Report on the work done in support of GEBCO at BODC, acting as the Seabed 2030 Global Center; including statistics on access to GEBCO's gridded bathymetric data sets and access to its web site.

Submitted by British Oceanographic Data Centre (BODC) of the National Oceanography Centre (NOC)

SUMMARY

Executive Summary: This document provides details of the work carried out at BODC in support of GEBCO since the previous GEBCO meetings in November 2023. Annex I includes statistics on the distribution of GEBCO's data sets. Annex II includes information on access to GEBCO web site.

1. Overview/Introduction

The BODC, of the UK National Oceanography Centre, acts as the Global Center for the Nippon Foundation-GEBCO Seabed 2030 Project. Its primary role is to compile the GEBCO global bathymetric grid from data provided by the Seabed 2030 Regional Centers, and to maintain and deliver the grid, and related bathymetric products and services, on behalf of GEBCO.

The Center carries out a number of activities in support of GEBCO's work including maintaining and updating the GEBCO web site.

Staff involved in work for GEBCO at BODC:

- Dr Helen Snaith, Head of the Seabed 2030 Global Center
- Ms Pauline Weatherall, GEBCO Grid Manager
- Dr Chris Thompson, IT Developer
- Additional IT support from BODC's IT team

2. Delivery of GEBCO's bathymetric data sets

2.1 Development and release of the GEBCO_2024 global grid

The GEBCO_2024 Grid, the sixth GEBCO grid produced through the framework of The Nippon Foundation-GEBCO Seabed 2030 project, was released in July 2024.

The grid is a global terrain model at 15 arc-second intervals. The data set is accompanied by a Type Identifier (TID) Grid that indicates the type of data (e.g. multibeam, single beam or

interpolated/predicted etc.) that the corresponding grid cell in the bathymetric grid is based on.

Acting as the Seabed 2030 Global Center, BODC was responsible for compiling the global bathymetric grid from regional grids provided by the Seabed 2030 Regional Centers and using a base grid (SRTM15_plus v2.6) provided by Scripps Institution of Oceanography (SIO).

The regional grids have been included on to the base grid using a 'remove-restore' blending procedure (Smith and Sandwell, 1997; Becker, Sandwell and Smith, 2009 and Hell and Jakobsson, 2011). This is a two-stage process of computing the difference between the new data and the 'base' grid and then gridding the difference and adding the difference back on to the existing 'base' grid. The aim is to achieve a smooth transition between the 'new' and 'base' data sets with the minimum of perturbation of the existing base data set.

For the polar regions, data sets were supplied in the form of complete grids. These data sets were merged with the 'central section of grid', i.e. the region 60N-50S, using feather blending techniques from GlobalMapper software made available by Blue Marble Geographics.

An initial draft grid was made available for review by the Seabed 2030 Regional Centers, GEBCO TSCOM and SCRUM Sub-Committees and the SRTM15_plus team.

Feedback from the review process was passed to the Regional Centers and SRTM15_plus team. Revised data sets were then generated and passed to the Global Center who compiled the final version of the GEBCO_2024 Grid and Type Identifier (TID) Grid.

Two versions of the GEBCO_2024 Grid are made available, one with land and ice surface elevation information and a version with under-ice topography information for Greenland and Antarctica. The sections of the global grid showing under-ice topography have been developed by the Arctic and North Pacific Seabed 2030 Center Team based at Stockholm University, Sweden and the Southern Ocean Center team based at the Alfred Wegener Institute, Germany.

Bathymetric data sets are available for polar regions in polar projection co-ordinates.

The GEBCO_2024 Grid can be accessed from:

- https://www.gebco.net/data_and_products/gridded_bathymetry_data/
- For user-defined geographic areas via the download app: https://download.gebco.net/

Previous releases of the GEBCO grid can be accessed from: https://www.gebco.net/data_and_products/historical_data_sets/

A Digital Object Identifier (DOI) has been minted for the data set by BODC on behalf of GEBCO: GEBCO Compilation Group (2024) GEBCO 2024 Grid (doi:10.5285/1c44ce99-0a0d-5f4f-e063-7086abc0ea0f).

Information on some of the references that are citing GEBCO's grids can be found on BODC's Published Data Library pages:

- GEBCO_2019 - https://www.bodc.ac.uk/data/published_data_library/catalogue/10.5285/836f016a-33be-6ddc-e053-6c86abc0788e

- GEBCO_2020 - https://www.bodc.ac.uk/data/published_data_library/catalogue/10.5285/a29c5465-b138-234d-e053-6c86abc040b9

- GEBCO_2021 - https://www.bodc.ac.uk/data/published_data_library/catalogue/10.5285/c6612cbe-50b3-0cff-e053-6c86abc09f8f

- GEBCO_2022 - https://www.bodc.ac.uk/data/published_data_library/catalogue/10.5285/e0f0bb80-ab44-2739-e053-6c86abc0289c

- GEBCO_2023 –

  https://www.bodc.ac.uk/data/published_data_library/catalogue/10.5285/f98b053b-0cbc-6c23-e053-6c86abc0af7b

For the period, 1st October 2023 – 30th September 2024, there have been over 261,000 downloads of GEBCO's bathymetric data sets via GEBCO's web site and app.

Statistics on downloads of all GEBCO's data sets can be found in Annex I.

2.3 Development of a Web Map Service (WMS) for the GEBCO_2024 Grid

A WMS for the GEBCO_2024 Grid has been developed. This includes layers showing:

- shaded relief imagery
- colour shaded for elevation
- areas that are 'considered mapped'
- versions showing ice surface and sub-ice topography

The service includes layers that support GetFeatureInfo requests – allowing users to query data values from the GEBCO grid and TID grid.

Information on how to access the WMS layers can be found on GEBCO's web site: https://www.gebco.net/data_and_products/gebco_web_services/web_map_service/

WMS layers for previous GEBCO grid releases are also available: https://www.gebco.net/data_and_products/gebco_web_services/web_map_service/previous_wms.html

During the year, the URL for the WMS were changed – this was done in relation to the migration of the GEBCO web site to a new hosting platform. We advertised this change via the GEBCO and Seabed 2030 web sites and, where known, by informing users of the services directly by email.

3.0 Maintaining and updating GEBCO's web site

GEBCO's web site (https://www.gebco.net) is maintained and updated at BODC on behalf of GEBCO.

As reported previously, BODC has worked on the migration of the GEBCO site to a new management platform (Drupal). This will allow users, external to BODC, to manage sections of the site and give more options for future development of the site. This migration work was directly funded through an additional budget line provided through TSCOM.

Annex II provides information on access to GEBCO's web site.

3.0 Acting as a trusted node for Crowdsourced Bathymetry Data (CSB)

BODC, as the Seabed 2030 Global Center, is part of a network of 'Trusted Nodes' for crowdsourced bathymetry data. This involves acting as an intermediary between data collectors and the data repository at the IHO DCDB.

During the year, two CSB data sets have been processed and submitted to the IHO DCDB. We have also processed sample CSB data sets received from the Seabed 2030 Pacific Ocean Regional Center and provided feedback to the Center on these data sets.

4.0 Development of an application for the delivery of the GEBCO grid at multiple resolutions

The Seabed 2030 Global Center has been developing a means of making a multiple resolution GEBCO grid products available.

The GEBCO grid is currently made available as a global 15 arc-second interval grid. However, in some regions, it is based on data at higher resolutions. To accommodate users who want access to higher resolution data, where it exists, a multi-resolution grid product is being developed. Initial work on this was application was reported at the GGC40 meeting.

It is intended that:

- The higher-resolution grids would be 'sparse populated' – i.e. only grid cells that are based on measured data are populated.
- Only contributed data that meets, or exceeds, the resolution goal for each depth range would be integrated into the higher-resolution data products, as defined in Table 1. That is, data will not be over-sampled to provide higher resolution products.
- The grids would be delivered in geographic co-ordinates.
- The 15 arc-second interval grid will continue to be delivered as a global fully-populated grid, with areas not supported by direct measurement based on predicted bathymetry.

The table below shows the depth range and grid resolution for the various multi-resolution grids.

Depth range (meters)	Grid resolution (degrees)	Approximate grid resolution (meters)
0–1,500	0.001	100
0 – 3,000	0.002	200
0 – 11,000	0.004	400

Table 1. Depth range and grid resolution for GEBCO multiple resolution products

A draft application has been developed to provide access to both the global 15 arc-second interval grid and the multi-resolution grid product. After further development work, it is intended to make the application generally available for testing and feedback.

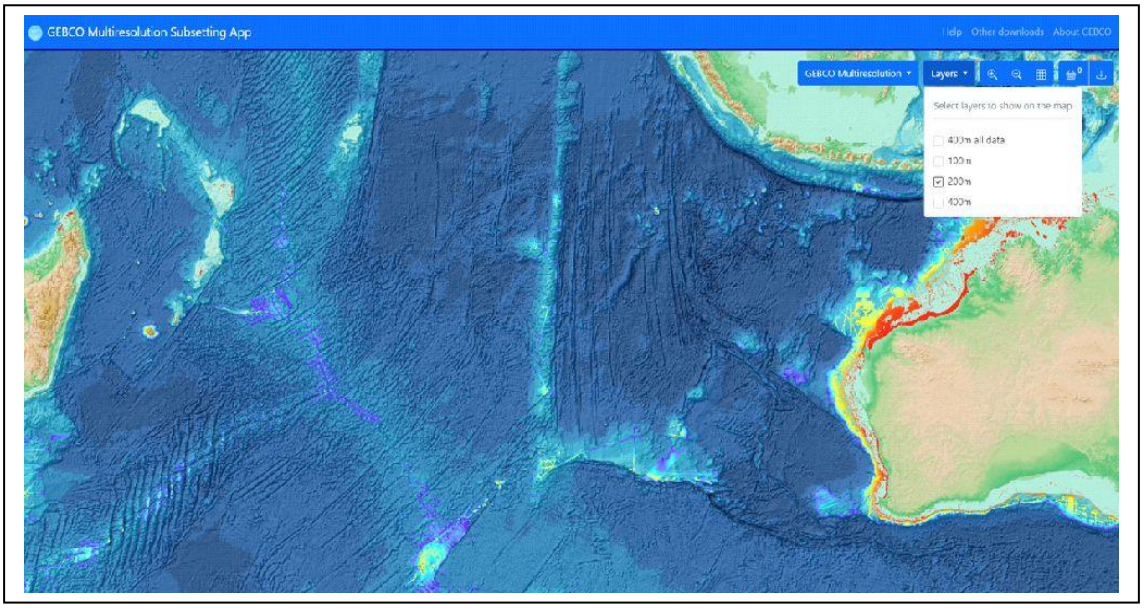

Figure 1: Imagery from the draft multi-resolution grid delivery application - the ‘rainbow colours’ show areas of multi-resolution data plotted on the 15 arc-second GEBCO grid (areas of blue shaded-relief).

5.0 Development of an Application Programme Interface (API) for access to the GEBCO grid

Development work has been done on a ‘proof of concept’ API which would allow users to connect to/use data from the GEBCO grid directly without having to download the data set via the download application.

It is intended that this development work will continue and a demonstration API will be made available for feedback.

6.0 Miscellaneous activities in support of GEBCO

6.1 Providing GEBCO data set user-support

At BODC, we answer enquiries relating to GEBCO's data sets and products. The enquiries can be related to:

- Feedback on the GEBCO grid/reporting errors – we work with the relevant Seabed 2030 Regional Center, and with the SRTM15_plus team to investigate any errors reported in the grid and provide feedback to the enquirer. We keep a log of 'known issues' in the grid on GEBCO's web site and aim to fix them in subsequent grid releases.
  https://www.gebco.net/data_and_products/gridded_bathymetry_data/data_set_errata/

- Technical – enquiries relating to how the grid was produced; the grid file formats or advice on how to use the data in particular systems

- Sources of bathymetry data – information on the availability of source bathymetric data sets for a particular region, we endeavour to advise about available source data sets and provide links to where the data can be accessed.

Enquiries come from all parts of the world and all sectors, i.e. commercial companies, academic institutions, students and private individuals. During the reporting period, 40 general enquiries were answered.

6.2 Maintenance of mailing lists and Google drive space for committee use

BODC manages a google workspace, within the domain gebco.net, primarily for serving group mailing lists and shared drive space on behalf of GEBCO, its sub committees and working groups. The TSCOM, SCRUM and SCOPE chairs have dedicated email accounts setup on the workspace.

Each sub-committee also has a dedicated shared drive space, with additional space for the web working group and Cookbook Editorial Board.

6.3 Involvement in the work of some of GEBCO's Sub-Committees and Working Groups

- Participated in TSCOM and SCOPE intersessional meetings.

- Involved in TSCOM activity to work with colleagues in the Argo float community to assess if bathymetry data derived from information collected by grounded Argo floats can be used to update the GEBCO grid.

  Bathymetry data derived from grounded Argo floats was used in the generation of the SRTM15_plus v2.6 data set. This data set is used as a base for the GEBCO_2024 Grid.

6.4 Miscellaneous

- Provided text and imagery to be included in the GEBCO/Seabed 2030 contribution to the UNESCO State of the Oceans Report 2024.
- Poster presentation about the work of GEBCO and Seabed 2030 at the International Conference on Marine Data and Information Systems (IMDIS) 2024. https://imdis.seadatanet.org/Posters/Session-PRODUCTS

7.0 Action

The GGC is requested to not**e** the contents of this report.

References

J J Becker, D T Sandwell, W H F Smith, J Braud, B Binder, J Depner, D Fabre, J. Factor, S Ingalls, S-H Kim, R Ladner, K Marks, S Nelson, A Pharaoh, R Trimmer, J Von Rosenberg, G Wallace, P Weatherall (2009). Global Bathymetry and Elevation Data at 30 Arc Seconds Resolution: SRTM30_PLUS, Marine Geodesy, 32:4, 355-371.

Hell, B and M Jakobsson (2011), Gridding heterogeneous bathymetric data sets with stacked continuous curvature splines in tension, Mar. Geophys. Res., 32(4), 493-501, doi:10.1007/s11001-011-9141-1.

Smith, W H F and D T Sandwell (1997). Global seafloor topography from satellite altimetry and ship depth soundings, Science, v. 277, p. 1957-1962, 26 Sept.

Annex I - statistics on the distribution of GEBCO's data sets

Internet downloads of GEBCO's gridded bathymetric data sets

https://www.gebco.net/data_and_products/gridded_bathymetry_data/

To note: statistics relating to the number of downloads of GEBCO's data sets and access to its web sites are given for the reporting period: 1st October 2023 – 30th September 2024.

GEBCO's latest bathymetric grid, the GEBCO_2024 Grid, was released in July 2024. GEBCO's previous grids are made available as global grid files to download, through the 'historical data sets' section of GEBCO's web site and for user-defined areas through the GEBCO download app (https://download.gebco.net/).

Downloads for the reporting period (1st October 2023 – 30th September 2024) split by grid type:

- GEBCO_2024 Grid: 42,366 (global grids: 8,886)
- GEBCO_2023 Grid: 204, 201 (global grids: 37,497)
- GEBCO_2022 Grid: 6,667 (global grids: 2,069)
- GEBCO_2021 Grid: 2,866 (global grids: 738)
- GEBCO_2020 Grid: 2,204 (global grids: 620)
- GEBCO_2019 Grid: 2,547 (global grids: 736)

Historical data sets (global grids):

- GEBCO_2014 Grid (30 arc-second): 416
- GEBCO One Minute Grid: 465

The image below shows the number of downloads of bathymetry data via GEBCO's web site, i.e., complete global grids (1 click totals) and data for user-defined areas (download app) and polar projection grids during 2023/2024.

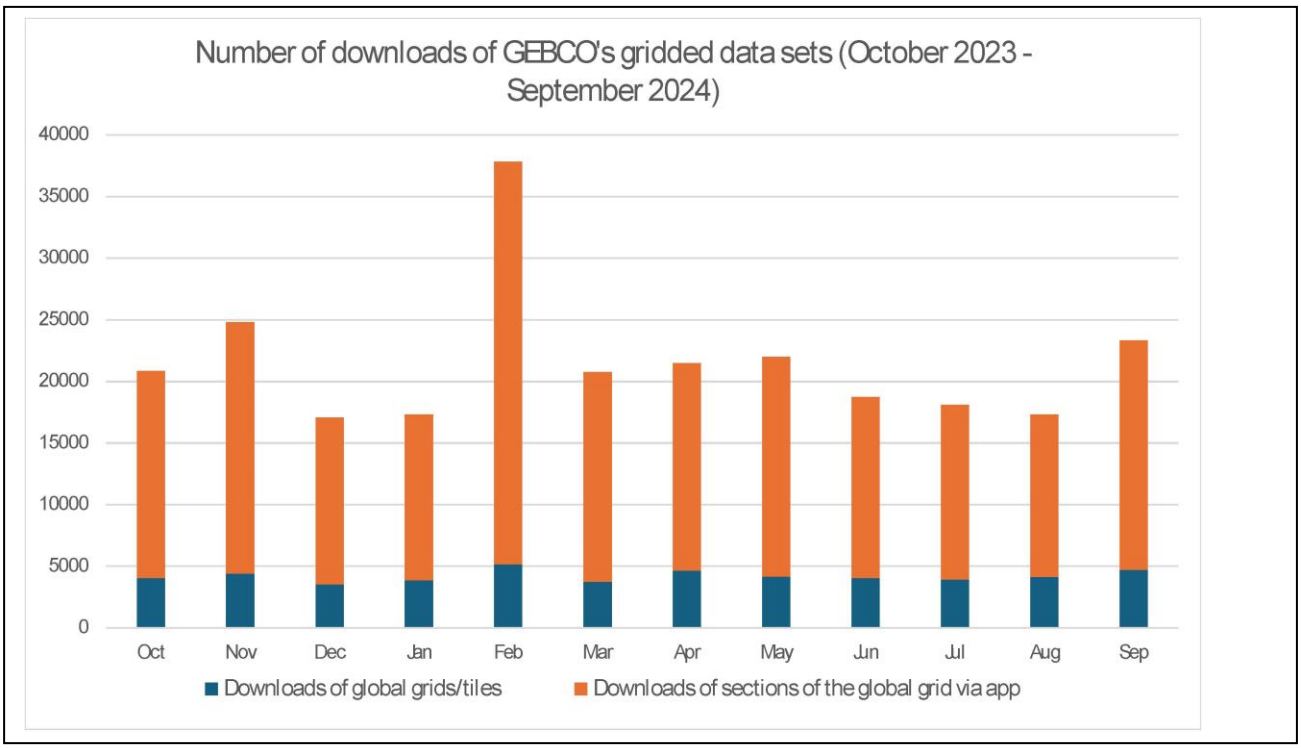

Figure 2: The number of downloads of GEBCO's gridded data sets from 1st October 2023 to 30th September 2024

Annex II – Access to the GEBCO web site

The GEBCO web site is maintained by BODC on behalf of GEBCO. The following tables and images provide information and statistics on access to the web site for the period (1st October 2023 – 30th September 2024).

Access to GEBCO's web site (www.gebco.net)

During the reporting period over 709,300 pages have been accessed on GEBCO's web site.

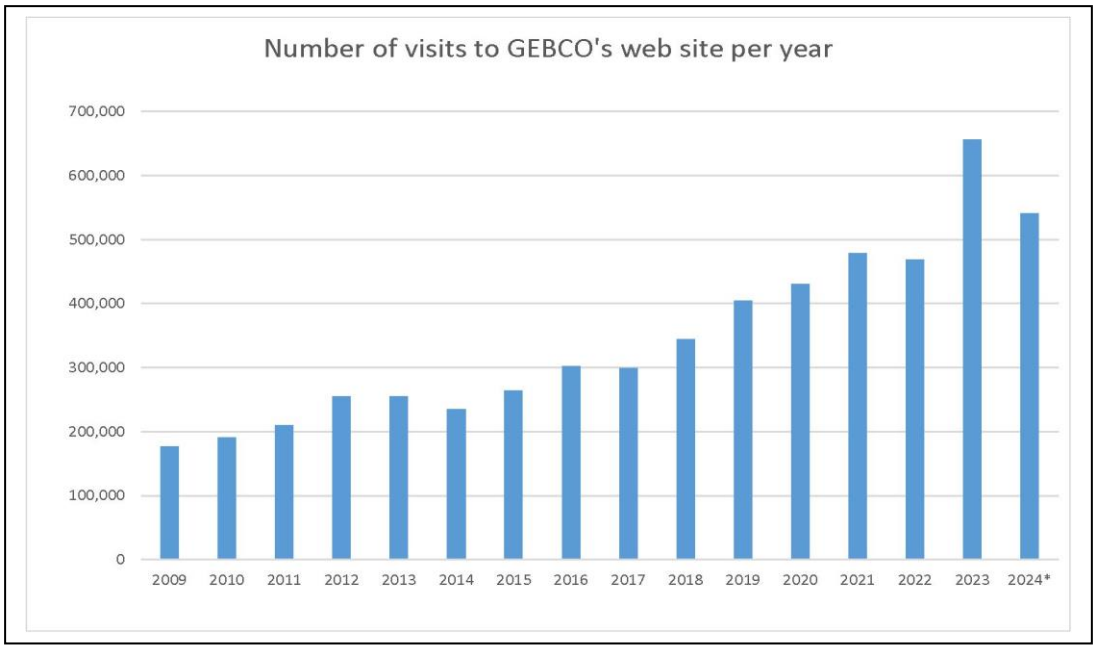

Figure 3: The number of pages viewed on GEBCO's web site per year * up to 30th September 2024

Number of visits to individual web pages

The following table details the number of visits to the 'top 20' most popular pages on GEBCO's web site for the reporting period.

Explanation of terms used:

Page title and URL	Title of the GEBCO web page viewed with URL
No. page views	The total number of pages viewed during the reporting period

Page title and URL	**No. of page views**
GEBCO home page https://www.gebco.net/index.html	299,375
Gridded bathymetry data* https://www.gebco.net/data_and_products/gridded_bathymetry_data/index.html	184,129
Web Map Service (WMS) page	31,159

https://www.gebco.net/data_and_products/gebco_web_services/web_map_service/index.html	
GEBCO's data and products https://www.gebco.net/data_and_products/index.html	24,295
Printable Maps https://www.gebco.net/data_and_products/printable_maps/	13,897
Arctic Ocean bathymetry (IBCAO) https://www.gebco.net/data_and_products/gridded_bathymetry_data/arctic_ocean/index.html	10,391
Undersea feature names https://www.gebco.net/data_and_products/undersea_feature_names/index.html	9,316
Seabed 2030 Project https://www.gebco.net/about_us/seabed2030_project/index.html	8,951
Training https://www.gebco.net/training/index.html	8,430
Information about the GEBCO_2019 Grid https://www.gebco.net//data_and_products/gridded_bathymetry_data/gebco_2019/gebco_2019_info.html	7,718
GEBCO grid terms of use information https://www.gebco.net/data_and_products/gridded_bathymetry_data/gebco_2019/grid_terms_of_use.html	7,014
Information about the GEBCO_2023 Grid https://www.gebco.net//data_and_products/gridded_bathymetry_data/gebco_2023/index.html	6,555
International Bathymetric Chart of the Southern Ocean (IBCSO) https://www.gebco.net/data_and_products/gridded_bathymetry_data/southern_ocean/	5,885
Historical GEBCO data sets https://ww.gebco.net/data_and_products/historical_data_sets/index.html	5,836
Imagery index page https://www.gebco.net/data_and_products/imagery/index.html	5,577
Information on Web Map Services https://www.gebco.net/data_and_products/gebco_web_services/index.html	5,177
Information on Polar grids https://www.gebco.net/data_and_products/gridded_bathymetry_data/polar_grids/index.html	3,802
Frequently Asked Questions (FAQ) https://www.gebco.net/about_us/faq/index.html	3,349
Contributing data https://www.gebco.net/about_us/contributing_data/	3,275
Previous GEBCO WMS https://www.gebco.net/data_and_products/gebco_web_services/web_map_service/previous_wms.html	3,223

* See Annex I for details on Internet downloads of GEBCO's gridded bathymetric data sets.