The Nippon Foundation – GEBCO Seabed 2030 Project Year 2 Annual Report

Submitted by Dr Graham Allen, acting Seabed 2030 Director

SUMMARY

Executive Summary:
Year 2 of Seabed 2030 was 1st August 2018 to 31st July 2019. Each year the project submits an annual report to the GGC. The project requires GGC endorsement of annual report. At GGC36, we will present a brief overview of some Year 2 highlights, provide opportunity for the GGC to ask questions and discuss the report.

Action to be taken:
The GGC are invited:

- to REVIEW the Seabed 2030 Year 2 Annual Report prior to GGC36
- to SEEK points of clarification at GGC36
- to ENDORSE the Year 2 Annual Report

Related documents:
The Seabed 2030 Year 2 Annual Report consists of a core report document and several appendices. All documents are submitted as 1 zipped file named:
Seabed 2030 Project Year 2 Annual Report to GGC 5-Oct-19 V1.0.zip

The Nippon Foundation GEBCO

Seabed 2030 Project

100% of the ocean floor mapped by 2030

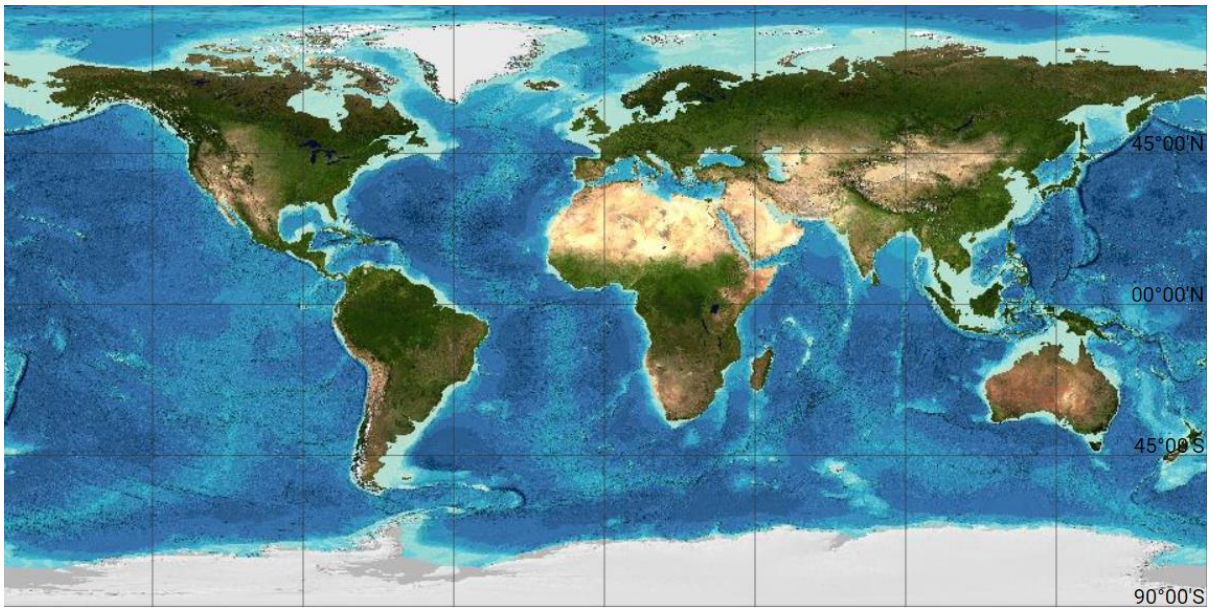
Year 2 Annual Report

5th October 2019

Authors: Seabed 2030 Project Team

Martin Jakobsson, Helen Snaith, Vicki Ferrini, Boris Dorschel, Geoffroy Lamarche, Dani Edgar, Larry Mayer

Contents



GEBCO 2019

Seabed 2030 Vision

By 2030, the World's oceans are fully mapped and the freely-available GEBCO Ocean Map is a complete map of the global ocean bathymetry.

Executive Summary

This is the Annual Report of Year 2 of The Nippon Foundation – GEBCO Seabed 2030 Project covering 1st August 2018 to 31st July 2019. As Year 1 included a six-month establishment phase, Year 2 is the first full year of project operation. All four regional centers and the global center are now established with a full complement of staff. The IHO – Data Center for Digital Bathymetry (IHO-DCDB) has been fully integrated into the project structure and data flow processes. The Project Team (center leads and the director) meet online regularly to manage the annual project work plan. A wider group from the centers meet as required in online and in person technical meetings to address technical decisions.

On 4th April 2019, the new version of the GEBCO product (GEBCO 2019) was released. This is the first version delivered as part of Seabed 2030. The release was the first major step in achieving the Seabed 2030 vision. The release increased the completeness of the map from 6% to 15% and included the equivalent of 32,000,000 square kilometres of new data coverage. Such a massive increase in data coverage is testament to the significant work of the project team in connecting with the global mapping community and eliciting such data contributions. The network of data contributors, the series of regional mapping meetings and high visibility created by the Project Team in Years 1 and 2 has clearly proved a successful strategy for sourcing data and positions the project well to continue the large year on year increases towards a fully mapped ocean.

Significant updates of the two polar regional grid (IBCSO and IBCAO) have been made, with the next incremental releases of these products due in October 2019.

Significant improvements have been made to the delivery of the product. A dedicated download service is in beta testing to support the newly available doi and single-click download options.

In support of identification and integration of existing, and new, contributions, the project team have determined a metadata scheme to be used for describing all known data sources and this is under review by GEBCO working groups. This scheme will define the essential information to be included with data contributions, supporting the data workflow from contributors to the IHO-DCDB and then to regional centres. The collected information will also underpin tools to readily map existing data and identify gaps for planning applications.

New web based tools have been developed to identify data issues: The polar centre have integrated a bespoke data tagging tool into their workflow, whilst an online tool for comparison and annotation of the global products by the wider community has been provided by CCOM.

Design work continues on the next generation of GEBCO products, to effectively deliver a depth-dependent resolution grid and community-driven user applications.

Within the project, technology innovations are being sought through collaboration with industrial partners. Work has been carried out with Sea-Kit, toward planning an unmanned cross-Atlantic expedition during year 3. In addition, an MOU has been agreed with XPRIZE in support of future collaboration, exploring how winning technology can be used within the project.

Discussions are ongoing with JAMSTEC on leading this work package, to utilise their technological expertise in developing the technology innovation strategy.

During year 2, a strategy has been developed in the project for extending the mapping potential of planned, and funded, expeditions with technical support. A trial expedition, to act as proof of concept of this 'Extending the mapping of ocean frontiers' has been designed as part of year 3 activities.

Engagement with industrial partners is fundamental to realising this task, and an *ad hoc* Working Group of GEBCO, including industry partners, has developed an outline funding strategic plan. Dedicated and extended missions also continue to be supplemented by Crowd Sourced bathymetry (CSB), in core partnership with IHO CSB activity. The CSB guidance document, which provides the data pipeline, is now in place and outreach activities will focus on community engagement to ensure a single message continues to be given, to build on the data interfaces producing data from the Carnival line fleet.

The project director resigned early in the project year 2 and the original Establishment team of Robin Falconer, Martin Jakobsson and Graham Allen took over management responsibility of the Project. From 28th September 2018, at the request of the Project Sponsors, Graham Allen, took on the role of acting Project Director. Whilst some management activities have been paused, awaiting a full time director's input, areas of internal project communication and strengthening of communication with, and feedback from, parent bodies have moved forward. GEBCO Working Groups are more engaged in technical project decisions, including new products, system and tool development, ensuring they meet community best practise.

A full program of engagement activities has been undertaken, with project members directly contributing to a large number of papers and presentations. Members of GEBCO GGC have also been active on behalf of the project and the extended project team have presented at 61 events in 30 countries. Following a major website refresh, the website has continued to provide a focus for information sharing combined with use of a managed mailing list.

A key activity this project year has been increased engage with a widening sphere of stakeholders. The regional centres have all held regional mapping meetings, with new membership providing both input to requirements and priorities and additional data contributions. The total number of supporters has increased from 42 to 106, whilst new partnerships were formally ratified with MOUs: 4 being fully ratified and a further 4 in development.

Media interest in the project remains very strong: over 200 publications on the project in Year 2. Major media outlets, e.g. BBC, Reuters Online and Japan Today closely follow the project and continue to provide effective and very supportive coverage of the project. Republishing of content is providing a major global platform for Seabed 2030.

Appendices

The body of the report is contained within this document, but a catalogue of documents is included to provide further details. This document should be read in conjunction with the associated documents.

Document name
Appendix 1 - Seabed 2030 Year 2 Presentations
Appendix 2 - Seabed 2030 Supporters
Appendix 3 - Seabed 2030 Media Coverage in Year 2
Appendix 4 - Data Contributors to GEBCO 2019
Appendix 5 – Year 2 Financial Report
Appendix 6 - Seabed 2030 Year 3 Proposal to The Nippon Foundation
Appendix 6.2 - The Nippon Foundation-GEBCO Extending The Mapping of Ocean Frontiers V1.1
Appendix 6.3 - Proposal to fund Ryder Expedition V1.0
Appendix 6.4 – Grant award letter from the Nippon Foundation
Appendix 7 – Seabed 2030 Year 2 Work Plan All deliverables

Introduction

This is the Annual Report of Year 2 of The Nippon Foundation – GEBCO Seabed 2030 Project covering 1st August 2018 to 31st July 2019. The report fulfils the annual reporting obligation of a Nippon Foundation grant recipient and the annual reporting obligation of Seabed 2030 to the GEBCO Guiding Committee. The report can also be read by the wider marine community as a status update on the progress of Seabed 2030 in its journey to fully map the world's oceans by 2030.

Seabed 2030 is a collaborative project between The Nippon Foundation and GEBCO to inspire the complete mapping of the world's ocean by 2030 and to compile all bathymetric data into the freely-available GEBCO Ocean Map.

Working under the auspices of the International Hydrographic Office (IHO) and UNESCO-Intergovernmental Oceanographic Commission (IOC), GEBCO has a 100 years history of ocean floor mapping. Seabed 2030, launched at the United Nations Ocean Conference in 2017, is building a global community of ocean mappers, hydrographers, scientists, industry and the public to discover and publish all existing bathymetric data. Seabed 2030 also advocates for new mapping expeditions to 'map the gaps' in our knowledge of the seafloor and provide the World with the definitive map of the world's bathymetry.

Seabed 2030 is built on a global network of 4 regional centers, 1 global center and a data center. Management of the project is the responsibility of the Project Team consisting of the Project Director and the leads of the Seabed 2030 Centers.

Center information:

Seabed 2030 Center	Location	Lead
Southern Ocean Regional Center	Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Germany	Dr Boris Dorschel
South and West Pacific Ocean Regional Center	National Institute of Water and Atmospheric Research, Wellington, New Zealand	Dr Geoffroy Lamarche
Atlantic and Indian Oceans Regional Center	Lamont-Doherty Earth Observatory, Columbia University, United States of America	Dr Vicki Ferrini
Arctic and North Pacific Oceans Regional Center	Joint center: • Department of Geological Sciences, Stockholm University (SU), Swede • Center for Coastal and Ocean Mapping, University of New Hampshire (UNH), USA	Co-Leads: Prof Martin Jakobsson (SU) & Prof Larry Mayer (UNH)

Global Center	British Oceanographic Data Centre, National Oceanography Centre, United Kingdom.	Dr Helen Snaith
IHO Data Center for Digital Bathymetry	National Oceanic and Atmospheric Administration's National Centers for Environmental Information in Boulder, Colorado, USA	Jennifer Jencks

The project works on an annual work plan and budget approved by The Nippon Foundation as the funding agent. As a project of an IHO working group, Seabed 2030 is accountable to the GEBCO Guiding Committee (GGC) for the successful delivery of the annual work plan. The GGC also approves the annual work plan and the annual report from the previous year.

The work plan is structured across 5 work packages:

- WP1: Data: Sourcing and publishing the data
- WP2: Systems and tools: Building the technical systems to manage and deliver the grid
- WP3: Technology Innovation
- WP4: Mapping the Gaps
- WP5: Management
    - WP5.1: Operational Management
    - WP5.2: Strategic direction
    - WP5.3: Communication and Outreach
    - WP5.4: Capacity Development

Further details of the project can be found on the Seabed 2030 website.

Year 2 was not a typical project year. In the first month of Year 2 the Director resigned, leaving the post on 28th September 2018. At the request of the Seabed 2030 Sponsors (The Nippon Foundation, IHO and IOC) Graham Allen has been acting Director since 28th September 2018. The recruitment process for a replacement Director began in September and continues. Hence, Seabed 2030 has operated for most of Year 2 and into Year 3 without a full time dedicated Director. The absence has resulted in changes to the original work plan and a reduction in Director and some project activities. More details are provided in the work package sections.

This report continues with reports from each center on center activities in Year 2 and followed by progress reports by work package.

Seabed 2030 Center Reports

Southern Ocean Regional Center

Location: Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research

Center Lead: Boris Dorschel

Summary

The main activities of year 2018/19 of the Seabed 2030 Regional Centre Southern Ocean was to finish the recruiting process. In addition, partners and networks of the International Bathymetric Chart of the Southern Ocean (IBCSO) were contacted to prepare IBCSO v2 in conjunction with the release of GEBCO 2018 component south of 60°S. Therefore, continuously throughout the year, bathymetric data sets were identified and collected to be incorporated in the Southern Ocean grid and IBCSO v2. To accommodate the generation of the grid, workflows were optimized for faster grid outputs.

Center Staff

In Seabed 2030 RDAC Southern Ocean activities at the Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, the following staff is involved:

Dr Boris Dorschel, Dr Jan Erik Arndt, Simon Dreutter, Laura Hehemann, Armin Mardani-Nejad and Sacha Viquerat. For the past year, this adds up to 3.75 Full Time Equivalent (FTE). This number will however change at the end of July 2019. At this stage, money rolled over from 2017/18 will be consumed on salaries and will not be available for funding salaries in year 2019/20. Furthermore, approximately 0.25 FTE is funded from non-Seabed 2030 funds. This support to the project is provided by AWI.

Regional Mapping progress

Members of the Regional Centre Southern Ocean have participated in the Polar2018 Conference in Davos (Switzerland), 15 - 26 June 2018 and in the First Arctic-Antarctic and North Pacific Mapping Meeting in Stockholm (Sweden), 8 - 10 October 2018. During these meetings, data sets for the Southern Ocean, so far not included in the Southern Ocean compilation, were identified and future data collection activities have been communicated.

Following the Stockholm meeting, a regional mapping committee Southern Ocean (RMC-SO) was established based on the editorial board of the International Bathymetric Chart of the Southern Ocean (IBCSO). Invitations to participate in the RMC-SO were sent out. Participation is confirmed by 15 representatives and outstanding for eight representatives. Additional representatives will be approached over the course of the next year.

Currently, the main focus is on the preparation and release of IBCSO V2. For IBCSO V2, data accumulation is almost completed. Furthermore, workflows have been streamlined and optimized to

be functional for the increased amount of bathymetric data to be processed. It is envisaged to have the grid available by the end of autumn 2019.

Major data and grid contributions

For the GEBCO 2018 grid, data sets recorded by AWI were the most significant contribution. A major change in comparison to the IBCSO V1, which was contributed to the last GEBCO grid, was the extension of the Southern Ocean contribution from 60°S to 50°S. The focus during the past year was, however, on identifying data sets to be included in the GEBCO 2019 / IBCSO v2 release. Simultaneously, the constant data inflow was formatted and homogenized for the in-cooperation in the next release.

Financial report

All staff funds have been allocated. In addition, all funds rolled over from Year 1 were used to augment Year 2 staff by the short-term hire of data scientists to support data homogenization and meta-data generation and contribute to process streamlining. The recruiting process is finished. The current number of personnel will be reduced by the end of July 2019 when the short-term recruitment terminates. The salary costs of the remaining personnel will be in agreement with seabed 2030 annual funds. As all Seabed 2030 funds (Year 2 and unspent Year 1) have been spent there are no Year 2 funds to roll over. Additional cost to the Seabed 2030 Project were the participation of three people in the First Arctic-Antarctic and North Pacific Mapping Meeting in Stockholm (Sweden), 8 – 10 October 2018, the participation of one person in the 35th GEBCO Guiding Committee meeting in Canberra (Australia), 12 – 16 November 2018, one person visit to the British Antarctic Survey, Cambridge (UK) and to Lamont Doherty Earth Observatory, New York (USA) to organize data transfer and for knowledge exchange. Furthermore, funds were used to support bathymetric data acquisition during Expedition PS118 with the German research icebreaker *Polarstern*.

Other activities

Participation of the AWI Bathymetry team in several cruises to the Southern Ocean to collect multibeam data. Preparation and execution of expedition PS118 with the German research icebreaker *Polarstern* to the Southern Ocean to collect also multibeam data. In the EU Horizon 2020 project iAtlantic, Boris Dorschel is deputy chair of the expedition coordination working group. This provides an overview of bathymetric data collected in the frame of the iAtlantic project with the aim to facilitate data contributions to seabed 2030.

South and West Pacific Ocean Regional Center (SaWPaC)

Location: National Institute of Water and Atmospheric Research, Wellington, New Zealand

Centre Lead: Dr. Geoffroy Lamarche

Summary

The main achievements of the South and West Pacific Centre (SaWPaC) during Year 2 (1 August 2018 - 31 July 2019) were :

1. Gathering, assembling and gridding of bathymetric data collected in the SW Pacific region.
2. Submission of the 15-arc sec resolution sparse grid to be integrated into the GEBCO_2019 grid release; delivery to GDACC was done on the 29th November 2018. SaWPaC 2018 delivery populated ca. 13.3 % [~16 .5 M km^2] of the GEBCO_2019 cells for the SaWPaC regional extent [~123.5 M km^2].
3. Preparation of the regional inventory of bathymetric data, and identification of unmapped areas. This included:
   - Development of ArcGIS Online viewers to visualize the coverage of bathymetric data holdings SaWPaC and other institutes conducting ocean mapping in the SW Pacific region.
   - Identification of potential sources to be explored and data holders to be contacted.
4. Recruitment and appointment of a Data Manager for the Centre for the period March 2019-Feb 2021.
5. Organisation and running of the inaugural Regional Mapping Committee Meeting in Wellington, NZ, in early March 2019. One of the SaWPaC's work priorities is developing network and strengthening connections with the Regional Mapping Community.
6. Promotion of the Seabed 2030 project and SaWPaC: multiple research conferences, meeting with stakeholders.
7. Communication and outreach:
   - Launch of the SB2030 project page on the NIWA web site
   - Promotion of the Seabed 2030 project and SaWPaC through multiple international conferences, seminars, individual meeting with stakeholders, and media interviews. A total of 21 presentations were made at various events.
8. Networking and education:

   SaWPaC hosted short-term interns from academic institutions that maintain educational programmes leading towards an FIG/IHO/ICA Cat. A certificate in Hydrography:
   - ENSTA Bretagne (French State Engineering School and Research Institute for innovation in defence, maritime development and hi-tech companies) Eng. Dipl. in Hydrography & Oceanography and M.Sc. in Hydrography programmes;
   - Nippon Foundation-GEBCO University of New Hampshire post-baccalaureate Certificate program in Ocean Mapping.

Centre Staff

The Centre is based at NIWA Wellington and led by Dr. Geoffroy Lamarche (NIWA Programme Leader: Marine Geological Processes and Resources; Associate Professor, University of Auckland). The Centre Lead is supported in his task by a Seabed 2030 Data Manager (Dr Evgenia Bazhenova) and a Technical Management Committee (TMC).

SaWPaC Data Manager

An interim, part-time, Data Manager (Mr. Patrick Hayes) was employed between May and October 2018.

In November 2018, a 2-year full-time position was advertised internationally, including through the GEBCO (gebco_folk@mailman.ngdc.noaa.gov) mailing list, for a Seabed 2030 Data Manager. More than 40 applications were received. The selection process was undertaken following the NIWA employment procedure and the successful candidate – Dr. Evgenia Bazhenova - started on March 3, 2019. Evgenia holds a PhD from the University of Bremen (2012), and an FIG/IHO/ICA Cat. A certificate in Hydrography (2016) and is a 2016 alumnus of the NF-GEBCO UNH Training programme in 2016. She also was an active member of the NF-GEBCO team in the Shell Ocean Discovery XPRIZE competition.

The SaWPaC TMC includes representatives of NIWA, GNS Science (Institute of Geological and Nuclear Sciences) and LINZ (Land Information New Zealand - which hosts the New Zealand Hydrographic Office):

- Mr. Kevin Mackay, IOC IODE National Coordinator for Oceanographic Data Management; Marine Database Manager, NIWA.
- Dr. Helen Neil, Operations General Manager, NIWA.
- Dr. Tilmann Steinmetz, GIS Data Analyst & Administrator, NIWA. Tilmann retired from the TMC in April 2019, but continues to support the SaWPaC work in terms of GIS consultancy.
- Dr. Vaughan Stagpoole; Head of Marine Geoscience Department, GNS Science.
- Dr. Jenny Black, IBCSO editorial member; Data Technician, GNS Science.
- Mr. Adam Greenland, New Zealand National Hydrographer, member of the IHO SWPHC; LINZ.
- Mr. Glen Rowe, Senior Tide Analyst, Hydrographic Authority, LINZ.

TMC meetings were held monthly at rotating locations in Wellington (NIWA, GNS Science, LINZ). Records of the agendas and minutes of the TMC meetings are kept at NIWA. These TMC meetings aim:

- to follow up on the progress of the SaWPaC technical and administrative work,
- to provide updates on participation in meetings/conferences aiming to promote Seabed 2030 and seek bathymetric data,
- to identify actions for the upcoming month.

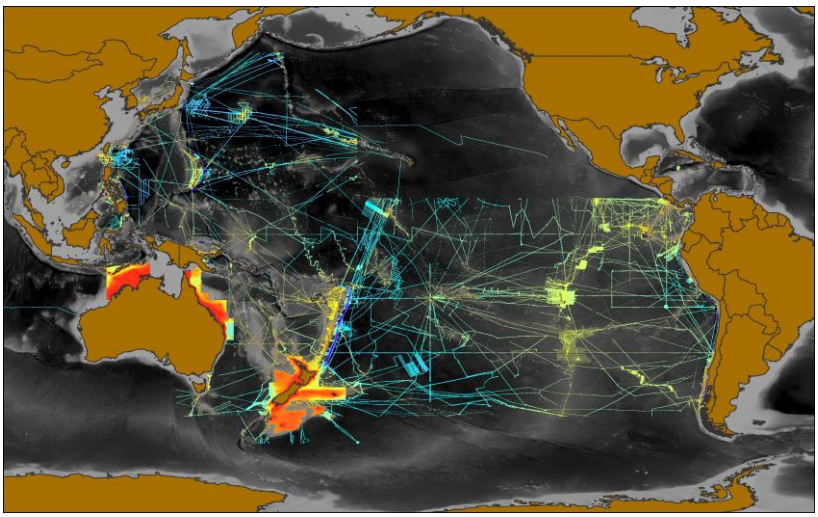
Short-term interns at SaWPaC (Year 2)

- Ms. Haruka Ogawa, Japan Coast Guard, NF-GEBCO Alumni; August 2018.

- Mr. Hugo Chonavel, ENSTA Bretagne; June - August 2019.

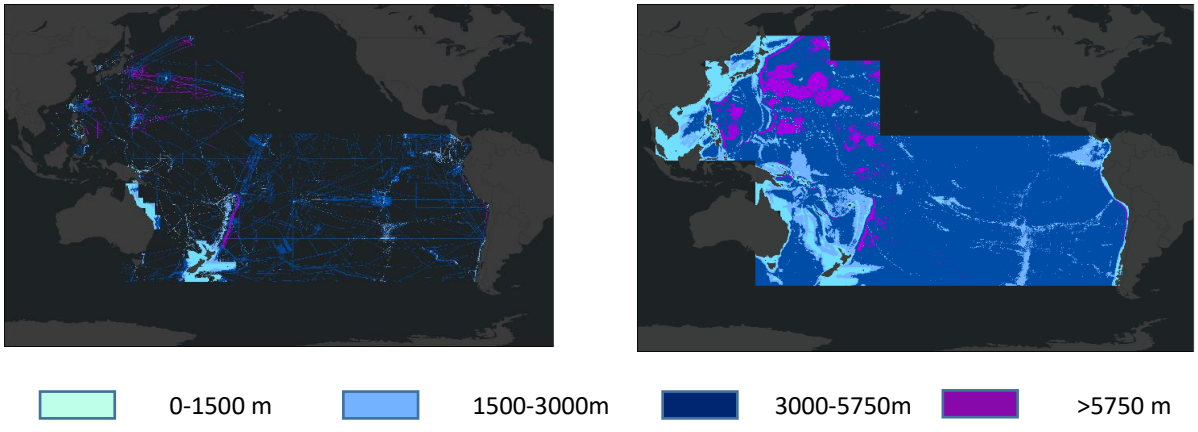
Regional Mapping progress

SaWPaC 2018 delivery integrated into the GEBCO_2019 release covers ca. 13.3 % of the GEBCO_2019 cells (15 arc sec grid cell size) for the SaWPaC regional extent.



SaWPaC delivery 2018 - bathymetric data layer, 15 arc sec sparse grid- overlain on the GEBCO_2019 gridded bathymetry.

SaWPaC uses the NIWA ArcGIS infrastructure to maintain a bathymetric database, which references source data (processed multibeam soundings and regional compilations) stored in native resolution (as received from the data holders) and allows gridding using different cell size. This will be used to create the target depth-banded Seabed 2030 grid.



SaWPaC delivery 2018 (left) and target Seabed 2030 - GEBCO coverage for the SW Pacific (right). Depths are coloured according to the ranges defined by the Seabed 2030 target grid resolution.

To visualize the data delivered in 2018 and current bathymetric data holdings, SaWPaC is developing apps using ArcGIS online viewer. More advanced ArcGIS users can access and download different open source layers through the NIWA open data page.

Stakeholder Engagement and Outreach

Members of the SaWPaC Technical Management Committee presented the Seabed 2030 Project at various regional conferences, workshops and seminars, as listed below.

SaWPaC directorate also organized face-to-face meetings with potential industry and international partners, including :

- Sanford Fisheries (Auckland, CEOs- George Clement, Volker Kuntsch, Clement Chia) – discussed potential input from NZ fisheries to Seabed 2030 (mostly SBES data) and proposed benefits for the industry. Detailed notes on this meeting are available at SaWPaC. Crowd-sourced bathymetry resources to be discussed and explored by all the RDACCs.
- JAMSTEC (Eitchi Kikawa) – discussed renewal of NIWA-JAMSTEC MOU, potential involvement of JAMSTEC in Seabed 2030. Actions pending approval from the Seabed 2030 Director.
- Ocean Exploration Trust (Lindsay Gee) - OET is seeking approval to collect data through number of SW Pacific SIDS and is asking for contacts in these countries (including Kiribati, Cook Islands, Samoa) and support from SB2030. This has been implemented by SaWPaC.

The centre activities were also presented at IOC/IHO meetings in the region, including the 12th Intergovernmental Session of the IOC Sub-Commission for the Western Pacific (WESTPAC-XII), in Manila, Philippines in April 4, 2019 and at the 31st GEBCO SCUFN Plenary Session, Wellington on October 25, 2018.

Science articles in peer-reviewed journals

Wölfl, A.-C., Snaith, H., Amirebrahimi, S., Devey, C., Dorschel, B., Ferrini, V., Huvenne, V.A.I., Jakobsson, M., Jencks, J., Johnston, G., Lamarche, G., Mayer, L., Millar, D., Pedersen, T.H., Picard, K., Reitz, A., Schmitt, T., Visbeck, M., Weatherall, P. and Wigley, R. (2019) Seafloor Mapping - the challenge of a truly global ocean bathymetry. *Frontiers in Marine Science,* 6.

Conference/workshop presentations

Lamarche, G., Bindra, S., Dorschel, B., Ferrini, V., Jakobsson, M., Mayer, L., Snaith, H., and Weatherall, P. (2018) 100% of the World Ocean floor mapped by 2030. The Nippon Foundation-GEBCO Seabed 2030 Project. *GeoCart' 2018 "Cartographies of Change"*, Wellington, NZ, September 5-7, 2018.

Black, J. (2018) Seabed2030: South and West Pacific Centre. *First Seabed 2030 - Arctic, Antarctic &North Pacific Mapping Meeting*, Stockholm, Sweden, October 8, 2018.

Lamarche, G. (2018) The Nippon Foundation – GEBCO Seabed 2030. *31st GEBCO SCUFN Plenary Session*, Wellington, New Zealand, October 25, 2018.

Lamarche, G. (2018) The Seabed 2030 - South and West Pacific Centre. *Seabed 2030 Atlantic and Indian Ocean Centre Mapping Committee meeting*, Lamont Doherty Earth Observatory, New York, USA, October 29, 2018.

Mackay, K. and Lamarche, G. (2018) 100% of the World Ocean floor mapped by 2030. The Nippon Foundation-GEBCO Seabed 2030 Project. *Australasian Hydrographic Society Seminar*, Suva, Fiji, December 7, 2018.

Lamarche, G. (2018) The Nippon Foundation – GEBCO SEABED 2030. *Internal seminar*, IRD Nouméa, New Caledonia, December 12, 2018.

Mackay, K. (2019) *7th IHO Crowd-Sourced Bathymetry Working Group (CSBWG7),* Quebec, Canada, February 12-14, 2019.

Greenland, A. (2019) National Report by New Zealand. *South-West Pacific Hydrographic Commission (SWPHC) 16th Meeting*, Alofi, Niue, February 13-14, 2019.

Mackay, K. and Lamarche, G. (2019) 100% of the World Ocean floor mapped by 2030. The Nippon Foundation-GEBCO Seabed 2030 Project (Poster). *25th International Ocean Data Exchange (IOC) Committee of the UNESCO/IOC*, Tokyo, Japan, February 20-22, 2019.

Steinmetz, T., Bazhenova, E. (2019) Using the ESRI Bathymetry Information System in Seabed 2030. *NZ ESRI User Group Conference*, Wellington, March 27, 2019.

Lamarche, G. (2019) The Nippon Foundation-GEBCO Seabed 2030 Project South and West Pacific Regional Centre. *12th Intergovernmental Session of the IOC Sub-Commission for the Western Pacific (WESTPAC-XII),* Manila, Philippines, April 4, 2019.

Bazhenova, E. (2019) 100% of the World Ocean floor mapped by 2030 – Progress of the Seabed 2030 Initiative. Survey*&Spatial New Zealand Conference*, Auckland, NZ, May 10, 2019.

Lamarche, G., and Bazhenova, E. (2019) The Nippon Foundation-GEBCO Seabed 2030 Project: Update from the South and West Pacific Region. *GeoHab Annual Conference*, St. Petersburg, Russia, May 13-16, 2019.

Lamarche, G. (2019) The Nippon Foundation-GEBCO Seabed 2030 Project South and West Pacific Regional Centre. *Seminar the Service Hydrographique et Oceanographique de la Marine National*, Brest, France, June 5, 2019.

Lamarche, G. (2019) The Nippon Foundation-GEBCO Seabed 2030 Project South and West Pacific Regional Centre. *Seminar IFREMER and University of Bretagne Occidentale*, Brest, France, June 7, 2019.

Bazhenova, E. (2019) Seabed 2030 South and West Pacific Centre. *SW Pacific Region - World Hydrography Day Seminar "Hydrographic information driving marine knowledge"*, Suva, Fiji, June 21, 2019.

Greenland, A. (2019) The Nippon Foundation – GEBCO Seabed 2030 project. *LINZ seminar for the World Hydrography Day*, Wellington, NZ, June 21, 2019.

Lamarche, G., Bazhenova E., Mackay, K., Steinmetz, T., Neil, H., Black, J., Stagpoole, V., Greenland, A., Rowe, G. (2019) The Nippon Foundation-GEBCO Seabed 2030 project: Contribution of the South and West Pacific Ocean regional data centre to the 2019 bathymetric grid release. *New Zealand Marine Sciences Society Conference*, Dunedin, NZ, July 3-5, 2019.

Mackay, K., Lamarche, G. and Bazhenova, E. (2019) Progress towards 100% of the World Ocean floor mapped by 2030. The Nippon Foundation-GEBCO Seabed 2030 Project. *Australian Marine Sciences Association Conference*, Fremantle, Australia, July 7-11, 2019.

Neil, H. (2018) 100% of the World Ocean floor mapped by 2030. The Nippon Foundation-GEBCO Seabed 2030 Project (Keynote address), *HYDRO18*, Sydney, Australia, October 30 – November2, 2018.

Media interviews

Funnell, A., 2019. An ambitious project aims to map the entire ocean floor. It could also open it up to mining, Future Tense. ABC News.

Pope, E., 2019. 'More than just science' in mapping project Seafood New Zealand. Seafood New Zealand, Wellington, NZ, pp. 26-29.

Lamarche, G., 2018. NZ to map quarter of Earth's seafloor in global project, in: Charlie Dreaver, R. (Ed.), Morning Report, Radio NZ, Wellington.

Report of status of regional mapping committee

The inaugural (first) Regional Mapping Committee Meeting was held by SaWPaC in Wellington, NZ, on March 3-6, 2019.

The following materials are available from this meeting:

- workshop program,
- list of participants,
- presentations,
- meeting report.

The objectives of this meeting were to:

- Establish a Regional Mapping Committee with representatives from relevant organizations,
- Identify sources of bathymetric data in the SW Pacific region,
- Discuss methods and protocols of data sharing and management,
- Identify upcoming mapping expeditions.

Sixty-five people from 18 countries from the Pacific region registered their interest in participating in the meeting. Delegates originating from 13 countries attended the workshop and two attendees from New Caledonia connected remotely. Five Nippon Foundation - GEBCO Alumni attended the workshop

demonstrating the strong link with this educational program. Members of the regional mapping community were strongly encouraged to share information about the upcoming meetings, available online resources etc., through SaWPaC.

The 2.5 day workshop included a short formal Māori welcome, followed by an opening from Dr Robin Falconer, ex. Chair of the GEBCO Guiding Committee and member of the Seabed 2030 establishment team. Day 1 consisted of presentations on the Seabed 2030 Project and initiatives that could benefit from and to the Project. On day 2, presentations were more technical and focused on online data portals and data sharing, as well as the potential input from new technologies (including advances achieved during the Shell Ocean Discovery XPRIZE competition, growing role of Satellite-Derived Bathymetry, etc.) to the Seabed 203 project. Day 3 included three short break-out sessions during which the role of the Regional Mapping Committee, the need to facilitate data sharing by developing data sharing agreements and the importance of understanding the value proposition for all stakeholders were debated.

One key point discussed was the role and composition of the RMC. While most workshop participants seemed to favour a large, open group, several participants strongly recommended to limit the number of people to ensure more effective work of the RMC. A list of 17 points (values proposed) was drafted for the RMC, including: searching for data and funding, advocating for and developing the regional mapping community, involving regional and government leaders; developing crowdsourcing initiatives, providing feedback to Seabed 2030 as point of contact for their country/sector, source of local knowledge, prioritization of areas to be mapped.

The role of the RMC still needs to be clarified, e.g. whether it should be a steering or advisory committee; or a committee vs. a community in terms of roles/weight. SaWPaC directorate, and especially the Centre Lead, should be working towards equal representation/involvement of all the Pacific regions.

An annual meeting of RMC was discussed and the possibility to hold them in another (sub-)region was well received (e.g. east Pacific, NW Pacific). Also, a joint one with the North Pacific RDACC.

There was a request for sending letter of invitation/intent for formal support from the GDACC. This will need to be investigated.

Other tasks such as developing an online calendar, list of possible meetings, RMC mailing list, generic pptx presentations to pass a consistent and clear message about the SB2030 goals are all already being implemented.

The proposed action points raised during the meeting were many and wide-ranging from setting up a strategy of communication, engaging with industry, developing specific outreach events, developing standard data sharing agreements, reviewing metadata, ensuring data security, etc.

Action	What	Priority
1	Finalise the list of members of the RMC	1
2	Set up strategy for communication with industries. A table of point-of-contacts for sectors. How do we identify roles in the SaWPaC's RMC? How do we communicate (Dropbox, weblinks, Slack, Microsoft Team, Monday.com…)?	1

3	Develop Web site w.r.t. gaps (online and offline solutions)	1
4	Connection with National Initiatives	1
5	How to submit data, whom to contact. Consistent procedure for everyone.	1
6	Standard licensing agreements. Data security. Getting a clear idea of the position we are in; How are we going to legally contribute?	1
7	Review metadata currently recommended by IHO DCDB. Need for minimum standards.	1
8	Ensuring we have the appropriate procedures for attributions.	1
9	Create a "common message" for outreach purposes	1
10	Create a common internal communication channel for the RMC	1
11	Engagement with shipping companies re. shipping lines (see Act 12)	2
12	Identify priority areas of "no data" within the SaWPaC region	2
13	Contact SB2030 Director to investigate about adding an attribute to AIS	2
15	Outreach and industry contacts in South America	3

SaWPaC extent includes EEZs of 39 countries and territories. A list of RMC members was proposed that comprises representatives of as many countries in the region as possible. SaWPaC is working towards encouraging the “missing” countries to join the RMC. Additional members include industry partners and other organizations. Current list of the RMC members is available from SaWPaC.

Another SW Pacific region seminar “Hydrographic information driving marine knowledge” was jointly organized by the Australasian Hydrographic Society and Fiji Hydrographic Service on the World Hydrography Day (June 21, 2019) in Suva, Fiji.

Seminar presentations focused on the role of some key data holders in the SW Pacific region: IHO SWPHC, AusSeabed, Seabed 2030, SPC. Fiji Hydrographic Service introduced their new vessel equipped with a multi-beam echosounder. FHS also expressed their interest to involve hydrographers from other organizations into the FHS surveys. This case was later debriefed with Larry Meyer, as one of the possible examples of how a “Map the Gaps” fund could be applied.

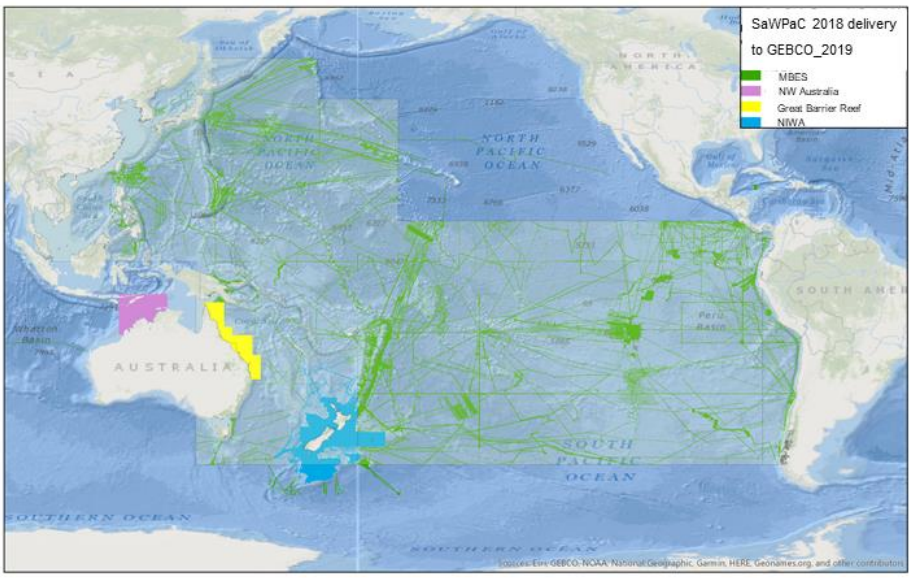
One of the key messages of this seminar was to emphasize the importance of networking in the very diverse Pacific region. SaWPaC should encourage more active involvement of the NF-GEBCO UNH training Alumni into mapping activities in the region.

Major data and grid contributions

During Year 2, the SaWPaC regional inventory of bathymetric data was updated (the table below lists the datasets status codes as identified by the Year 2 Goals for Regional Centres).

Dataset inventory status	Status code
has been integrated into the GEBCO_2019 grid	1
publicly available	2
awaiting submission	3
has been submitted to SaWPaC	4

Data from 5 major databases were accessed and delivered to GDACC in December 2018 as a 15-arc second resolution sparse bathymetric grid and a source-identifier (SID) layer.



Data holder	Data source	Status code
Commonwealth of Australia (Geoscience Australia)	**High-resolution depth model for Northern Australia - 30m** https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search#/metadata/121620	1
Deep Reef Explorer (www.deepreef.org)	**High-resolution depth model for the Great Barrier Reef – 30m** Beaman, R J (2018). High-resolution depth model for the Great Barrier Reef - 30 m. Geoscience Australia, Canberra, Australia. http://pid.geoscience.gov.au/dataset/115066	1

National Institute of Water and Atmospheric Research Ltd (NIWA Wellington)	**New Zealand Bathymetry compilation - 250m** Mitchell, J.S., Mackay, K.A., Neil, H.L., Mackay, E.J., Pallentin, A., Notman P., 2012. Undersea New Zealand, 1:5,000,000. NIWA Chart, Miscellaneous Series No. 92 https://www.niwa.co.nz/our-science/oceans/bathymetry For delivery to the GEBCO_2019 grid, only areas covered by multibeam and high-density singlebeam data were masked out of the 250m compilation.	1
Alfred Wegener Institute for Polar and Marine Research (AWI)	6 Cruises of multibeam data in the South and West Pacific	1
Japan Agency for Marine-Earth Science and Technology (JAMSTEC)	22 cruises of MBES data in the South and West Pacific Ocean region Data and Sample Research System for Whole Cruise Information in JAMSTEC http://www.godac.jamstec.go.jp/darwin/e	1
GMRT v.3.5 (February 2018)	https://www.gmrt.org/about/	1

Currently, SaWPaC attempts to perform assembly of bathymetric data from the following sources.

Data holder	Data source	Status
JAMSTEC	http://www.godac.jamstec.go.jp/darwin/e	2
NOAA NCEI	https://maps.ngdc.noaa.gov/viewers/bathymetry/	2
GeoMapApp		2
AusSeabed	http://ausseabed.gov.au/surveys-data	2
IFREMER	http://seadatanet.maris2.nl/v_cdi_v3/search.asp	3
SHOM	https://data.shom.fr	4
SPC		tbd
PIBHMC	http://www.soest.hawaii.edu/pibhmc/cms/	2
PANGAEA	www.pangaea.de	2
BSH/GEOMAR		tbd
German Research Vessels Portal	https://www.portal-forschungsschiffe.de http://manida.awi.de/casestudy-bathymetry	tbd

Financial report

As agreed, the small unspent Year 1 funds were rolled over and augmented to the Year 2 budget. All Seabed 2030 funds (Year 2 and unspent Year 1) have been spent as allocated and hence, there are no Year 2 funds to roll over.

Atlantic and Indian Oceans Regional Center

Location: Lamont-Doherty Earth Observatory, Columbia University, United States of America

Center Lead: Vicki Ferrini

Overview

The Regional Center for the Atlantic and Indian Oceans has focused on stakeholder engagement, data assembly and the gathering and assembly of information about existing embargoed data. With respect to data assembly, the RDACC team continues to revise and improve data and metadata management and integration workflows to facilitate the assembly of data products. Ongoing efforts include developing and implementing GIS approaches for (1) overall metadata management and graphics for outreach materials, (2) revealing gaps in data coverage based on existing data (integrated and not integrated, public and embargoed), (3) tracking progress of and (3) computing area mapped. Significant effort continues to be dedicated to regional stakeholder engagement. Engagement efforts focused both on within-region stakeholder engagement and broader project-level engagement and includes working closely with the Meso-American and Caribbean Regional Hydrographic Commission, coordinating a special session at the Western Indian Ocean Marine Science Association (WIOMSA) meeting in Mauritius, holding a second Regional Mapping Committee meeting, and participating in panel discussions at scientific and technical conferences.

The Center welcomed back GEBCO Scholar Tinah Martin as a member of the RDACC team in January 2019. She joins Vicki Ferrini and Frank Nitsche on the project, which also receives technical support from John Morton. Additional staff engaged in and contributing to the project at LDEO include Claudia Giulivi, Andrew Goodwillie, and Sara Robinson. For the summer of 2019, the Center welcomed 4 undergraduate students to assist with data processing: Hayley Drennon (College of Charleston) and Jesse Jenkins (Vassar College) both returned for a second summer working with the center, and Mikayla Drost, and Treyson Gillespe both from the College of Charleston. During the academic year, students Hayley Drennon (College of Charleston) and Cindy Lin (Columbia University) worked with the RDACC assisting with data processing. Students are important accelerators are a critical component of global capacity building. Ongoing efforts at LDEO related to data processing and integration of data for GMRT continue to feed content into all regional data products for Seabed 2030.

Regional Mapping progress

Regional Stakeholder Engagement

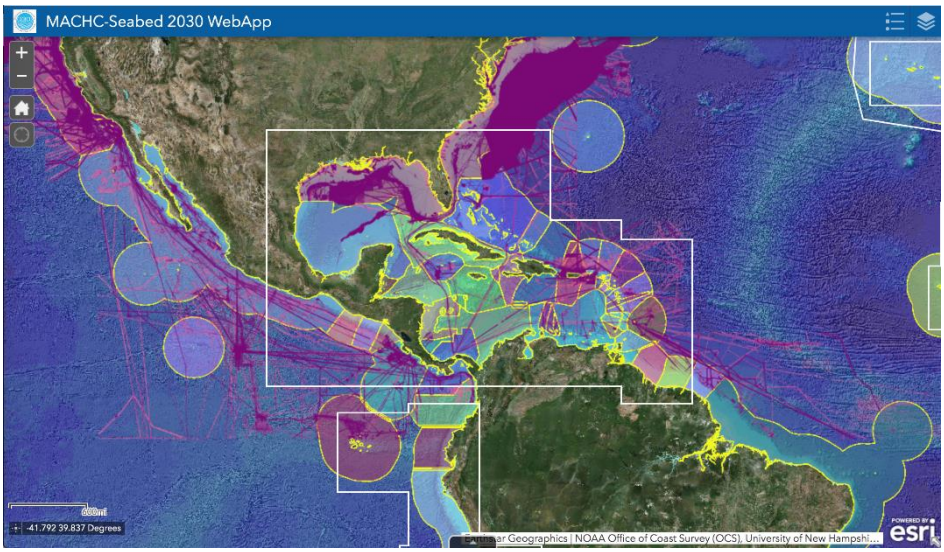
Outreach and engagement activities of the RDACC include engaging with regional stakeholders focused on data contribution, capacity building, and data needs. Presentations made throughout the year focused on engaging data contributors and data consumers relevant to regional data assembly and coordination as well as overall Seabed 2030 Project outreach and publicity. The development of materials for distribution and stakeholder engagement is ongoing within the RDACC. Materials generated include (1) a general GEBCO slide deck (2) a Seabed 2030 project one pager, (3) a new industry-focused one pager, and (4) an industry-focused 'get involved' webpage as well as large graphics for signs used at meetings and conferences. Efforts are also underway to coordinate an exhibit booth at upcoming meetings to promote the Seabed 2030 Project.

GEBCO-NF Alumni

Throughout the year, the Atlantic/Indian RDACC has worked closely with several Alumni of the GEBCO-NF Training Program. Several alumni participated in our Regional Mapping Committee meetings (Rochelle Wigley, Yr4, South Africa/USA; Amon Kimeli, Yr 11, Kenya; Walter REynoso-Paralta Luis, Yr1, Argentina; Djoko Hartoyo, Yr 2, Indonesia, Eunice Ofoli-Anum Nuerkie Yr 9, Ghana; Runghen Ravi Hemanaden, Yr 10, Mauritius; Vasudev Mahale, Yr 3, India). Alumni from Africa are also actively involved in regional coordination and are organizing a special session at the 2019 Western Indian Ocean Marine Science Association (WIOMSA) Symposium which took place in Mauritius in July. Alumni have also been critical in helping to coordinate with Regional Hydrographic Commissions and with giving presentations throughout the region.

Regional Hydrographic Commissions & International Bathymetric Chart Efforts

To promote regional engagement, virtual presentations were made at two RHC meetings this year: the Meso-American and Caribbean Hydrographic Commission (MACHC) and the South West Atlantic Hydrographic Commission (SWArtlHC). The MACHC has been particularly eager to engage with the center and together we are developing a web app that they can use to help coordinate activities within the region (Figure). The RDACC is working closely with the MACHC as they develop a new website which prominently promotes the Seabed 2030 Project. As a result of engagement with the MACHC, a videoconference was held in March 14 between the RDACC and members of the IBCCA including representatives from the US, Mexico, Brazil and Colombia to establish relationships and begin to coordinate efforts as they near completion of their first edition data product.



The MACHC-Seabed 2030 WebApp highlights existing data in the GEBCO world map and several other layers relevant to developed for coordination and engagement of members of the Regional Hydrographic Commission. It will be presented and utilized at the 2019 MACHC meeting.

Regional Mapping Committee Meetings

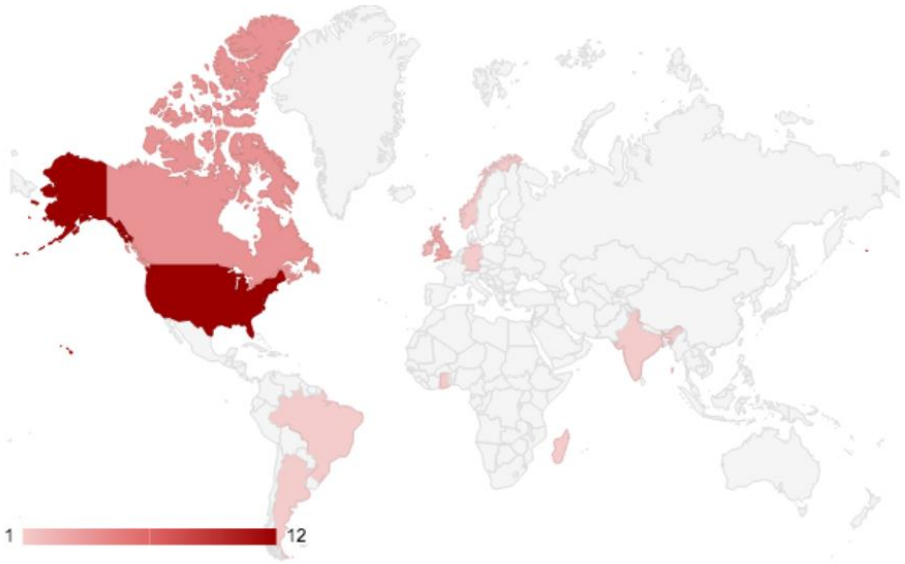
Two Atlantic/Indian Regional Mapping Committee (RMC) meetings were held this year. The first RMC Meeting was held at Lamont-Doherty Earth Observatory in Palisades NY from Oct 30 - Nov 1, 2018. The meeting was coordinated with a US Federal Agency Working Group on Coastal and Ocean Mapping and a meeting of the Leads of the Atlantic Seabed Mapping International Working Group (ASMIWG). Both of these groups met independently at Lamont on Oct 29. By combining these meetings, we were able raise awareness about complementary mapping efforts within the region, better inform stakeholders about the Seabed 2030 Project, and to foster the exchange of ideas and information among stakeholders. Day one of the Seabed 2030 meeting was attended by ~30 in person participants and another six remote participants. It included several presentations (see agenda) focused on Seabed 2030 and its mission, US Federal Perspectives on the project, an overview of GEBCO and capacity building efforts within GEBCO (Training Program and XPRIZE). This was followed by status updates from the Atlantic Seabed Mapping International Working Group (ASMIWG), and three of the Seabed 2030 Atlantic/Indian, South and West Pacific and North Pacific Regional Data Assembly and Coordination Centers. The next session of the meeting focused on updates from mapping efforts within the region including multiple presentations from participants from the EU, Israel, Mauritius, Australia, and the GEBCO International Bathymetric Chart of the Indian Ocean. The final presentations focused on tools and technology and included a presentation from the IHO Data Center for Digital Bathymetry, an overview of recent and ongoing gap analysis conducted by NOAA to assess coverage within the US EEZ, and a presentation about gridding and visualization strategies. The day closed with group discussions. During Day 2 members of the Regional Mapping Committee (RMC) met for a brainstorming session. Topics included developing an inventory of some existing data that has not yet been integrated and opportunities for data acquisition within the Atlantic and Indian Oceans, and strategies for lowering the barriers of data acquisition globally. The committee also discussed strategies for gaining access to existing data that is not yet shared and in some cases not yet

inventoried, capacity building strategies and synergies with ongoing mapping efforts, and discussions about technical needs and tools. On Day 3, the RMC focused on discussing organizational strategies for engaging regional stakeholders and approaches for optimizing data gathering within the region. The RMC plans to hold regular virtual meetings.

The second Seabed 2030 Atlantic/Indian Oceans Regional Mapping Meeting was held at NOAA / NCEI Boulder, Colorado on April 16-18, 2019. The meeting was held in conjunction with the Atlantic Ocean Research Alliance (AORA) Atlantic Seabed Mapping International Working Group (ASMIWG). Several members of both groups participated in both meetings. The first day of the meeting was a joint meeting between the two groups, and the objectives of this session were to better understand what each effort is focused on, identify synergies and complementary activities and define and explore where collaboration and coordinated promotion can strengthen efforts to map the Atlantic Ocean. Attendees provided updates on activities in the region and about general progress of mapping efforts in the Atlantic Region. It was identified that AORA and ASMWIG are focused primarily on the operational aspects of data acquisition, while the Seabed 2030 RDACC is focused more on data compilation. The two efforts share a need for coordination and both efforts are critical to achieving common goals. The complementary relationship between the two groups provides a solid foundation for accelerating progress in the Atlantic Ocean, and serves as a model for other regions. During Day 2, the discussion was focused on Data Coordination and Data Assembly. This included reviewing data integrated into the GEBCO 2019 grid leveraging an ArcGIS online Web Map Application that brought together several publicly available layers including the 2019 SID grid and the IHO-DCDB holdings. The concept of quantifying and presenting information about coverage of data integrated into GEBCO, data that exist and are not yet integrated, and clearly identifying areas that require new data acquisition was also discussed. Relevant to this concept was a discussion about metadata needs - from the perspective of interfaces, stakeholder needs, and information to help both groups pursue their priorities. Day 3 was spent discussing capacity building, communication and outreach. While this discussion was largely focused on coordination within the region several suggestions were offered that would apply project-wide. This included a lengthy discussion about data submission pathways and the need for the project to provide information that clearly guides interested parties toward contributing to the project. Other suggestions focused on the webpage, a public calendar of events, and the need for dynamic map interfaces that can be used to explore data coverage in detail. Extending the network and engagement throughout the region was also discussed. In addition to engaging more of the Scholars, suggestions were made about engaging active scientific networks in the region (e.g. SCOR, InterRidge, India EEZ project, Nansen Cruise). Several upcoming regional meetings were mentioned and there is a general willingness of participants to help spread information about the Seabed 2030 initiative. Participants requested access to materials for dissemination at meetings including slides and printable material. Finally, it was agreed that the next RMC meeting should be held in a country that borders the Indian Ocean.

Summary of Action Items and Suggestions/Recommendations

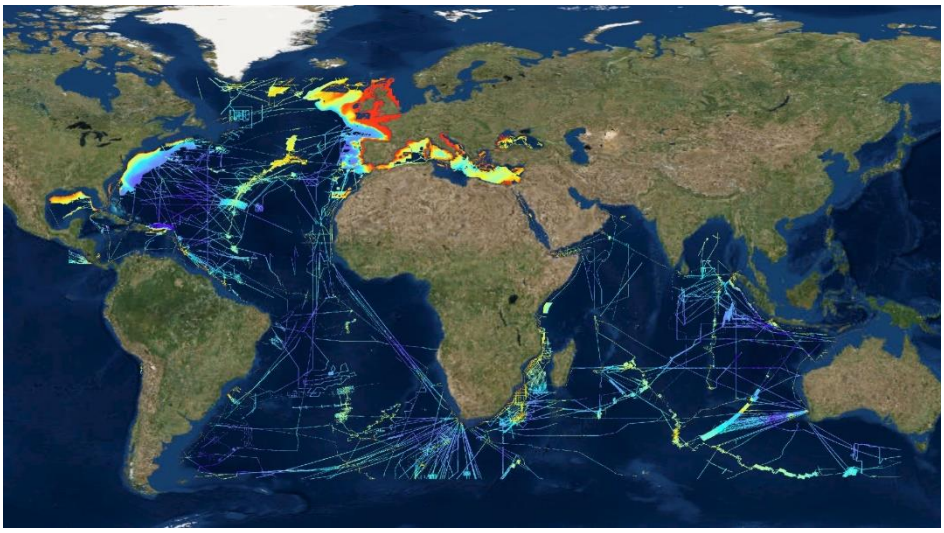
There were 10 in-person participants at this RMC meeting, and 6 remote participants. Participants spanned the academic, government and industry sectors and included GEBCO-NF Training Program Alumni from throughout the region. Participating countries are indicated in the map below:



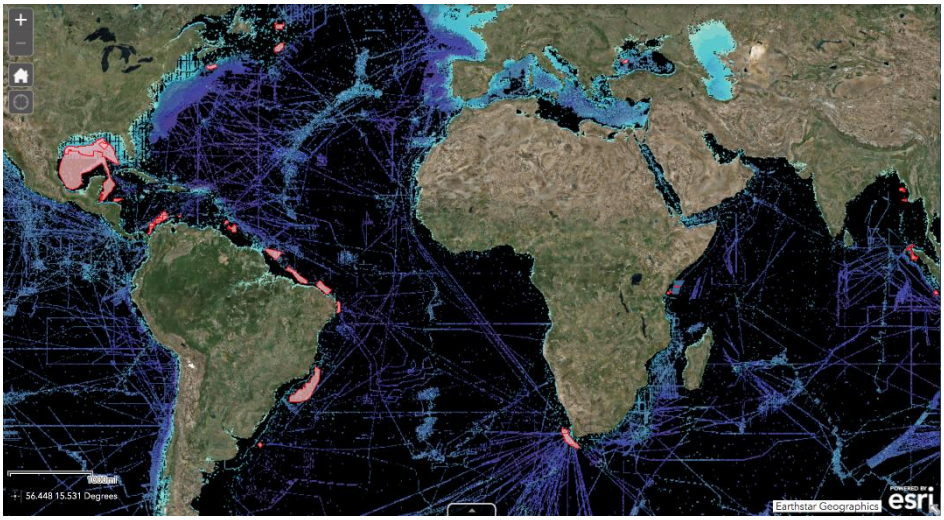
Geographic Distribution of participants in the second RMC meeting, April 2019.

Major data and grid contributions

Regional data products for the Atlantic and Indian Oceans include several new and updated data compilations: GMRT v3.5 (primarily US Academic data), Geoscience Australia's MH370 grids, BOEM Gulf of Mexico, US Law of the Sea Atlantic Margin, 2018 EMODnet bathymetry, and the Indian Ocean Compilation from R. Wigley and the GEBCO Scholars. Multibeam transit data contributed by Fugro, multibeam data acquired aboard the Celtic Explorer as part of AORA, extensive unprocessed multibeam holdings from AWI, and ENC data from South Africa were also contributed and integrated. Several other data sets that were contributed or made available online (e.g. ENC data contributed by Brazil, Canadian Hydrographic Service data, new AORA mapping campaign data). These are being reviewed and integrated for the next data release. A list of current and future data sources was developed and is maintained in the wiki and includes maps and contact info of proprietary industry data for which shapefiles have been provided. Shapefiles revealing spatial extent of embargoed industry data have been supplied by Fugro and PGS and are being integrated into map based representations that reveal gaps in data coverage to help inform new data acquisition.



Data assembled by the Atlantic/Indian RDACC that was included in the GEBCO 2019 Product.



Example of the spatial extent of known existing embargoed Industry data (source: Fugro) within the Atlantic/Indian Region.

Financial report

Carry-over funds from Year 1 were used to augment Year 2 activities. Year 2 funds were spent as allocated and hence there are no residual funds.

Arctic and North Pacific Oceans Regional Center

Locations: Department of Geological Sciences, Stockholm University (SU), Sweden/Center for Coastal and Ocean Mapping, University of New Hampshire (UNH), USA

Centre co-Leads: Martin Jakobsson (SU) & Larry Mayer (UNH)

Summary

IBCAO Ver. 4.0: The status by Aug 1, 2019, is that after 17 compiled versions of the IBCAO grid since the work begun during the fall 2018, a review has been completed by the Arctic Regional Mapping Committee (RMC). Of 224 marked-up issues using the online web quality control tool, 88 remains to be fixed by the Regional Center compilation team. This will be done in August and September in order to have IBCAO Ver. 4.0 completed for public release by Oct 15, 2019. An article highlighting the release of IBCAO Ver. 4.0 as well as comparing it to previous version is currently being drafted. The plan is to submit this paper to Geophysical Research Letters in October.

North Pacific:
During the first half of 2019 the NorPac data team at CCOM has identified 115 cruises that are within the RDACC polygon but were not included in previous releases of GRMT nor GEBCO, and 4 more were grids sent over from GDACC to be included in the processing workflow. The majority (108) of the datasets were downloaded from NCEI and consist of 1.4TB of storage on CCOM servers and will be processed following the workflow and metadata guidelines that will be decided upon by the SB2030 technical group.

Deliverable details: IBCAO Ver. 4.0 has a resolution of 100x100 m on a Polar Stereographic Projection, a data coverage of 19 % considering the Seabed 2030 variable grid resolution scheme. A new strategy for mult-resolution gridding of global datasets has been developed and distributed to the technical leads of the regional and global centers for discussion.

Centre Staff

In addition to Co-Center Leads:

Stockholm University

- Ms. Caroline Bringensparr, data analyst
- Mr. Rezwann Mohammad, developer and data manager
- Mr. Björn Eriksson, IT support
- Mr. Carlos Castro, data analyst

Center for Coastal and Ocean Mapping, University of New Hampshire

- Mr Paul Johnson, data manager
- Mr Tomer Ketter, data analyst

Regional Mapping Progress

Compilation of IBCAO Version 4.0

The Arctic and North Pacific Regional Center proposed to take the lead of the IBCAO project during the Arctic – Antarctic – North Pacific Mapping Meeting held in Stockholm Oct 8-10, 2018. This proposition was endorsed during the meeting and a Regional Mapping Committee (RMC) was established for the Arctic region. Active members of the IBCAO Editorial Board were included in the new Arctic RMC.

Bathymetric data from the Arctic region identified during the meeting in Stockholm and thereafter were provided to the Regional Center team at Stockholm University during the fall of 2018 and spring of 2019. The updating process of IBCAO, involving data cleaning, merging and gridding, begun when the first data arrived. This is an iterative process, where the web based grid/data visualization and quality control tool developed by Rezwan Mohammad the Regional Center (see Report Year 1) was intensively used: https://seabed.geo.su.se/ibcao/#4/89.89/0.00/v3.0 . Both the teams from Stockholm University and University of New Hampshire were engaged in the work of updating IBCAO.

An invitation to review the new Arctic Ocean grid, to be released as IBCAO Ver. 4.0, was sent out to the RMC members June 19, 2019. Prior to this RMC review, the data had been compiled into 17 different grids, and discovered data problems had been fixed in between each version. The review was done using web tool where a markup tool was included that permits all members to highlight identified problems in the grid and insert comments (see other activities).

The status by Aug 1, 2019, is that of 224 marked-up issues, 88 remains to be fixed. This will be done during the months of August and September. IBCAO Ver. 4.0 is estimated to be completed for public release by Oct 15, 2019. An article highlighting the release of IBCAO Ver. 4.0 as well as comparing it to previous version is currently being drafted. The plan is to submit this paper to Geophysical Research Letters in October. Compared to the previous Ver. 3.0, the data coverage has increased 3 times. Approximately 19 % of the Arctic region is constrained covered by bathymetric data considering the Seabed 2030 defined grid resolutions of 100 x 100, 0-1500 m; 200 x 200, 1500-3000 m; 400 x 400, 3000-5750 m; 800 x 800, 3000-5750 m. IBCAO Ver. 4.0 is planned to be released as a 100 x 100 m grid on a Polar Stereographic projection as there are few software yet that can handle truly multi-resolution grids.

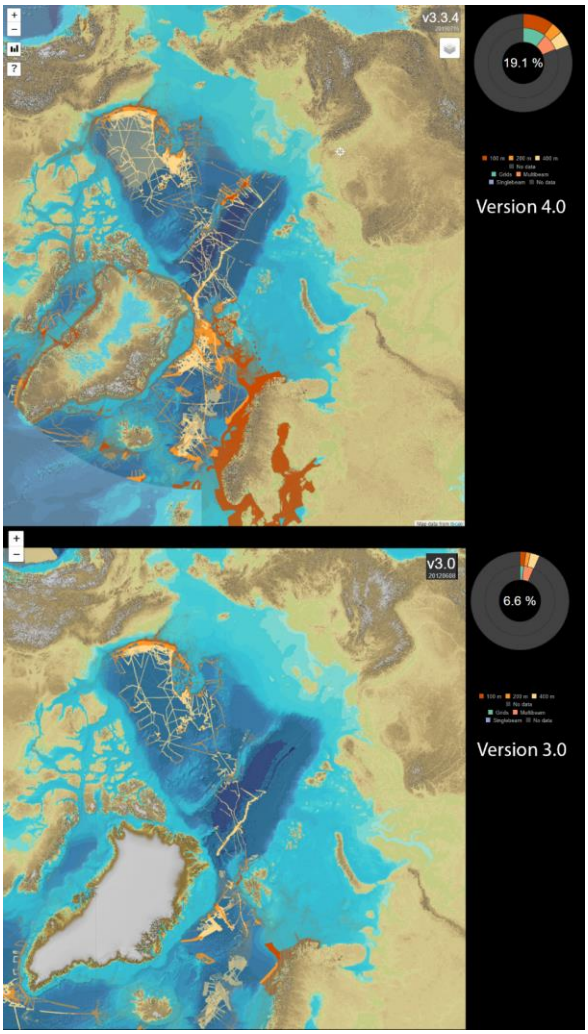
The Seabed 2030 plan stipulates that the Regional Mapping Committees (RMCs) for the North Pacific-Arctic Ocean should benefit from the existing established IBCAO Editorial Board. At the Regional Mapping meeting in Stockholm October 8-10 October 2018 a RMC was formed using the active IBCAO Editorial Board Members as a core. The members appointed at the meeting were:

- Bernard Coakely (USA), University of Alaska Fairbanks
- Julian A. Dowdeswell (UK), Scott Polar Research Institute, University of Cambridge
- Maurizio Demarte (Italy), Italian Hydrographic Institute
- Boris Dorschel (Germany), Alfred Wegener Institute for Polar and Marine Research

- Hanne Hodnesdal (Norway) Norwegian Mapping Authority, Hydrographic Service
- Roberta Ivaldi (Italy), Italian Hydrographic Institute
- Martin Jakobsson (co-chair) (Sweden) Stockholm University
- Larry Mayer (co-chair) (USA) Center for Coastal and Ocean Mapping/Joint Hydrographic Center, University of New Hampshire
- Riko Noormets (Norway/Svalbard/Estonia) UNIS, University Center of Svalbard
- Michele Rebesco (Italy), Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS)
- Mark Zimmermann NOAA Fisheries (North Pacific
- Joanna Gerlings (Denmark), Danish Geodata Agency
- Yulia Zarayskaya (Russian Federation), Geological Institute of Russian Aaedmy of Science
- Paola Travaglini (Canada), Canadian Hydrographic Service

Following the meeting, two additional members have been appointed:

- Seth Danielson (USA), University of Alaska Fairbanks
- Tao Zhang (China), The Second Institute of Oceanography



IBCAO Version 4 and 3 data coverage shown in the web tool developed by Rezwann Mohammad (see other activities).

North Pacific Region

The North Pacific Ocean could not benefit from a previously established project equivalent of IBCAO, implying that the work had to be setup from scratch including building a regional network. The RMC is joint for the Arctic and North Pacific Oceans, but members representing the latter ocean region are yet to be complemented. Despite this, the UNH team identified and processed 28 high-quality multibeam data sets from 26 cruises that have not been incorporated into the GEBCO grid. These data sets come from two primary sources (data collected by CCOM/UNH in support of the U.S. Law of the Sea effort, and data collected by E/V Nautilus in support of U.S. Ocean Exploration). Additionally, approximately 191 North Pacific data sets that are not in either the GEBCO grid or GMRT were identified. The quality and relevance of these data is currently unknown but will be examined in the coming year.

Major data and grid contributions

The list of major data contributions is long, for the Arctic Ocean it comprises >200 new datasets since the release of IBCAO Version 3.0 in 2012. For the Pacific Ocean an evaluation of new datasets which are not included in the new releases of GMRT and GEBCO is being conducted and 28 UNH/CCOM and NAUTILUS data sets from 25 cruises have been processed thus far and submitted to the GEBCO Global Center. Below are some examples of the major data contributions.

1- **Alfred Wegener Institute for Polar and Marine Research and MARUM:** Data from >70 cruises in the Arctic region with RV Polarstern and RV Maria S. Meriam.
2- **The Canadian Hydrographic Service (CHS) Non-Navigational (NONNA-100) Bathymetric Data Bathymetric Data products, Canadian Waters, 144-47°W; 40-80°N:** All currently validated, digital bathymetric sources acquired by CHS, combined at a resolution of approximately 100 metres. https://open.canada.ca/data/en/dataset/d3881c4c-650d-4070-bf9b-1e00aabf0a1d
3- **IceBridge BedMachine Greenland, Version 3, -80 - 10°E; 60-90°N:** Bed topography/bathymetry map of Greenland based on mass conservation, multi-beam data, and other techniques. Morlighem et al. (2017). BedMachine v3: Complete Bed Topography and Ocean Bathymetry Mapping of Greenland From Multibeam Echo Sounding Combined With Mass Conservation. *Geophysical Research Letters* 44, 11,051-011,061, doi:10.1002/2017GL074954. http://nsidc.org/data/IDBMG4
4- **Alaska Region Digital Elevation Model (ARDEM) Version 2.0, 45ºN-80ºN and 130ºE-120ºW: Digital bathymetric model with a nominal 1-km grid spacing over the domain**. Danielson, S. L. et al. Coupled wind-forced controls of the Bering–Chukchi shelf circulation and the Bering Strait throughflow: Ekman transport, continental shelf waves, and variations of the Pacific–Arctic sea surface height gradient. Progress in Oceanography 125, 40-61, doi:http://dx.doi.org/10.1016/j.pocean.2014.04.006 (2014). More information: http://research.cfos.uaf.edu/bathy/

5- **Stockholm University/Swedish Polar Research Secretariat:** Multibeam bathymetry from five cruises (2011-2016) with Swedish icebreaker Oden. The Geological Survey of Denmark and Greenland (GEUS) were the main collaborating partner for two of the cruises.

6- **University of New Hampshire:** Multibeam bathymetry from ten cruises in the Arctic and North Pacific since 2012 with USCGC Healy and RV Kilo Moana and 16 NAUTILUS cruises in the North Pacific have been submitted to the Global Center:
CCOM-LOTS CRUISES:

Region	Year	Cruise ID
Gulf of Alaska	2005	KM0514-1
Gulf of Alaska	2005	KM0514-2
Gulf of Alaska	2018	KM1811
Kingman Palmyra	2010	KM1009
Kingman Palmyra	2015	KM15-20
Kingman Palmyra	2016	RB16-01-L2
Mendocino Ridge	2009	EX0903
Mendocino Ridge	2014	AT26-21
Necker Ridge	2011	KM1121
Necker Ridge	2017	KM17-18

OET-NAUTILUS CRUISES:

Region	Year	Cruise ID
Juan Defuca Canyo	2016	NA070
Nitinat Fan	2016	NA071
Vancouver to Cali.	2016	NA072
Loudoun Canyon	2016	NA073
Olympic Coast	2016	NA074
California Margin	2016	NA075
California Margin	2016	NA077
California Margin	2016	NA078
Santa Catalina	2017	NA079
Channel Islands	2017	NA080
Barkley Canyon	2017	NA081
Washington to Cali.	2017	NA082
Channel Islands	2017	NA083
Olympic Coast	2017	NA086
Astoria	2017	NA087
Astoria	2017	NA088
Soccoro	2017	NA089

7- **British Antarctic Survey/Scott Polar Research Institute, University of Cambridge:** Multibeam bathymetry from 3 cruises in the Arctic.
8- Ocean Melting Greenland project: Multibeam bathymetry from Greenland fjords acquired by the Nasa Ocean Melting Greenland project.
9- OLEX: Compilation of bathymetry primarily from fishing vessels using the Olex system. More information at: http://www.olex.no
10- Alaska Fisheries Science Center of the US National Oceanic and Atmospheric Administration's National Marine Fisheries Service: Bathymetry data from the Alaska bathymetry compilations for the Aleutian Islands, central Gulf of Alaska and Norton Sound. https://www.afsc.noaa.gov/RACE/groundfish/Bathymetry/default.htm.

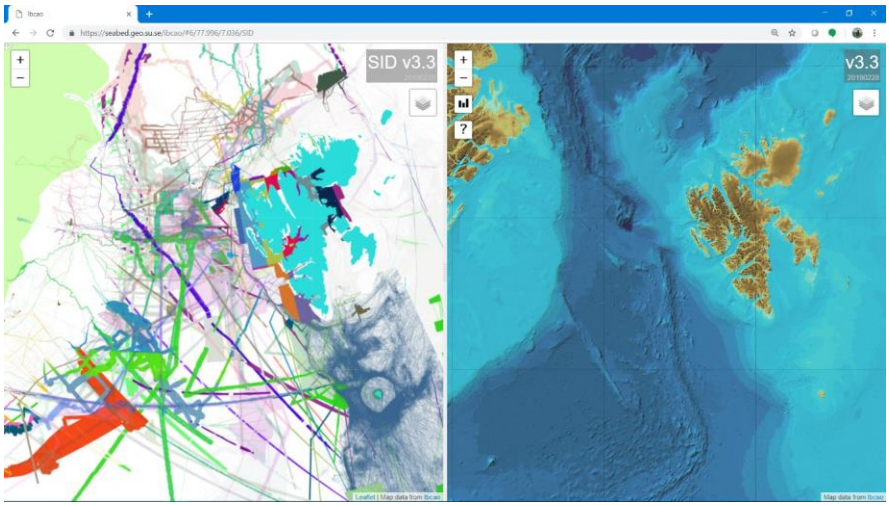
Financial report

As agreed, the small unspent Year 1 funds were rolled over and augmented to the Year 2 budget. All Seabed 2030 funds (Year 2 and unspent Year 1) have been spent as allocated and hence, there are no Year 2 funds to roll over. The new recruitment at SU of Dr Carlos Castro implies the Ms Caroline Bringesparr will have to be supported in part from other sources than the Seabed 2030 project.

Other activities

Online interactive QC-tool

The SU team has developed a web application aimed to streamline the data processing and gridding workflows. The tool developed by Dr Rezwann Mohammad permits comparison between grid versions and inspection of the underlying source data in web browser. A QC function is included that permits the analyst to highlight issues in the bathymetric grid that need to be addressed, for example outliers or noticeable interference between data sets. The annotated issues are saved in a database and addressed before the next gridding. A major goal with the online tool was to include the RMC members in the QC process of the grid, specifically encourage them to monitor that data from their regions are included properly. The source data ID and can been shown as well as the coverage at the Seabed target resolutions (100 x 100 m, 200 x 200 m, 400 x 400 m, 800 x 800 m). The percentages covered by source data at these targets can also been shown on the fly.



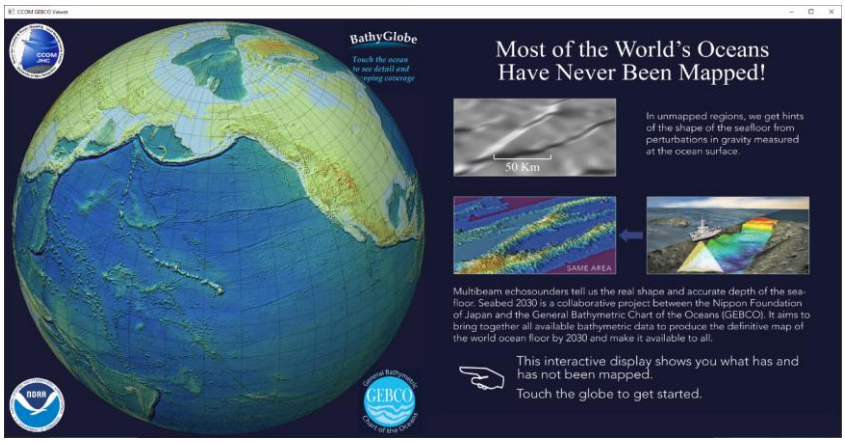
Screen shot from web application showing the source data in the left panel and the bathymetric grid in the right. Several tools exist in this application, all aimed to streamline the gridding-data processing workflow (not to replace online GIS applications showing data coverage).

BathyGlobe

The BathyGlobe is a project (started in 2018) being developed for the display of global bathymetric data. One of its goals is to provide support for the Seabed 2030 initiative to heighten awareness of the extent to which the ocean floor has and has not been mapped. The BathyGlobe can be used with a high resolution (4K) touchscreen in order to show high resolution images of the seafloor with load times that appear instantaneous. The current state of the project is shown in Figure 1. A touch on part of the globe selects that region and causes the globe to rotate so that the indicated region is centered and a higher resolution view of the area appears to the upper right. Selecting within the higher resolution view causes a 3D view of that location to appear in the lower right quadrant.

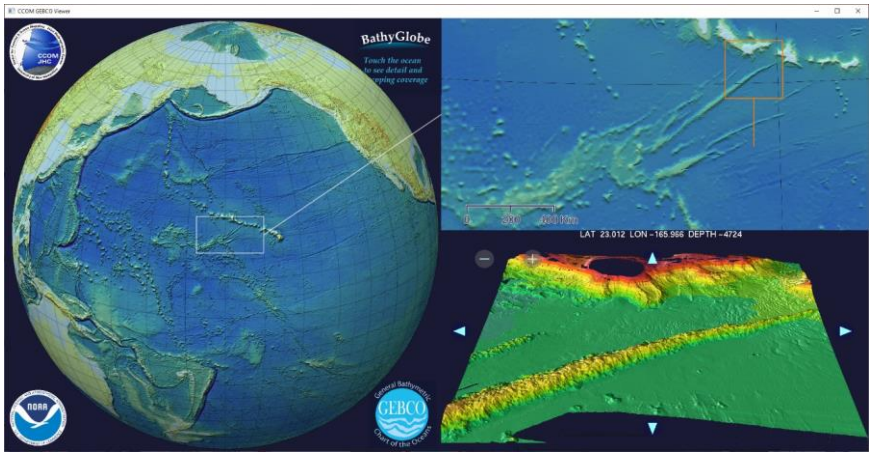
New developments of the first half of 2019 include the incorporation of entire GMRT multibeam database. This was done by writing code to directly access the GMRT files (which are stored in a compressed Mercator form), resample them into geographic coordinates and compress them. The compression method involves multiplying the depths by five and converting to an unsigned 16 bit integer. Lossless png compression is then applied. The result is that the entire database currently uses 3.4 GB with a maximum loss due to compression of 10 cm. An example of the results are shown in Figure 1.

A more substantive development is the Global Geographic Grid System, described below. However, this has not yet been integrated with the BathyGlobe. Once this is done the BathyGlobe will be able to display data at any resolution.



Home page of the "Bathy Globe" – interactive tool for visualizing just how little of the ocean is actually mapped.

Area selected showing GEBCO grid in upper right box and then actual sonar data it is based in in lower box. White lines represent single beam sonar data and yellow and gold areas represent multibeam data sets.



Zoom box showing ability to interactively explore high-resolution multibeam data 3-D sets.

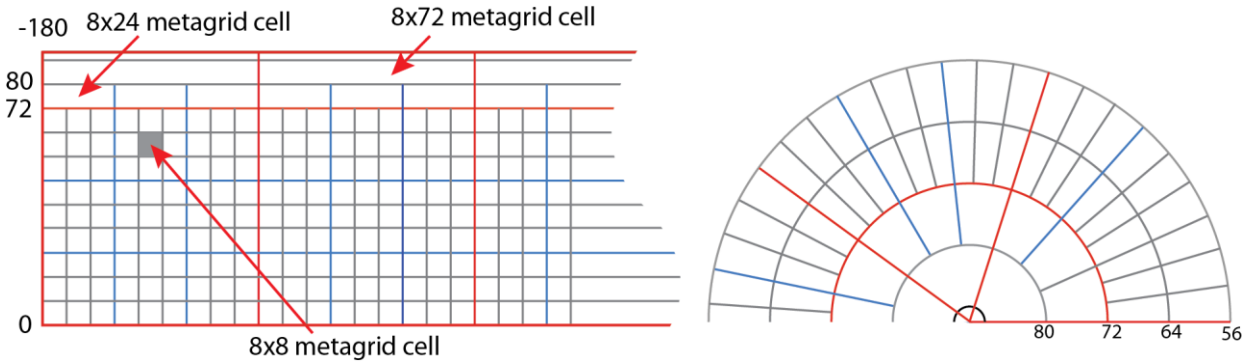
Global Geographic Grid System (GGGS)

The 2018 progress report provided a preliminary description of a Global Geographic Grid System (GGGS) for visualizing bathymetry. This was developed to address the needs of the seabed 2030 project and for other applications where a geographic grid is desirable. A first draft was submitted to the Seabed 2030 Technical Committee in January 2019 and revised version was submitted in April. The system has been discussed at a number technical group meetings. A manuscript for publication has been completed and is being prepared for submission in the journal Computers and Geoscience.

GGGS combines a metagrid hierarchy with a system of compatible data grids. Metagrid nodes define the boundaries of data grids. Data grids are square grids of depth values. Both metagrids and data grids are defined in geographic coordinates to allow broad compatibility with the widest range of geospatial software packages. An important goal of the GGGS is to support the meshing of adjacent tiles with different resolutions so as to create a seamless surface. This is accomplished by ensuring that abutting data grids either match exactly or only differ by powers of two.

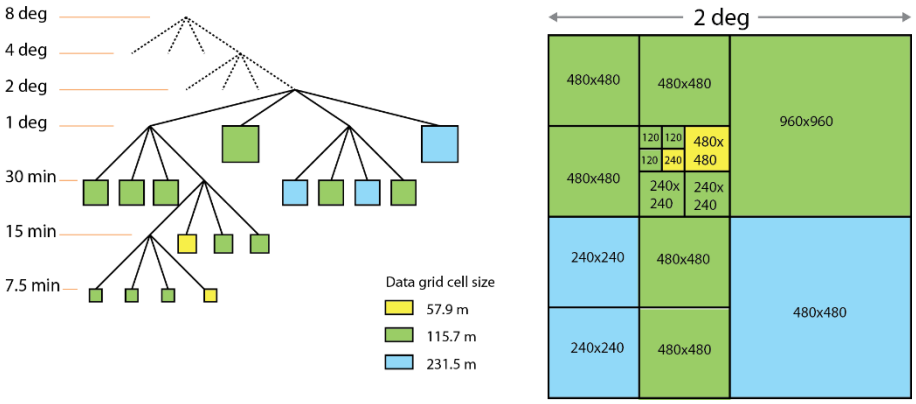
The system supports differently sized data grids in a way that is independent of resolution. It is useful to have large tiles to represent large areas of the sea floor mapped at a constant resolution, but grids that are very large are slow to load and display and therefore difficult to handle in most interactive display systems. Smaller grids are space efficient for areas of the seafloor mapped at different resolutions, but numerous small grid tiles are also not efficient to render in computer graphics since large numbers of tiles must be managed. For this reason GGGS grids are constrained in both minimum and maximum size.

The GGGS also supports the seamless meshing of low-latitude data with polar data sets. Often polar data sets use a different projection than the one used for data at lower latitudes creating difficulties in displaying data that cross the boundary. In the GGGS, Arctic and sub-Arctic and Antarctic and sub-Antarctic data are supported essentially in the same way.



Part of the global metagrid is illustrated above. On the left it is shown in a standard geographic view. On the right is a polar view.

The basic principle of polar grid construction is that the number of grid columns *decreases* by powers of 2 as distances between lines of longitude decrease by a factor of two. The first such boundary is at 60 degrees where lines of latitude have half the spacing that they do at the equator. The next is at (approx.) 75 deg. where lines of longitude half again. The third transition is above 82.5 deg. where data grids have 1/8th of the number of columns per deg. relative to rows.



An example of a quad-tree metagrid hierarchy is shown. To the left in a standard tree diagram. To the right the same structure is shown as a map. Different resolutions are color-coded.

Implementation

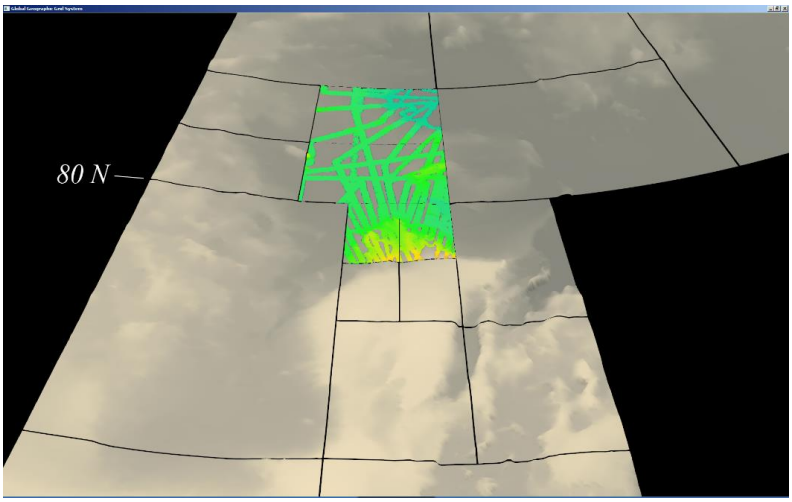
Much of the effort to June 2019 has been devoted to building a proof-of-concept implementation of GGGS using C++ and Open GL. The implementation has three main classes

GGGSroot has the responsibility of implementing the global metagrid shown in Figure 2. As data is loaded it creates a top level *metaGridNode* at the appropriate location and inserts the data. This hands the responsibility of building a quad tree for that 8x8 deg location to an instance of the *metaGridNode* class.

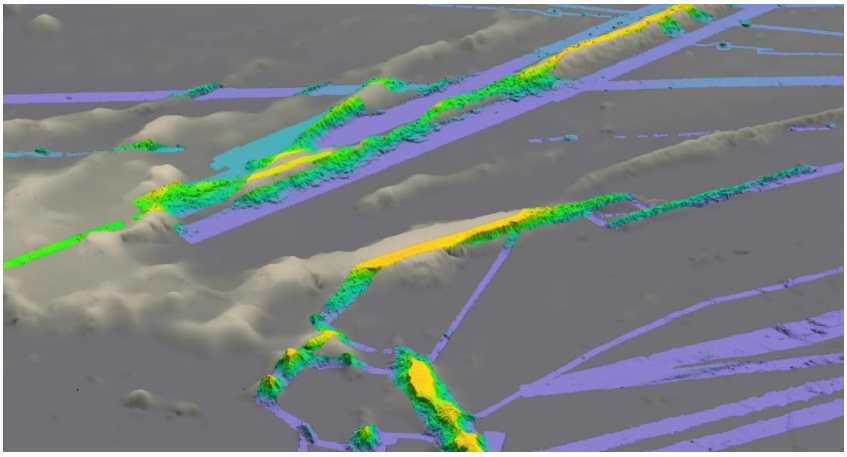
metaGridNode has the responsibility of implementing the quad tree metagrid hierarchy as illustrated in Figure 3. As data nodes are inserted the quad tree structure is built to the appropriate depth depending on the size of a data node. A pushdown function subdivides high level low resolution nodes so that they fill in around high resolution nodes as illustrated in Figure 4. In this example the data tiles are shown without the polygon strips that tie them together so as to reveal the structure.

MetaGridNodes also have the responsibility of building the polygon strips that tie together adjacent tiles, although the rendering is done by the bathyGrid nodes.

bathyGrid implements bathymetric data grids. These are loaded, transformed into an orthographic projection centered on a designated focus point and rendered. This class has an 8 bit attribute layer in addition to the bathymetric grid and the attributes can be shown by means of multiple colormaps (currently up to 8 are supported). An example is shown in Figure 5. A vivid high saturation colormap is used to highlight the areas where multibeam bathymetric data exists. BathyGrid also has the responsibility of constructing surface normals for the data grids and rendering both the data grids and the connecting strips.



An example of a metagrid structure above and below the 80 N contour. The grey areas have been subdivided to fill in around the high resolution data.



Two colormaps applied according to an attribute layer in GGGS

Global Center

Location: British Oceanographic Data Centre, National Oceanography Centre, United Kingdom.

Center Lead: Helen Snaith.

Summary

The primary focus of the Global Center in year 2 has been delivery of the first GEBCO product from the Seabed 2030 Project.

The Global Center successfully integrated the regional Center contributions to the GEBCO 2019 map with the SRTM15+ base grid and additional data held at the Center to create the new product, including definition of the Source Identifier grid and mapping of the data sources onto this grid. Using the new product, we have calculated the percentage mapped for the depth dependent grid.

The products were released in April 2019 and delivered through a new data delivery service that has been integrated into the GEBCO website to allow unrestricted one-click download of the new product. In addition, for the first time, a doi has been generated for the data release for ease of reference.

During the first part of the year, the entire GEBCO and Seabed 2030 website was completely redesigned to provide an enhanced user experience for visitors. All existing site material was reviewed and rewritten to give easy access to key information whilst retaining the depth of archive material on the site.

Significant development has been undertaken to overhaul and replace the existing data service (hosted on the BODC system) with a dedicated GEBCO data service for improved efficiency, which is currently undergoing beta testing.

Center Staff

The Global Center now has a full staff complement after recruitment of a full time application developer in January 2019.

There are currently three staff working on the Seabed 230 Project at the Global Center (Helen Snaith, Pauline Weatherall and Chris Thompson).

Seabed 2030 will fund 1.6 FTE of the staff time in year 2 of operation. Additional contribution of 0.4FTE has been provided from central British Oceanographic Data Centre funds for year 2 of operations.

Major data and grid contributions

Global Center Lead, Helen Snaith, successfully negotiated with David Sandwell of Scripps Institution to include the SRTM15+ global terrain model as the basis for the GEBCO 2019 map, including recalculation of the grid on the cell-registered grid used within GEBCO, representing a very significant improvement in the resultant product over the previously used SRTM30 dataset.

Center staff are now in discussions with the UKHO to provide access to data previously only available for navigation purposes.

Financial report

All staff funds from Year 2 of operation have been spent as allocated, including the small amount of salary funds unspent from Year 1 funds. The activity budget has been fully utilized in Year 2 supporting the Global Center activities. There are no Year 2 funds to roll over.

Other activities

Global Center staff support the primary communications mechanisms for the Seabed 2030 project. As well as maintaining the website content, we provide content to the Seabed2030 and GEBCO Facebook and Twitter accounts, maintain the mailing lists for the project. As the access point to the Seabed 2030 Project and the data products, we provide users support to product users and statistics on data access and usage for GEBCO.

We also maintain the internal project communications tools (wiki and document repositories) as well as arranging and facilitating the monthly project and technical team meetings.

The Global Center Lead was a principle author on a major community white paper for the decadal OceanObs Conference (Seafloor Mapping – The Challenge of a Truly Global Ocean Bathymetry, https://doi.org/10.3389/fmars.2019.00283).

Center staff have represented the Center, and the project, at a number of national and international meetings, including the 1st Arctic, Antarctic and North Pacific Mapping Meeting, Stockholm, Sweden, October 2018 and the International Conference on Marine Data and Information Systems (IMDIS) 2018, Barcelona, October, 2018.

IHO Data Center for Digital Bathymetry

Location: National Oceanic and Atmospheric Administration's National Centers for Environmental Information (NOAA NCEI) in Boulder, Colorado, USA

DCDB Director: Jennifer Jencks

Summary

The IHO Data Center for Digital Bathymetry (DCDB) is the recognized IHO repository for all deep ocean bathymetric data collected by hydrographic, oceanographic and other vessels. Since 1990, NOAA's NCEI (formally NGDC) has hosted the DCDB. In support of the IHO Crowdsourced Bathymetry (CSB) Initiative, the DCDB built and supports a data pipeline that allows for the ingest, discovery and access of CSB data.

Due to the resignation of the DCDB/NCEI bathymetry data manager in March 2019, ingest of new bathymetric data was severely delayed. However, we will be bringing on two bathymetry data managers in 2019: a junior cooperative institute position has been filled and the new hire will begin

September 1, 2019; we are currently reviewing applications for a senior Federal government position and hope to have him/her onboard by the end of 2019.

The main activities of Year 2 include:

- Continuing to work with FarSounder Inc. (press release), Carnival Cruise Line, and James Cook University to set up automated data delivery of crowdsourced bathymetry data to the DCDB.
- Received 20 TB of multibeam bathymetry from the Puerto Rico Trench, collected by Five Deeps Expedition, the first company to reach the deepest points in each of the five oceans.
- Testing and finalizing of CruisePack, a stand-alone packager for cruise-based data that creates consistent BagIt format data packages complete with md5 checksum manifest files and generates cruise-level and series level metadata files.
- Establishing a process for the delivery of bathymetric soundings from ENCs to the DCDB.
- Implemented numerous enhancements to the IHO DCDB Data Viewer:
    - Re-organized layers in the left panel. The layers are now grouped together by IHO member state, as well as a category for general "Bathymetric Coverage Maps".
    - New basemaps for the GEBCO_2019 grid (visualizations produced by NCEI): color and grayscale versions are available, in addition to bathymetric contours derived from GEBCO_2019.
    - GEBCO_2019 color-coded source identifier grid added. Clicking on the map provides the description for each cell
    - GEBCO Gazetteer of Undersea Feature Names layer added (geometries/map labels)

Data submission

The DCDB has archived over 4 TB of new multibeam bathymetry data since August 2018.

This includes:

- 100 surveys from 10 vessels contributed by UNOLS Rolling Deck to Repository
- 35 surveys from 3 vessels contributed by the CSU Monterey Bay Seafloor Mapping Lab
- 28 surveys from 4 vessels contributed by the National Oceanic and Atmospheric Administration fleet
- 7 surveys from 4 vessels contributed by Fugro
- 2 surveys from 2 vessels contributed by the University of Southern Florida
- 1 survey contributed by LDEO's Marine Geoscience Data System

Other activities

- The IHO Crowdsourced Bathymetry Guidance Document was officially adopted by Member States of the IHO. IHO Circular Letter 28/2019 states that thirty-five of thirty-eight Member States supported the adoption.

- As discussed at GGC-35, have begun the effort to draft the new IHO Circular Letter (to update the CL 23/1990) with regard to increasing roles and importance of the IHO DCDB in relation to the increasing ocean mapping, CSB and SB2030 activities. This letter will serve as a reminder to IHO Member States and stakeholders to provide their bathymetric data to the DCDB.
- Represented the IHO DCDB on a Seabed 2030 Panel at the Oceanology International Americas meeting (Feb 26)
- Gina Brewer, IHO DCDB data manager, attended the South Pacific RMC meeting in March 2019 and presented on the role of the DCDB, current activities, and tools the DCDB could provide to data collectors.
- Jennifer Jencks remotely attended and presented on the DCDB at the Atlantic/Indian Ocean RMC (Oct 30-31). NCEI hosted the second Atlantic/Indian RMC meeting, which crossed over with the meeting of the AORA Atlantic Seabed Mapping International Working Group (ASMIWG) (Apr 15-18).
- Hosted IHO Sec General Mathias Jonas (Mar 14) and Canadian Hydrographic Service Director General Geneviève Béchard (Mar 20).
- Currently working with the US Geological Survey to archive large volumes of high resolution bathymetry data off Florida. Established contact with USGS and Atlantic RMC to have grids contributed to Seabed 2030.
- Supporting US Bathymetry Data Gap Analysis and Meso-American and Caribbean Sea Hydrographic Commission Bathymetry Data Gap Analysis
- Drafted and signed data submission agreements with Fugro and FarSounder Inc.

Project Update by work stream

Work Package description

Work Package	Description
WP1	Data: Sourcing and publishing the data
WP2	Systems and tools: Building the technical systems to manage and deliver the grid
WP3	Technology Innovation
WP4	Mapping the Gaps
WP5	Management
WP5.1	• Operational Management
WP5.2	• Strategic direction
WP5.3	• Communication and Outreach
WP5.4	• Capacity Development

Change to work plan due to reduced capacity

The version 1 Year 2 Work Plan was developed on the assumption of the project working with a full time Director. After the resignation of the Director in early Year 2, the work plan was reviewed to assess the impact of operating without a full time Director. At the annual GEBCO Guiding Committee Meeting (GGC-35) in November, the tasks were prioritized to indicate which ones the Project Team should focus on producing a version 2 of the work plan. The low priority tasks would be progressed if resources were available through Year 2. A full list of Version 1 and Version 2 project tasks are presented in Appendix 7 – Seabed 2030 Year 2 Work Plan All deliverables. In the section below, only tasks that were progressed are discussed.

WP1: Data

Task 1.1. Identify data not yet known to Seabed 2030

D1.1.1 - Discovered data metrics:

- Vol of data and sources not yet submitted
- Estimate of equivalent % coverage of multi-resolution Grid

The first step towards delivery of the discovered data metrics is understanding the metadata needed from contributors, or potential contributors, necessary to determine coverage.

At the technical fact-to-face meeting in June 2019, a proposed metadata structure was determined (see Year 2 D2.2.1) which captures essential coverage information.

The methodology for determining coverage using shapefile information has been tested using metadata for the Atlantic and Indian Ocean areas, demonstrating the feasibility of this methodology once the metadata schema has been implemented.

Once implemented, metadata will be collected on data sources (ingested, submitted but not yet ingested and known but not submitted) using a combination of: known data at regional centres; known data at publicly accessible data centres with metadata portals and direct metadata contributions using a custom web upload facility (to be developed in year 3).

Task 1.2 Submission of data to Seabed 2030

D1.2.1 - 2019 Data submission metrics

Additional contributions to the GEBCO product amount to an increased coverage of more than 10% at the target resolution for the project.

The statistics on additional holdings at the regional centers not yet incorporated into the products and of data held by other data centres, including DCDB and partner organisations such as EMODNET, is pending finalisation of the metadata required to make these calculations.

The contributors to the 2019 product are highlighted on the data contributions website, and partners providing new contributions are highlighted on the Seabed2030 Partners webpages.

A list of contributors to data in GEBCO 2019 is in Appendix 4.

Task 1.3 Publish Data Products

D1.3.1 - Publish GEBCO Grid 2019 at 15-arc second

The GEBCO_2019 Product was released on 4th April 2019, together with the SID grid and all associated documentation.

The regional grids were provided to the Global Center as either fully populated grids (for polar regions) or sparse grids for the lower latitudes, together with the SID values. The resultant grids were merged into the SRTM15+ v1 & DMTED2010 base grids at the global center, together with a small number of ENC data holding not yet provided to regional centers, to produce the global GEBCO products. These products were provided to the project team for checking and improvements were made to some areas before the final versions were created.

NetCDF CF-compliant files, including full global attributes, were generated for both the bathymetry and SID grids and documentation was produced, including data contributors, data sharing agreements and grid descriptions.

The data were published with a citable data doi:10.5285/836f016a-33be-6ddc-e053-6c86abc0788e

D1.3.2 - Publish IBCAO 2019

The status by Aug 1, 2019, is that after 17 compiled versions of the IBCAO grid since the work begun during the fall 2018, a review has been completed by the Arctic Regional Mapping Committee (RMC). Of 224 marked-up issues using the online web quality control tool, 88 remains to be fixed by the Regional Center compilation team. This will be done in August and September in order to have IBCAO Ver. 4.0 completed for public release by Oct 15, 2019. An article highlighting the release of IBCAO Ver. 4.0 as well as comparing it to previous version is currently being drafted. The plan is to submit this paper to Geophysical Research Letters in October.

D1.3.3 - Publish IBCSO V2 2019

The International Bathymetric Chart of the Southern Ocean (IBCSO) is a regional compilation of the Sub-Committee of Regional Undersea Mapping (SCRUM) of the General bathymetric Chart of the Ocean (GEBCO). Therefore, it provides data to the GEBCO grid for the area south of 60°S. The extension of IBCSO coincides with the area of responsibility of the RDACC Southern Ocean.

In 2013, Arndt et al. (2013) published IBCSO v1. Since then, a considerable amount of new bathymetric data has become available for the Southern Ocean justifying IBCSO v2. This new version covers the areas south of 50° south, thus, almost doubling the area of seafloor.

Status

The gathering of bathymetric data from data holders for the next version is almost completed. However, late contributions to the IBCSO v2 bathymetric database can still be considered. In parallel and ongoing, existing and new data sets are homogenised and initially cleaned for ingestion in the IBCSO v2 grid. During year two, the production workflows for the IBCSO digital bathymetric model and the accompanying source identifier (SID) grid were streamlined for faster computation. In addition, a MySQL database for metadata was developed for improved metadata handling in-house and inter-RDACC exchange.

Next steps

The major upcoming task is the area-based cleaning of the data base as the quality of the incorporated data is highly variable. Special emphasis is on systematic depth offsets between different datasets. This is an iterative process that has to be repeated until the grid passes our quality criteria. Towards the end of 2019, the finalised products are expected to be created. Scientific publication of IBCSO v2 in a peer-reviewed journal is envisioned as soon as products are available. The slight delay with regards to the year two work plan has been caused by the large amount of newly integrated data and the development of new optimised workflows. However, these new workflows are expected to speed up future grid productions thus compensating for this delay.

Arndt J.E., H.-W. Schenke, M. Jakobsson, F.O. Nitsche, G. Buys, B. Goleby, M. Rebesco, F. Bohoyo, J. Hong, J. Black, R. Greku, G. Udintsev, F. Barrios, W. Reynoso-Peralta, M. Taisei, R. Wigley, 2013. The International Bathymetric Chart of the Southern Ocean (IBCSO) Version 1.0—A new bathymetric compilation covering circum-Antarctic waters. Geophysical Research Letters 40, 1-7. https://doi.org/10.1002/grl.50413

Task 1.4 Identify data gaps

D1.4.1 – 2019 Grid Metrics

Calculations for the Arctic and Antarctic were carried out by Stockholm and AWI for inclusion in global statistics (because of projection corrections)

All other calculations were carried out at the global center using a block-median methodology (consistent with the baseline statistics used for the 2014 grid) from the source data.

Additional 'observational' data are incorporated into the SRTM15+ base grid used for GEBCO_2019 and coverage for these data was approximated using the SID grid associated with the SRTM15+ grid.

An initial visualisation has been provided by CCOM online to test possible options for display of the data coverage.

Crowd sourced metrics will depend critically on outcomes of Year 2 D4.2.1 in terms of definition of 'Crowd Sourced' for Seabed2030

WP2: System and tools

Task 2.1 Define standards for submissions to Seabed 2030

Technical Team has come to consensus and metadata requirements are under review by TSCOM and IHO DCDB Director

Task 2.2. Design the next-generation product

The 2018 progress report provided a preliminary description of a Global Geographic Grid System (GGGS) for visualizing bathymetry. This was developed to address the needs of the Seabed 2030 Project and for other applications where a geographic grid is desirable. A first draft was submitted to the Seabed 2030 Technical Committee in January 2019 and revised version was submitted in April. The system has been discussed at a number technical group meetings. A manuscript for publication has been completed and is being prepared for submission in the journal Computers and Geoscience.

BathyGlobe is a project (started in 2018) being developed for the display of global bathymetric data. One of its goals is to provide support for the Seabed 2030 initiative to heighten awareness of the extent to which the ocean floor has and has not been mapped. New BathyGlobe developments of the

first half of 2019 include the incorporation of entire GMRT multibeam data base. This was done by writing code to directly access the GMRT files (which are stored in a compressed Mercator form), resample them into geographic coordinates and compress them. The GGGS system described above has not yet been integrated with BathyGlobe, but once it has, BathyGlobe will be able to display data at any resolution.

Task 2.3 Enhance data access and visualization tools

- Publish Seabed 2030 website updates
- Update GEBCO data portal website
- Users can download 15-arc second Grid

During Year 2 a complete redesign of the GEBCO and Seabed2030 websites has been carried out at the global center. The new design provides a modern, clean interface to information on the projects as well as enabling easy access to the data download options.

The data download section has undergone a complete reworking, with users now able to download the complete global products using a 'one-click download' option from the data download page without registration.

The data can also be downloaded using the BODC data sub-selection tool, in a number of formats, with user registration. This system is to be replaced by the GEBCO data download tool, developed by the Global Centre during year2. The data download tool is in final beta testing (https://download.gebco.net/dda-beta) and provides a more responsive sub-setting tool, with no registration required.

A web map service for delivery of the 2019 products, as shaded relief, flat topography and source identifier, is also in beta testing and should be releases by mid-August.

Task 2.4 Establish data flow policies

D2.4.1 – Publish a Data Flow Process

A document detailing the process of data flow and data sharing has been produced at the South and West Pacific Regional Center. It is intended for distribution to all data contributors to Seabed 2030. It is due for feedback and comments by the Project Team for sign-off.

The main purpose of the document is to provide consistency and common messaging on the data flow process, from data acquisition to full publication into the annual release of the GEBCO Ocean Map. Presently the Regional Centers, Global Center and NOAA NCEI have somewhat different approaches and protocols to receiving and managing data, which has proven confusing for data providers and carries an element of risk for potential providers to misunderstand our procedure and purpose.

Data flow is described in the following steps in the Seabed 2030 procedures:

- **Data assembly:** contributors to Regional Centers (and Global Center, IHO DCDB)

- **Data integration and storage:** data management within the Regional Centers, archiving, as well as the computation of area mapped (Appendix 2)
- **Data delivery**: from Regional Centers to Global Center.

However, details of the data flow process should also be considered for any contributor of data to Seabed 2030, and for each source type format: singlebeam, ENC, Multibeam. This was discussed in detail at the June 2019 Technical Face to Face Meeting.

The preferred data flow for contributors is:

- To deliver raw data to the IHO-DCDB, including single-beam, ENC and multi-beam.
- To deliver processed/gridded datasets, such as XYZ ASCII files in WGS 84 projection, to Regional Centers. Processed grids can also be submitted as bag, netCDF, tiff, xyz, sd, grd, asc, etc. However, this should be discussed with Regional Centres prior to data submission, as specific hydrographic software may not be available at each Center.
- Alternatively, contributors can provide ship track-lines or shape-files showing data coverage for data that could potentially be shared with Seabed 2030 in the future. This will assist in identifying the gaps ('Z'). An **Online form** has also been developed by SCRUM to assist in this endeavour, which Regional Centers should encourage potential contributors to use.
- Data can be submitted at the following resolutions:
    - 30-arc second version of the GEBCO Ocean Map - started as GEBCO 2014
    - 15-arc second version of the GEBCO Ocean Map – started as GEBCO 2019
    - Multi-resolution (or depth-banded resolution, see the Table below) version of the GEBCO Ocean Map. Note that this will not be implemented in the 2019 and 2020 GEBCO releases.
- The required metadata for contributions was determined at the June 2019 Technical Face to Face meeting, and sent to TSCOM and the Metadata Working Group for comments. A centralised database will be built at the Global Center based on these metadata fields, with interfaces to allow Regional Center interaction. This will act as the Global Data Inventory. A joint portal is also planned at the Global Center.
- The contributor of each data source will be referenced in the corresponding field of the proposed metadata database at the Global Center. For each release of the GEBCO Ocean Map, the list of data contributors will accompany the grid.
- A Data Sharing Agreement template has also been produced, providing the basics of data usage. This can be amended for specific use cases as appropriate by data contributors.

Other initiatives to consider:

- Crowd-sourced bathymetry: Data assembly process should be discussed at Regional Centers.
- Kongsberg Crowd Solution (KCS): Aims to facilitate the contribution of raw data to IHO-DCDB, submission of processed (hopefully gridded) data to SB2030. This should be pursued by NCEI (Jennifer Jenks) and Kongsberg, and fully integrated into the Data Flow document.
- One option to use Kognify has been suggested but not discussed properly yet.

WP3: Technology Innovation

Task 3.1. Establish a Technology Innovation Strategy

Early in Year 2, the Project Team held several discussions on how best to progress this work stream. They concluded that the best approach was to establish a Technology Innovation Strategy for the project. How best to leverage and expedite technology innovation into seabed mapping is a globally distributed and complex activity and a planned and coordinated approach was required. Reviewing how to develop such a Strategy it was concluded that an existing organization that had great depth, expertise and ongoing activity in seabed mapping technology innovation would be most effective at leading this Work Package and developing the technology innovation strategy. After a comprehensive global review of potential collaborating organizations the Project Team identified Japan Agency for Marine-Earth Science and Technology (JAMSTEC) as a most suitable partner.

Several meetings have been held with senior members of JAMSTEC at JAMSTEC offices and regional mapping meetings to explore how JAMSTEC can contribute to leading this Seabed 2020 Work Package. Planning on JAMSTEC involvement continues with the Vision to Action Event the next planned meeting.

Task 3.2 Continued use of SEA-KIT

Throughout Year 2, Seabed 2030 continued to work with Sea-Kit Limited (the owners of Sea-Kit) on the Unmanned Trans-Atlantic Survey (UTAS): a cross Atlantic expedition to demonstrate the viability of using unmanned surface vessels for long-range ocean basin mapping. Planning continues for the expedition sometime in Year 3.

Task 3.3 Collaborate with industry

This task was impacted by the absence of a full time Director. Discussions were held with the XPRIZE exploring how to engage the 8 Shell Discovery XPrize finalists with Seabed 2030 and leverage the technology innovation that the XPRIZE had stimulated. To support this work a Memorandum of Understanding (MOU) was signed between XPRIZE and Seabed 2030 to support future collaboration and exploring how XPRIZE technology can be utilized in Seabed 2030.

WP4: Map the Gaps

Martin Jakobsson and Larry Mayer identified a very effective strategy of increasing the ocean mapping potential of planned and funded expeditions. This concept originally called ‘Mapping the Remote Gaps’, but renamed ‘Extending the Mapping of Ocean Frontiers’ was discussed and developed through Year 2. Towards the end of Year 2 the concept and how to implement was agreed. A trial expedition was included in Year 3 activities as a proof of concept of the idea.

Task 4.1 Design a Funding Strategy

An ad-hoc Seabed 2030 Fundraising Working Group was established at the GGC35 in Canberra, Australia on 15-16 November, 2018. The primary purpose of the working group was to advance ideas around fundraising and develop a Fundraising Strategic Plan for The Nippon Foundation-GEBCO Seabed 2030 project in the absence of a dedicated, full-time Project Director.

The working group was originally comprised of the following members:

- Shin Tani (Japan) – GGC Chair
- Martin Jakobsson (Sweden) – GGC Deputy Chair
- David Millar (USA) – GGC Member
- David Heydon (Australia)
- Shereen Sharma (Australia)
- Brian Busey (USA)
- Lindsay Gee (USA)
- Tim Kearns (USA)
- David Heydon has since resigned from the working group.

An outline for The Fundraising Strategic Plan has been developed and approved by the working group, though the Plan itself has yet to be completed. It will be developed and completed collectively by Working Group members by the GGC36 Meeting in Portsmouth.

One area of significant concern raised during development of The Fundraising Strategic Plan was the absence of a strong value proposition for producing a higher resolution map of the world's oceans and thus for Seabed 2030. It was this issue that ultimately led to David Heydon's resignation. In light of this concern, David Millar has solicited and obtained additional material from the United States Government (NOAA) and the Republic of Ireland's Government (The Marine Institute) to help in the development of a strong value proposition. The initial planning and numerous town hall meetings for the United Nations Decade of Ocean Science for Sustainable Development have also aided in the provision of information to support the value proposition. This material will be shared with the working group members in advance of the next working group meeting.

In terms of next steps, the working group will meet (via Skype or similar) in August to review the value proposition material mentioned above and allocate writing assignments for completion of The Fundraising Strategic Plan. The plan is to share the writing assignments and have an initial draft of The Fundraising Strategic Plan ready to present to the full GGC at the GGC36 meetings in November.

Task 4.2 Design a Crowd Sourcing Strategy

As discussed at GGC35, Seabed 2030 is looking to complement, not duplicate, any existing CSB initiatives. Seabed 2030 participated in CSB Working Group 7 and the inaugural IHO CSB Industry Day. Kevin Mackay (South & West Pacific RDACC) has joined the CSBWG and will continue to participate and represent Seabed 2030 in the future. This direct engagement between the projects should ensure there is visibility on the work being undertaken, coordination of effort and harmonization of action;

however this will only achieve the intended goals if robust internal communication with all relevant stakeholders is maintained and encouraged. Outreach is the key component for advancing the CSB initiative. Now that a CSB guidance document has been approved and published, and a CSB data ingest and extract pipeline is in place, we must focus on encouraging the community to collect, contribute and see the value of CSB data. Though the CSBWG has many outreach ideas, it is Seabed 2030 that will have the resources and capacity to implement them. The CSBWG will be looking to Seabed 2030 for outreach and communications assistance in developing sector targeted messages to encourage participation and increase contributions. The CSBWG and Seabed 2030 will need to work together to ensure that the communication is harmonized and that there is no duplication of outreach efforts. Representatives from both projects will need to maintain dialogue and inform one another of contacts made and intended next steps. This approach was amply demonstrated with the coordinated email exchanges and discussions between Seabed 2030 (V. Ferrini), CSBWG (E. Flier) and PGSas the MoU between the IHO and PGS was developed.

The main activities of Year 2 included:

1. The Canadian Hydrographic Service hosted the first IHO CSB Industry Day in Quebec City, Canada (Feb 12-13). The purpose of the workshop was to create stakeholder partnerships for mobilizing action towards the collection and sharing of CSB data. The IHO CSB Working Group then met (Feb 13-14) to discuss lessons learned from Industry Day and steps for moving forward with their task to develop outreach and recognition strategies for the IHO CSB initiative.

- Vicki Ferrini provided an overview of Seabed 2030
- Kevin Mackay (South & West Pacific RDACC) has joined the CSBWG
- An Industry Workshop report was shared with Seabed 2030 leadership

2. In February, the IHO issued a circular letter (Call for Approval of Edition 2.0.0 of IHO Publication B-12 Crowdsourced Bathymetry Guidance Document) requesting Member States to (1) take into account the endorsement of the IRCC and the IHO Council and consider approving the Edition 2.0.0 of B-12and (2) indicate whether they support the activity within their waters of national jurisdiction, including any caveats they wish to apply. 35 Member States approved the adoption of B-12 out of 38 replies. Awaiting consolidation of replies on second part of CL.

3. Several CSB Working Group members co-authored: “Citizen-Science for the Future: Advisory Case Studies from Around the Globe” in Frontiers in Marine Science.

4. Focused outreach strategies on the Geophysical, Research Vessel, Cruise Liner, Submarine Cable, and Recreational Leisure sectors. Identified leading organizations and companies within each sector to be identified and approached to act as CSB ambassadors.

- Cruise Liner: Carnival Cruise Line and MacGregor: The Macgregor Maritime Data Engine (MDE) is a data normaliser that collects, standardizes and stores data from a ship’s Voyage Data Recorder (VDR); currently working to implement a single interface between MDE and the DCDB that can connect the Carnival fleet
- Geophysical (Marine Survey): Fugro

- Geophysical (Seismic Survey): PGS: MoU signed by PGS; CEO test data being evaluated by Norway
- Research Vessel: Antarctic Treaty Consultative Meeting: Working Paper drafted by Norway, assisted/co-sponsored by Italy, New Zealand and USA - presents a stronger resolution for countries to commit their research vessels to contribute to bathymetric data collection.

WP5 Management

WP5.1 Operational Management

Strategic Advisory Group

The purpose of the Strategic Advisory Group is to provide the Director and the Project Team with independent, strategic advice. While the original Director had been in informal discussions with a small number of potential group members, the Strategic Advisory Group was never formally convened or functioning. On resignation of the Director, the acting Director decided to pause the creation of the Strategic Advisory Group, due to capacity issues. The purpose and participants of the group will be reviewed once the new Director is known, giving the opportunity to configure the group to best support the new Director.

Technical Review Panel

The purpose of the Technical Review Panel is to provide the GGC with independent assurance that the project is successfully delivering the annual work plan and is on course to meet the Seabed 2030 vision. Timing of the GGC, timing of the Seabed 2030 annual cycle and the resignation of the Director have meant it has not yet been possible to convene the Technical Review Panel. It is expected that once the new Director is in post, the Technical Review Panel will be established and contribute to the project governance.

Task 5.1.1 Strengthen internal communications

As Seabed 2030 operates in a very distributed manner (the project team and IHO-DCDB are located at 8 locations around the world), the ability to share information online is vital to the project. Seabed 2030 uses an online collaboration tool, Confluence wiki, to share information amongst the team and with the wider project when required. This tool has proved very effective and internal communication of information and documents is seamless. Reporting on task status is via the wiki, allowing all team members to keep abreast of project progress. The coordination of attendance at meetings and presentation material is also managed via the wiki, creating a transparent catalogue of community engagement and presentation material.

The Project Team held regular (approximately fortnightly) online skype project meetings. Frequent online technical meetings were also held for in-depth discussion when technical decisions were

required. The team trialled a dual-site in-person technical meeting when a serious of particularly complex technical discussions and decisions were required. Project Team members attended the meeting either at the Global Center in Southampton, UK or the Regional Center at LDEO, which ever was the most convenient location. The 2 day meeting was a mixture of virtual plenary sessions between the 2 locations and individual in-person discussions at each location. This format was very effective and will be considered for future technical meetings when participation of the extended technical team is required but as an alternative to all meeting in one location.

Task 5.1.2 Consult extensively and formalize efficient administrative work flows

The acting Director worked closely with the IHO Secretariat to agree appropriate administrative work flows on financial approvals and processing. The work flows are documented in the Seabed 2030 Operating Procedures document. These processes meet IHO Secretariat and The Nippon Foundation audit requirements as well as being efficient.

Task 5.1.3 Create legal and admin framework to raise funds

No progress. It was decided to pause this work until completion of Task 4.1 Design a Funding Strategy and the Project Team could assess how the Funding Strategy would be implemented and hence what legal and administrative framework was required.

Task 5.1.4 Engage with GEBCO community

The GEBCO community was engaged extensively in Year 2: during the GEBCO Guiding Committee Meeting (GG35) and throughout the year. A diary of engagement with GEBCO community is maintained in the project wiki. Several activities were undertaken over the year including participation in a virtual TSCOM/SCRUM meeting and regional engagement with Alumni of the Nippon Foundation / GEBCO Training Program.

Details of meetings are contained in Appendix 1 - Seabed 2030 Year 2 Presentations.

Task 5.1.5 Operational Project management

Finance management

Financial management of the project was the responsibility of the acting Seabed 2030 Director, with close coordination with IHO Secretariat Finance Manager, Ghislaine Fauchois. The end of year finance report will be published later as Appendix 5 – Year 2 Financial Report.

Deliverables management

The Seabed Project Team use the online collaboration wiki to manage project activities. Each deliverable has an online report which allow deliverable leads to report on progress and status and other project team members to have any-time access to deliverable status reports.

Task 5.1.6 Project Management Reporting

Reporting to The Sponsors

There was 3 Sponsor meetings in Year 2:

- 27th Sep 2018, IHO Sec, Monaco.
  Participants: Mr Unno (The Nippon Foundation), Mathias Jonas (IHO); David Wyatt (IHO); Mustafa Iptes (IHO); Vladimir Ryabinin (IOC); Julian Barbiere (IOC); Maso Hasebe (The Nippon Foundation) Martin Jakobsson (Seabed 2030); Graham Allen (Seabed 2030)
  Main topic: Directors replacement.
- 5th Feb 2019, IOC, Paris, France
  Participants: Mr Unno (The Nippon Foundation), Mathias Jonas (IHO); Mustafa Iptes (IHO); David Wyatt (IHO); Vladimir Ryabinin (IOC); Tetsushi Komatsu (IOC), Rejane Hervé (IOC); Thorkild Aarup (IOC); Maso Hasebe (The Nippon Foundation); Martin Jakobsson (Seabed 2030); Graham Allen (Seabed 2030).
  Main topics: General project status update; Directors replacement and Vision to Action event at The Royal Society in October 2019.
- 31st May 2019, IHO Sec, Monaco
  Participants: Mr Unno (The Nippon Foundation), Mathias Jonas (IHO); David Wyatt (IHO); Vladimir Ryabinin (IOC); Maso Hasebe (The Nippon Foundation); Martin Jakobsson (Seabed 2030); Robin Falconer (Seabed 2030); Graham Allen (Seabed 2030).
  Main topics: Directors replacement and Vision to Action event at The Royal Society in October 2019

Reporting to The Nippon Foundation

There were many meetings with The Nippon Foundation through Year 2. Seabed 2030 representatives were Martin Jakobsson; Robin Falconer; Graham Allen. Meetings included: by skype, by phone and when possible in person, e.g. when a Seabed 2030 representative was in Tokyo or Mr Unno in UK. Verbal updates on Seabed 2030 progress were provided at each meeting aswell as in depth discussions of important activities, e.g. Directors recruitment and the Vision to Action event. Formal reporting was in the form of the Year 2 Annual Report.

Reporting to GGC

As agreed at GEBCO Guiding Committee (GGC) Meeting 35 in November 2018, the Seabed 2030 Director provided 2 email updates on project progress during Year 2 and the Year 2 Annual Report.

1) GEBCO Guiding Committee (GGC35) Meeting in November 2018, Canberra, Australia.
2) GGC Year 2 Project Update by email on 24-Mar-19
3) GGC Year 2 Project Update by email on 25-May-19
4) Seabed 2030 Annual Report

Task 5.1.7 Secure Year 3 Funding and Work Plan

The Nippon Foundation Board approved the Year 3 proposal and budget at the Nippon Foundation Board Meeting of 30th July 2019.

The proposal presented to The Nippon Foundation is attached in Appendix 6 - Seabed 2030 Year 3 Proposal to The Nippon Foundation. Appendix 6 contains the Year 3 budget.

The full Year 3 proposal consists of:

- Appendix 6 - Seabed 2030 Year 3 Proposal to The Nippon Foundation
- Appendix 6.2 The Nippon Foundation-GEBCO Extending The Mapping of Ocean Frontiers V1.1
  This initiative was originally referred to as 'Mapping the Remote Gaps' but during the late stages of the Year 3 proposal preparation and in consultation with the Nippon Foundation the initiative was renamed to *Extending The Mapping of Ocean Frontiers*. This is an initiative to augment planned and funded cruises with additional mapping capability/capacity to maximize the bathymetric data return. The initiative is targeted at expeditions to remote, rarely-visited parts of the ocean. Each year Seabed 2030 will solicit proposals from the mapping community to fund under this initiative.
- Appendix 6.3 – Proposal to fund Ryder Expedition V1.0
  This is the proposal to fund the first expedition under the Extending the Mapping of Ocean Frontiers initiative.
  Note: In support of the Nippon Foundation Board considering the Year 3 Seabed 2030 proposal, Mr Unno (Executive Director of the Nippon Foundation) presented to the Board an overview of the Extending the Mapping of Ocean Frontiers initiative. This presentation is not included in the Seabed 2030 Year 2 Annual Report.

As agreed at GGC35 in November 2018, the GGC were provided the opportunity to provide their input to the Year 3 proposal during the preparation phase and before submission to The Nippon Foundation. A draft of the Year 3 proposal was circulated to the GGC on 25th May and GGC feedback and suggestions were incorporated into the final version of the proposal.

WP5.2 Strategy

Task 5.2.1 Greater engagement with GEBCO users

Many of the active members of the GEBCO community and the Seabed 2030 project are ocean mappers and hence creators of GEBCO products. This task is to increase the engagement of users of the GEBCO Products. A detailed map of the ocean floor is an enabler across a diverse range of other activities in the ocean. The advent of the UN Decade of Ocean Science for Sustainable Development has proven very timely to help add to the momentum of Seabed 2030 but also act as a forum for engaging with the global marine science community or more pertinently users of the GEBCO

products. Various members of the Project Team and GGC have been engaging with the UN Decade planning process to build closer relationships with GEBCO users. This approach is proving very effective with recognition of Seabed 2030 and GEBCO at an all time high amongst the IOC community. Graham Allen (as acting Director) and David Millar (GGC member) were invited presenters at the 1st Global Planning Meeting for the UN Decade in Copenhagen. Seabed 2030 also presented a Seabed 2030 side event at the IOC Assembly, Paris, July 2019.

Graham Allen also pursued greater direct user engagement by meetings with key user communities including: the IOC Tsunami programme and the UK numerical modelling/ocean forecasting community.

WP5.3 Comms and outreach

RaittOrr have continued to provide media and communication support through Year 2. RaittOrr have worked tirelessly to identify and cultivate effective media opportunities and create high quality media content for Seabed 2030.

Task 5.3.4 Publish project content

Appendix 3 - Seabed 2030 Media Coverage in Year 2. Media interest in the project remains very strong: over 200 publications on the project in Year 2. Major media outlets, e.g. BBC, Reuters Online and Japan Today closely follow the project and continue to provide effective and very supportive coverage of the project. Republishing of content is providing a major global platform for Seabed 2030. There are many instances of cross-references with other seabed mapping initiatives such as the UN Decade of the Ocean Science and the Five Deeps Expedition, magnifying the exposure for Seabed 2030. Partnering with other initiatives, e.g. Five Deeps Expedition is proving a very effective strategy for publishing the project and for extending the Seabed 2030 partners. Further such joint-media events should continue to the sought by the project through Year 3.

Task 5.3.6 Promote Seabed 2030 at events

Year 2 was extremely busy raising the profile of Seabed 2030 and soliciting data contributions. Averaging just over 1 per week, the wider project team represented Seabed 2030 at 61 events in 30 different countries, presenting talks, posters and information on Seabed 2030.

See Appendix 1 - Seabed 2030 Year 2 Presentations for the catalogue of presentations and events attended.

Task 5.3.8 Stakeholder Management

The number of organizations supporting and contributing to Seabed 2030 continues to rapidly expand. The list of Seabed 2030 Supports is presented in Appendix 2 - Seabed 2030 Supporters. In Year 2 we have increased the number of supporters from 42 to 106.

These gains are impressive given the absence of a full time Director. The project was not able to invest as much as originally planned time for travel and cultivating relationships with individual organizations. Instead Seabed 2030 has taken a very targeted approach and pursued relationships which would act as gateways into key communities. For example, Seabed 2030 has partnered with World Ocean Council (WOC) to co-present at events targeted at engaging with sectors of the maritime industry that wish to contribute crowd sourced data to Seabed 2030. Members of WOC have already expressed commitment to Corporate Ocean Responsibility and hence are expected to be very supportive of contributing bathymetric data to Seabed 2030.

At time of writing, Seabed 2030 has 4 formal MoUs with partner organizations and is working on a further 4 MoUs.

Task 5.3.9 Publish new content to Seabed 2030 website

Following the Website revamp in November 2018, the Seabed 2030 website has undergone regular revision by the global center team, following any agreed updates from the acting project director and project team. All relevant messaging for press releases etc have been published on the website.

Additional presentation material is consistently updated and made available through the project's collaboration tools (internal project wiki and document sharing sites) to ensure consistent messaging through all presentations.

Task 5.3.10 Publish map of key data contributors

The initial GEBCO Product release has a static table of data contributors available at https://www.gebco.net/about_us/acknowledgements/our_data_contributors/ which includes links to the data sources, where available, with their graphical representation.

As part of the larger development of metadata capture, the information currently displayed here will be expanded to include shape files of the contributions. A viewer is to be developed to allow the spatial metadata to be displayed in a consistent interface

A list of contributors to data in GEBCO 2019 is in Appendix 4.

WP5.4 Capacity Development

Due to time constraints and absence of a full time Director, the original plan to undertake a comprehensive capacity development review to identify the future training requirements to support Seabed 2030 and ocean mapping was not possible in Year 2. Seabed 2030 continues to seek opportunities for capacity development and a greater engagement of NF-GEBCO Alumni in the project.

Task 5.4.1 Increase data processing ability of alumni

This task has some cross-over with the Extending the Mapping of Ocean Frontiers concept. Seabed 2030 identified an opportunity on in-flight expeditions that were not necessarily making full use of the installed ocean mapping instrumentation. If the usage limitation was due to absence of trained

instrument operators, Seabed 2030 could provide the operators and extend the mapping capability of the expedition. The Five Deeps Expedition presented such an opportunity. Seabed 2030 was able, at short notice, to arrange for the participation of several NF-GEBCO Alumni on sections of the expedition and the collection of bathymetric data that would otherwise not have been lost. This provided great training opportunities for NF-GEBCO alumni as well as producing exciting new bathymetric data in poorly sampled regions of the ocean.

Version Notes:

	Date	Change
V0.1	June 2019	Empty template
V0.2.0	5th Aug 2019	Included text for Global Center from Helen Snaith
V0.2.0	5th Aug 2019	Included NIWA text for SaWPaC from Kevin Mackay
V0.2.0	5th Aug 2019	Included AWI text from Boris
V0.2.0	5th Aug 2019	Included IHO-DCDB text from jennifer
V0.2.0	5th Aug 2019	Included text for Atlantic and Indian oceans (LDEO) from wiki
V0.2.0	5th Aug 2019	Sent to Dani as examples of what is required for the Centre report
V0.2.1.	5th Aug 2019	Added in tasks and sent to Dani to include deliverable eoy reports
V0.2.2.	6th Aug 2019	Dani has include most deliverable eoy reports
V0.2.3	9th Aug 2019	Graham adds his deliverable eoy reports and reference to Appendices 1 to 8. Missing: - Martin's Center text - Boris deliverable; D1.3.3 - Geoffroy deliverable: D2.4.1 – text on wiki - Graham's finance summary – Appendix 5 - Exec Summary
V0.2.4	10th Aug 2019	Sent V0.2.3 to Dani to incorporate D2.4.1 wiki text into word doc. Dani added D2.4.1 to V0.2.4 on 13th Aug 2019 and sent back to Graham. Graham added D1.3.3
V0.2.4	8th Sep 2019	Post leave restart…. - Tweeked wording of each Financial Report to make more consistent across centers - Sent to Helen and Dani asking to supply what text they can to the exec summary
V0.2.5	15th Sep 2019	Helen Snaith included more text into Exec Summary
V0.2.6	22nd Sep 2019	Exec summary WIP Merged in Martin's resent Center Section Removed appendix 7 – grant award letter and so Appendix 8 (year 3 work plan) became Appendix 7
V0.2.6	22nd Sep 2019	Circulated to Project team for review
V0.2.7	29th Sep 2019	• Included Boris's few minor corrections from V0.2.4 into V0.2.6 • Sent PDF version to Mao Hasebe (The Nippon Foundation) for funders review
V0.2.8	4th Oct 2019	• Included Geoffroy's comments on V0.2.6 into V0.2.7 • Included other material that was part of the Year 3 proposal to the Nippon Foundation
V1.0.0	5th October 2019	Renamed V0.2.8 in preparation for distribution to GEBCO Guiding Committee as a deliverable of Year 2 (D5.1.6)