CHAPTER 8

The Quest to Completely Map the World's Oceans in Support of Understanding Marine Biodiversity and the Regulatory Barriers We Have Created

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Abstract

This paper reviews the current poor state of our knowledge of the bathymetry of the seafloor (only approximately 15% has been mapped by modern bathymetric sonars) and discusses the efforts being made under the auspices of the Nippon Foundation GEBCO Seabed 2030 program to rectify this situation and to produce a publically available, complete map of the ocean basins that can be used to support UN Sustainable Development Goal 14 by 2030. It will be impossible to achieve the targeted level of sustainable development without a comprehensive map of the ocean floor, a fact recognized by the planners of the Decade of Ocean Science for Sustainable Development who have identified "mapping the entire ocean floor and its processes" as a proposed priority area for the Decade. For this ambitious undertaking that will benefit all mankind to be achieved, we will need to ensure that the collection of the data needed to produce such maps will not be impeded. There are serious fiscal and technological challenges in trying to map the remaining unmapped 85% of the world's oceans by the target date, but these can be overcome by collective efforts and technological innovation. Less obvious are the sometimes arbitrary regulatory barriers to achieving complete mapping of the seafloor that coastal states may present in their interpretation of Marine Scientific Research under the 1982 UN Convention on the Law of the Sea. The recognition that the collection of bathymetric data in support of such a publicly-available global map is not categorized as MSR under the context of Part XIII of the Law of the Sea Treaty would go a long way to help meet this critical goal.

Keywords

oceans – mapping – marine biodiversity – regulations – bathymetry – seafloor – marine scientific research – United Nations Convention on the Law of the Sea – Seabed 2030

 | DOI:10.1163/9789004422438_009

1 Introduction

In concert with its establishment of The Sustainable Development Goals, the United Nations has recently proclaimed a **Decade of Ocean Science for Sustainable Development (2021–2030)** "to support efforts to reverse the cycle of decline in ocean health and gather ocean stakeholders worldwide behind a common framework that will ensure ocean science can fully support countries in creating improved conditions for sustainable development of the Ocean."[1] The proclamation of the Decade of Ocean Science is a clear recognition of the critical role that the ocean plays in sustaining life, moderating climate and contributing to the overall physical and economic well-being of humankind. It also recognizes the serious threats to the health of the oceans and that action is urgently needed to ensure a sustainable future. In proclaiming the Decade of Ocean Science for Sustainable Development, on December 5, 2017, General Assembly Resolution 72/73[2] provided:

> 283. *Notes* that the depth of a significant percentage of the world's oceans, seas and waterways has yet to be measured directly and that bathymetric knowledge underpins the safe, sustainable and cost-effective execution of almost every human activity in, on or under the sea;

and

> 285. *Encourages* Member States to consider contributing to mechanisms that encourage the widest possible availability of all bathymetric data, so as to support the sustainable development, management and governance of the marine environment

In making these statements, General Assembly Resolution A/72/73 recognized that a critical first step in establishing the knowledge needed to understand, manage and sustain biodiversity and other marine resources is establishing the geospatial context of the oceans – i.e., maps that accurately depict depths, the distribution of seamounts, ridges, trenches, and the nature of the seafloor substrate (e.g., sand, rock, mud, manganese nodules, coral, etc.), all critical aspects of understanding critical habitat. This fundamental geospatial context also provides insight into the paths of deep-sea currents, controlling the global distribution of heat and a key component of climate modeling. Mapping can

1 https://en.unesco.org/ocean-decade.

2 Oceans and the Law of the Sea: General Assembly Resolution A/72/73 adopted 5 December 2017. Distributed 4 January 2018. Identical texts appear as paragraphs 286 and 288 of the 2018 omnibus oceans resolution A/RES/73/124.

provide insight into the stability of the seafloor and other key processes that impact habitat and biodiversity. Knowledge of bathymetry is also an essential component for the accurate prediction of where tsunamis will have the greatest impact and where storm surge will do the greatest damage. Modern mapping systems also allow us to image the water column, mapping the distribution of fish, gas seeps, and hydrothermal vent communities. General Assembly Resolution A/72/73 also recognized, however, that despite many years of effort, only a small fraction of the world ocean's seafloor has been mapped by modern sonar systems, limiting our ability to explore and understand these critical ocean and seafloor processes. As will be outlined below, direct measurements of bathymetry using modern mapping techniques is available for only about 15% of the world's oceans. Thus, for almost 85% of the world's ocean's seafloor, no direct depth measurement is available. To state paragraph 285 of G.A. Resolution A/72/73 in a different way – *how can we manage and protect what we do not yet know and understand?*

This paper will review the current poor state of knowledge of the bathymetry of the seafloor and discuss the efforts being made to rectify this situation and to produce a complete, publicly-available map of the ocean basins that can be used to support UN Sustainable Development Goal 14 – "Conserve and Sustainably Use the Oceans, Seas and Marine Resources for Sustainable Development." It will be impossible to achieve this sustainable development goal without a comprehensive map of the ocean floor, a fact recognized by the planners of the UN Decade of Ocean Science for Sustainable Development who have identified "mapping the entire ocean floor and its processes" as a proposed priority area for the Decade. This paper will also discuss the fiscal and technological challenges of trying to map 85% of the world's oceans by a target date of 2030, challenges that are formidable but obvious; less obvious, however, are the regulatory barriers to achieving complete mapping of the seafloor that coastal states may present in their interpretation of Marine Scientific Research under the 1982 UN Convention on the Law of the Sea.

2 Mapping Earth

Our ability to map Earth, and with this mapping understand a variety of Earth processes, including biodiversity, has advanced at tremendous pace through developments in remote sensing. Satellite-deployed sensors can collect topographic data and produce digital elevation models (3-D models of topography) with sub-meter accuracy depicting landforms (and thus the geospatial context) in remarkable detail. Optical, infrared and multi-spectral sensors can instantly map with high resolution, over large areas, the distribution of land cover (e.g., forests, agricultural areas, deserts), the nature of the land cover (species of trees, plants, etc.) and even the health of the vegetation. Any five-year old using Google Earth, can, with a few keystrokes, zoom into most anywhere on earth and see detailed imagery of our planet. The value of this ability with respect to understanding earth processes, exploring, navigating, planning, building and carrying out a host of other activities is immeasurable. Yet our ability to image the earth with this incredible detail is limited to the approximately 29% of the earth that is terrestrial. If we attempt to use the same imaging techniques to map the 71% of the planet that is covered by seawater, we will see nothing but a blue surface. This is because the electromagnetic waves (e.g., light waves) that are used by satellite remote sensing systems cannot penetrate far through seawater.

Because light does not propagate very far in the ocean, if we are interested in mapping the seafloor at the same scale at which we can map the land surface, we need to bring our camera and lighting systems very close (within a few meters) to the seafloor. Fortunately, we have developed the technology to do this using towed camera systems, remotely operated vehicles (ROVs) or autonomous underwater vehicles (AUVs), but imagery collected from such systems, particularly in the deep sea, comes at a very slow pace. In deep water, it can take several hours for a system to get close to the seafloor and once there, these vehicles move at very slow speeds (a few knots or less) and cover a very small area (1–3 square meters) with each image. Given that the area of the seafloor is approximately 360 million square kilometers,[3] and estimating the coverage of a typical deep-sea image to be approximately 4 square meters, we can estimate that to cover the world ocean with detailed optical imagery (i.e., create a Google Ocean at a scale commensurate with Google Earth), it would take about 90,000,000,000,000 images. Factoring in the time it takes to bring a vehicle down and back from the seafloor and the time it takes to capture the images, we are looking at something like 200 million years to completely image the seafloor using optical techniques – clearly an impossible task.

3 Costello, M.J., Cheung, A., De Hauwere, N., 2010, "Surface Area and Seabed Area, Volume, Depth, Slope and Topographic Variation for the World's Seas, Oceans and Countries," *Environmental Science and Technology*, v. 44, no. 23, pp. 8821–8828.

3 Tools to Map the Seafloor

Given the limits of optical techniques, other means have had to be developed to map the oceans' depths. For thousands of years, depths were measured by lowering a weight at the end of a line and then measuring the length of the line (lead-line). While such a technique can provide a reasonably accurate measurement of depth in shallow water (less than about 200m), lead-line measurements in deep-water (roughly 200m – 11,000m)[4] are very inaccurate (if at all possible) and very time-consuming (many hours for a single measurement). Such measurements are also very sparse and, in reality only representative of the single point that the lead-line landed on. With the invention of sonar between the First and Second World Wars, a new technique of "echo-sounding" was developed that allowed a much more rapid and accurate determination of ocean depths. Unlike electromagnetic waves, sound waves propagate extremely well in ocean water and thus a sound pulse at an appropriate frequency generated by a surface vessel can travel to even the deepest depths of the ocean, bounce off the seafloor and return to a sonar receiver on the vessel. If the speed of sound in seawater is known (it is easily measured), then the travel time of the sound wave from the seafloor and back can be converted to an estimate of depth. At the speed at which sound travels in seawater (nominally 1500 m/sec), even measurements in the deepest parts of the ocean take only a few seconds to make. With the advent of ships' echo-sounders, (single beam sonars) hydroacoustic measurements of ocean depths became much more frequent. Ships transiting the world's oceans standardly ran their echo-sounders in order to support safe navigation.

As the technology to collect bathymetric data evolved, so too did the desire to compile these measurements into maps of the seafloor. In 1903, Prince Albert I of Monaco, in collaboration with Professor Julien Thoulet of the University of Nancy created the General Bathymetric Chart of the Ocean (GEBCO), a Monaco-based organization dedicated to the production of publicly available charts of the world's oceans. GEBCO continues to this day as a project of the International Hydrographic Organization (IHO) and the Intergovernmental

4 For this discussion, "deep" water will be considered depths greater than 200m (typically deeper than the edge of the geological continental shelf) to depth of 11,000m – the approximate depth of the deepest known point in the oceans – the Challenger Deep of the Marianas Trench. The depth of the trench as measured by modern multibeam sonar was 10,984m +/-25m (Gardner, J., Armstrong, J.V., Calder, B.R., and Beaudoin, J., 2014, "So How Deep is the Mariana Trench," *Marine Geodesy*, 37:1–13, 2014 Copyright© Taylor & Francis Group, LLCISSN: 0149-0419 print / 1521-060X online DOI: 10.1080/01490419.2013.837849).

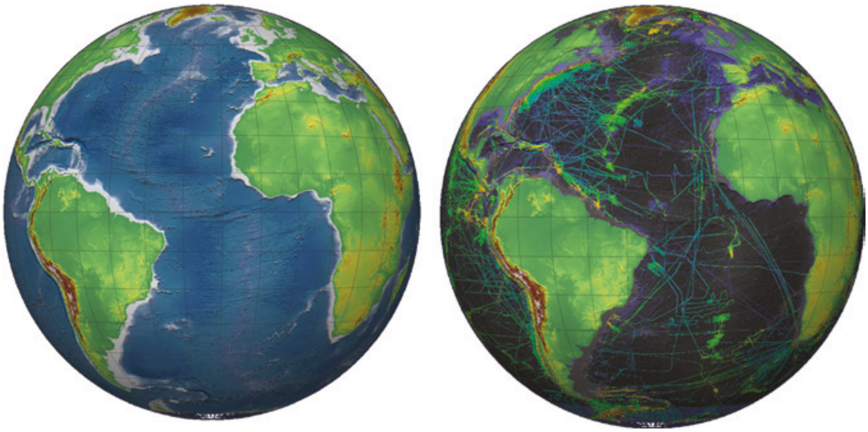

FIGURE 8.1 "Bathy-Globe", an application developed at the Center for Coastal and Ocean Mapping that shows the world ocean bathymetry derived from satellite altimetry and other data (left) and the sparse multibeam sonar data that actually exists (right)

Oceanographic Commission (IOC) and is still supported by the royal family of Monaco. The products of GEBCO have evolved over the years from charts containing a few sparse lead-line soundings to charts based on single-beam echo-sounder data and finally, since 1994, the incorporation of multibeam echo-sounder data. As mentioned above, however, the latest release of the GEBCO map (GEBCO 2019[5] – now a digital product), despite attempts to compile as much data as is available, has modern multibeam echo-sounder data coverage for only approximately 15% of the world ocean, meaning that most of the seafloor has never been directly mapped at adequate resolution.

4 Where Do Those Beautiful Maps of the World's Ocean Seafloor Come From?

If high-resolution multibeam echo-sounder data exists for only approximately 15% of the world's oceans, where then do the beautiful maps we often see of the ocean basins come from? (Figure 8.1 – left).

5 GEBCO_2019, "Gridded Bathymetry Data" <https://www.gebco.net/data_and_products/gridded_bathymetry_data/>.

Maps like those shown in Figure 8.1 (left) are typically derived from compiling all available single- and multibeam echo-sounding data (again covering only about 15% if the world's seafloor) and then combining that with a background that is "predicted" bathymetry from satellite altimetry. Predicted bathymetry from satellite altimetry is based on the fact that the sea surface will respond to the gravitational attraction of features on the seafloor. If a large mountain (seamount) on the seafloor contains excess mass, the gravitational attraction of the feature pushes the sea surface up above its neutral level. If there is a deep trench in the seafloor, the absence of mass, also creates a change in the gravity signal that results in a depression of the sea surface. Sensitive altimeters that measure the height of the sea surface can then be used to provide a rough indication of the depth of the ocean.[6] The bathymetry derived from this approach has offered an unprecedented global view of the major features of the ocean basins (ridges and deep trenches). However, this approach can only resolve features that are very large (on the order of 10 – 15 km laterally) with a depth accuracy of a few hundred meters or worse.[7] And so while predicted bathymetry from satellite altimetry offers a beautiful image of the major ocean features, the resolution and accuracy it provides is not enough to support many needs for seafloor mapping data, including the detail needed for understanding benthic habitat and biodiversity, for understanding deep-sea hazards, for predicting tsunami and storm surge inundation and many other applications (Figure 8.2).

In addition to high-resolution bathymetry, modern multibeam echo-sounders are also capable of collecting another type of information that directly relates to the nature of the seafloor (i.e., the seafloor bottom type). This information, called "backscatter," is a measure of the strength or amplitude of the echo returned from the bottom. The backscatter will vary as a function of seafloor type (rock, mud, sand, gravel, etc.) and while the interpretation of backscatter is complex, it can be used to gain important insight into the nature

6 Smith, W. H. F., and D. T. Sandwell, "Global seafloor topography from satellite altimetry and ship depth soundings," *Science*, v. 277, p. 1957–1962, 26 Sept. 1997.

7 When Malaysian Air Flight MH370 was lost over the Indian Ocean, the only maps available for the region were based for the most part only on predicted bathymetry from satellite altimetry. When multibeam echo-sounders were brought in to map the region they found that in some areas the predicted bathymetry was as much as 1000m different from the actual depths – see: Picard K., Brooke B.P., Harris P.T., Siwabessy P.J.W., Coffin M.F., Tran M., Spinoccia M., Sullivan J. 2018, "Malaysia Airlines flight MH370 search data reveal geomorphology and seafloor processes in the remote southeast Indian Ocean" *Marine Geology*, 395, pp. 301–319.

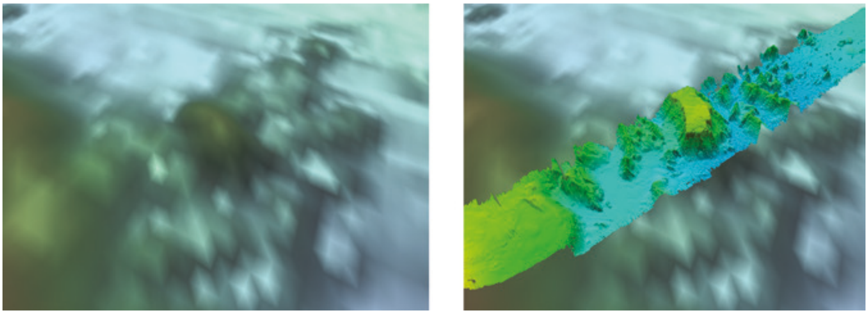

FIGURE 8.2 Comparison of predicted bathymetry from satellite altimetry for 200 km x 200 km area of seafloor (left) with single swath of multibeam sonar data (right) from same area. Note detail on seafloor structure provided by multibeam sonar data that is not available in the predicted bathymetry.

of the seafloor, another key parameter in understanding benthic habitat and biodiversity. Finally, the latest generation of multibeam echo-sounders also offer the opportunity to directly map targets in the water column. Water-column mapping has provided the ability to directly measure the distribution and behavior of fish and plankton, has been used to measure natural and man-made gas seeps (playing an important role in efforts to control the Deepwater Horizon spill), and can even discern fine-scale oceanographic structure in the water column.[8] (Figure 8.3)

5 How Feasible Is It To Map the Entire Seafloor?

And so we have a suite of hydroacoustic tools that can map the seafloor and the water column at the scale needed to support efforts for sustainable development of the oceans and to meet the primary objectives outlined in the UN Decade of Ocean Science for Sustainable Development. However, as previously discussed, only about 15% of the world's oceans have been mapped with

8 Mayer, L.A., Li, Yanchao, and Melvin, G., 2002, "3-D visualization for pelagic fisheries assessment and research," *ICES Journal of Marine Science*, vol. 59, pp. 216–225; Weber, T. C., Mayer, L., Jerram, K., Beaudoin, J., Rzhanov, Y., and Lovalvo, D. (2014), "Acoustic estimates of methane gas flux from the seabed in a 6000 km^2 region in the Northern Gulf of Mexico," *Geochem. Geophys. Geosyst.*, 15, 1911–1925, doi:10.1002/2014GC005271; Stranne, C., Mayer, L.A., Weber, T.C., Ruddick, B.R., Jakobsson, M.J., Jeram, K., Weidner, E., Nilsson, J. and Gardfeldt, K., 2017, Acoustic mapping of thermohaline staircases in the Arctic Ocean, Nature Scientific Reports, 7:15192, DOI:10.1038/s41598-017-15486-3.

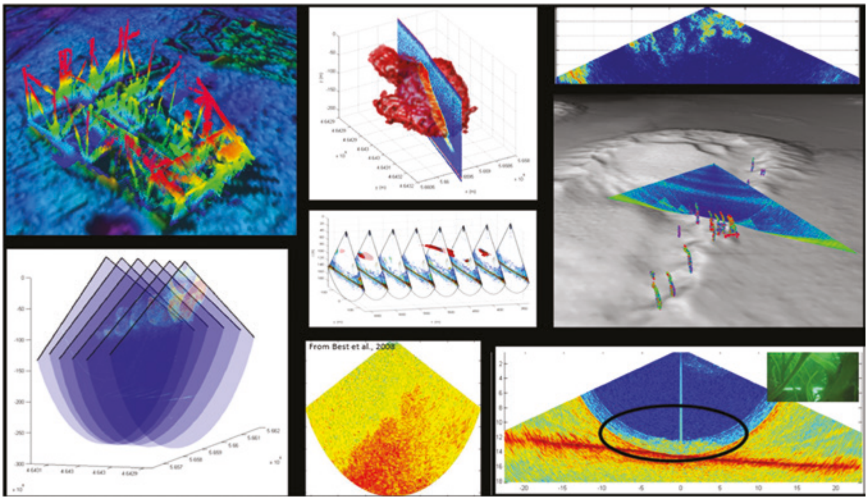

FIGURE 8.3 Water column capabilities of multibeam sonar including depiction of rig structure on seafloor (upper left), fish aggregations – middle two upper (Atlantic herring, upper; and walleye pollock lower) and lower left (Atlantic herring), bubbles in breaking waves (upper right), gas seeps (mid right) and eel grass (lower right)
SOURCE: FROM TOM WEBER, CCOM UNH

these tools. Recognizing this poor state of our knowledge of ocean depths and the critical role such knowledge plays in understanding and maintaining our planet, GEBCO and the Nippon Foundation have joined forces to establish the Nippon Foundation/GEBCO Seabed 2030 Project, an international effort with the objective of producing the definitive map of the world's oceans by 2030.[9] The Seabed 2030 Project has established globally distributed regional data assembly and coordination centers (in Sweden, New Zealand, Germany and the United States) that are actively identifying existing data that are not currently publicly available and working to make these data available. A Global Data Assembly and Coordination Center (in the United Kingdom) is integrating the data into a global grid (called the GEBCO grid) for freely available, worldwide distribution.[10] At the start of the Seabed 2030 project in late 2017, the GEBCO database contained modern multibeam echo-sounder data from only about 6% of the deep-sea floor. With the first update of the GEBCO grid processed by Seabed 2030 and made public in early May 2019, the data holdings have

9 <https://seabed2030.gebco.net/>.
10 <https://seabed2030.gebco.net/data_centers/>.

more than doubled, but as outlined above, still only represent about 15% of the seafloor. The effort will continue to identify existing data but there will soon be little more of these data available. In the coming years efforts must turn to encouraging and facilitating the collection of new data in the many regions of the world that have yet to be surveyed.

The complete mapping of the yet unsurveyed regions of the world's oceans is an ambitious task. Modern multibeam echo-sounders capable of mapping the deep sea are large and expensive and are typically mounted on large (> 50m) vessels that are in themselves expensive to operate. It has been estimated that to map the deep (>200 m) portions of the world's ocean seafloor using current day technology would take more than 300 ship years and cost on the order of three to five billion dollars.[11] While this may seem an implausible amount to be directed to the mapping of the world's oceans, it is on the order of the cost of a single Mars mission of which there have been many, including missions that have mapped Mars to far better resolution and coverage than our own earth. In this context it should not be unthinkable that an international effort can be mounted to see our own planet mapped, particularly in light of the growing recognition of the critical need to map the entire seafloor in support of UN Sustainable Development Goal 14.

One approach to fulfilling this goal is to take advantage of the fact that several hundred research and commercial vessels are currently equipped with modern multibeam echo-sounding equipment but do not necessarily collect mapping data when transiting from one work area to another. One of the goals of the Seabed 2030 program is to ensure that these vessels do collect data during these transits and make these data freely available to the general public. Progress has already been made in this area with several commercial entities agreeing to provide transit data to the Seabed 2030 project.[12] Additionally, the Seabed 2030 project has been able to place operators on research vessels that, in transit, had not planned on collecting mapping data.[13] Another aspect of bringing the goal of mapping the world's oceans to reality is to call upon technological innovation. The estimate for the cost and level of effort associated with the complete mapping of the world ocean was made using current technology and thus is a conservative approach. New technologies, however, may lead to gained efficiencies and lower costs. Leading among these is the

11 Mayer – *Geoscience* – 2018.

12 For example, the global survey company Fugro has already submitted more than 450,000 sq. km of transit mapping data to Seabed 2030 and has committed to continue to continue to do so.

13 https://seabed2030.gebco.net/get_involved/partners/five_deeps.html.

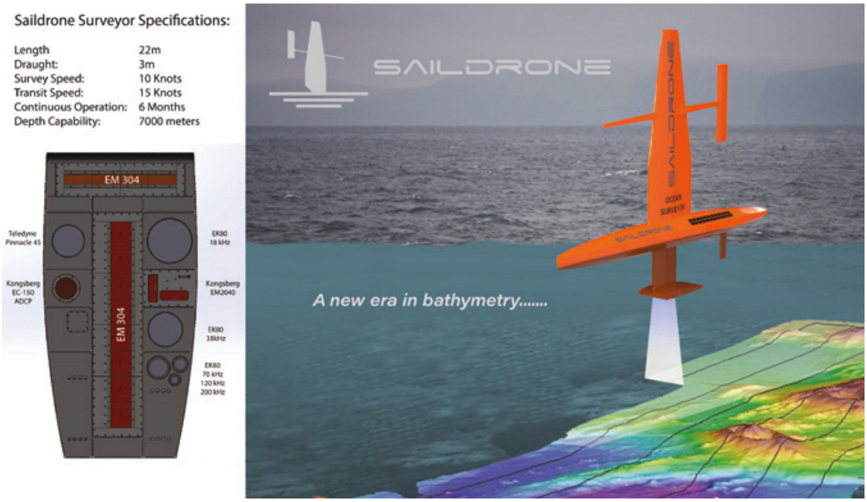

FIGURE 8.4 Autonomous Saildrone equipped with deep water multibeam mapping system

potential use of autonomous vehicles (including autonomous sailing vessels) that can be deployed for many months, surveying the most remote areas of the oceans 24 hours per day (without the need to return to port) and transmitting data via satellite back to a control center (Figure 8.4). Using such technology, the overall cost of mapping the entire deep-sea floor may be reduced and the logistical and financial challenges of meeting this ambitious goal lessened.

6 Will Interpretation of the Law of the Sea Convention Stand in the Way of Mapping the World Ocean?

While the technical, logistical, and fiscal details of mapping the entire world ocean's seafloor are challenging, they are manageable, and with technological innovation may make the ambitious goal of collecting the full geospatial context for the ocean basins feasible. A more difficult barrier to provide this important information to the global community, however, may lie in how coastal states interpret the Marine Scientific Research regime of the Law of the Sea Convention. The fundamental problem lies with the interpretation by some coastal States that the collection of underway bathymetry, no matter what the purpose of the collection, represents Marine Scientific Research (MSR). Such an interpretation requires that those collecting bathymetric data while on passage through either the Exclusive Economic Zone (EEZ) or the Continental Shelf (we will refer to the juridical continental shelf as the Extended

Continental Shelf or ECS to distinguish it from the geological continental shelf) receive consent from the coastal state under the provisions of Part XIII of the Law of the Sea Convention.[14] While article 246 of the Convention states that:

> 3. Coastal States shall, in normal circumstances, grant their consent for marine scientific research projects by other States or competent international organizations in their exclusive economic zone or on their continental shelf to be carried out in accordance with this Convention exclusively for peaceful purposes and in order to increase scientific knowledge of the marine environment for the benefit of all mankind. To this end, coastal States shall establish rules and procedures ensuring that such consent will not be delayed or denied unreasonably.[15]

The reality of practice is that, as discussed by Long,[16] the process for seeking and receiving clearances from most coastal states, even within the EU, is cumbersome and time-consuming; globally the problem is far worse. The request for clearance to do MSR can be manageable for a research expedition that works in the EEZ or ECS of one or two coastal States, but consider the situation where a vessel is transiting from Japan to Indonesia. In this case, the vessel would travel through the EEZs (and ECSs) of six or seven coastal states (depending on the route taken, see Figure 8.5). If the collection of bathymetric data in support of the production of a global map of the seafloor to serve as the foundation for long-term management and protection of the oceans is considered MSR, current process and practice would make this task an extremely difficult one.

We are thus faced with a serious quandary. On the one hand, the United Nations has clearly stated that the complete mapping of the world's oceans is a critical component of achieving UN Sustainable Goal 14 and a primary goal

14 The FAQ section of the Seabed 2030 Project states that "initial efforts will focus on mapping the 93% of the ocean deeper than 200 meters, leaving national hydrographic agencies to cover waters closer to shore." <https://seabed2030.gebco.net/faq/#q6>. MSR in the territorial sea requires the express consent of the coastal State. LOS Convention article 245.

15 UN Convention on The Law of the Sea, Montego Bay, Dec. 10, 1982, entered into force Nov. 10, 1994, 1833 UNTS 397, Part XIII, Article 246.

16 Long, Ronán, "Regulating Marine Scientific Research in the European Union: It Takes More than Two to Tango," in: Myron Nordquist, J. Norton Moore, Alfred A. Soons, and Hak-So Kim (eds.), *The Law of the Sea Convention: US Accession and Globalization.* Leiden/Boston: Martinus Nijhoff Publishers, 2012, pp. 428–491.

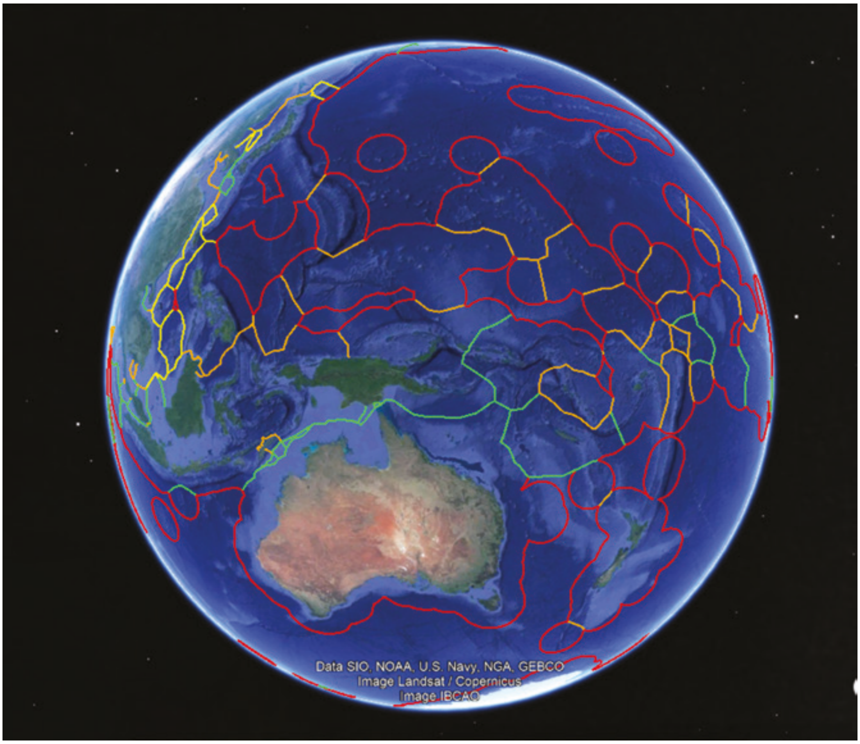

FIGURE 8.5 EEZs in the western Pacific, from Google Earth

of the UN Decade of Ocean Science for Sustainable Development. On the other hand, certain interpretations of Part XIII of the Convention on the Law of the Sea may greatly impede the achievement of this goal. The MSR regime of the Convention on the Law of the Sea is irrefutable; however, there may be an approach that fully respects the tenants of Part XIII, but still allows the collection of data critically needed to improve our ability to manage and sustain our oceans.

7 Is the Collection of Underway Bathymetry in Support of a Freely Available Map of the World's Oceans MSR?

The key to the solution of this quandary lies in the absence of a definition of MSR in the Convention on the Law of the Sea. In not defining MSR in the Convention, the drafters created an ambiguous situation that has led to a wide range of interpretations of the meaning. These ambiguities and their broad implications have been addressed in detail by several authors.[17] Interpretation of what is and is not MSR varies broadly amongst coastal States, ranging from those that support the concept of full freedom of research to those that very strictly enforce coastal State consent with respect to most any data collection conducted in their EEZ and/or ECS.

In presenting the US perspective on MSR, Roach[18] has offered powerful arguments that certain types of marine data collection should not be considered MSR under the Convention on the Law of the Sea. Among the data collection types that Roach proposes are NOT MSR are hydrographic surveys. In *Definitions for the Law of the Sea*,[19] hydrographic surveys are defined as:

> the science of measuring and depicting those parameters necessary to describe the precise nature and configuration of the seabed and coastal strip, its geographical relationship to the land mass, and the characteristics and dynamics of the sea. … Hydrographic surveys may be necessary to determine the features that constitute baselines or basepoints and their geographical position.

In determining that hydrographic surveys are not MSR, Roach's arguments focus on the distinction between survey activities and MSR, citing Article 19(2)(j) of the Law of the Sea Convention which explicitly distinguishes between "research or survey activities" and Article 21(1)(g) which again distinguishes between "marine research and hydrographic surveys" in discussing innocent passage in the territorial sea. Also, Article 40 distinguishes between "research and survey activities" both in its title and in its discussion of "marine scientific research and hydrographic survey ships" which may not carry out "any research or survey activities in straits without prior coastal state authorization." As Roach points out, the drafters of the Convention thus clearly knew the distinction between research and surveys and used this distinction to ensure limits on survey activity in some regimes (straits used for international navigation,

17 Soons. A, 1989, "Marine Scientific Research Provisions in the Convention on the Law of the Sea: Issues of Interpretation" in Brown and Churchill (eds.) *The UN Convention on the Law of the Sea: Impact and Implementation* (Law of the Sea Institute, William S. Richardson School of Law, Honolulu, HI); Roach, J.A., "Marine Scientific Research and the New Law of the Sea," 1996, *Ocean Development and International Law,* pp. 59–72.

18 Roach, J.A., 2015 "Marine Data Collection: U.S. Perspectives" in M. Nordquist, J.N. Moore, R. Beckman, and R. Long, (eds.), *Freedom of Navigation and Globalization*, (Brill-Nijhoff), pp. 285–302.

19 Walker, G.K. (ed.), *Definitions for the Law of the Sea: Terms Not Defined by the 1982 Convention*, Leiden/Boston, Nijhoff, 2012, p. 227.

territorial seas, and archipelagic sea lanes) but put no such limitations on survey activity in the EEZ or ECS.

Thus, there is strong evidence that hydrographic surveys are not MSR and thus should not be regulated by the MSR regime of Part XIII of the Convention. If we accept this premise, then one of the key barriers to the collection of bathymetric data in support of the creation of a publically available map of the world's oceans to support sustainable development will be removed. Research or other vessels, whether manned or autonomous, may conduct surveys in transit across broad stretches of the oceans including the EEZ and ECS of coastal States and collect bathymetric data in support of the creation of a freely available global map. Additionally, many modern vessels equipped with multibeam echo-sounders use these systems as their primary tool for fulfilling their SOLAS Chapter Five, Regulation 19, carriage requirements for shipborne navigational systems and equipment.

8 It's Probably Not That Simple

While the solution proposed above would be a simple step towards providing the global community with a complete map of the world's oceans (much like we have for the terrestrial parts of the Earth), and one that we hope would be widely accepted, experience gleaned from records of the negotiations at UNCLOS III[20] and current practice demonstrate that there will inevitably be some coastal States that will not easily accept the proposition that hydrographic surveying in their EEZ or ECS should be without prior consent. Recognizing this to be the case, we offer a compromise solution that accepts that hydrographic surveying is not MSR (and thus does not require consent) but involves prior notification of activity through a central database and the ability of a coastal state to assert some level of control over the distribution of data collected in their EEZ or ECS should they deem it sensitive. Such an approach would remove the long lead times and cumbersome processes (which vary from state to state) necessary to receive consent, and would greatly enhance our ability to serve the needs of the global community in providing a freely available map of the world ocean.

The approach we propose is similar to that developed for the Argo Float Program, an international effort that has deployed almost 4,000 free-floating

20 UNCLOS III, Vol. VI, Summary Record of Meetings Third Committee, 30th Meeting, Sept. 14, 1976, pp. 95–100 <https://legal.un.org/docs/?path=../diplomaticconferences/1973_los/docs/english/vol_6/a_conf62_c3_sr30.pdf&lang=E>.

devices that profile the ocean continuously collecting environmental data like temperature and salinity.[21] The observations made by Argo floats are critical components of global ocean and weather forecast models and, like a global bathymetric database, are essential to understanding and modeling current and future oceanic and climatic conditions. These floats are deployed from surface vessels and then drift freely for several years, submerging themselves to collect profiles of environmental data and then transmitting the data by satellite to a data reception center. While most often deployed in regions beyond national jurisdiction, they can often drift into the EEZ or ECS of a coastal state. The Intergovernmental Oceanographic Commission of UNESCO (IOC) spent several years debating the legal framework for the collection of data from Argo floats and eventually adopted guidelines for their operation.[22] The guidelines basically provide that those deploying Argo floats must coordinate the deployment of floats through an Argo Information Center (AIC – a body specifically established by the IOC to coordinate the deployment of floats), which in turn will notify, if notification is requested,[23] a designated point of contact in the coastal State that an Argo float may enter its EEZ. Guideline 4 states that all data collected by the Argo floats will be freely available, though the coastal State may restrict the release of data for a limited amount of time if the data are of direct significance to the exploration and exploitation of living or non-living natural resources. (The legal aspects of the Argo Float Program and a discussion of the IOC guidelines can be found in Maeos and Montserrat (2010).)[24]

With respect to bathymetric surveying during transits, a similar mechanism can easily be established. In the bathymetric case, the GEBCO/Nippon Foundation Seabed 2030 program already offers a structure that can easily implement a notification system. As outlined earlier, the GEBCO/Nippon Foundation Seabed 2030 program will be the focal point for data collection for the creation of the definitive map of the world oceans. Its Global Data Center, hosted at the British Oceanographic Data Centre, National Oceanography Centre, Southampton, U.K.,[25] will serve to distribute data products (GEBCO grids) but at the same time will establish a series of web-based tools that provide information on existing bathymetric coverage so that precious ship time is not wasted by duplicating tracks where data already exists. It can also easily become the

21 http://www.argo.ucsd.edu/About_Argo.html.

22 IOC Executive Council Resolution EC-XLI.4 Annex (2018) <http://ioc-unesco.org/index.php?option=com_oe&task=viewDocumentRecord&docID=21855>.

23 It is understood that very few coastal States have requested to be notified.

24 See Maeos, A., and Montserrat, G-Y, 2010, *SEAS*, Issue 8, v. 14.

25 <gdacc@seabed2030.org>.

focal point for dissemination of information on planned bathymetric survey transects in support of its global mapping effort. As a project of the IHO and the IOC, the GEBCO/Nippon Foundation Seabed 2030 project can coordinate these efforts with the Member States with the point of contact in each Member State being their representative to the IHO. A website can be provided that shows current and planned ship tracks for all bathymetric surveys associated with the project and those Member States that specifically request notification can be alerted by the Global Data Center of upcoming transits that may be in their EEZ or ECS. The Global Data Center can also arrange for the coastal State to review the data before it is included in the global mapping product and make arrangements for the management of those data (e.g., only include it at reduced resolution) if deemed sensitive to the coastal State.

The importance of the collection of hydrographic survey data has long been recognized by the UN and the global community. In 2012, well before the statements made about the need for global ocean mapping to support UN Sustainable Goal 14 and the UN Decade of Ocean Science, the UN General Assembly in its annual resolutions on oceans and the law of the sea noted:[26]

> Recognizing further that hydrographic surveys and nautical charting are critical to the safety of navigation and life at sea, environmental protection, including the protection of vulnerable marine ecosystems, and the economics of the global shipping industry, and encouraging further efforts towards electronic charting, which not only provides significantly increased benefits for safe navigation and management of ship movement, but also provides data and information that can be used for sustainable fisheries activities and other sectoral uses of the marine environment, the delimitation of maritime boundaries and environmental protection. …

The same resolution also encourages efforts to build capacity in the area of surveying for developing States, as follows:

> Encourages intensified efforts to build capacity for developing countries, in particular for the least developed countries and small island developing

26 UNGA resolution A/RES/67/78, Dec. 11, 2012. Similar statements appear in earlier resolutions A/RES/66/231, A/RES/65/37A, A/RES/64/71, A/RES/63/111, A/RES/62/215, A/RES/61/222, A/RES/60/30, A/RES/59/24 and A/RES/58/240, *available through links at* <https://www.un.org/Depts/los/general_assembly/general_assembly_resolutions.htm>.

> States, as well as coastal African States, to improve hydrographic services and the production of nautical charts, including electronic charts.

The proposed approach to gathering bathymetric data and making it publicly available would serve to provide key bathymetric data and products to all developing States. In addition, through the Seabed 2030 Global Data Center, developing States would be able to make requests for the collection of transit bathymetric data in regions of particular relevance to them and then work with those collecting the data to include young surveyors on the transits to build local capacity. The contribution of local data to a publicly available high-resolution bathymetric database can be of tremendous benefit to developing States as it can be used by modelers world-wide to generate more accurate models of potential tectonic activity and tsunami inundation in their waters.

9 Concluding Statement

The well-being of mankind is inextricably linked to the health of the oceans. Our ability to maintain ocean health is dependent on our understanding of the complex physical, chemical and biological interactions that take place in the vast ocean system. But as we embark on the UN Decade of Ocean Science in Support of Sustainable Development and global ocean observation programs that try to understand these interactions, we are trying to do so with only a minimal understanding of the geospatial context within which our observations are made. Imagine trying to predict weather patterns without knowing where the mountains and valleys are, or predict where flooding will occur without a topographic map. This is the situation we face in the oceans. We have high-resolution mapping data for only about 15 percent of the three quarters of our planet that is covered by water. Recognizing this situation, an international effort, Seabed 2030, has been undertaken to attempt to produce a freely available comprehensive map of the world ocean by the year 2030. This is an ambitious undertaking that will benefit all of mankind; but for this goal to be achieved we will need ensure that the collection of the data needed to produce such maps will not be impeded. The recognition that the collection of bathymetric data in support of such a global map is not MSR under the context of Part XIII of the Law of the Sea Treaty would go a long way to help meet this critical goal.