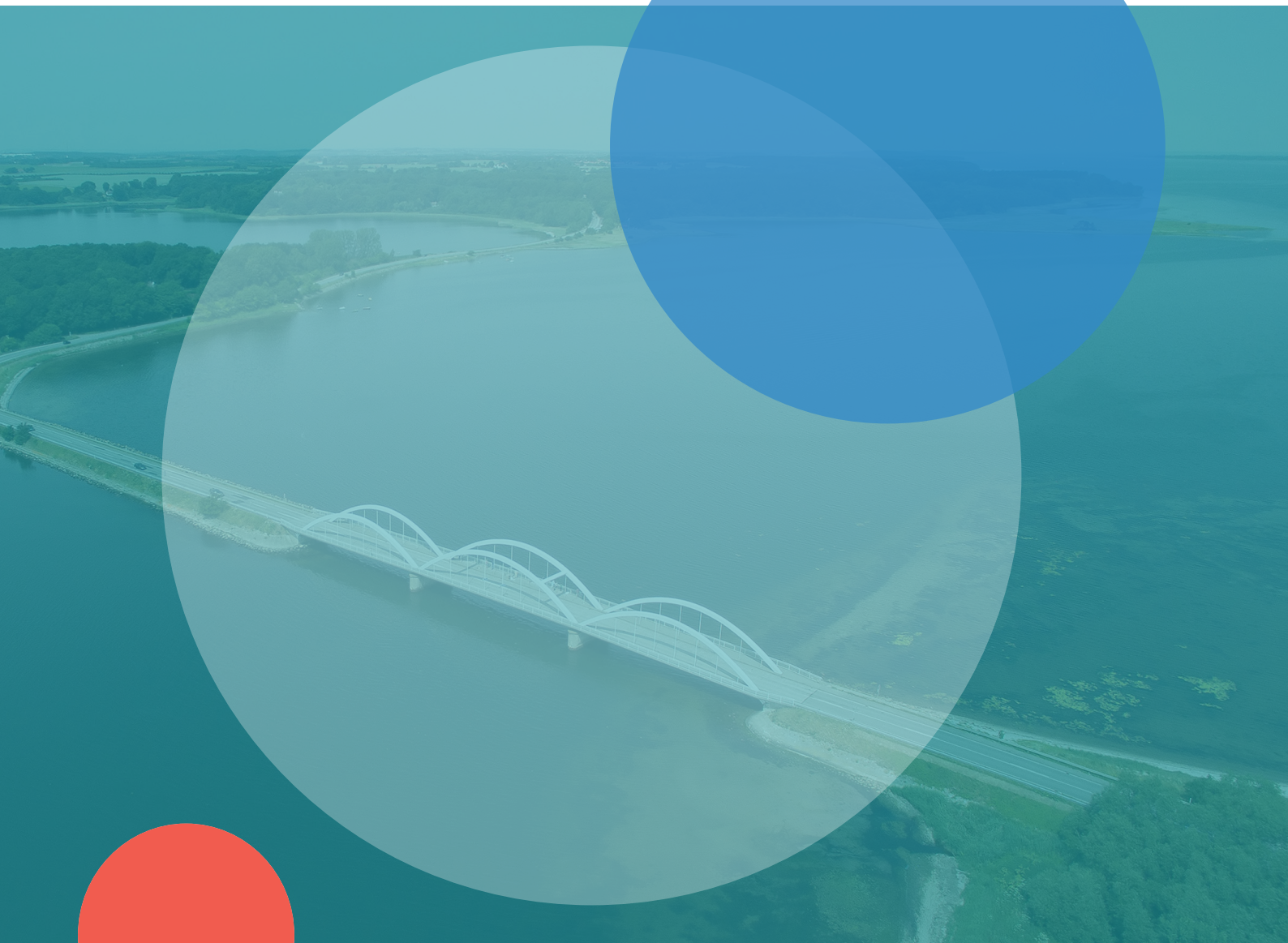


NHC National Report of Denmark

2023



Executive summary

This report gives a summary of the main activities within the Danish Hydrographic Office since the last report given at the NHC65 Meeting 26th – 27th April 2022

1. Hydrographic Office

The Danish Geodata Agency (DGA) is part of the Danish Ministry of Climate, Energy and Utilities. The Ministry consists of the Danish Energy Regulatory Authority, Energinet, the Agency for Data Supply and Infrastructure, the Danish Energy Agency, the Danish Meteorological Institute Department, the Geological Survey of Denmark and Greenland.

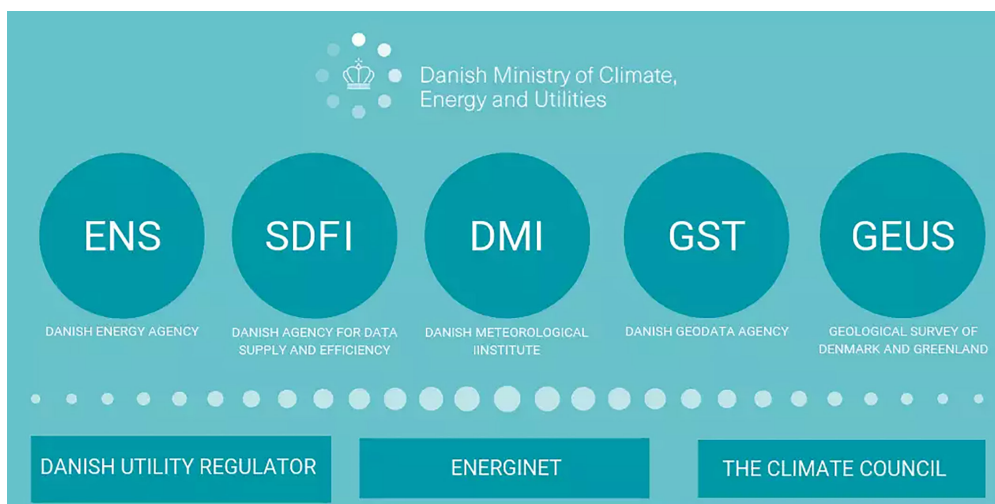


Figure 1. Ministerial institutions.

DGA in its role as a hydrographic office has responsibility for hydrographic surveys and for the production of nautical charts of the waters surrounding Denmark and Greenland, just as the DGA is responsible for the Danish MSDI. DGA is also responsible for issuing Chart Corrections and related nautical publications such as INT 1 and pilots (sailing directions) and for technical support to demarcation of the Danish maritime boundaries. DGA has 150 employees, of which 76 are employed in the hydrographic office. The practical work of hydrographic surveys is carried out by personnel and ships from the Royal Danish Navy (Danish Hydrographic service). Survey personnel from the Navy are part of the organization of DGA.

On behalf of the Kingdom of Denmark, DGA has the responsibility for areas related to foreign, security and defence policy for the Faroese waters. These are e.g. visualization of limits and boundaries in nautical charts, INT charts, nautical charting for the Defence, negotiations in international forums etc. and representing the Kingdom of Denmark in IHO and IHO related working groups.

The Danish Geodata Agency works closely together with the Danish Maritime Authority, which is responsible for issuing of Notices to Mariners and List of Lights. Tide tables and operational tide gauges are the responsibility of Danish Meteorological Institute.

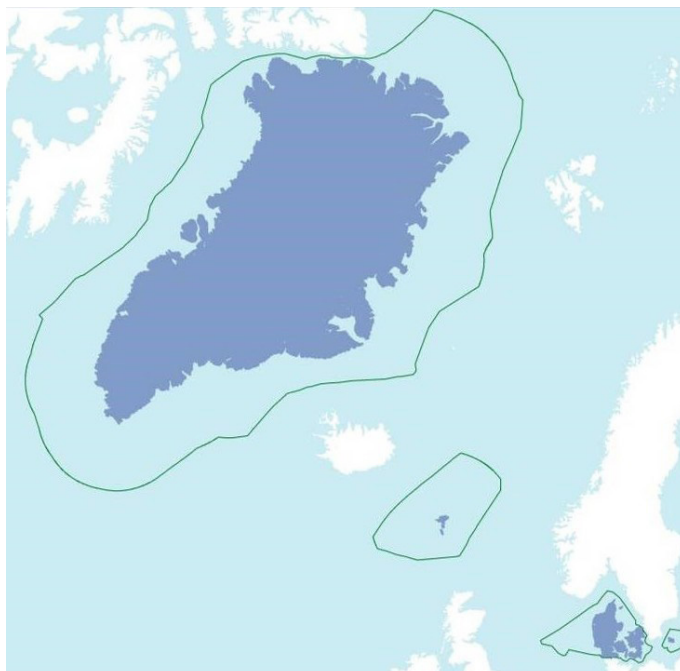


Figure 2. Greenland, Faroe Islands and Denmark.

ORGANIZATION IN THE DANISH HYDROGRAPHIC OFFICE

Head of Department:

- Elizabeth Hagemann
- Niels Tvilling Larsen
- Allan Idd Jensen

Functions:

- PAF – Policy, Utilization & Business Development
- PUK – Processes, Development and Quality Control
- SØP – Nautical Chart Production
- SOP – Case Handling and Updating
- DAT – Data Production
- SAS – Systems, Application & Support.
- Hydro – Hydrographic Data Management
- DML – Data Management & -Deliverables
- SOM – Hydrographic Service

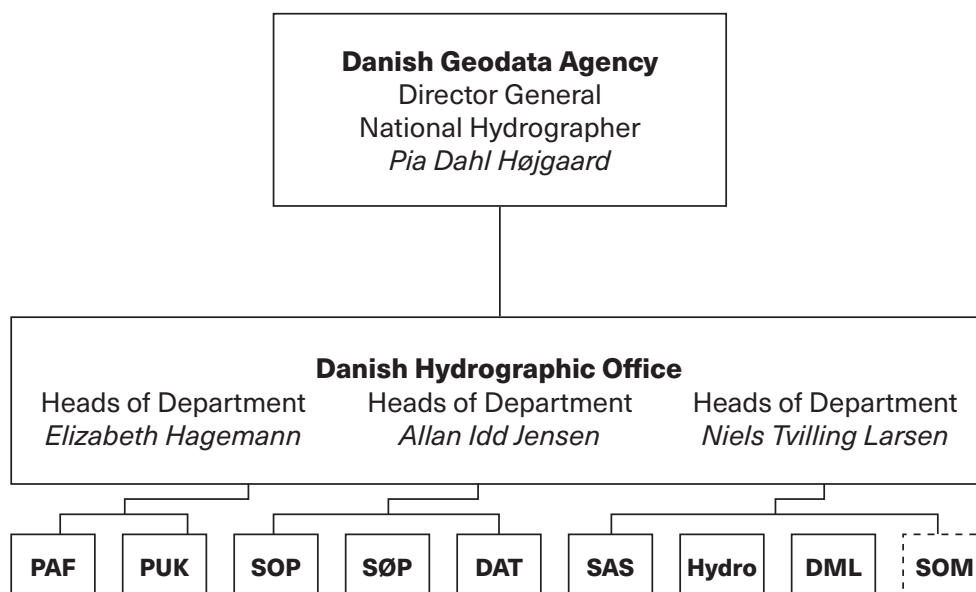


Figure 3. Organization in the Danish Hydrographic Office.

1.2. Faroese Hydrographic Office

Umhvørvisstovan is responsible for surveying and mapping the waters around the Faroe Islands.

Umhvørvisstovan is working with the UKHO to ensure that sailing directions are available in English, A new edition of Admiralty sailing direction NP52 was published in 2022, and the publication is expected to be renewed every 4-5 years. The previous publication issued 1983 "Faroe Islands Pilot and Harbor information for the Faroe Islands" has been canceled

1.3 Implementation of new strategy for the Danish Hydrographic Office 2030

DGA has developed a new strategy that runs until 2030. The overall goals reflect the motivation to enhance the production and usage of hydrographic data, services and products for both navigation and to support the production of other marine geospatial products for the benefit of the environment and the society.

In the past year, DGA has worked on forming the right structures to streamline the implementation of the strategy. Different internal roles and responsibilities have been defined, and both a steering group and a strategic change board have been set up, operationalizing and deciding on strategic areas of action, efforts and projects related to the strategy.

This structure allows the steering group to establish a clear overview of the strategy portfolio and supports decision making and prioritization of resources linked to the 2030 strategy and its different focus areas.

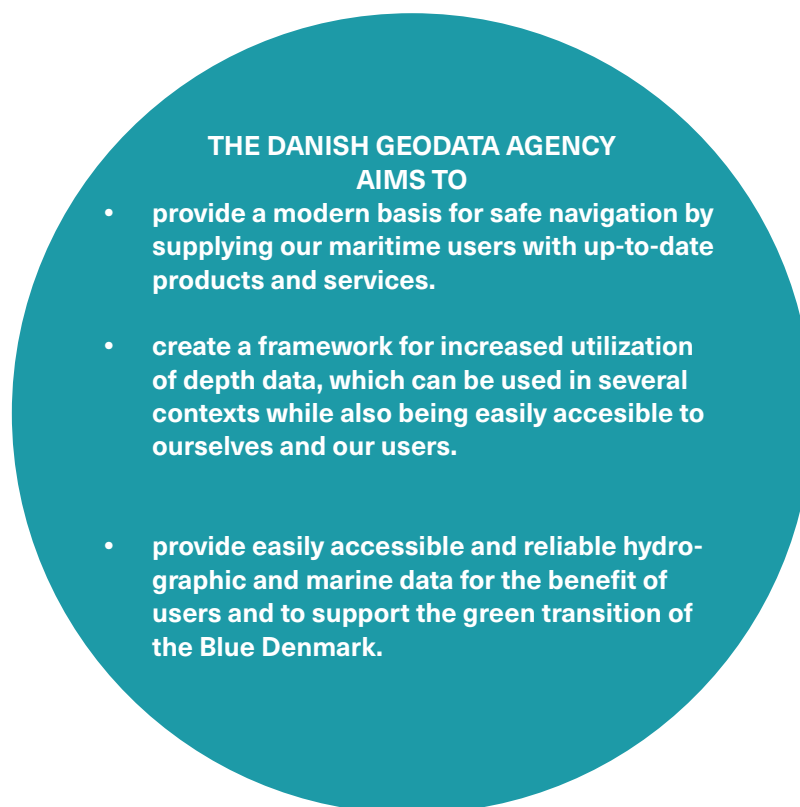


Figure 4. DGA Strategy.

The focus areas of the DGA 2030 Strategy

- New technologies for depth data collection
- Integration of IHO S-100
- Accessible and targeted data and products for the maritime users
- Coordination and collaboration of marine data:
- Efficient production
- Long term finance mode

2. Surveys

2.1 Overall status and surveys 2022

2.1.1 Denmark

The Survey Directive for the Danish waters reflects the decisions taken at the HELCOM Ministerial Council meetings in Copenhagen in September 2001 and October 2013 on the resurvey of the main navigation routes and other areas of interest for shipping in the Baltic Sea and inland Danish waters. Furthermore, CAT III areas are incorporated into the survey plan, as decided by HELCOM ministerial meeting in 2021. The target for surveying in Danish waters in 2022 was to complete 22.000 Km of survey lines in Danish waters. The result was 31.184 Km.

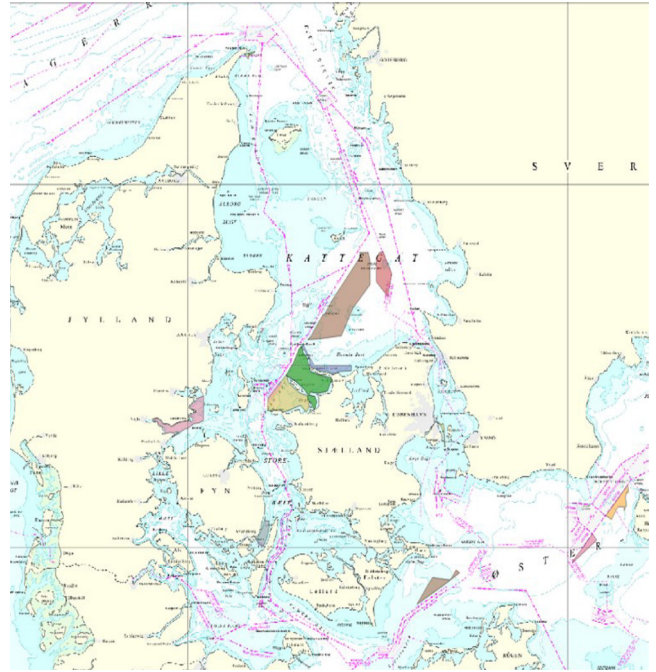


Figure 5: Planned surveys in Danish waters 2020 and 2021.

2.1.2 Greenland

The Survey Directive for Greenland is based on the overall priorities of surveying areas in Greenland, which have been agreed with the Government of Greenland.

The overall priorities for surveying in Greenland in 2022 was as following:

Priority 1.

The inland routes between the cities of Greenland's west coast from Nunap Isua (Cape Farewell) to Upernavik. Priority 2.

Survey of sailing routes in coastal areas on the west coast of Greenland, where the general water depth is less than 200 meters and the basis of survey is insufficient. Examples of priority 2 may be coastal areas where inshore sailing is not possible, due to ice conditions and geography and surveys are of older date or completely missing.

Priority 3.

Surveying areas of particular interest for business and tourism development. Examples of priority 3 areas may be: Selected fjords with frequent visits of cruise ships and areas of impending mining where increased sailing with larger ships is expected.

The target for surveying in Greenland in 2022 was 6.500 km surveyed line. The result was 6366,1 Km.

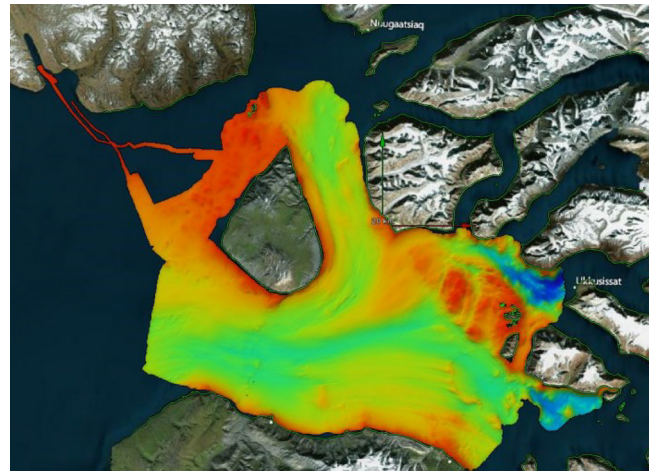


Figure 6: Actual Surveys in Greenland 2022. Uummanaq area.



Figure 7: Danish Navy Arctic patrol vessel Lauge Koch, used for surveys in Greenland.



Figure 8: Real survey work. SAR-vessel used for in shore work and transportation.

2.1.3 Vessels

Vessels used for survey in Denmark:

I / F Poul Løwenørn

(Danish Maritime Authority)

The surveying vessel FYRHOLM and BIRKHOLM (Danish Navy)

The survey boats SOM-1 and SOM-2 (Danish Navy)

Surveys were carried out in Greenland waters in June and July, with:

LAUGE KOCH Arctic patrol vessel (Danish Navy)

The survey boat SAR-3 (Danish Navy)

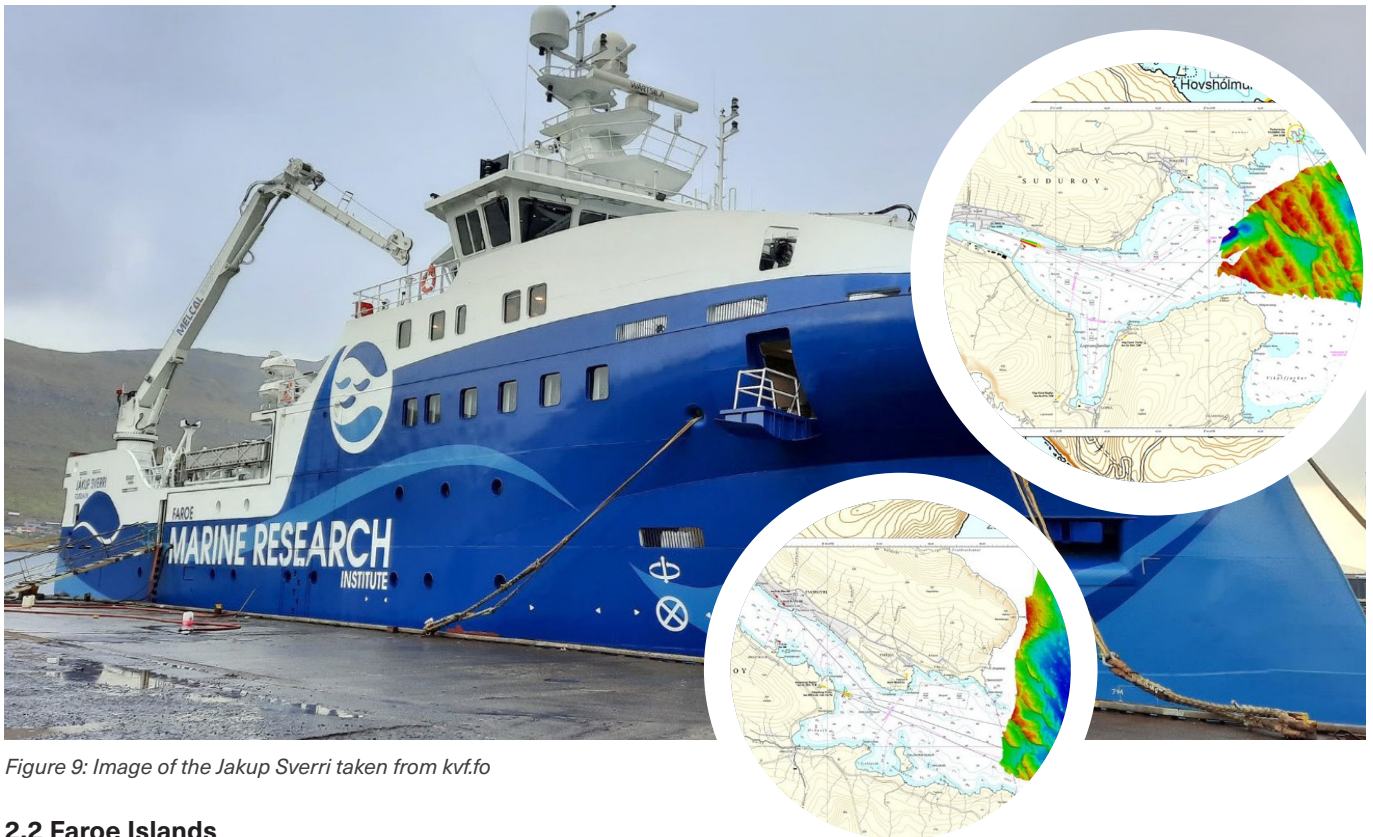


Figure 9: Image of the Jakup Sverri taken from kvf.fo

2.2 Faroe Islands

The Faroese Hydrographic Office continued to gather bathymetry data with the Faroese Marine Research vessel *Jákup Sverri*, mainly whilst the vessel is on research trips. The vessel was also hired for 2 days to collect data in Suðuroy, in the outer entrances to Vágur and Tvøroyari. Moreover, the Hydrographic Office has received data from private companies, who collect data for a future subsea tunnel between Suðuroy and Sandoy, as well as for the positioning of underwater kites generating electricity tidal streams.

2.3 New Technology

Crowdsourced bathymetry (CSB)

With the increasing maturity of the CSB technology DGA has targeted resources towards establishing an infrastructure for collecting more reliable CSB data, denoted Trusted CSB. This involves collaboration with research institutions and private industry in order to implement the infrastructure for Trusted CSB. See section 10.4 for more information.

In addition, DGA is participating in the Horizon Europe project called MobiSpaces exploring CSB data processing at the edge and how to optimize data paths with the global aim of improving navigational safety at sea.

Airborne lidar bathymetry

DGA has in collaboration with Hexagon AB successfully collected, processed and evaluated airborne lidar bathymetry for three pilot areas in Danish waters. See below example from one of the pilot areas, Figure 10

The next step is to assess how the collected airborne lidar bathymetry can be used in the production of nautical charts.

Satellite Derived Bathymetry (SDB)

SDB methods includes a range of technologies for deriving depths from satellite data and is expected to become more prevalent in the future.

DGA has compared SDB with collected airborne lidar and modern

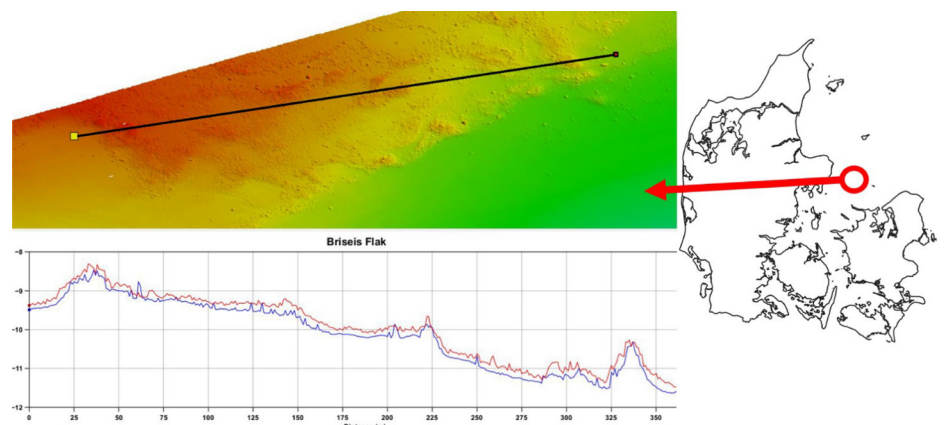


Figure 10: Depth profile at Briseis Flak, Kattegat. Airborne lidar in red and multibeam in blue.

multibeam bathymetry for two pilot areas in Danish waters. This is to explore where the different technologies may complement each other and where they may be limited to.

ICESat-2

One of the more recent satellite technologies for measuring water depths is the ICESat-2 mission. The satellite utilizes a green lidar system that can, in optimal conditions, detect photons reflected off the ocean bottom from which the depth can be derived. DGA has in 2022 collaborated with Aalborg University on evaluating ICESat-2 data in Danish waters and the results indicate that the technology has potential.

Hydrographic survey with autonomous surface vessels

A large part of the Danish maritime territory has not yet been surveyed with modern technology. When including the areas around Greenland, only a small percentage has been surveyed in high resolution.

In collaboration with a Danish company who are developing a multi-sensor system for autonomous navigation, the DGA will in the near future launch pilot projects on collecting bathymetric data. With the project, the DGA will collect bathymetric data in near-shore and offshore areas with a sailing drone. The project will pave the way eventually to operate maritime drones off the coast of Greenland or far from the Danish coast. Introduction of autonomous vessels for hydrographic surveys will enhance the ability to cover more areas and enhance flexibility.



Foto: Colourbox

3 New charts and updates

3.1 New ENC and Paper Charts

All the produced ENCs and updates are distributed through IC-ENC authorized distributors. In 2022 all charts (paper as well as ENCs covering the Danish, and Greenlandic waters) were produced and updated by DGA. Charts covering the Faroes waters were produced and updated by the Faroese Hydrographic Office.

Denmark

The portfolio consists of 69 of Danish Paper Charts.
4 new Editions of Paper Charts were published in 2022.

The portfolio consists of 333 Danish ENCs.

Usage Band	Number of Danish ENCs
1 Overview	1
2 General	9
3 Coastal	6
4 Approach	19
5 Harbour	298

Faroe Islands

The portfolio consists of 8 Faroese Paper Charts.
3 new editions were published in 2022.

The portfolio consists of 10 Faroese ENCs.

Usage Band	Number of Faroese ENCs
1 Overview	0
2 General	1
3 Coastal	1
4 Approach	6
5 Harbour	2

Greenland

The portfolio consists of 103 Greenlandic Paper Charts.
9 New Editions of Paper Charts were published in 2022.

The portfolio consists of 201 Greenlandic ENCs.

Usage Band	Number of Greenlandic ENCs
1 Overview	5
2 General	0
3 Coastal	49
4 Approach	55
5 Harbour	25

3.2 Distributions and sale

The Danish Geodata Agency has continued to increase its cooperation with IC-ENC with focus on a variety of products. Respective changes are closely linked to the revision of the Danish Geodata Agency’s price list that has been updated in the beginning of 2023. Throughout 2023, DGA will focus on aligning products and agreements with emphasis of ensuring safety at sea and optimizing costs and revenues.

The following figures 11 and 12 display the number of sales through IC-ENC and the number of sales of paper charts through own distributors in the period 2017-2022. As the figures present the sales of paper charts are decreasing, while sales through IC-ENC are slightly increasing. This tendency is shown in figure 13.

Sales through IC-ENC

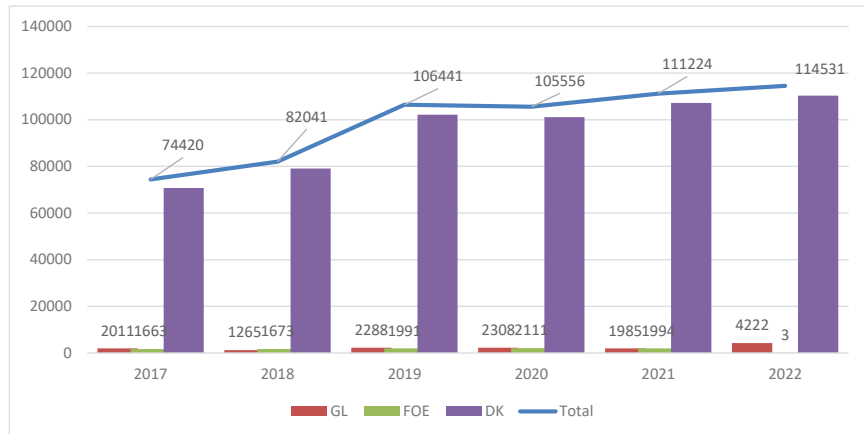


Figure 11: IC-ENC total sales 2015-2021.

Sales of paper charts through own distributor

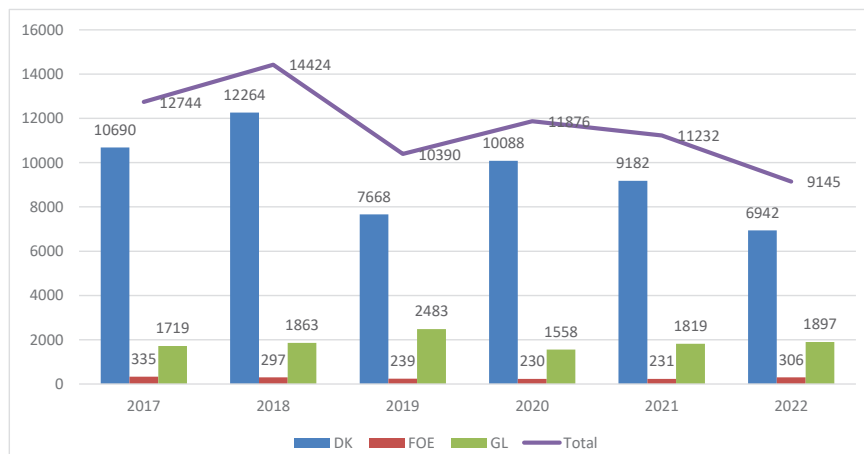


Figure 12: Paper charts total sales 2017-2022. Sales from bilateral agreement are not included.

Trend of total number of sales from IC-ENC and paper charts from 2017-2022

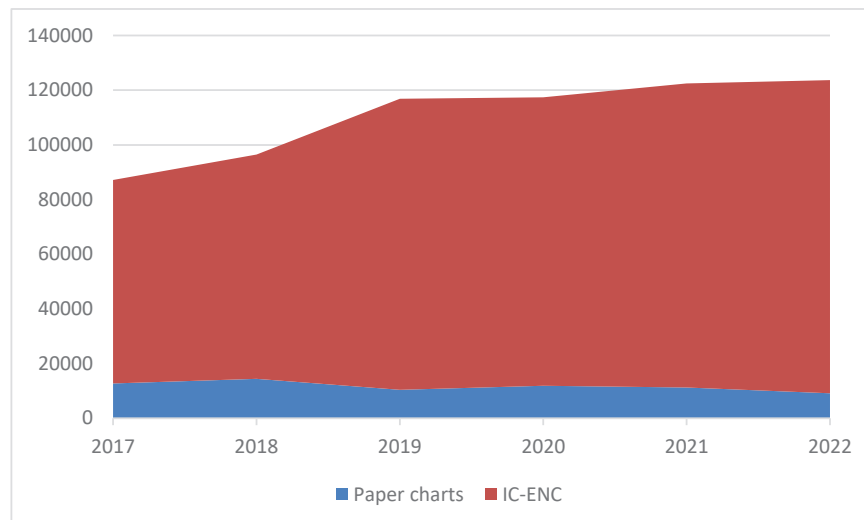


Figure 13: Trend of total number of sales from IC-ENC and paper charts from 2017-2022.

4 New publications & updates

4.1. New Publications

New version of Kort 1 INT1 was made available at the end of June 2022

4.2. Updated publications

The Danish Notices to Mariners (EfS) are available on the website of The Danish Maritime Authority: Nautical information | Danish Maritime Authority (dma.dk)

The Danish Meteorological Institute updates the tides tables: Tidevandstabeller (dmi.dk)

The Danish Geodata Agency publishes a number of publications, which can be found at the DGA website: Nautical Publications (gst.dk)

Publication	Formats			Available in English
	Paper	PDF	Digital	
Denmark				
Denmark Harbour Pilot - https://www.danskehavnelods.dk/			X	No
Denmark Pilot - General informations		X		No
Denmark Pilot II	X			No
Greenland				
Greenland Harbour Pilot - https://www.gronlandskehavnelods.dk			X	Yes
Greenland Pilot – General Information about Greenland		X		Yes
Greenland Pilot - Sailing Directions for East Greenland		X		Yes
Greenland Pilot - Sailing Directions for West Greenland		X		Yes
Greenland Pilot - Explanations of the place names		X		Yes
Faroe Islands				
Admiralty Sailing Directions NP52	X	X		Yes
Other				
Kort 1 · INT 1	X	X		Yes
Behind the Nautical Chart		X		Yes
Danish Chart Corrections		X		Yes
Product Catalog		X		No
Mariners' Routing Guide Baltic Sea			X	Yes
Navigation.gl			X	Yes

5 MSI

NAV Warnings are available in English on the following web page:
Nautical information | Danish Maritime Authority (dma.dk)

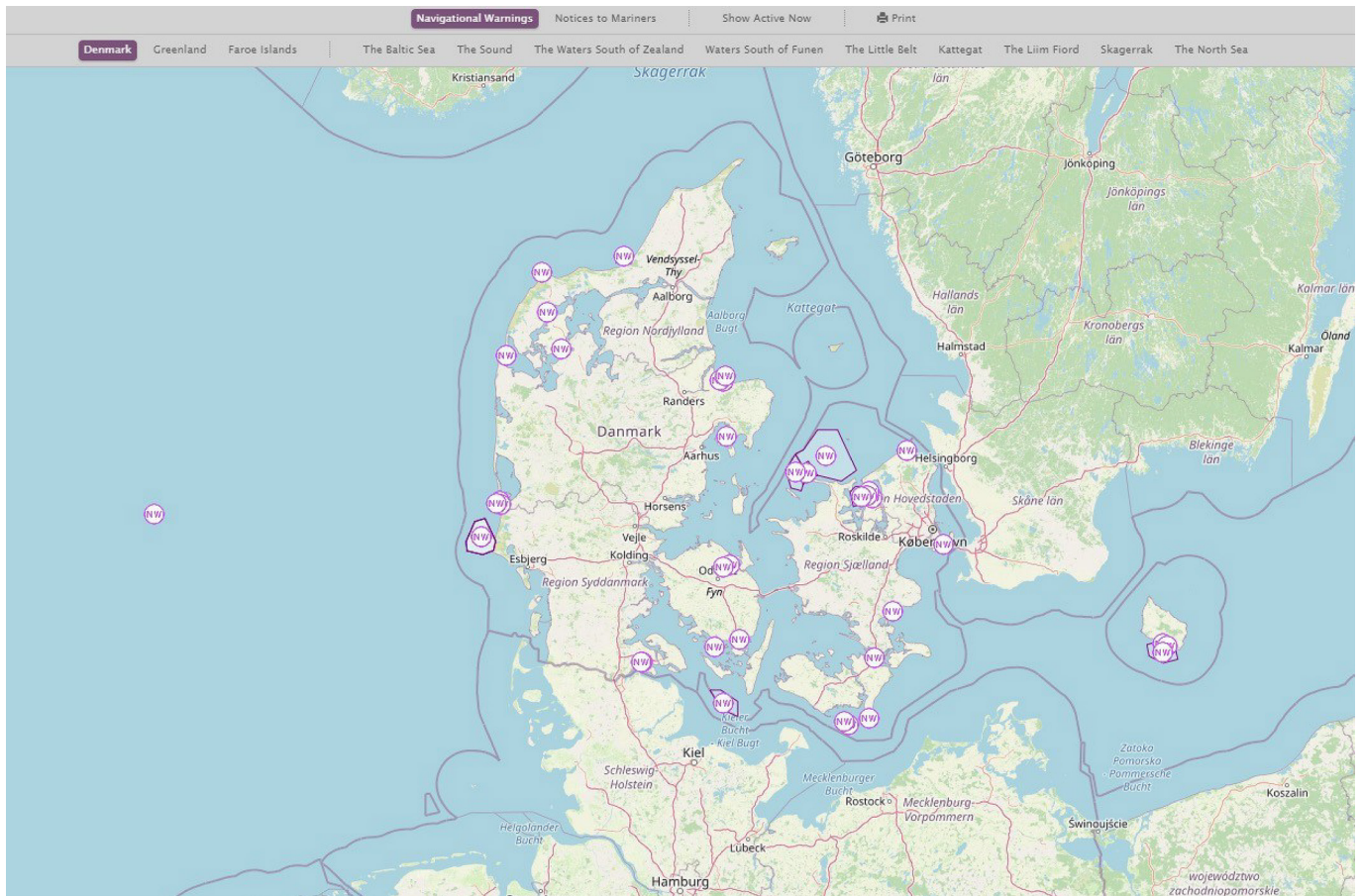


Figure 14. Navigational warnings Denmark.

6 C-55

C-55 was updated March 2023.

7 Capacity Building

Denmark has not been active in the area of capacity building during the period.

8 Oceanographic activities

8.1 Tidal levels

The Danish Meteorological Institute (DMI) and other governmental bodies maintain a network of tide gauges located across Denmark. The collected data are used in several ways: e.g. for safety of navigation, but they also represent an integral part of the national storm surge monitoring and prediction system. Newly collected data is transferred from the stations to the oceanographic database every tenth minute.

Online observations and forecast are available on several web sites (in Danish):

<https://www.dmi.dk/vandstand/>

<https://www.dmi.dk/dmis-vejrprodukter/vandstand/>

<https://app.fcoo.dk/ifm-maps/select/index.html>

<https://app.fcoo.dk/ifm-maps/select/index.html>

Tides are predicted for Danish, Faroese and Greenland waters, and the tables are updated once a year. In 2022, DMI provided tide forecasts (for 2023) for 187 locations spread across 100 Danish, 76 Greenlandic and 11 Faroese sites. In Greenlandic waters, DGA has collected tide data at six new locations. This data contributes to the LAToid project. This project - coordinated by the Danish Agency for Data Supply and Infrastructure (SDFI) with contributions from DMI, DTU Space, and DGA - aims to estimate the LAT (lowest astronomical tide) height above the ellipsoid based on satellite altimetry, hydrodynamic modelling and local observations.

Tidal predictions are available in a tabular form on the DMI website: Tide tables | Center for Ocean and Ice | (dmi.dk) and through a graphical interface on the Defence Centre for Operational Oceanography for the Greenlandic stations (<https://app.fcoo.dk/ifm-maps/select/index.html>).



Foto: Colourbox

9 Marine Spatial Data Infrastructure in Denmark

DGA is responsible for the Danish Marine Spatial Data Infrastructure (MSDI) and supports various activities related to access to marine data and collaborations in the marine data field in Denmark.

Through the website "The Marine Map of Denmark," DGA exhibits marine data from a wide range of public authorities and serves as a central entry point for more than 100 marine datasets in Denmark. In 2023 or 2024, the map portal will transition to a new ESRI platform, which will offer new opportunities for displaying and combining data.

Regarding collaborations in the marine field, DGA seeks to influence various initiatives in the government, business, and research sectors to create better conditions for sharing and accessing marine data. For example, the large investment in offshore wind turbines in Denmark requires easy sharing of marine data between private and public authorities. DGA is actively involved in this work. Another area where DGA contributes knowledge in the marine data field is the work surrounding the UN's Decade of Ocean Science for Sustainable Development, where DGA focuses on creating better conditions for access to marine data for the marine research community in Denmark.

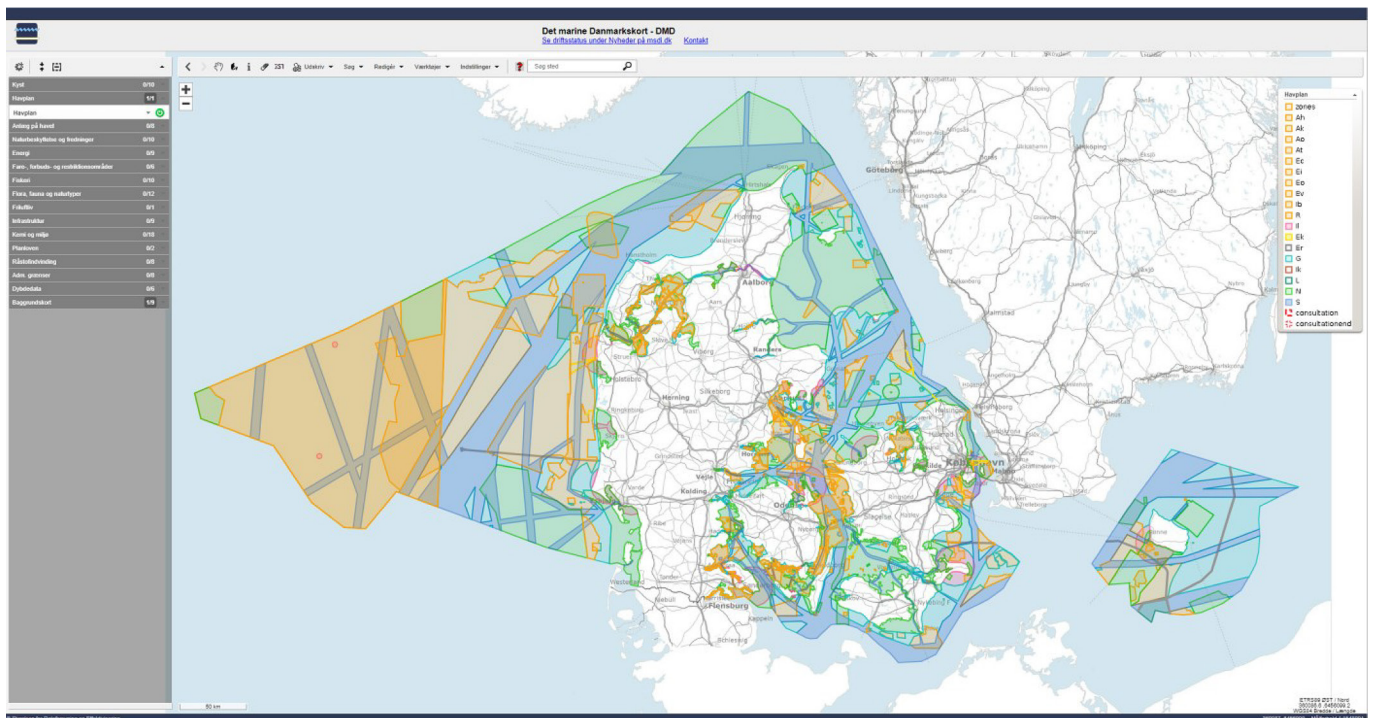


Figure 15. The Danish MSDI Map viewer with MSP data.

10 Innovation

10.1 Band 5 ENC's and paper harbor plans in Denmark and Greenland

In 2022 DGA has finished the production of the remaining band 5 ENC's and paper harbor plans in Denmark. The project has been ongoing for several years and has increased the numbers of band 5 ENC's in Denmark with approximately 180 new ENC's and paper harbor plans. In 2022 DGA has used a newly developed semiautomatic process to generate land data in Greenland for the use in the production of further 29 new Greenlandic band 5 ENC's and paper harbor plans in 2022 (see 10.2 below).

10.2 Semi-automated extraction of land data in Greenland

The manual extraction of land data from external sources for use in navigational charts is challenging and resource-intensive. To overcome this issue, DGA has been taking steps to reduce manual labor, such as mapping and documenting repetitive tasks related to land data and implementing visual programming languages in GIS platforms. The use of these tools helps transform external data into S-57 compliant features, which reduces the potential for human error and allows quality control to focus on the primary product, depth data. 90% of this transformation is semi-automated, while the remaining 10% is used to correct any irregularities and meet S-57 standards. This improves the accuracy of the information. In conclusion, utilizing visual programming languages and documenting repetitive tasks can efficiently reduce the manual processing of large datasets, resulting in improved efficiency and accuracy in representing land data alongside depth data.

10.3 Updated Depth Model in 50 Meter Grid resolution

Since early 2020, DGA has made relevant efforts to organize available bathymetric datasets in Danish and Greenlandic waters into a modern geospatial data management system named DYBDB, and elaborate methodologies to compile these data sources into digital bathymetric models and other valuable products (e.g., hydrographic survey overviews).

At the end of 2022, DGA released the Denmark's Depth Model (DDM), the first bathymetric product created employing DYBDB. This Depth model in 50-meter grid resolution has been made publicly available through the Danish Data and Map Supply (dataforsyningen.dk) as a downloadable geotiff-file or as a web map service (WMS).

The model is a depth-averaged digital bathymetric model, covering Denmark's Exclusive Economic Zone (EEZ). The depths are estimated using an averaging and interpolating approach, and the model is not for navigational use. The original bathymetric datasets are not distributed with the model, but are described in auxiliary layers to provide information about the bathymetric sources used for DDM. For more information: Denmark's Depth Model, 50 m resolution (gst.dk)

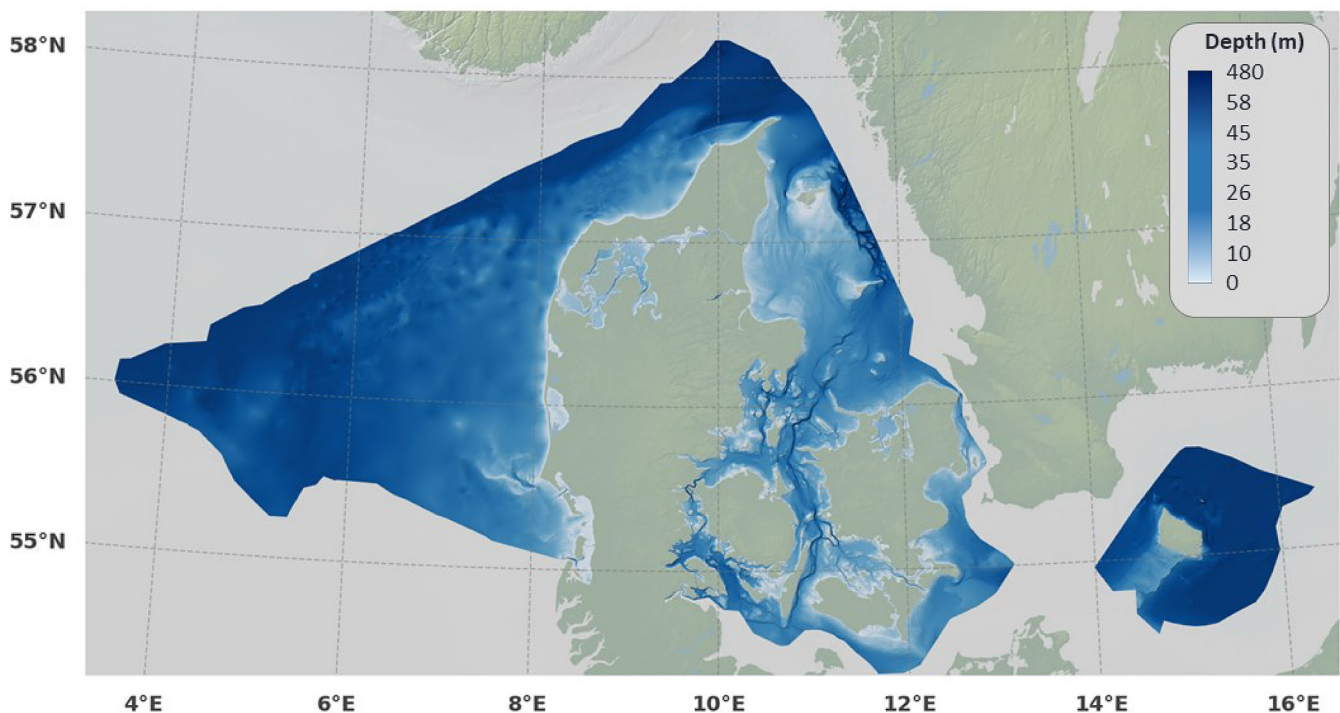


Figure 16: Depth Model in 50 Meter Grid resolution

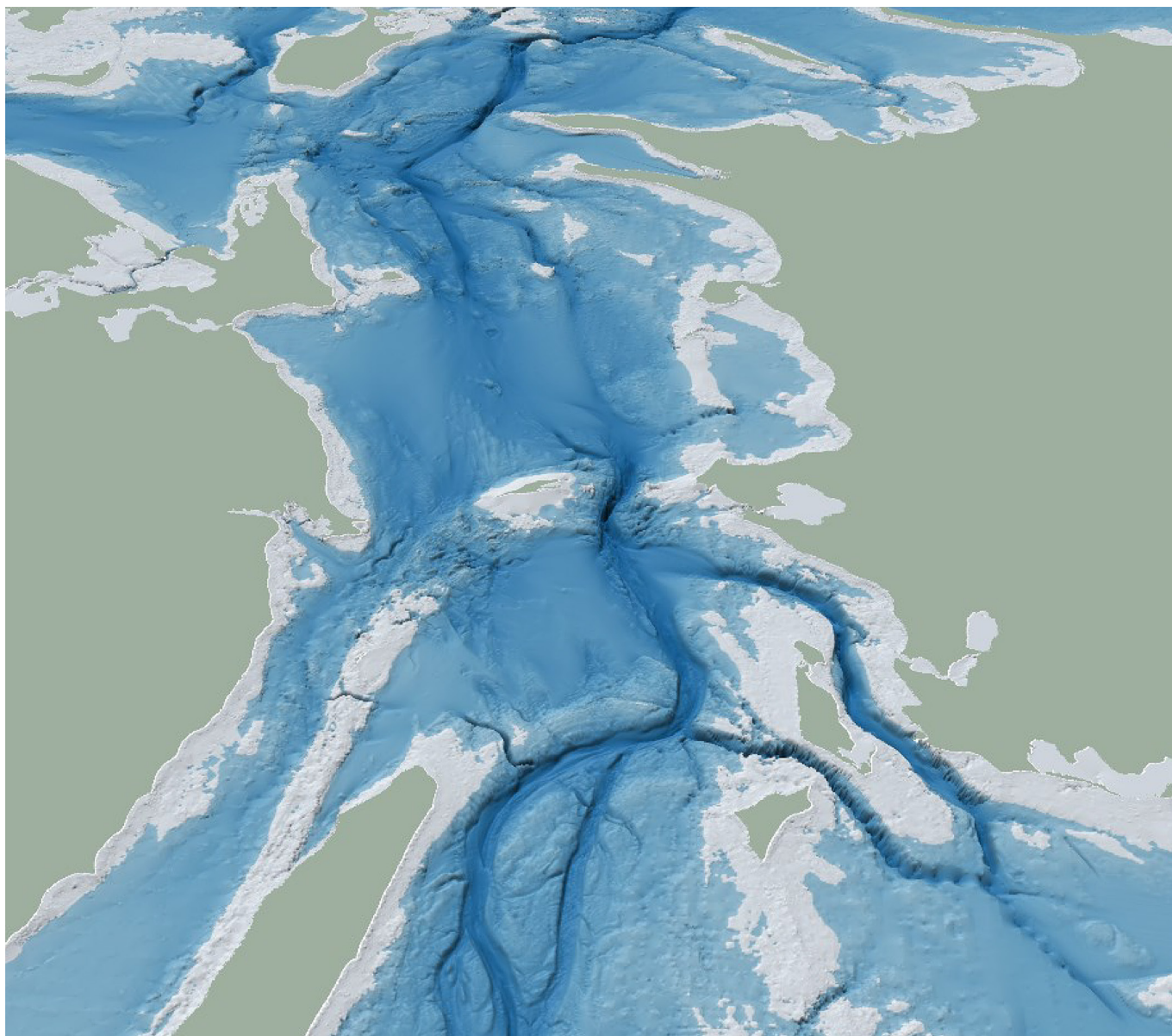


Figure 17: Perspective view of Denmark's Depth Model at the Great Belt facing north. The area is located between the greater islands, Funen (west) and Zealand (east), and is a heavily trafficked route to the Baltic Sea. The model hill-shading is rendered using a depth exaggeration of 25 times. The maximum model depth in the area is ~70 m.

A scientific article describing the data sources and compilation approach can be found here: [Geomatics Denmark's DepthModel: Compilation of Bathymetric Data within the Danish Waters \(mdpi.com\)](https://www.mdpi.com/2076-3213/12/12/2023). The adopted interpolation approach based on the Natural Neighbor algorithm shows positive results in preserving the details of the areas with dense MBES-type data (see Figure 16), as well as in transitioning between areas of wildly different density.

10.4 Trusted-Crowdsourced Bathymetry

In 2022, DGA has initiated a collaboration with the company Sternula to develop a scalable solution for trusted crowdsourced bathymetry (CSB) as a part of the strategy to increase the coverage of bathymetric data. The intention is to collect bathymetric data on a variety of marine vessels and to evaluate onboard the required level of prioritization for the transmission of data to DGA. The overall aim is to develop a framework for trusted CSB that is easily deployed, has open source app integration and is based on VDES (AIS 2.0) technology.

A prototype device has been successfully developed, and the next steps are to operationalize the concept, preparing for sea trials in Danish waters in 2023. For more information and the press release about the collaboration, please see [trusted CSB](#).

10.5 Strategic Sector Cooperation with Ghana

By agreement with the Danish Maritime Authority and the Ghana Maritime Authority, DGA is engaged in a project focusing on the enhancement of navigational safety on Lake Volta in Ghana. Through the combined use of satellite-aided identification of danger areas and Crowd-Sourced data collection, DGA aims to assess 'no-go areas', as well as danger areas within pre-determined areas on Lake Volta, Ghana.

In cooperation with an external maritime start-up, DGA is developing a prototype "Crowd-Sourced Data Box". This box is then installed on ordinary operating vessels on Lake Volta collecting relevant data of the vessels' sailing routes. The obtained data and results will facilitate the creation of danger/hazard maps of Lake Volta, and the goal is also to present the danger areas within the pilot area for end-users on Lake Volta, possible on an e-navigation platform, as a part of the capacity building. The results will furthermore allow DGA to gain knowledge on the limitations and benefits of Crowd-Sourced collection and satellite data analysis.

10.6 Hans-Island and the Border Agreement between Canada and the Kingdom of Denmark

Work has been ongoing on the delimitation of the border between Canada and Greenland for almost 20 years (since 2004). Initially intended as a modernization of the border agreed upon in 1973, in 2013, it was decided to also establish the northernmost part of the border including the so-called Hans Island.

The Danish Geodata Agency has provided technical advisory work together with GEUS (Geological Survey) and The Danish Agency for Data Supply and Infrastructure. In June 2022, in Ottawa, the new agreement was signed at ministerial level. An agreement that established the entire border from the Labrador Sea in the south to the Lincoln Sea in the north. The agreement also includes the land border on Hans Island, as well as the area south of Greenland, where a division between Canada and Greenland based on the claim submitted by the Commission on the Limits of the Continental Shelf (UNCLOS §76) was added as a border. The agreed border between Canada and Greenland now stretches from south to north for a distance of 3,962 km, of which 1.23 km is the land border on Hans Island.

Other relevant activities are described under item 2.4 New Technology.

11 Other activities

11.1 International activities

The Danish Geodata Agency holds the chair role in the Baltic Sea and North Sea MSDI Working Group (BS-NSMSD-IWG) and has the vice chairmanship for the S-100 Working Group and the ENC Working Group.

DGA also participates in the newly established IHO Hydrographic Surveys Working Group (HSWG) and the Tides, Water Level and Surface Currents Working Group (TWCWG).

The Danish Geodata Agency has been involved in the work done by e.g. IRCC, HSSC, S100-WG, ENCWG, WENDWG, NCWG, NIPWG, IENWG, CSBWG, DQWG, OGCMWDWG, HDWG and UNGGIM MWG.

Denmark supported both GEBCO and EMODnet by submitting bathymetric data.



Foto: Colourbox



Danish Geodata
Agency

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