



GEBCO Report to the IHO Inter-Regional Coordinating Committee

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Dr. Christopher G. Fox
Vice-Chair, GEBCO



GEBCO OVERVIEW

The General Bathymetric Chart of the Oceans (GEBCO) aims to provide the most authoritative, publicly-available bathymetry data sets for the world's oceans. GEBCO is a non-profit organization that relies largely on the voluntary contributions of an international team of geoscientists and hydrographers who work on the development of a range of bathymetric data sets and data products. It operates under the joint auspices of UNESCO's Intergovernmental Oceanographic Commission (IOC) and the International Hydrographic Organization (IHO). GEBCO's work is directed by a Guiding Committee and supported by the Technical Sub-Committee on Ocean Mapping (TSCOM), the Sub-Committee on Undersea Feature Names (SCUFN), the Interim Sub-Committee on Regional Undersea Mapping (iSCRUM), and the Nippon Foundation/GEBCO Training Project Management Committee. Additional *ad hoc* working groups are convened as necessary. Through the work of its committees and working groups, GEBCO produces and makes available a range of bathymetric data sets and products, including gridded bathymetric data sets, the GEBCO Digital Atlas, the GEBCO world map and the GEBCO Gazetteer of Undersea Feature Names. GEBCO maintains a comprehensive website at <http://www.gebco.net>

Current GEBCO Officers

Chair, GEBCO: Dr Robin K. H. Falconer

Vice-Chair, GEBCO: Dr. Christopher G. Fox

Permanent Secretary, GEBCO: Mr. David M. Clark

Chair, Technical Sub-Committee on Ocean Mapping (TSCOM): Dr. Walter H.F. Smith

Chair, Sub-Committee on Undersea Feature Names (SCUFN): Dr-Ing. Hans-Werner Schenke

Director, IHO Data Centre for Digital Bathymetry: Ms. Lisa A. Taylor

GEBCO Bathymetric Editor: Mr Colin Jacobs

GEBCO Digital Atlas Manager: Ms Pauline Weatherall

Full information on current membership can found on the GECBO website

GEBCO PRODUCTS

GRIDDED BATHYMETRY DATA

GEBCO develops and delivers regional and global bathymetric data sets for the world's oceans (http://www.gebco.net/data_and_products/gridded_bathymetry_data/). The two global gridded bathymetry data sets currently available are the GEBCO_08 Grid and the GEBCO One Minute Grid.

The British Oceanographic Data Centre (BODC) makes the grids available for download on behalf of GEBCO. Using the BODC web application, users can download the complete global grid files or custom data for a user-defined area. The data are made available in the form of netCDF files and can be used with Generic Mapping Tools (GMT) software system.

THE GEBCO_08 GRID — A GLOBAL 30 ARC-SECOND GRID

This global 30 arc-second grid was largely generated by combining quality-controlled ship depth soundings with interpolation between sounding points guided by satellite-derived gravity data. Although every effort has been made to reduce the number of errors, the GEBCO_08 Grid is currently a development product, which will undergo periodic update.

THE GEBCO ONE MINUTE GRID — A GLOBAL ONE ARC-MINUTE GRID

The GEBCO global one arc-minute grid was originally released in 2003 and updated in 2008. The grid is largely based on the most recent set of bathymetric contours contained within the GEBCO Digital Atlas.

GRID DISPLAY SOFTWARE

Free software is available to view and access data from GEBCO's gridded bathymetric data sets. It provides the means for displaying the data and accessing the data in netCDF and simple ASCII formats. Version 2.13 of the software was released in April 2010. It includes the option to export the gridded data in ASCII form for conversion to an ESRI raster file.

GEBCO DIGITAL ATLAS

The GEBCO Digital Atlas is maintained by BODC on behalf of the International Hydrographic Organization (IHO) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO. The Centenary Edition of the GEBCO Digital Atlas (GDA) is a two-volume DVD set containing the GEBCO_08 global bathymetric grid at 30 arc-second intervals, the GEBCO One Minute Grid global bathymetric grid, a global set of digital bathymetric contours and coastlines, the GEBCO gazetteer of undersea feature names, the IHO DCDB trackline inventory of digital echo-sounding data (June 2002), and a software interface for viewing and accessing the data sets. A complete listing of data contained in the GDA is available from the GEBCO GDA website (http://www.bodc.ac.uk/projects/international/gebco/gebco_digital_atlas/).

HARD COPY CHARTS AND PUBLICATIONS

Printed charts and publications include;

- GEBCO World Map
- GEBCO 5th Edition Maps

- Intergovernmental Oceanographic Commission (IOC) International Bathymetric Charts
- International Hydrographic Office (IHO) Publications
- Geological/Geophysical Atlases

HISTORY OF GEBCO

"The History of GEBCO, 1903-2003" is a 140-page illustrated book covering the development of GEBCO in the 20th Century from early bathymetric mapping and data collection techniques through to the development of the GEBCO Digital Atlas.

GEBCO WEB SERVICES

The GEBCO_08 Grid is now available as a Web Map Service (WMS), a means of accessing georeferenced map images over the internet. Web services distribute information, imagery or data, across the internet in such a way that users can control exactly how and when the information is processed and reproduced in their own applications. To define how web services will operate and deliver information in a uniform manner, a set of standards have been developed by the Open Geospatial Consortium (OGC). Access the GEBCO WMS and future Web Feature Service for delivering the IHO-IOC GEBCO Gazetteer of Undersea Feature Names at http://www.gebco.net/data_and_products/gebco_web_services/.

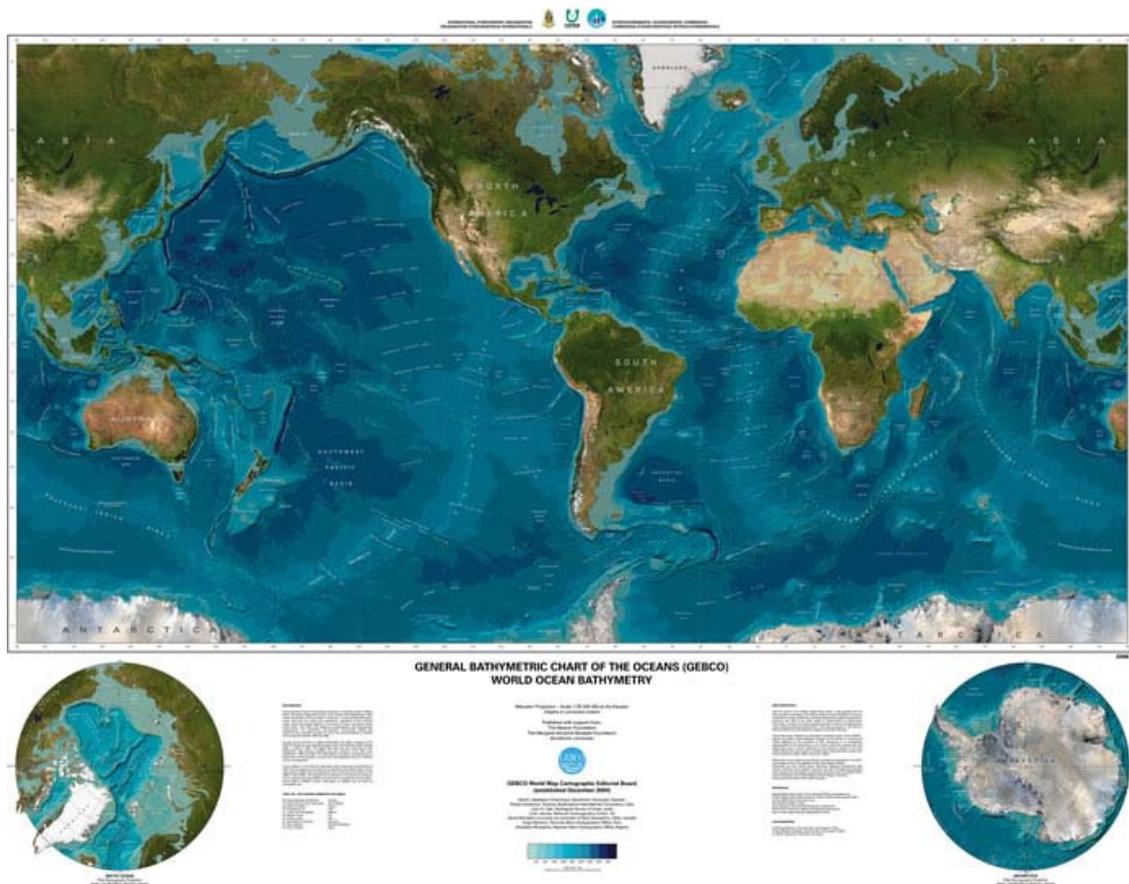
UNDERSEA FEATURE NAMES

The undersea feature names shown on sheets and products of GEBCO and Regional International Bathymetric Charts (IBC) projects, and on international (INT) nautical charts are selected by the GEBCO Sub-Committee on Undersea Feature Names (SCUFN). All names selected by SCUFN are contained in the IHO-IOC GEBCO Gazetteer of Undersea Feature Names. The most recent version of the digital gazetteer was released in March 2011 and is available to download from the GEBCO website.

NOAA's National Geophysical Data Center (NGDC) and co-located IHO Data Center for Digital Bathymetry (DCDB) is currently working with the SCUFN Secretariat at the International Hydrographic Bureau to review, update and transfer the GEBCO Undersea Feature Names Gazetteer from a spreadsheet to a geospatially enabled on-line database. The new Gazetteer database will allow graphical display of the names and corresponding geometric representations in multiple applications including GIS systems and Google Earth. It will be searchable by name, location, feature type, discoverer, etc. via on-line text and map interfaces and will be downloadable from the GEBCO website in multiple formats, including web service, shape files and KML files. This new service is anticipated to be completed in September, 2011.

GEBCO WORLD MAP

The GEBCO world map began as a laboratory workshop project of the Nippon Foundation/GEBCO Training Project at the Center for Coastal and Ocean Mapping of the University of New Hampshire, USA. The bathymetry data shown on the map is based upon the GEBCO One Minute Grid, a global bathymetric grid with one arc-minute spacing, as contained within the Centenary Edition of the GEBCO Digital Atlas (published in 2003). The land imagery is taken from the US National Aeronautics and Space Administration's (NASA) Blue Marble data set. The coastline is taken from the World Vector Shoreline. The map is on a Mercator projection at a scale of 1:35,000,000 at the Equator.



GEBCO RECENT AND UPCOMING EVENTS

GEBCO 2010 MEETINGS, SEPTEMBER 2010 IN LIMA, PERU

The GEBCO Guiding Committee, Sub-Committee on Undersea Feature Names (SCUFN), Technical Sub-Committee on Ocean Mapping (TSCOM), Interim Sub-Committee on Regional Undersea Mapping (iSCRUM) and Nippon Foundation/GEBCO Training Project Management Committee met in

Lima, Peru from 11 – 18 September 2010. The meeting was sponsored and hosted by the Directorate of Hydrography and Navigation, Peruvian Navy. Over 60 hydrographers, oceanographers, engineers and scientists from numerous countries attended. Meeting minutes and reports of this event can be found on the GEBCO website; http://www.gebco.net/about_us/meetings_and_minutes/

GEBCO DATA FLOW WORKSHOP, MARCH 9-11, 2011, BOULDER, COLORADO, USA

NGDC hosted a data flow workshop bringing together the principal GEBCO partners in development of global grids. The goal of the workshop was to develop a plan to allow data, grids, products, etc. to flow in a predefined manner through the GEBCO community and be incorporated into the compiled GEBCO product. In addition, standard methodologies for data cleaning and gridding were agreed upon and a suite of tools to support this effort were identified and developed.

Attendees were from government and academia and included NOAA, US Naval Oceanographic Office, University of Stockholm, British Oceanographic Data Center, British National Oceanographic Center, Scripps Institution of Oceanography, and the Lamont-Doherty Earth Observatory. Minutes from this workshop will be posted on the GEBCO website as soon as they are finalized by the attendees.

ARCTIC-ANTARCTIC SEAFLOOR MAPPING MEETING, MAY 3-5, 2011, STOCKHOLM, SWEDEN.

The aims of the IOC International Bathymetric Chart of the Arctic Ocean (IBCAO) and the International Bathymetric Chart of the Southern Ocean (IBCSO) are to compile the most up-to-date bathymetric portrayals of these two regions. To bring together the key experts conducting bathymetric mapping in Arctic and Antarctic waters, the IBCAO and IBCSO held a meeting at Stockholm University, May 3-5, 2011.

The main objectives of the meeting are to:

- coordinate mapping activities
- improve the IBCAO and the IBCSO
- discuss the uses and technical requirements of regional bathymetric compilations
- discuss data sharing and acknowledgment

GEBCO has long benefited from contributions from regional mapping projects. Through the Interim Sub-Committee on Regional Undersea Mapping (ISCRUM), GEBCO is aiming to build on and extend its collaboration with regional mapping groups, such as the IBCAO and IBCSO, in order to improve its global bathymetric models. The results of this meeting will be presented at the next IRCC.

GEBCO 2011 MEETINGS IN LA JOLLA, USA

The GEBCO Guiding Committee, Technical Sub-Committee on Ocean Mapping (TSCOM), Interim Sub-Committee on Regional Undersea Mapping (iSCRUM) and Nippon Foundation/GEBCO Training Project Management Committee will meet in the USA in 2011. The meeting will be held at the Scripps Institution of Oceanography, University of California - San Diego, La Jolla, California, USA, on October 3-7, 2011. The meeting will be sponsored by NOAA and hosted by Scripps. Information of this upcoming event can be found on the GEBCO website;

http://www.gebco.net/about_us/meetings_and_minutes/gebco_meetings_2011.html

GEBCO PERSONNEL CHANGES

GEBCO Permanent Secretary: On January 1, 2011, David Clark, Visiting Scientist at NOAA/NGDC has replaced Bob Whitmarsh, University of Southampton as GEBCO Permanent Secretary.

GEBCO SCHOLARS PROGRAM

At the 100th year celebrations of GEBCO in 2003 we acknowledged that most of those active in ocean mapping were of an older generation. Since then, with funding from the Nippon Foundation of Japan, we have trained a new generation through a special GEBCO-designed course in ocean mapping at the University of New Hampshire (UNH). The UNH GEBCO course is a one year master level course. Students are taught theoretical and practical aspects of ocean mapping, work on a team project, spend time at another ocean mapping institute and participate in a deep sea mapping cruise. The Nippon Foundation funding for the UNH program, about US\$540,000 per year, pays all tuition and expenses for the students and a modest stipend. There are now 27 course graduates working in their home country organizations, two in international industry and six currently at UNH. A new group begins in September. Scholars are from 26 countries bounding on all the world's major oceans. Existing scholars are active members on GEBCO subcommittees and working groups and increasingly are in influential positions in their organizations and internationally as a result of their training.

The Nippon Foundation has recently granted GEBCO US\$400,000 for 2010/11 to establish a program of ongoing development of the existing scholars and deepening of the ocean mapping human network. This is going to be largely carried out through development of regional mapping programs involving the scholars, specialist short courses on new ocean mapping developments and support for international collaboration initiatives. A new lab visit at NGDC will be focused on developing high-quality coastal digital elevation models will be offered to a maximum of two scholars per year.

Opportunities and issues

- The Nippon Foundation funding provides significant capacity building
- IOC, IHO and other agencies also do significant capacity building
- Linking efforts could provide strength to programs

IHO DATA CENTER FOR DIGITAL BATHYMETRY (DCDB)

The National Geophysical Data Center (NGDC) in Boulder, Colorado, USA, operates a worldwide digital data bank of oceanic soundings on behalf of the Member Countries of the [International Hydrographic Organization \(IHO\)](#). In 1988 NGDC offered to host and operate a worldwide digital oceanic bathymetry data centre on behalf of the IHO Member States. This led to the official establishment (in June 1990) of the IHO Data Centre for Digital Bathymetry (DCDB). Since that time, the IHO DCDB has made substantial progress toward establishing itself as the focal point for digital hydrographic data services for IHO Member States.

The worldwide digital data bank of oceanic soundings is maintained in several data bases, including the GEODAS global marine geophysical data base, and the Hydrographic Survey Data System. The NOSHDB (National Ocean Service Hydrographic Database) is a subset of the Hydrographic Survey Data System.

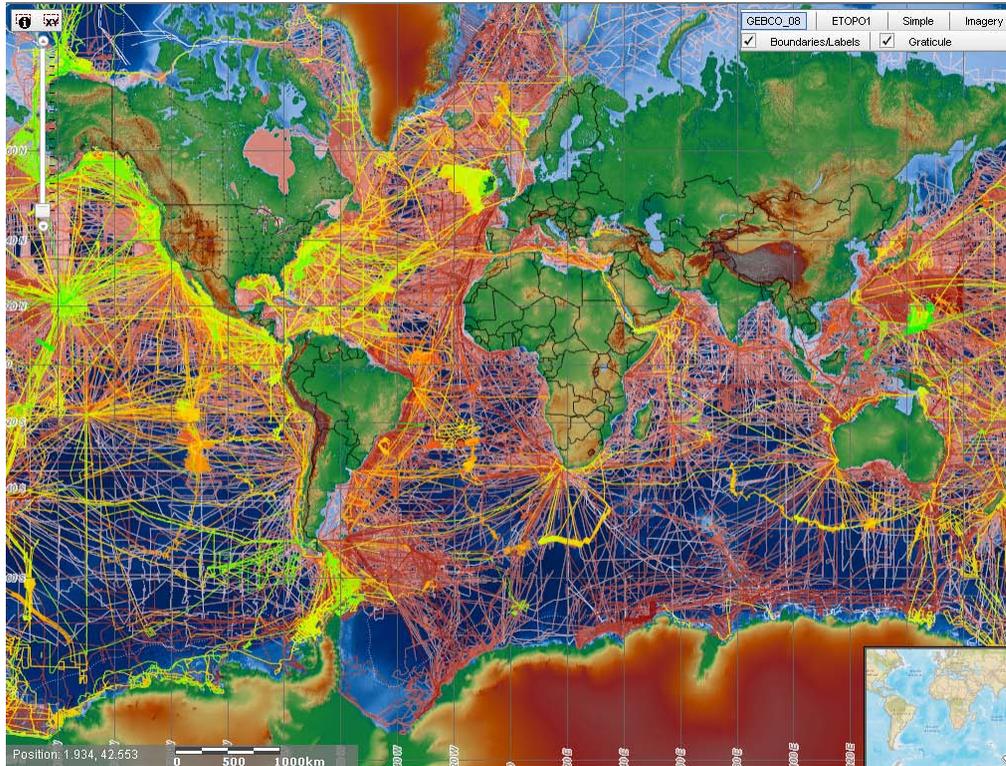
The following services are provided by the NGDC on behalf of the IHO:

1. Operation of the data center with a focus of activity on oceanic regions with depths greater than 100 meters.
2. Provision, free of charge to the IHO for use by its Member Countries, of the data needed for their national or international projects. IHO Member Countries' Hydrographic Offices are requested to provide the IHO DCDB with digital bathymetric data collected by their nation's institutions in oceanic regions.
3. Maintenance of a quality control facility whereby data provided to the IHO DCDB are checked for violation of physical principles (*e.g.*, instantaneous changes in ship position, high ship speeds) and completeness of metadata for contributed cruises.
4. Maintenance of inventories in digital form of all digital bathymetric data held in the data center.
5. Collaboration with various international organizations in the developments of exchange formats and standards to expedite bathymetric data exchange.

IHO DCDB WEBSITE

NGDC is coordinating with the IHO to update and restructure the [International Hydrographic Organization Data Center for Digital Bathymetry \(IHO DCDB\) website](#) to allow IHO member states easier access to hydrographic and bathymetric data through interactive graphical display and search capability. The new site will also provide user-friendly data and metadata submittal through a custom on-line interface and editor. NGDC is leveraging custom infrastructure developed for the U.S. Extended Continental Shelf Project to search, display and upload data and metadata. The website will provide users with all unrestricted multibeam swath sonar data, track line geophysical data, bathymetric and bathymetric/topographic digital elevation models, and point soundings archived at NGDC as well as metadata for locating data which is not archived at NGDC. The website restructuring is part of a larger IHO effort to engage the Regional Hydrographic Commission members in contributing data and metadata to the IHO DCDB.

The [Bathymetry Data Viewer](#) (shown below) is a single website hosted by NGDC where users may access all multibeam bathymetry, trackline bathymetry, U.S. National Ocean Service (NOS) hydrographic surveys, and digital elevation models (DEM).



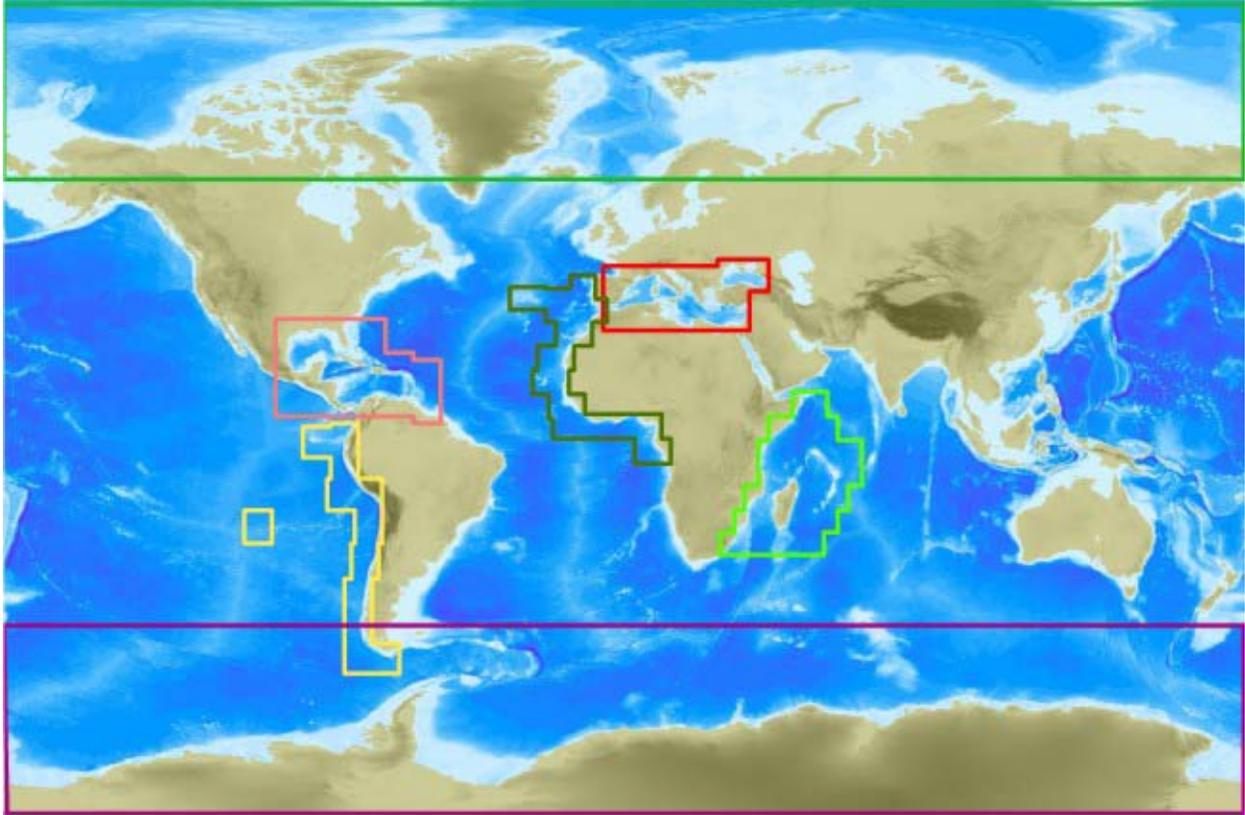
IRCC ACTION ITEM: “CONSIDER WAYS TO STRENGTHEN COLLABORATION WITH REGIONAL HYDROGRAPHIC COMMISSIONS WITH A PRIORITY ON IMPROVING HIGH RESOLUTION SHALLOW WATER BATHYMETRY AT THE REGIONAL LEVEL.”

REGIONAL MAPPING

Improved bathymetry of all the world’s oceans is important, but in practice significant progress will be made only through tackling it by regions. Regional projects also provide the opportunity for capacity building and data sharing between countries and organizations. Regional mapping has been very successful in some areas, for example the IOC supported [International Bathymetric Chart \(IBC\) of the Arctic Ocean, IBCAO](#). There are currently [eight IBC projects](#) of various activity levels. More areas need regional projects. GEBCO has set up the Interim Sub-Committee on Regional Mapping (iSCRUM) to,

- Facilitate closer coordination between existing regional mapping efforts
- Encourage establishment of new regional mapping projects
- Coordinate and encourage incorporation of their compilations into GEBCO

GEBCO's relationship to both the IOC and the IHO, and the existing Regional Hydrographic Commission structure of the IHO, coordinated by IRCC, makes GEBCO a logical vehicle for bringing the IOC and the IHO regional mapping efforts together through iSCRUM.



Currently active International Bathymetric Chart (IBC) areas

SHALLOW WATER BATHYMETRY

Knowledge of the bathymetry of shallow water areas is important for coastal zone development and management, maritime safety and marine hazards. The impact of tsunamis in particular is strongly influenced by shallow water bathymetry. Modeling of tsunami run up for mitigation and preparation requires detailed bathymetric data. The primary challenge to developing improved depictions of the coastal relief is access to appropriate bathymetric and topographic data. NGDC, in its role as host of the IHO DCDB, would like to partner with other countries, potentially through the IRCC, to obtain already collected bathymetry and coastal topography. Where possible, NGDC will also utilize the existing IHO/IOC Generalized Bathymetric Chart of the Oceans (GEBCO) / NIPPON Postgraduate Certificate in Ocean Bathymetry program to enable scientists from other nations to work at NGDC developing public DEMs for their coastal waters. Supporting this effort results in capacity building within other countries and builds lasting partnerships. Partner agencies may include hydrographic offices, coastal communities, foreign offices, and hazard mitigation, preparedness and emergency

response offices. Public dissemination of contributed data will be decided upon by the country of origin.

Traditionally GEBCO had been focused on waters deeper than about 200m, but that has changed recently for several reasons. First, because of the importance of the coastal zone, but also because bathymetric grids used by modelers, even on a global scale, have to be complete and consistent right to the coastline. GEBCO has therefore increased its emphasis on shallow water areas. Satellite altimetry data that provides interpolation in the deep ocean does not apply in shallow water. Hydrographic soundings are required. Through the IHO, some hydrographic data have been obtained from coastal countries, and a special project has extracted data from Electronic Navigation Charts (ENCs) and fishing industry data. All of these data, after appropriate quality controls, are being integrated into the GEBCO 0.5 arc-minute global grid. Additional special products are being considered for regional mapping efforts. There are, however, many areas in which valuable data exist, but nations or organizations do not make it available for assimilation into GEBCO products. Additional efforts by GEBCO, through the IHO-IRCC, to obtain these data sets would greatly improve the overall global and regional products.

REINVIGORATING DATA SUBMISSIONS

A significant issue at present is how to reinvigorate data submissions. Some Member States have concerns about sharing near-shore data, including security concerns, protecting revenue and the time and resources required to prepare data for the IHO-DCDB. To address these concerns, the IHO-DCDB is considering a variety of solutions. In the case of restricted or partially restricted data, providers could be asked to provide the geospatial extent and discovery metadata with a link to the provider/source information. The decision to share data can then be made on a case-by-case basis by the source agency. Alternatively, member states are encouraged to make available a lower resolution grid either hosted by the IHO DCDB or made available via a link to the source organization. One possible approach to reinvigorate data submissions from IHO member states is to work with the IHB by partnering or reaching out to RHCs and the IRCC. For example, 1) the IHO could send out a Circular Letter after the data accepting web sites had been completed, 2) GEBCO representatives could attend RHC meetings and 3) scholars of the NF/GEBCO Training Project could work in partnership with the RHCs. Another aspect was whether access for data submittal should be password protected or not. Controlled access, with minimal contact information to register, would allow data and metadata to be entered directly into databases.

There are opportunities to improve the global and regional maps, tsunami and storm surge inundation hazard products, and to build capacity within countries.

- shallow water bathymetry data bases are improving
- valuable data exist that are not available to GEBCO
- IOC and IHO can help

IHO-DCDB OPPORTUNITY FOR THE GEBCO/NIPPON FOUNDATION TRAINING PROGRAMME

The IHO Data Center for Digital Bathymetry, hosted at NOAA's National Geophysical Data Center (NGDC), invites one or two GEBCO/Nippon Foundation students each summer to work at NGDC in Boulder, Colorado, for a three-week period building coastal digital elevation models (DEMs) of international communities of interest. The goal is for students to learn techniques for building and evaluating high-quality, integrated bathymetric-topographic DEMs that are suitable for modeling of coastal processes (including tsunami inundation), ecosystems management and habitat research, or hazard mitigation and community preparedness. The products of this collaboration include both accurate, publically-available Digital Elevation Models for IHO member states as well as trained experts in DEM generation in those countries. The IHO can support this effort by assisting the Nippon students in obtaining the necessary hydrographic data to produce the DEMs before their arrival in Boulder.

DEVELOPMENT OF ENHANCED DIGITAL ELEVATION MODELS TO IMPROVE NOAA TSUNAMI FORECAST AND WARNING PRODUCTS FOR NON-U.S. COASTS

The National Oceanographic and Atmospheric Administration (NOAA) Tsunami Warning Centers (TWCs) currently issue tsunami forecast and warning for all U.S. coasts and for partner nations, primarily in the Pacific and Caribbean. As was evidenced by recent tsunami events in Japan and Chile, lack of access to modern coastal relief models impacts the TWC capability to issue timely and accurate tsunami forecast and warning products for non-U.S. partner countries. Following the February 27-28, 2010 earthquake in Chile and its Pacific Basin wide tsunami, NOAA conducted an assessment on how to improve tsunami forecasts and warnings. A primary finding of the assessment was

“Tsunami forecast efforts to date have focused on domestic and Canadian coasts. Without an accurate forecast method for international regions, PTWC will continue to act conservatively, which results in significant amounts of over-warning.”

This finding led to the following recommendation:

“Upgrade tsunami forecasting capabilities by:

- 1. Increasing the number of sites at which forecasts are provided.*
- 2. Extending forecast techniques to generate accurate forecasts for international regions.*

NOAA tasked NGDC with pursuing the development of Digital Elevation Models to support tsunami forecasts for coastal communities throughout the Pacific Ocean, Indian Ocean, and Caribbean Sea. NGDC, through the IHO Data Centre for Digital Bathymetry, would like to collaborate with the IHO IRCC to acquire hydrographic/bathymetric data and build improved regional and coastal digital elevation models (DEMs) for international coastal communities. These DEMs will form the basis of tsunami forecast models that will be provided to the host countries and used to enhance tsunami forecasts and warnings from the Tsunami Warning Centers.

