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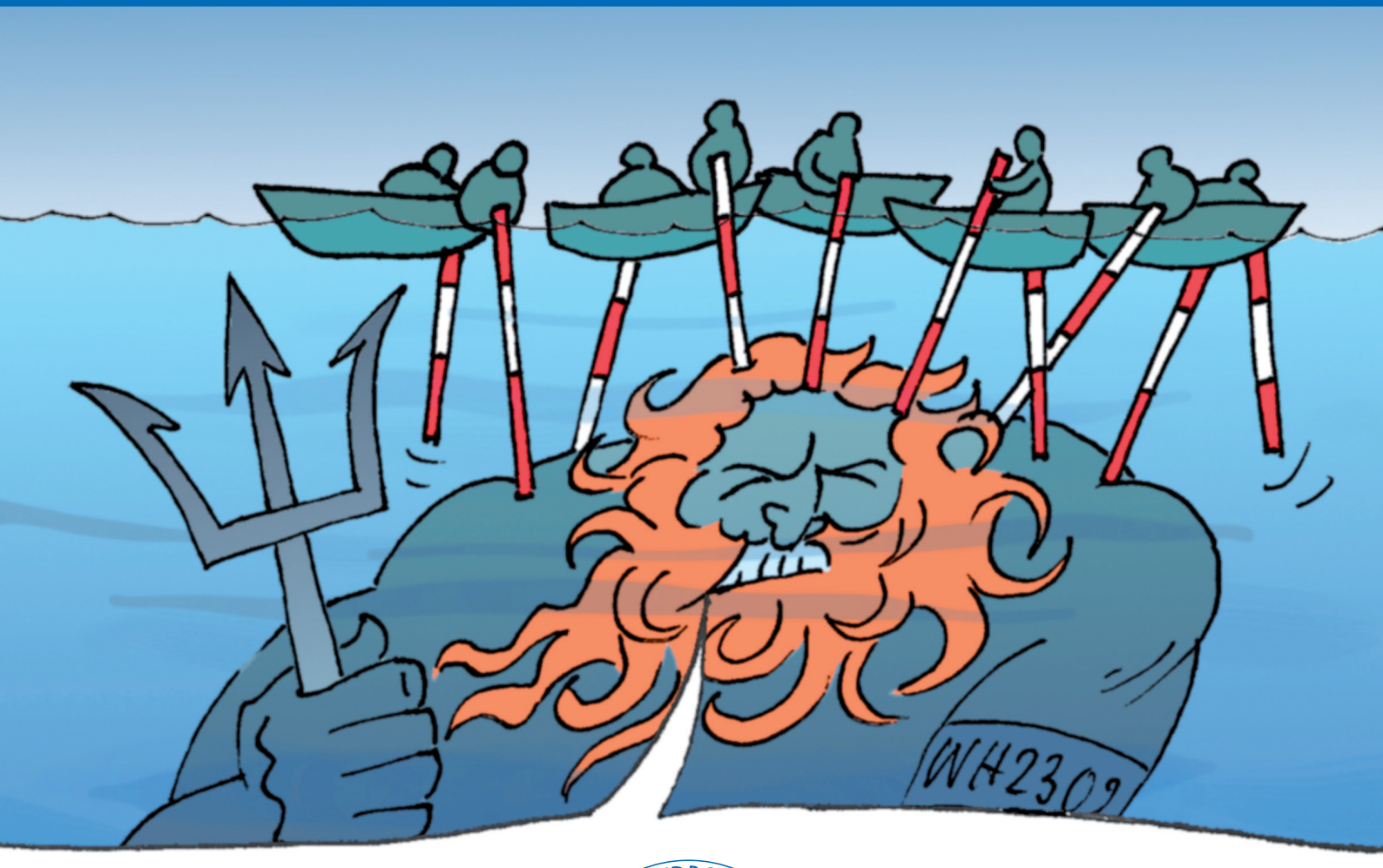

Depth measurement per **crowdsourcing**. Damn it!

DEUTSCHE HYDROGRAPHISCHE GESELLSCHAFT e.V. DHyG

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»I would like anyone interested to have the ability to record their depth data«

An interview with JENNIFER HENDERSON JENCKS

Jennifer Jencks is a physical scientist at NOAA's National Centers for Environmental Information in Boulder, Colorado. She is the director of the IHO Data Centre for Digital Bathymetry (DCDB) and she is chair of the IHO Crowdsourced Bathymetry Working Group (CSBWG). In this interview, she talks about the opportunities of crowdsourced bathymetry (CSB), the importance of metadata and how people can be motivated to volunteer to collect depth data.

crowdsourced bathymetry – CSB | citizen science | Seabed 2030 | Trusted Node
Crowdsourced Bathymetry – CSB | Bürgerwissenschaft | Seabed 2030 | Trusted Node

Jennifer Henderson Jencks ist Physikerin bei den National Centers for Environmental Information der NOAA in Boulder, Colorado. Sie ist die Leiterin des IHO Data Centres for Digital Bathymetry (DCDB) und Vorsitzende der IHO-Arbeitsgruppe für Crowdsourced Bathymetry (CSBWG). Im Interview spricht sie über die Chancen von Crowdsourced Bathymetry (CSB), über die Bedeutung von Metadaten und darüber, wie sich Leute motivieren lassen, freiwillig Tiefendaten zu sammeln.

Interviewer
The interview with Jennifer Henderson Jencks was conducted by Lars Schiller and Patrick Westfeld via email in February.

We know more about the topography of Mars and Moon than we do about the topography of our own ocean floor. What do you think are the reasons?

Technology and interest. Mapping the ocean floor is just harder than mapping the surface of Mars or the Moon. Mapping planets using satellite altimetry is pretty effective when water isn't in the way. Unfortunately for us, the ocean is impermeable to the laser altimeter. To get the resolution we want, ocean floor mapping techniques always come back to using acoustic waves and the need for a vehicle that can emit them and then listen to the echo.

But no matter how advanced our sonar systems and ships or other platforms get, coverage will remain limited by the speed and size of the vessel when compared to the largeness of the ocean, the water depth and the ever-changing environmental conditions. Compare that to satellites which can move really fast and cover large distances quickly.

And then, of course, there's interest. Operating professional survey vessels is expensive, but one can certainly argue that satellites and robotic sensors aren't exactly cheap! Yet we, as a society, have always been more supportive of spending billions to map other planets and just haven't exactly gotten onboard (no pun intended) to mapping our own planet for a fraction of the cost.

The aim of Seabed 2030 is to bring together all available bathymetric data to produce the definitive map of the world ocean floor by the end of this decade. Can CSB make a significant contribution to this?

Yes. I believe it can. The fact is, there is no single solution, technology or approach that's going to get Seabed 2030 across the finish line. Volunteer observers operating vessels-of-opportunity in places where surveys are poor, inadequate, non-existent or where hydrographic assets are not readily available absolutely stand to make a significant contribution. If you then consider that SOLAS requirements oblige all commercial vessels to be equipped with systems consisting of at least a single-beam echo sounder and a satellite-based navigation system, then you realise that the world's commercial fleet represent another source of potential depth measurements. Even most non-commercial ships and boats are equipped to measure and record their depth in coastal waters and an ever-increasing number of vessels can also take measurements in deeper water with more affordable and accurate systems than could previously be achieved.

I rarely miss an opportunity when given a microphone to quote Tim Thornton from TeamSurv, »If we got 1 % of all seagoing vessels logging data, and on average they spent half their time at sea, then that's about 5 billion data points a day.«

That's a lot of potential data!

Professional echo sounders, positioning systems and data management infrastructures are needed for hydrographic surveying. What kind of hardware and software solutions do »everyday citizens« need to provide usable data?

Volunteer data from any ship with an echo sounder or fish finder can be used – which many »everyday citizens« likely already have. Then, routinely meas-

ured parameters, such as under keel depth and position, can be stored, uploaded and contributed from either an Electronic Chart System participating in the CSB initiative (for example Rose Point's Coastal Explorer or GEC's Aqua Map), or through a variety of data loggers that can be interfaced to the ship's NMEA data bus. Data loggers and systems that are currently being used in the initiative are manufactured by TeamSurv, Orange Force Marine, CIDCO, McGregor, FarSounder and the open source WIBL project. More are on the way too! SeaID's NEMO-30 is currently under development but should be out in the community soon.

Now that we have a record generated, who would we need to contact in order for the data to be used?

I would recommend reaching out either to your hydrographic office or directly to the IHO Data Centre for Digital Bathymetry (bathydata@iho.int). At the DCDB, we accept CSB contributions through a network of what are referred to as »Trusted Nodes«. A Trusted Node is an approved organisation or individual who systematically receives CSB data collected by vessels and is set up to deliver them to the IHO DCDB. We can help identify the best-suited Trusted Node type for you. Or if you're an organisation that is thinking about sponsoring and/or supporting data collection, we'd love to talk to you as well and figure out what it might take to get you going!

What approaches have been developed to ensure the quality of CSB data? Who is responsible for quality control? What is the minimum quality?

The intent of the IHO CSB initiative has always been to encourage the collection of, and access to, more data from different sources and with variable quality. Which is, to say, there is no minimum quality requirement. In fact, raw or »as captured« data (i.e., as close in form to the data presented to the data logger as possible), with a good indication of what the observer's configuration was, are preferable as a contribution to the DCDB. By providing the minimally required information about the time and date a depth measurement was collected, future data users will be able to reprocess the data (e.g., to apply water level corrections), if they so choose.

To allow for an assessment of the quality of the data, it is important to document certain additional information (»metadata«) together with the data, which is why we strongly encourage active data collectors to provide as much extra information as they can (e.g., offsets between GPS and echo sounder, type of corrections applied, if any, etc.). The metadata associated with a data set will provide valuable supporting information relating to how the data collection was performed and will enable appropriate processing, corrections and an informed assessment of the data quality to be made.

Jennifer Henderson Jencks

As a citizen, collecting depth data in international waters is certainly legally unproblematic. How does it behave in territorial waters? What would you like to see from coastal states in this context?

Well, it depends on the coastal state. In 2020, the IHO issued circular letters to all IHO Member States (IHO CL 21/2020) and non IHO member states (via IRCC CL1/2020) requesting they state their position on the sharing of CSB data collected within their waters under national jurisdiction. At the DCDB, we've implemented a geographic filter to take into account these national positions as they are stated and evolve and redistribute the data accordingly. The intent here is to take the onus off the mariner (i.e., of needing to be up to date on national regulations while sailing through various national waters). The simpler we can make things for the individual volunteers, the more data we're likely to get.

»We are telling the story again and again to fresh ears – that some charts still use soundings collected by Captain Cook«

Jennifer Henderson Jencks

To date, it is encouraging to see that 33 coastal states have replied positively to the letters. The letters were written to not only request permission, but also to allow for the capturing of caveats. For example, a state might permit data collected within their EEZ be distributed, but not data from within their territorial sea. Those positions and their associated caveats are available online.

But what we would really like is for *all* coastal states to provide their status. Hopefully a positive one! Because, unfortunately, we have to assume that a lack of reply equates to a negative stance. This is a real shame because that means a *lot* of data has been contributed that can't be used by anyone for any purpose.

How do you get people to contribute to CSB?

So far, there seem to be two primary drivers. The first simply involves outreach. The majority of mariners, no matter their affiliation, aren't even aware this is something they can get involved with. Once the interest from a mariner or a group of mariners is there, we work together to determine the best way to initiate data collection and contribution – meaning, do they use a participating navigational software on their boat, or are they interested in installing a data logger? The second piece involves giving those that have contributed their data something back – preferably a product their own data has been added to. We see time and time again, that getting something useful back in return for their effort, is the greatest incentive for participation. Streamlining that feedback loop is key. And we're working on that.

What is the contribution of the IHO's CSBWG, of which you are chair, to CSB?

The biggest contribution of the IHO's CSBWG, which is composed of international scientific, hydrographic and industry experts, has been the publication of an IHO Guidance Document on Crowdsourced Bathymetry – referred to as *B-12* (iho.int/uploads/user/pubs/bathy/B_12_CSB-Guidance_Document-Edition_3.0.0_Final.pdf). This document describes what constitutes CSB, the installation and use of data loggers, preferred data formats, how to become a Trusted Node and instructions for submitting data to the IHO DCDB. The document also provides information to help data collectors and users better understand quality and accuracy issues with CSB.

There would be no outreach for this initiative without the contributions of such an amazingly diverse working group. In addition to passionate members from national hydrographic offices, there are so many expert contributors from all sectors of industry (hardware and software companies, yachting communities, academia, etc.). The working group has provided a sort of nucleation point for people interested in the process to get together and develop new technologies and projects and to acknowledge issues and try to find solutions to overcome them. These folks not only represent their communities to us, but our work to their communities. They really are an incredible group.

And would we be where we are today without this IHO-led citizen-science initiative?

I can confidently say no. However, my answer oddly is not about data contributions. A citizen-science initiative means we are out there engaging with citizens around the world. We are telling the story again and again to fresh ears – that the global ocean floor is only ~23 % mapped, coastal waters only ~50 % mapped, that some charts still use soundings collected by Captain Cook, etc. Before, these conversations took place mainly among ourselves, at scientific conferences. Now they're taking place in fishing communities in the Canadian Arctic and yacht clubs in Monaco. It's awesome. The more people are educated on the issues, the more they want to be a part of the solution. Remember that most people that work or play on the ocean love their environment and want to know more about it. If we can facilitate this through the citizen-science collection of depth measurements, that's impactful.

Who are the most avid data loggers – the commercial shipping industry, fishery or rather the hobby sailors? Who contributes the most?

I would say the users of Rosepoint Navigation Systems Coastal Explorer software, who provide an easy opt-in to contributing logged data to the DCDB, have contributed the majority of the data holdings. It appears most of their users are hobby sailors, in North American waters. Rose Point was genius in making it super easy to participate, and

their customers operate mainly in waters that allow the sharing of data. That said, commercial shipping and especially fisheries vessels go places that hobby sailors don't, and therefore we want to try to encourage as many different sea-going communities to be involved as possible.

What percentage of ocean floor topography do we know thanks to CSB? Which areas are particularly well mapped, where is data still missing?

To see where CSB is making an impact, we need to look at localised data collections. Today, that's really just two regions: North America and along the Great Barrier Reef. The »Crowdsourced bathymetry on the Great Barrier Reef« project, started by Dr. Rob Beaman from James Cook University in 2018, focuses on filling the data gaps along the less-than 40 % mapped GBR. 164,000 line km of CSB data have been added by just eight vessels over the last several years.

As of January 2023, CSB has contributed ~3,000 square nautical miles of new bathymetric data coverage to the U.S. EEZ – or 0.17 % of the total bathymetric data contributions.

Does it happen that you become aware of interesting locations in CSB data such as previously unknown seamounts or other special features under water? Are such areas then specifically surveyed again afterwards?

For those that are actively using these data, yes.

The Canadian Hydrographic Service (CHS) have used CSB data from the DCDB to update several Inside Passage charts along the coastal routes stretching from Seattle, Washington, to Juneau, Alaska. A systematic comparison of charted depths less than 10 m yielded improved charted channel depths, data density and improved chart compilation in areas that were surveyed with traditional single-beam. CSB data has helped prioritise survey areas for following survey seasons and initiated the publication of Notices to Mariners.

In the U.S., NOAA views CSB as a potential valuable tool for chart adequacy assessments to enhance the quality of NOAA's cartographic products, especially in situations of immediate need, such as disaster response. However, NOAA is still in the early stages of determining a sustainable process for handling these data.

The idea behind CSB is to fill the white space on ocean maps and nautical charts. The same idea is pursued by research vessels on their transit. Can you influence their routing in any way to force heterogeneously distributed in-transit bathymetry?

We would like to! Colin Ware's BathyGlobe Gap-Filler tool, which is available online, is intended to support planning for transit and area mapping using GEBCO bathymetry as a background. And GEBCO's Technical Subcommittee on Undersea Mapping have been trying to tackle the issue of pulling in and navigating multiple data layers in addition to GEBCO data (known proprietary data coverage, CSB, transit data, systematic surveys, etc.) to estimate true coverage that a mariner could then use to guide their route planning. We aren't there yet, but we are moving in that direction.

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Survey data from research vessels is certainly much more accurate than data from a cargo or cruise ship. How do you deal with these different accuracies? Is the uncertainty later specified as a metric in the database?

That's correct, CSB is unlikely to ever reach the uncertainty and quality achieved by professionally collected data. But the best available data for an area isn't necessarily the best possible quality data according to standards. As long as the data quality is quantified or qualified, it may very well be the best available data if nothing else exists. And it can certainly be used to fill in between authoritative data or highlight inaccuracies. To allow for a comprehensive assessment of data quality, which we look to the community to do, the richer the metadata the better. As a data centre, our goal is to encourage metadata inclusion and ensure it's available to the public.

As our data volumes and public interest grow, we're hopeful that hydrographic offices and academic institutions will take on these issues, perform analyses, create products, etc. In the meantime, we, as a data centre, are looking for feedback to enhance the way we serve CSB to the public.

Citizen scientists are helping to map ocean's bathymetry. Will the data later be made available to the public, and if so, how?

All types of bathymetric data (multibeam, singlebeam, lidar, CSB) provided to the IHO Data Centre for Digital Bathymetry are made available to the public via our map viewer (ncei.noaa.gov/maps/iho_dcdb/). For CSB data specifically, we redistribute these data in agreement with the information received by the IHO Secretariat from individual coastal states on request.

You work at NOAA and lead the IHO Data Centre for Digital Bathymetry. What are your duties?

Most of my internal day-to-day activities involve working with a wonderful team of data managers trying to improve the various aspects of stewarding bathymetric data. This includes streamlining data ingest and improving data discovery and access. Externally, I spend quite a bit of time collaborating with colleagues around the world who are also motivated to see the number of bathymetric data collectors and contributors increase, not just by encouraging participation, but by reducing the roadblocks that might be in their way.

What do you think about bringing together even more hydrospatial data from a wide variety of sources, with the aim of building a comprehensive hydrospatial information system or even a Digital Twin of the Ocean? What role can hydrography play here?

It's certainly an interesting concept, and one we're hopefully moving closer towards, technologically speaking, every day. Trying to envision the real-time or semi-real-time feed of bathymetric data from a variety of sources needed to make a true Digital Twin seems a bit … daunting. But there are a lot of smart people out there and unimaginable technology becomes imaginable all the time, so who knows what will be possible in the future.

In the meantime, hydrographic information is fundamental to all descriptions of the ocean and while traditional survey methods will likely continue to dominate the collection of bathymetric data, the community dedicated to mapping our global ocean floor understand that it will take a combined effort of all technologies. This includes acknowledging and accepting contributions from volunteers. Vessels journeying across the ocean floor, collecting valuable »passage soundings«, routinely observing and documenting weather and other marine environmental observations, have been taking place for centuries. Remembering that observations from wide variety of sources play a role is critical and should be encouraged.

What would you like to be able to do better?

As far as the CSB initiative goes, it would be the onboarding of mariners who want to participate. Ideally, I would like anyone interested to have the ability to record their depth data. I would then like those data to easily come off the boat and into the DCDB. Basically, the barrier to entry is still too great. Luckily, we have a lot of dedicated people out there that are working on overcoming these obstacles as we speak. We'll get there!

What do you know without being able to prove it?

What a great question! What I know is that people are more likely to want to see a goal be achieved if they're able to participate in the process. »Help us map the ocean floor!« will get us much further than simply stating to the world, »We need a fully mapped ocean floor«. If you get people involved, then they become invested, they'll encourage their peers to join, and suddenly, a truly global effort is underway, working together to reach this extraordinary but achievable goal. //