Joint meeting of the
GEBCO Technical Sub-Committee for Ocean Mapping
GEBCO Sub-Committee for Regional Undersea Mapping
Hosted by the Royal Malaysian Navy and PETRONAS
Kuala Lumpur, Malaysia
October 6, 2015

Notes

See agenda, Appendix 1

Radm Zaaim Hasan, Director General, National Hydrographic Center of Malaysia welcomed all of the participants and stress the overall importance of mapping the sea floor.

Martin Jakobossn, Chair of SCRUM, presented the current status of the TSCOM-SCRUM and reviewed the current activities.
http://www.gebco.net/about_us/meetings_and_minutes/documents/tscom_scrum_update_2015.pdf

He suggested the GEBCO goal is "To produce the most authoritative coherent portrayal of the seafloor, from the coast to the deepest parts of the oceans." He noted that the GEBCO Cookbook has been receiving periodic updates and is a very useful publication. He also noted the GEBCO paper which was published in 2015.

He then described various regional mapping projects, noting that the recent updates Antarctic database and map have been well received. Updates to regional areas, Antarctic is significant. Other important updates have been in the Arctic, Baltic, Mediterranean and Indian Ocean. Currently 19% of the world is being regionally mapped. More could be done but there are regional restraints and complications. New SCRUM/TSCOM initiatives and activities include: IBCAO - Greenland; IBCAO – Svalbard; ARDEM (New Western Arctic and North Pacific Digital Elevation Model); swIOBC (Southwest IOBC); Arctic - Antarctic seafloor mapping meeting in Monaco 2016.

Karen Marks reviewed the TSCOM activities.
http://www.gebco.net/about_us/meetings_and_minutes/documents/tscom_update_2015_marks.pdf
The GEBCO_2014 grid release. Recommendations for updating the grid include seeking bathymetric contributions from member states; move from 30 arc second grid spacing to 15 arc second; and, seek to use the current version of the SRTM15_Plus without copyright restrictions. Marks noted the publication of the GEBCO_2014 paper in the AGU's Earth and Space Science on-line journal. The paper was publicized on GEBCO Facebook and blog.

The 2014 Bathymetric Science day was held as a scientific session at the American Geophysical Union's Fall annual meeting following the meeting at Google.

Other TSCOM activities in 2015 included the updating and promoting of the GEBCO Cook book that was started in 2009 and published in 2012; and organizing Nautical Chart Adequacy Workshop at NOAA Headquarters in July 2015.

Status Reports from regional bathymetric compilations and technical work on bathymetric grid

Updating the GEBCO grid
http://www.gebco.net/about_us/meetings_and_minutes/documents/updating_gebco_grid_weatherall.pdf

Pauline Weatherall gave an overall on the techniques and methods for updating the GEBCO 2014 Grid. Fifteen new data sets were used in the update. These new date sets made a significant improvement to the Grid. The GEBCO gridded data sets are available by download from www.gebco.net/data_and_products/gridded_bathymetry_data/
They are available in several formats including One dimensional (1D) netCDF grid (aimed for use with GDA); CF compliant netCDF (2D); Esri ASCII raster, and Data GeoTiff.

Weatherall noted Other GEBCO related work at BODC included Development of a contour data set for the GEBCO_2014 Grid; Web Map Service (WMS) update work; and WMS development work for delivering metadata for the SID grid.

EMODnet
Thierry Schmitt reviewed the EMODnet program. The European Marine Observation and Data Network (EMODnet) consists of more than 100 organizations assembling marine data, products and metadata to make these fragmented resources more available to public and private users relying on quality-assured, standardized and harmonized marine data which are interoperable and free of restrictions on use. EMODnet is currently in its second development phase with the target to be fully deployed by 2020. Schmitt demonstrated the EOMDnet portal. He noted that GEBCO can fill the gaps in the EMODnet data coverage. Currently EMODnet is developing DEMs, but differing formats can be a problem with this compilation.

EOMDnet is concentrating on bathymetric data compilation for European waters, but GEBCO help the effort. Ultimately the compiled data base will be sent back to GEBCO. So Schmitt encourages EMODnet-GEBCO partnership. Shin Tani asked about the grid size of the data compilation. Schmitt replied that it was dependent on the source grid size.

Overview of Crowd Source Bathymetry Working Group
Lisa Taylor tabled this item since CSBWG is part of IHO and has a one day workshop scheduled for October 7 (the day following this TSCOM-SCRUM meeting).

GEBCO Outreach update- Plan for webpages for students
Hyo Sung presented the master plan for the GEBCO Outreach and Education Working Group. And the plan for webpages for students as part of the master plan.
http://www.gebco.net/about_us/meetings_and_minutes/documents/chang_sung_gebco_subpage.pdf

GEBCO High-Resolution Product
Vicki Ferrini gave an overview of the GEBCO High-Resolution Product.
http://www.gebco.net/about_us/meetings_and_minutes/tscom_and_scrum_2015.html
(To Be Added to GEBCO web site)
The concept is to produce a new High-Res GEBCO Product by leveraging the technical Components of Global Multi-Resolution Topography system at Lamont-Doherty Earth Observatory at Columbia University. This includes multi-resolutional data handling, grids, Images, Mask; access tools and services and attribution and provenance.

GEBCO/Nippon Foundation Indian Ocean Bathymetric Compilation (IOBC)
Rochelle Wigley described the current status of the IOBC.
http://www.gebco.net/about_us/meetings_and_minutes/documents/iobc_project_wigley_2015.pdf
The project is being done largely by GEBCO NF Scholars. The compilation prohect is a good teaching tool. 57 surveys have been compiles in the Indian Ocean which is the most sparsely surveyed ocean. As the data are compile, it is quality controlled. There was a successful CSB pilot project done in the Malaysian waters. So far smaller areas have been compiled, but it is hope to expand the areas. One constraint is the sharing of data, but it is hoped that this will change soon.

North Atlantic Seabed Mapping Project
David Wyatt and Jennifer Jencks presented the North Atlantic Seabed Mapping Project.
http://www.gebco.net/about_us/meetings_and_minutes/documents/natlantic_mapping_Jencks.pdf
They noted that GEBCO should take a strong role in this project.

Forum for Future Ocean Floor Mapping
Shin Tani announced the F-FOFM which will be held June 15-17, 2016 in the Proncipality of Monaco. It will be sponsored by GEBCO and the Nippon Foundation. Expected attendance 150. The Forum will concentrate on the future of Ocean floor mapping and the role of GEBCO for the next 10 years. The outcome will be a beginning of a roadmap to accomplish the goals developed over the three days. It is anticipated that all of the Nippon Foundation training programs alumni will actively participate in the Forum.

Break-out sessions

Breakout session on Future of the GEBCO grid
http://www.gebco.net/about_us/meetings_and_minutes/documents/update_procedures_weatherall.pdf

- Exploring the SRTM 15 version of the satellite altimetry, solving eventual copyright issues with SCRIPPS and selecting areas where significant improvements can be achieved using the new version. This may be developed as one or several GEBCO scholars projects.

Actions:
Contact David Sandwell. Jenifer Austin claims that SRTM is entirely funded by Google and must be made public, furthermore is compiled on publically available data.

Possible new regional mapping projects and efforts

- Jakobsson suggests that there is a good potential for Svalbard Islands for the various ongoing mapping projects.
- Pacific Ocean. Shin says that there is interest from several countries, and luckily Patricio Carrasco from Chile is member of the GEBCO GCC.
- Dave Clark reports about the SEPHC he attended in July, the attendance was very large and made of high level representatives, including the second in command of Patricio Carrasco for Chile. The concept of regional mapping was welcomed among the states during the session.
- Lisa Taylor reminds that the previous IBC mapping project of the East Pacific Ocean has failed because was too much relaying on personal contacts and people

who may become unavailable because displaced to other offices or moved to other jobs. Shin Tani suggests that Chile should take the lead of any possible Pacific mapping projects and because of the tsunami hazard on its coasts, it would be probably easier to persuading the Chilean government to support such an initiative.

- Martin Jakobsson suggests to write down a report on how a regional mapping project should be done with a list of deliverables, to be offered to regional groups that aim at making this effort.
- Robin Falconer suggests to leverage a workshop about compilation and interpolation. Who is the right person to be addressed for this task? Probably Patricio Carrasco himself. Geomar (Germany) and the University of Valparaiso have acquired a large amount of data on the Chilean trench.

Actions:
Contact Patricio Carrasco during one of the FOF skype teleconf.

- EEZ extension mapping projects. Most of the data are restricted or classified and won't be released before the process of negotiation and revision of the reports will be concluded.

Actions:
Robin to contact New Zealand
China for the north Pacific is a big player, but no solid contacts exist, one of the attendees is Chinese and she approached Marzia asking how and in what format are the data to be delivered to GEBCO.
India, Bangladesh, Pakistan difficult to reach out, not keen to cooperate.
Actions:
Prepare a letter signed by IHO/IHB asking for data and grids targeting specific countries that never provided data. But, first, approach countries that have already a relation with GEBCO for regional compilations. High resolution usage bands?
The next release must be 15 arcseconds. Next release 2017? Multiple resolutions?
Malaysia is collecting data from the ship owners, these data can be provided to GEBCO as crowdsourcing.
Brazil is one of those countries that must be approached because of the large extent of its coasts.
North Atlantic will be discussed at the forthcoming meeting on NA mapping projects (David Wyatt), to see who could take the responsibility of the regional mapping project.
Indian Ocean: data are already collected and only need to re-processing them?

<u>Breakout Session: Outreach Working Group- Webpages for students (Sung/Chang/Weatherall)</u>

Attendants: Hyo, Eunmi, Vicky, Rochchell, David, Mohammad, Tony

1. Collect the idea and outreach materials
   - Prototype from Eunmi
   - Galway Ocean Literacy and outreach-
   - Video tapes from Vicky (oceanvideolab) : Youtube product then linked
   – Historical GEBCO charts (1st ed. ~ 5th ed.) web developed by Tony then linked.
   - Google and Esri approach
   - Story on ocean mapping and App.

2. Need to define the purpose of Outreach program on GEBCO
Ex) share the GEBCO data or awareness GEBCO or ocean mapping

3. Develop the different Targets with different strategies (young kids, secondary school students and teachers, in general publics)
- Requirement survey needed

4. Develop the contents- including stuffs in general, activity, biodiversity, historical work, marine resources, business etc. in addition to GEBCO Products.

5. Need fund for develop the contents based on different targets with different strategies : Two ways to build outreach
- Build small stuffs voluntarily and put it together
- Make a big plan and make experts (need to fund):
Propose the fund for the outreach program in GGC meeting

6. Make front pages translations in GEBCO Web. or create brochure with local languages in perfect manners

<u>Uncertainty Breakout Group at GEBCO 2015</u>

Participants: Kamruddin Yusoff, Thierry Schmitt, Gustovo Gómez-Pimpollo Grespo, Julia Coursey, Jaya Roperez, James Ford, Paul Elmore (lead)

I. Overall objectives: Enable the GEBCO community to consistently & unambiguously
- Understand what uncertainty means
- Compute uncertainty estimates for bathymetry
- Communicate uncertainty in the GEBCO grid for the scientific integrity and safety of use of bathymetry

II. Paul Elmore (NRL) led the discussion with background information
Since 2002, the peer-review literature has published new science on estimation of uncertainty in bathymetry and hydrography products. Paul provided background (see appendix for details).

III. Questions Raised – What policies could we recommend for the following questions?
How do we develop uncertainty for GEBCO products?
How do we communicate and teach uncertainty issues to GEBCO users?
What are the conditions are required for the various techniques?
What kinds of standards do we need to set for receiving data?
How to deal with historical data?

IV. Recommendations
1. Build policies, tutorials & tools for the GEBCO community to understand for existing uncertainty estimation. Publish in the GEBCO Cookbook.
Definition for Uncertainty -> Use the NIST definitions (Appendix section A).
- Define conditions required to support different techniques
- Require source info needed
- Strategies for weighting data and/or rejecting data

For shallow water, require specification of vertical datum

2. Needs a working group to accomplish or perhaps a master's level graduate student (or students) to propose policies and test with test data set. (Could this task be done at CCOM?)

3. Build open GMT scripts for uncertainty processing.

Appendix: Background details

A. The National Institute of Standards and Technology in the United States has existing guidelines on reporting uncertainty. The reference is Taylor, B. N., and C. E. Kuyatt (1994), Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results, Technical Note 1297*Rep.*, National Institute of Standards and Technology, Gaithersburg, MD. This document can be downloaded from a Google search for the document.

1. Two classifications of uncertainty defined
   - Type A – "those which are evaluated by statistical methods"
   - Type B – "those which are evaluated by other means"

2. Definitions of uncertainty
   - Standard Uncertainty – equivalent to a standard deviation
   - Expanded Uncertainty – standard uncertainty multiplied by a coverage factor, usually performed to express uncertainty as a 95% confidence interval

B. Publications – Since 1995, the following publications have appeared dealing with bathymetric uncertainty to Paul's knowledge. Starting from earliest to latest, these publications are as follows (with a brief description in parenthesis)

1. Hare, R. (1995), Depth and Position Error Budgets for Multibeam Echosounding, International Hydrographic Review, 72(2), 37-69. (Provides error budgeting for multibeam systems.)
2. Jakobsson, M., B. Calder, and L. Mayer (2002), On the effect of random errors in gridded bathymetric compilations, Journal of Geophysical Research-Solid Earth, 107(B12), Article 2358. doi: 10.1029/2001JB000616. (Monte Carlo method for uncertainty using the Spline-In-Tension algorithm)
3. Calder, B. R., and L. A. Mayer (2003), Automatic processing of high-rate, high-density multibeam echosounder data, Geochemistry Geophysics Geosystems, 4, Art. No. 1048. doi: 10.1029/2002GC000486. (This is the CUBE paper)
4. Plant, N. G., K. T. Holland, and J. A. Puleo (2002), Analysis of the scale of errors in nearshore bathymetric data, Marine Geology, 191(1-2), 71-86. (Localized Regression for providing error from interpolation)
5. Calder, B. (2006), On the uncertainty of archive hydrographic data sets, IEEE J. Ocean. Eng., 31(2), 249-265. doi: 10.1109/JOE.2006.872215 (Uncertainty using Plant et. al. and ordinary Kriging and Monte Carlo method for uncertainty estimation of archived hydrographic data.)
6. Marks, K. M., and W. H. F. Smith (2008), An uncertainty model for deep ocean single beam and multibeam echo sounder data, Mar. Geophys. Res., 29(4), 239-250. doi: 10.1007/s11001-008-9060-y (Error analysis of older and nwer sonar data)
7. Elmore, P. A., D. H. Fabre, R. T. Sawyer, and R. W. Ladner (2012), Uncertainty estimation for databased bathymetry using a Bayesian network approach, Geochem. Geophys. Geosyst., 13, Q09011. doi: 10.1029/2012gc004144. (Extension of Monte Carlo method for gridded bathymetry databases where the original source data cannot be accessed.)
8. Zambo, S., P. Elmore, A. Perkins, and B. Bourgeois (2015), Uncertainty Estimation for Sparse Data Gridding Algorithms, paper presented at U.S. Hydro Conference, National

Harbor, MD, 16-19 March 2015 (New method for uncertainty for interpolation of sparse data using Splines-In-Tension of similar algorithm).

C. Why do we have multiple interpolators and uncertainty estimation: NFL "No Free Lunch" Theorem – given an infinite amount of data, all interpolators yield equivalent results; the success of a particular interpolator depends on data characteristics.

Appendix 1

Agenda

23 Sept 2015

Tuesday Oct. 6 (SCRUM and TSCOM)
Tun Sri Lanang Room, Royal Chulan Hotel

08:45-09:00 Arrival of delegates
09:00-0930 Welcome address by Radm Zaaim Hasan, Director General, National Hydrographic Center of Malaysia
09:30 TSCOM activities and preoccupations (Karen Marks)
09:45 SCRUM activities and preoccupations (Martin Jakobsson)

Status Reports from regional bathymetric compilations and technical work on bathymetric grid

- Updating the GEBCO grid (Weatherall)
- EMODNet (Thierry Schmitt)
- Overview of Crowd Source Bathymetry Working Group (Taylor)
- GEBCO Outreach update- Plan for webpages for students (Sung/Chang/Weatherall)
- GEBCO High-Resolution Product (Ferrini)
- GEBCO/Nippon Foundation Indian Ocean Bathymetric Compilation (IOBC) (Wigley)
- North Atlantic Seabed Mapping Project (Jencks/Wyatt)
- IBCAO/IBCSO/Baltic (Jakobsson)
- GEBCO Science Day (Elmore)
- GEBCO Topic (Tani)

10.30-11:00 Refreshment Break
11:00 -13:00 Continue Status Reports
13.00-14:00 Lunch Break
14:00-15:30 Continue Status reports
15:30-16:00 Refreshment Break
16:00-16:55 Organization of Break-out sessions
17:00 Adjourn
20:00-20:15: Arrival of guests for Welcome Dinner at Taming Sari 3, Ground Floor, Royale Chulan Hotel

Wednesday Oct. 7 (SCRUM and TSCOM)
Tun Sri Lanang Room, Royal Chulan Hotel

Break-out sessions (09:00 – 12:15)

- Crowd Source Bathymetry Working Group (Taylor)
- Outreach Working Group- Webpages for students (Sung/Chang/Weatherall)

- Update the GEBCO grid: Regional compilations and base grid (Jakobsson/Marks)

09:00-10:30 Break-out sessions
10:30-11:00 Refreshment Break
11:00-12:15 Continue Break-out sessions
12:15-13:00: Report results, recommendations, action plans
13:00-14:30 Lunch Break
14:30-17:00 Visit to PETRONAS Data Management Centre
17:00 Adjourn