Hydrographic Data Required for Digital Twin of the Ocean

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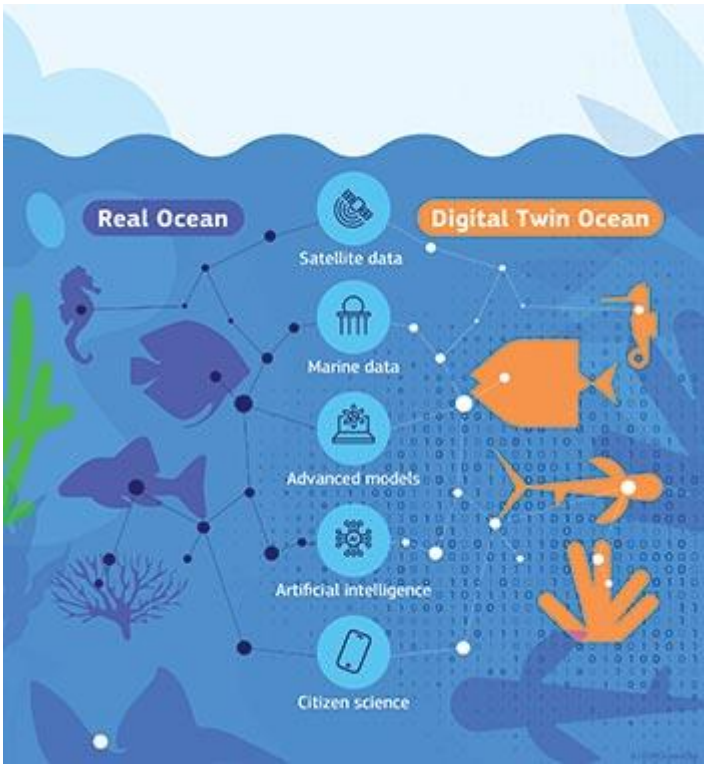

The ocean is of paramount importance to our planet and its inhabitants. It covers more than 76% of the Earth's surface. It plays a crucial role in regulating the Earth's climate, acting as a large heat sink and distributing heat through ocean currents. Furthermore, it produces over half of the planet's oxygen, supporting the breathing of terrestrial and marine organisms. But how much do we know about the ocean? More than 80% of our ocean is still unmapped, unobserved, and unexplored, leaving most of our planet unknown to us. Moreover, the ocean is the main driver of climate and influences human activity in numerous ways. As a result of increasing human activity, the oceans have become overburdened and teetering on the brink of permanent decline. At this stage, it is critically important that our oceans be preserved for the existence of mankind. So, we must know the ocean in-depth to avert a catastrophic situation in the future. Hydrography is that knowledge or applied science which is essential to know for the preservation of the ocean.

Hydrography refers to the science and study of bodies of water, including oceans, seas, lakes, rivers, and other water features. It involves measuring and mapping various aspects of these water bodies, such as their depths, contours, tides, currents, and the physical and biological characteristics of the water itself. Although this branch of applied science focuses primarily on bathymetric surveys and nautical mapping, it is not limited to those basic functions. Important physical marine systems like tides and water column observations and predictions are recorded using the Hydrographic Services measurement infrastructure. But, the interpretation of hydrography as "to measure all the physics of the seas" leaves room for further expansion and offers opportunities for a new collaboration with ocean sciences by providing data and metadata derived during the hydrographic survey. On a global scale, Hydrographic Offices operate the largest fleet and maintain the widest range of fixed and floating infrastructure to undertake regular ocean observations while carrying out specific aspects of their duties. In essence, hydrography plays a vital role in the conservation and protection of marine ecosystems that need to be globally recognized.

World Hydrography Day (WHD) is celebrated on June 21 every year to raise awareness about the importance of hydrography and its significance in various aspects of life. The apex organization of Hydrography, former International Hydrographic Bureau (IHB), and the present International Hydrographic Organization (IHO) was established on June 21, 1921, in Monaco. Hydrographic products and services support all activities associated with the oceans, seas, and navigable waters. The theme of this year's World Hydrography Day has been chosen by IHO as: "Hydrography- Underpinning the Digital Twin of the Ocean." This theme is intended to highlight the concept of the Digital Twin, which mainly refers to a virtual representation or simulation of a physical object, system, or process, therefore allowing for analysis, prediction, and optimization. In fact, hydrography forms the backbone of the Digital Twin of the Ocean (DTO) by providing essential data for mapping, navigation, environmental monitoring, and dynamic updates. It provides realistic virtual environments to help researchers, scientists, and stakeholders better understand and manage the complexities of the ocean.

So, how does a digital twin work, and what is unique about it? The Digital Twin of the Ocean refers to a virtual replica or simulation of the ocean environment. It integrates data, models, and algorithms in real time to provide an accurate and dynamic representation of the physical, biological, and chemical characteristics of the ocean. The Digital Twin of the Ocean combines hydrographic data with advanced technologies such as remote sensing, satellite imagery, and numerical modelling to create a comprehensive and dynamic digital representation of the ocean. It encompasses a wide range of data, including bathymetry (measurement of water depth and underwater topography), water quality parameters (such as temperature, salinity, and pH), ocean currents, wave patterns, marine ecosystems, and other relevant information. Underpinning the digital twin of the ocean, hydrography provides the baseline data needed to build an accurate and detailed representation of the marine environment. Hydrographers gather essential information about the shape and features of the seafloor, water column, and coastline by collecting data through various methods such as sonar systems, multibeam echo sounders, and airborne lidar. These hydrographic data and other environmental and oceanographic data sources are then integrated with the Digital Twin platform. As a result, it helps to understand and monitor the state of the marine environment, including changes in water quality, sea level, and the distribution of marine species. It supports the prediction of oceanographic events, such as tides, currents, and storms, and helps with marine safety, coastal management, and offshore operations. It also provides a platform for simulating and testing different scenarios, allowing assessment of the potential impacts of human activities, climate change, and natural disasters on the oceans.

Hydrography and digital technologies offer authoritative tools to understand ocean management. Hydrographic surveys provide the baseline data required to build the Digital Twin of the Ocean. These surveys involve mapping the seafloor topography, identifying underwater features, and determining water depths. The bathymetric data collected during the hydrographic surveys are integrated into the Digital Twin of the Ocean, allowing realistic 3D representations of the sea floor. These data help to identify underwater features, such as ridges, canyons, and seamounts that are critical to understanding ocean dynamics. Accurate charts and maps derived from hydrographic surveys are essential for safe marine navigation,

especially in areas with shallow water, underwater hazards, or changing seabed conditions. Incorporating hydrographic data into the Digital Twin of the Ocean improves the accuracy of the virtual environment, helping to train ship operators and improving marine safety. Hydrographic data contributes to the monitoring and understanding of marine ecosystems. Integrating this data into the Digital Twin of the ocean allows researchers and stakeholders to examine the impact of human activities, climate change, and pollution on the marine environment. By continuously integrating new hydrographic data into the Digital Twin of the Ocean, it ensures that the digital representation of the ocean remains current and accurate, facilitating real-time monitoring and analysis. In short, hydrography is the backbone of the Digital Ocean Twin, providing vital data for cartography, navigation, environmental monitoring, and dynamic updates.

On a final note, I want to reiterate that the ocean is in a dire state due to anthropogenic causes. It is true that, despite the many measures taken to mitigate the effects, much remains to be done to protect and conserve our oceans. It is the in-depth knowledge and science that can help to preserve our ocean and to formulate the ocean policy for better management. By combining hydrographic data with digital technologies, the Digital Twin of the Ocean offers a powerful tool for improving our understanding of the marine realm, promoting sustainable ocean management, and supporting decision-making processes related to marine resources, conservation efforts, and coastal development. Hence, our concerted effort should focus on augmenting hydrographic capacity and widening the scope of oceanic data collection and collaboration.

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