to provide marine spatial data that can be both mapped

and analysed. Digital marine spatial data was successfully standardized for navigation using the IHO standards and guidelines, and in particular through the IHO data exchange standard S-57 for electronic chart data and IHO INT 1 for the standardization of nautical paper charts.

However, the growing importance of economic and environmental considerations requires a more holistic view. The underlying hydrographic data, only some of which is shown in charts, is therefore in great demand for a much wider range of applications and as such, interoperability of this data is more important than ever before.

Illustration of the next generation of datasets capable of displaying the seabed topography: combination of S-101 ENC and S-102 Bathymetric Surface. (Image courtesy: NOAA)

Based on the ECDIS/ENC experience, the IHO continues to develop and set standards and issue guidance that ensures that hydrographic information is available and can be delivered to users through appropriate harmonized and interoperable products and services. The development of these new standards is driven by the need to continue to satisfy the SOLAS (Safety of Life at Sea) requirements of enhancing safety of navigation and to support the implementation of e-navigation led by the International Maritime Organization (IMO), the creation of a global tsunami early warning system and the sustainable use of the oceans as part of the UN Ocean Decade. These require easy access to standardized, high-quality digital geospatial information that can support marine spatial management. Accordingly, the IHO is continuing to work on the S-100 framework to support the creation and maintenance of interoperable marine data product specifications compliant with the ISO-19100 series of geographic information standards. S-100-based products including S-102 Bathymetric Surface and S-111 Surface Currents are under initial implementation, testing and evaluation in IHO testbed programmes. The series also includes a product specification for maritime limits and boundaries (S-121) and Marine Protected Areas (S-122).

Nautical charts and digital tidal data

Hydrographic offices around the world monitor tide gauges that provide dynamic data on sea level that helps to outline trends in currents and can be displayed in digital maps. However, the root of these applications dates back to the 1980s, when progress in technology introduced the possibility of a versatile software application that could digitally integrate a number of functions into a partially interactive navigational tool. The IHO and IMO worked together to make this vision a reality by providing specifications and performance requirements for such an application. In 1989, the IMO coined the name 'Electronic Chart Display and Information System – ECDIS' for this innovative class of computer-based shipborne navigation devices. To feed ECDIS with official nautical data, the IHO created the first standards for digital nautical maps in the mid-1990s, the 'Electronic Nautical Charts – ENC'. It took almost two decades before hydrographic offices were capable of establishing the regular provision of ENCs equivalent to paper charts in terms of quality and coverage for their sea areas of responsibility. Today, effectively all navigable waters are covered by ENCs, of which there are approximately 16,000 in total. There are mature distribution systems for ENCs operated in collaboration with industry that also facilitate regular updates via satellite communication.

Images of ENC coverage of the Channel. (Source: IHO online chart catalogue)

In the 2000s, user demand for real-time depth information services for navigation in conjunction with the availability of high-resolution bathymetric data prompted a key area of work: the implementation of dynamic tides in the digital environment associated with ECDIS. To this day, the IHO continues to encourage the use of tidal data and the recovery of historical tide gauge records for the study of long-term sea-level change. Some of the recent sea tests with S-100, the Universal Hydrographic Data Model, are also looking at getting near real-time data on the detailed seabed topography and currents.

Supporting early warning systems

Hydrographic data can also help to anticipate and prepare for extreme weather events and natural disasters such as tsunamis. At COP27 in Sharm el Sheikh, Egypt, UN Secretary-General Mr Antonio Guterres announced a plan to implement early warning systems around the globe within the next five years. The plan will address "key gaps in understanding disaster risk, monitoring and forecasting, rapid communication and preparedness and response."[1] In order to implement effective systems for the ocean, up-to-date and accurate data is needed to monitor changes in the marine environment and to develop more accurate models for future trends. Particularly because the shape and texture of the seabed influence tsunami wave propagation, better information can help to pinpoint areas on which to focus resources.

Sea-level measurements taken by Shom in Brest clearly show the level is rising. (Image courtesy: Shom)

General Bathymetric Chart of the Ocean (GEBCO)

The IHO is working together with IOC UNESCO to produce a complete and high-resolution map of the seafloor as part of the GEBCO programme. Data is stored at the IHO Data Centre for Digital Bathymetry (DCDB), hosted by NOAA's National Center for Environmental Information (NCEI) in Boulder, Colorado (US). The DCDB's bathymetric databank increases by several terabytes each year. The resulting freely available GEBCO grid – now updated annually – has evolved to become an interactive mapping tool with query capabilities. The coverage and quality of the grid is however dependent on the incoming survey data on the ocean topography.

The percentage of the global ocean mapped in high resolution by means of the GEBCO grid increased from 6% in 2017 to nearly 25% in 2022. There is however a significant gap in full high-quality coverage. The GEBCO programme is working to improve this through various initiatives. One of these is the joint Nippon Foundation-GEBCO Seabed 2030 project, which aims to map 100% of the ocean in high definition by the end of this decade. Seabed 2030 works to discover existing datasets not yet

ingested into the DCDB, supports the IHO's citizen science project to gather depth data ('crowdsourced bathymetry') and plans to sponsor the development of new survey technology. The objective is that each grid cell at the defined target resolutions that vary by depth will contain at least one depth sounding. The GEBCO grid released in June 2022 contained significantly more data, particularly in the Arctic and Antarctic regions, where the coverage has increased to approximately 15%. Recognizing its contribution to increased knowledge of the ocean, Seabed 2030 has been endorsed as a UN Ocean Decade Action.

Beside the S-100 standardization framework, the GEBCO grid is one of the most important ways in which hydrography can contribute to a better knowledge of the ocean. In addition to providing baseline data to monitor changes, better data feeds more accurate models for sea-level rise and ocean currents. The accuracy of prediction models for the impact of rising waters in coastal areas is highly dependent on the geometry and texture of the seabed. Hydrography as an applied science is the only discipline to deliver this ocean knowledge.

Checking tide gauges in Antarctica. (Image courtesy: Land Information New Zealand)

Building capacity

Capacity-building is an important component of the IHO Work Programme. The goal is to assist States to meet hydrographic, cartographic and maritime safety obligations with particular reference to recommendations in UNCLOS, SOLAS and other international instruments. The scope encompasses safety of navigation, protection of the marine environment, climate change mitigation and adaptation, national infrastructure development, coastal zone management, marine exploration, marine resource exploitation (minerals, fishing, etc.), maritime boundary delimitation, maritime defence and security and coastal disaster management.

More than 1,500 participants from 143 States have benefited from the IHO's Capacity Building programme's activities since 2005. The range of activities supported covers a wide spectrum, not only in terms of the type of activities but also in terms of their length. Short-term activities can include Technical Visits to assess the current state of knowledge, workshops, seminars and short courses. Technical Visits help to identify the hydrographic capability required to provide the services to meet the obligations linked to the SOLAS Convention. Workshops, seminars and short courses are dedicated to specific aspects of the obligations, such as those related to Marine Safety Information, specific parts of hydrographic surveying, data processing and management and the production of nautical charts.

The IHO has set up and maintains a system of funded education courses. Since 2009, 27 courses have been made available and completed by 137 students from 56 Member States and have provided an important contribution to the hydrographic capacity around the world.

The IHO Capacity Building programme is funded from the IHO budget and supplemented by contributions from Member States, industry and other partners. This includes ongoing financial support from the Nippon Foundation of Japan and the Republic of Korea. Taking into account the growing demand for IHO CB activities, the Secretariat is continuing its campaign to find additional donor states and funding organizations.

[1] UN.org *COP27: $3.1 billion plan to achieve early warning systems for all by 2027*

Shom checking levelling of tide gauges in Monaco. (Image courtesy: Shom)