Definition and important uses of CSB

> The International Hydrographic Organization (IHO) defines Crowdsourced Bathymetry (CSB) as the collection and sharing of depth measurements from vessels using standard navigation instruments during their normal operations.

CSB data provides a valuable, cost-effective method for supplementing traditional, high-precision hydrographic surveys, filling in gaps in the existing maps of the world's oceans and waterways, and fostering a global community of ocean data contributors, while utilizing vessels which are often non-scientific in nature. These can be anything from commercial fishing vessels, to dive boats, to leisure yachts. CSB programs rely on vessels equipped with common marine electronics, such as a depth transducer (echo sounder), a GPS unit, and ideally a motion reference unit (inertial navigation system), often linked through NMEA 2000 or NMEA 0183 networks. Together, these devices provide depth measurements tied to time and position, creating seafloor profiles as vessels move through the water and resulting in a map of the seafloor. As we move into an era of increasingly capable technology becoming more accessible and widespread among vessels, the door to utilizing the masses has opened.

Some of the major strengths of CSB lie in its relative (and increasing) affordability as depth sounders become more capable and simultaneously more connected. This creates the potential for countries or organizations to collect seafloor data on a much larger scale than was previously possible. Additionally, it should be noted that CSB relies on vessels that are often smaller and have a shallower draft than hydrographic research vessels. As a result, CSB can target shallow and narrow water bodies that have long been inaccessible with traditional tools. While CSB isn’t a cure-all solution, its specific strengths allow it to be useful in scenarios such as localized community waterway mapping, or first-time mapping of areas where more advanced tools are financially or physically inaccessible.

While CSB data has historically been overlooked by the hydrographic community at large, the use of a “crowd” helps to bring increased legitimacy to this hydrographic tool. While multibeam data is traditionally utilized within hydrography, a high enough density of single beam data tracks over an area of seafloor could eventually allow data managers to identify and remove outliers, increasing the statistical soundness of the data. This level of sounding density could easily be generated by just a few vessels routinely navigating through the same waterways. As the volume of data within a defined area increases, so too does the accuracy and utility of crowdsourced bathymetry. This approach also allows for high-frequency, low-cost sampling of navigationally significant coastal waterways when compared to traditional hydrographic surveying, as privately owned vessels can collect data on a highly regular basis, and all data are collected in locations where mariners are

actively navigating.

Data managers, hydrographic offices, and private companies alike can then put this data to use for various outcomes. For example, the National Oceanic and Atmospheric Administration (NOAA) in the United States of America has utilized the CSB data collected along the Gulf and Atlantic Coasts of America to identify areas in which older and potentially outdated charts are misaligned with current data. This may indicate a need for re-surveying with advanced hydrographic tools, providing safer operation for all vessels utilizing coastal waters. With enough data density, eventually this data can also be utilized to integrate into official hydrographic charts.

Private companies, such as Raymarine, Olex, and Garmin use CSB to inform charts made by their company (e.g. Raymarine's "RealBathy"), which in turn advise users on areas which may be shallower than expected. These tools help users to make more informed navigational decisions, avoiding areas that have been flagged as potentially shallow even if these readings are not verified by official hydrographic tools.

Another example can be found in work from NOAA's Anthony Klemm who scraped all CSB data from Seabed2030 within America's Atlantic and Gulf Coasts to assess areas of disagreement between official charts and CSB data. Through this process, more than 315 million data points were collected and assessed for their agreement with nautical charts, and areas of discrepancy were identified and tagged for potential future hydrographic resurveying utilizing more advanced survey tools. In this way, CSB has helped to identify cases in which advanced tools should be utilized and has helped to prioritize areas of interest.

In theory, this data can be used to support hydrographic efforts, especially in localized areas where seafloor shapes have direct impact on coastal populations. For example, this data could help to characterize tsunami impacts, results of hurricanes, and regular changes in dredged channels. A great example of CSB utility may be found in narrow waterways where isostatic rebound is causing waterways to become shallower, reducing navigability in waterways which may be vital for transport, recreation and industry.

CSB data can be used by hydrographic offices and companies to inform local mapping efforts and policies, but can also contribute to global scientific efforts, like the Seabed 2030 Project. This project is a joint initiative of the Nippon Foundation and GEBCO, the latter of which operates under the auspices of the International Hydrographic Organization (IHO) and UNESCO's Intergovernmental Oceanographic Commission (IOC). The project's aim is to completely map the world's seafloor with direct measurements by 2030. Any CSB data can be contributed to the Seabed 2030 Project, and the general international community, by submitting it to the IHO's Data Center for Digital Bathymetry (DCDB) via a Trusted Node. The "Trusted Node" conducts quality assurance on the data and then makes it available to the public, via the IHO DCDB.

The role of a trusted node is primarily to act as a secure source of data to the DCDB. This requires that someone be responsible for managing data flow from vessel into the DCDB, in line with the guidelines set up in the B-12 guiding document from the IHO. To become a trusted node, contact with the DCDB/NCEI is required. A list of existing trusted nodes exists here. Each trusted node has its own target audience; for example, the International SeaKeepers Society is primarily engaged

with privately owned yachts and leisure boats, whereas the University of South Florida Center for Ocean Mapping and Innovative Technologies (COMIT) primarily engages all types of vessels within the Tampa Bay region. Finding the right trusted node to fit your vessel helps to streamline this process. To enroll your own organization as a trusted node, review the guidance on the CSB tab of the IHO DCDB website, and contact the DCDB via email: bathydata@iho.int.

> DCDB contact for inquiries about becoming a Trusted Node: bathydata@iho.int

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