GGC GGC40/x
Meeting 40 23rd October 2023
Agenda Item GGC40-2.4

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 the 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 October 2023. Key activities are the calculation ad delivery of the GEBCO_2023 global grid and delivery of the GEBCO website.
Annex I includes statistics on the distribution of GEBCO's data sets.
Annex II includes information on access to GEBCO web site.

Action to be taken: See Section 7

Related documents: None

1 Overview/Introduction

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

The Center also maintains and updates the GEBCO web site and carries out a number of activities in support of GEBCO's work.

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
- Plus additional IT support from BODC's IT team

2 Delivery of GEBCO's bathymetric data sets

2.1 Development and release of the GEBCO_2023 global grid

The GEBCO_2023 Grid was published in April 2023.It is the fifth GEBCO grid produced through the framework of The Nippon Foundation-GEBCO Seabed 2030 project. The release of the data set comes 120 years after the publication of the GEBCO First Edition Chart series.

The grid is a global terrain model for land and oceans at 15 arc-second intervals. As with previous releases, the data set is accompanied by a Type Identifier (TID) Grid that indicates the type of data (e.g. multibeam, single beam or interpolated etc.) that the corresponding cell in the bathymetric grid is based on.

Acting as the Seabed 2030 Global Center, BODC was responsible for compiling the global bathymetric grid by combining regional bathymetric grids provided by the Seabed 2030 Regional Centers with a base grid (SRTM15_plus v2.5.5) developed at Scripps Institution of Oceanography (SIO).

As with the GEBCO_2022 Grid, the sparse 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 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 included using feather blending techniques from GlobalMapper software made available by Blue Marble Geographics.

An initial draft grid was produced and 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_2023 Grid, Type Identifier (TID) Grid and accompanying data contributors list.

Two versions of the GEBCO_2023 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 and the Southern Ocean Center team based at the Alfred Wegener Institute.

The GEBCO_2023 Grid and accompanying Type Identifier (TID) Grid can be accessed, in a number of formats as complete global grids or tiled data sets, from:
https://www.gebco.net/data_and_products/gridded_bathymetry_data/

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

Compiled from the information provided by the Regional Centers, a list of the data sets included in the grid is given on GEBCO's web site:
https://www.gebco.net/about_us/acknowledgements/our_data_contributors/

A Digital Object Identifier (DOI) has been minted for the data set by BODC on behalf of GEBCO: GEBCO Compilation Group (2023) GEBCO 2023 Grid (doi:10.5285/f98b053b-0cbc-6c23-e053-6c86abc0af7b).

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

Information on some of the references that are citing GEBCO's grids can be found on BODC's Published Data Library pages, and there have been 326 direct citations in published literature:

- 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

For the period, 1st October 2022 – 30th September 2023, there have been over 186,570 downloads of GEBCO's bathymetric data sets via GEBCO's web site.

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

2.2 Development of a Web Map Service (WMS) for the GEBCO_2023 Grid

A draft WMS for the GEBCO_2023 Grid is in development. This includes layers showing:

- shaded relief imagery
- colour shaded for elevation
- versions showing ice surface and sub-ice topography

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

In order to separate the WMS service from the website operations, a new address is being introduced for the WMS service: wms.gebco.net. The WMS will remain available at the existing address for a period of time, to allow users to change any automated code that accesses the service.

3 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.

The migration is complete, and the new site operates in parallel to the existing site. However, issues regarding the WMS service prevent a switch to this new service in the short term.

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

4 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 we have been working on developing an in-house application for the processing of raw CSB data to a form suitable for submission to the IHO DCDB. The application is based on opensource software developed by the Center for Coastal Ocean Mapping (CCOM), but also includes additional quality control checks to reject points, for example, for impossible geographic locations, to ensure data will be accepted by the IHO DCDB. We have been working with the International SeaKeepers Society to process data sets collected through their network and provide feedback and imagery on the collected data as SeaKeepers works to become a CSB Trusted Node. The CSB Trusted Node activity is funded through the Seabed 2030 project but directly supports the CSB working group and provides data to the DCDB.

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

The GEBCO global terrain model is currently made available as a 15 arc-second interval grid. However, users of the data set have different requirements, with some needing more detailed/higher resolution bathymetry in particular areas. Therefore, to provide users with a more flexible product, the Seabed 2030 Technical Team (consisting of Technical experts from Seabed 2030's Regional Centers and the Chair and Vice-Chair of TSCOM) have been looking at making GEBCO's grid available at multiple resolutions.

At the start of the Seabed 2030 project a set of depth-dependent 'resolution goals' were defined to help determine how much of the ocean floor has been mapped Mayer et al. (2018). This is effectively an estimation of data density, and the resolution goals were determined as being consistent with typical resolution of a modern, surface mounted, multibeam system. With each release of the GEBCO grid, the Project's progress towards these goals is computed. This is not determined from the 15-arcsecond gridded product, but from the contributed source bathymetry data using an algorithm developed at the North Pacific and Arctic Regional Center.

Based on work done by the Seabed 2030 Atlantic and Indian Ocean Center, the Seabed 2030 Technical Team have defined a methodology for generating and distributing multiple-

resolution data products for GEBCO that are consistent with these depth-dependent goals and based on the resolution of the source bathymetry data contributed by the global community.

The three grid intervals and depth ranges are shown in the table below.

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

It is intended that:

- The new 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. i.e. 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 Seabed 2030 Global Center, at BODC, has been developing a means of making the multiple resolution grid products available. Using a test dataset that has been provided by the Atlantic and Indian Ocean Regional Center Team, a demonstration data delivery system has been developed. This allows the user to view the geographic coverage of the various grids and select to download in netCDF, data geoTiff or Esri ASCII raster formats. The application also includes the option to download the data in the form of imagery.

The application is based on the existing download application (https://download.gebco.net/). Further work now needs to be done at the Regional Centers to finalise the development and quality control of the multiple resolution grids and at the Global Center to finalise the data delivery application. It is hoped to begin to deliver higher resolution data products to the global community in the coming year.

6 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 may be of a number of forms:

- 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.

A form is included on GEBCO's web site to allow users to provide feedback on how they are using GEBCO's data sets:
https://www.gebco.net/data_and_products/gridded_bathymetry_data/feedback/

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 (tscom_chair@gebco.net, scrum_chair@gebco.net and scope_chair@gebco.net) and mailing lists have been set up for the committees, awaiting confirmation of membership. Each sub-committee also has a dedicated shared drive space, with additional space for the web working group and Cookbook Editorial Board. The gebco_folk@gebco.net mailing list also uses this service.

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

- Provided feedback on the revised GEBCO World map, developed through the SCOPE Sub-Committee.
- Provided draft text on the GEBCO Digital Atlas, GEBCO grid development and data download service for the updated History of GEBCO book.
- 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.

7 Action

The GGC is requested to note the contents of this report.

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 2022 – 30th September 2023.

GEBCO's latest bathymetric grid, the GEBCO_2023 Grid, was released at the end of April 2023. 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 (for grids at 15 arc-second intervals) through the GEBCO download app (https://download.gebco.net/).

Downloads for the reporting period (1st October 2022 – 30th September 2023) split by grid type:

- GEBCO_2023 Grid:81,354 (global grids: 17,786)
- GEBCO_2022 Grid: 98,050 (global grids: 39,857)
- GEBCO_2021 Grid: 2,950 (global grids:773)
- GEBCO_2020 Grid: 2,089 (global grids: 698)
- GEBCO_2019 Grid: 2,130 (global grids: 324)

Historical data sets (global grids):

- GEBCO_2014 Grid (30 arc-second): 324
- GEBCO One Minute Grid: 306

GEBCO's grids can also be downloaded, for user-defined areas, in the form of imagery, either shaded relief or colour-shaded for depth. The table below shows the number of downloads of imagery for each grid.

Grid name	Number of image downloads
GEBCO_2023	81,639
GEBCO_2022	43,508
GEBCO_2021	872
GEBCO_2020	485
GEBCO_2019	909

Table 2: Number of downloads of imagery derived from the GEBCO grid

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) during 2023.

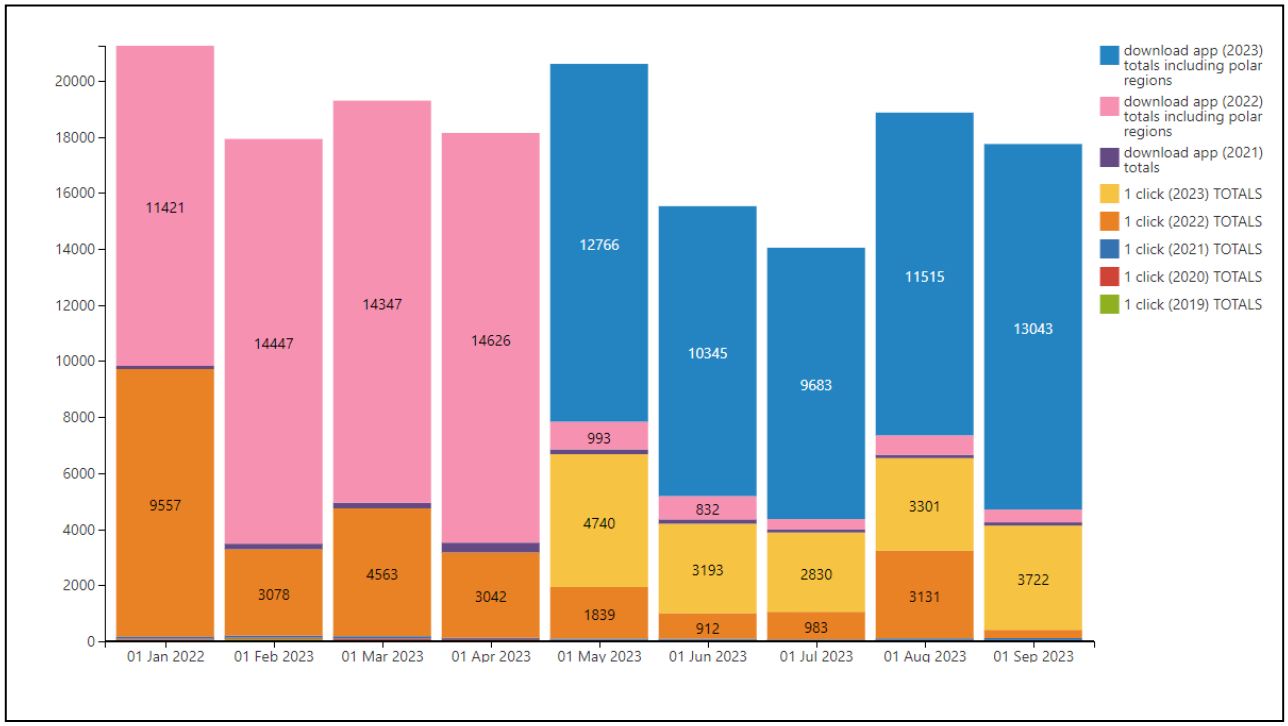

Figure 1: Statistics of the number of downloads of GEBCO's gridded data sets during 2023 (January-September)

Annex II – Access to the GEBCO web site

The GEBCO web site is maintained by BODC on behalf of the project. The following tables and images provide information and statistics on access to the web site for the period (1st October 2022 – 30th September 2023).

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

During the reporting period over 531, 800 pages have been accessed on GEBCO's web site.

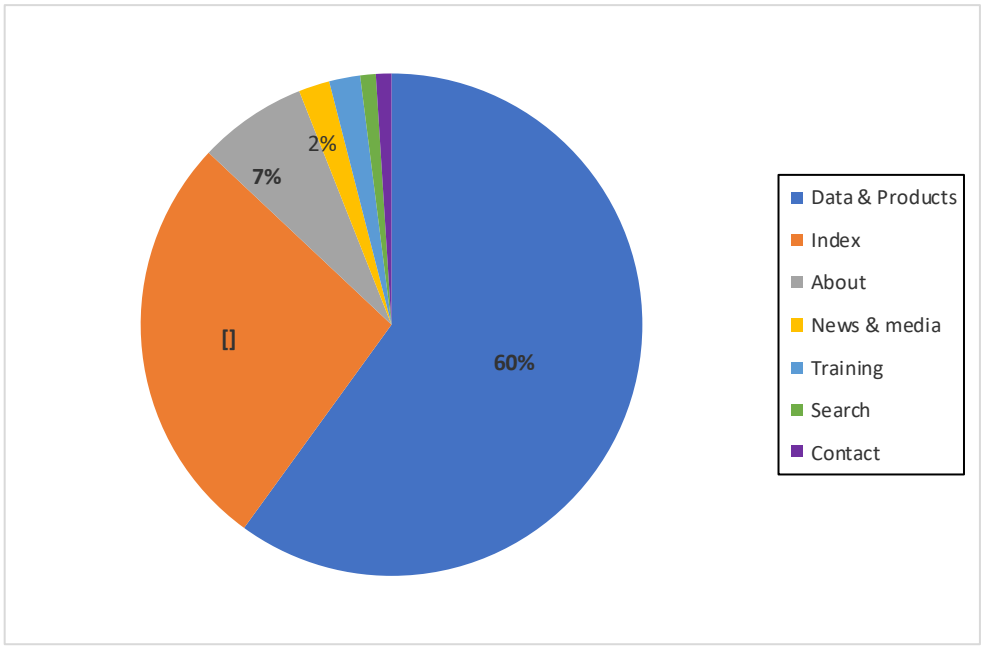

Figure 2: Frequency of visits to the various sections of GEBCO's web site during the reporting period.

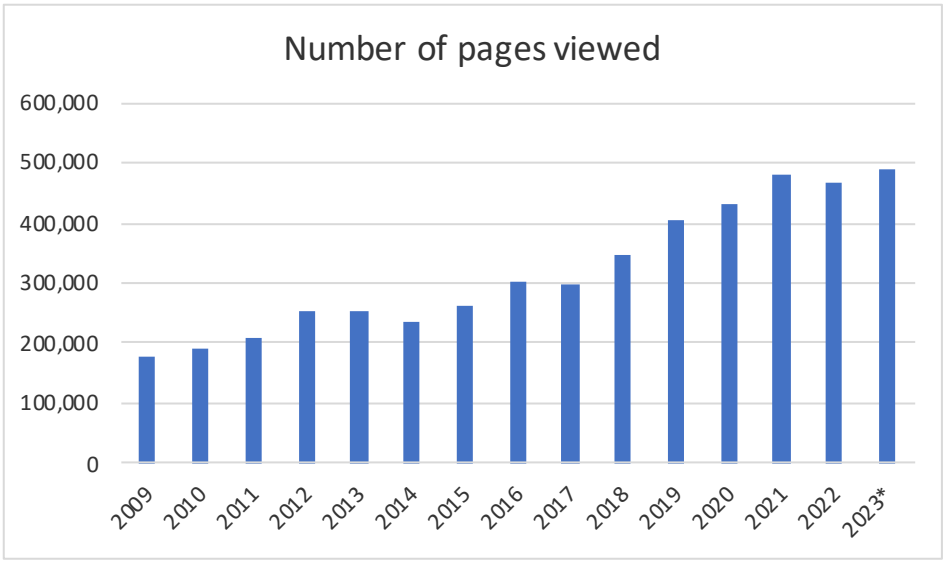

Figure 3: The number of pages viewed on GEBCO's web site per year * Up to 30th September 2023

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.

Title of the GEBCO web page viewed with URL	**[1]No. of page views**
GEBCO home page https://www.gebco.net	197,820
Gridded bathymetry data*[2] https://www.gebco.net/data_and_products/gridded_bathymetry_data	153,336
Web Map Service (WMS) page https://www.gebco.net/data_and_products/gebco_web_services/web_map_service	37,309
GEBCO's data and products https://www.gebco.net/data_and_products	19,568
Printable Maps https://www.gebco.net/data_and_products/printable_maps	12,177
Arctic Ocean bathymetry (IBCAO) https://www.gebco.net/data_and_products/gridded_bathymetry_data/arctic_ocean	10,120
Undersea feature names https://www.gebco.net/data_and_products/undersea_feature_names	9,061
Training https://www.gebco.net/training	8,920
Seabed 2030 Project https://www.gebco.net/about_us/seabed2030_project	8,772
Information about the GEBCO_2019 Grid https://www.gebco.net//data_and_products/gridded_bathymetry_data/gebco_2019/gebco_2019_info.html	8,566
Information about the GEBCO_2022 Grid https://www.gebco.net//data_and_products/gridded_bathymetry_data/gebco_2022	7,437
Imagery index page https://www.gebco.net/data_and_products/imagery	5,956
GEBCO grid terms of use information https://www.gebco.net/data_and_products/gridded_bathymetry_data/gebco_2019/grid_terms_of_use.html	5,733
Information on Web Map Services https://www.gebco.net/data_and_products/gebco_web_services	5,697

[1] The total number of times the page was viewed during the reporting period.

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

Title of the GEBCO web page viewed with URL	**[1]No. of page views**
International Bathymetric Chart of the Southern Ocean (IBCSO) https://www.gebco.net/data_and_products/gridded_bathymetry_data/southern_ocean	5,277
Historical GEBCO data sets https://ww.gebco.net/data_and_products/historical_data_sets	4,307
Information on Polar grids https://www.gebco.net/data_and_products/gridded_bathymetry_data/polar_grids	3,752
Contributing data https://www.gebco.net/about_us/contributing_data	3,599
Frequently Asked Questions (FAQ) https://www.gebco.net/about_us/faq	3,480
GEBCO Overview https://www.gebco.net//about_us/overview	3,190