Kartverket	**ARHC 12th Conference** **St John's, New Foundland, Canada,** **13 – 16 September 2022**	**ARHC** **National Report** **NORWAY**

NATIONAL REPORT
NORWAY

Executive Summery

This report gives the summary of the activities and events that have taken place within the Norwegian Hydrographic Service (NHS) since the last report given at the virtual ARHC11 Conference, November 2021.

1. Hydrographic Office

- **Organizational changes**
  As of 01.01.22, the Norwegian Hydrographic Service no longer runs its own survey vessel. The NHS is still the ship owner, but the maritime operations are now the responsibility of the Institute of Marine research (HI). While all maritime personnel have been transferred to the HI, the hydrographers remain NHS employees and are responsible for the hydrographic operations. After a short overlap period with the HI ship management department, the NHS ship management department was closed. Shown below is our updated organizational chart.

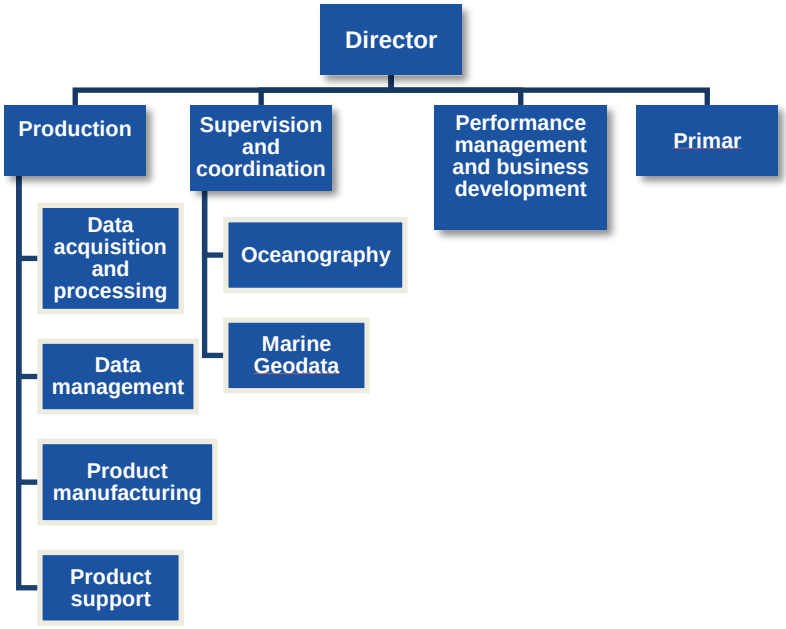


Figure 1 Organizational structure Norwegian Hydrographic Service

- **Marine Base Maps**
  The Marine Base Map pilot project is in its third and final year. The project team has staff from the NHS, the Geological Survey of Norway and Institute of Marine Resarch. Production of marine base maps, both bathymetrical, geological and biological for the 3 project areas is progressing according to plan. A proposal to Government for a national marine base map program has been handed over to Government, and we are eagerly awaiting their response. Although we have been optimistic, the onset of war and a subsequent energy crisis in Europe, we expect that a national program may be postponed.
  The focus in 2022, is to finish the production in the third project area. We will analyse data collected with new technology, for example airborne lidar. We will also continue to document user cases from the 3 pilot areas.

- **Ellipsoid Referenced Surveying and Processing**
  We have fully moved to ellipsoid referenced surveying and processing, but some refinements in the processes are still needed. In order for us to make the transition, we had to link Chart Datum to the Ellipsoid everywhere along the long and complex Norwegian coastline. A gridded model giving the vertical separation between CD and the ellipsoid for Norwegian territorial waters has been published but improving this model through sea level measurements in particular will be an ongoing process in the coming years.

- **Status S-100 implementation**
  A S-102 production line is set in operation. NHS have started production of S-102 data for some selected harbours and ports, and we will be releasing these over the coming 18-month period. Distribution of publicly available S-102 datasets will be done through PRIMAR RENC.
  NHS also produces restricted and not publicly available S-102 data for use by VTS stations and pilots, mainly covering selected anchorage areas and narrow passages.
  S-101 work is still in an early phase, focusing on competence and capacity building as well as production planning.

Hydrographic Surveys

2.1 Internal conducted surveying oct 2021 – aug 2022

R/V Hydrograf and its two survey launches have been working in the coastal waters of Norway and Svalbard.

Norwegian coast

The primary survey areas during this period have been fairway surveys along the Norwegian coast from Bergen to Harstad.

In addition, some areas close to the Swedish boarder were surveyed.

The total area surveyed along the Norwegian coast during this period was 650 km². *Figure 2* presents the coverage of internal surveying within the territorial waters.

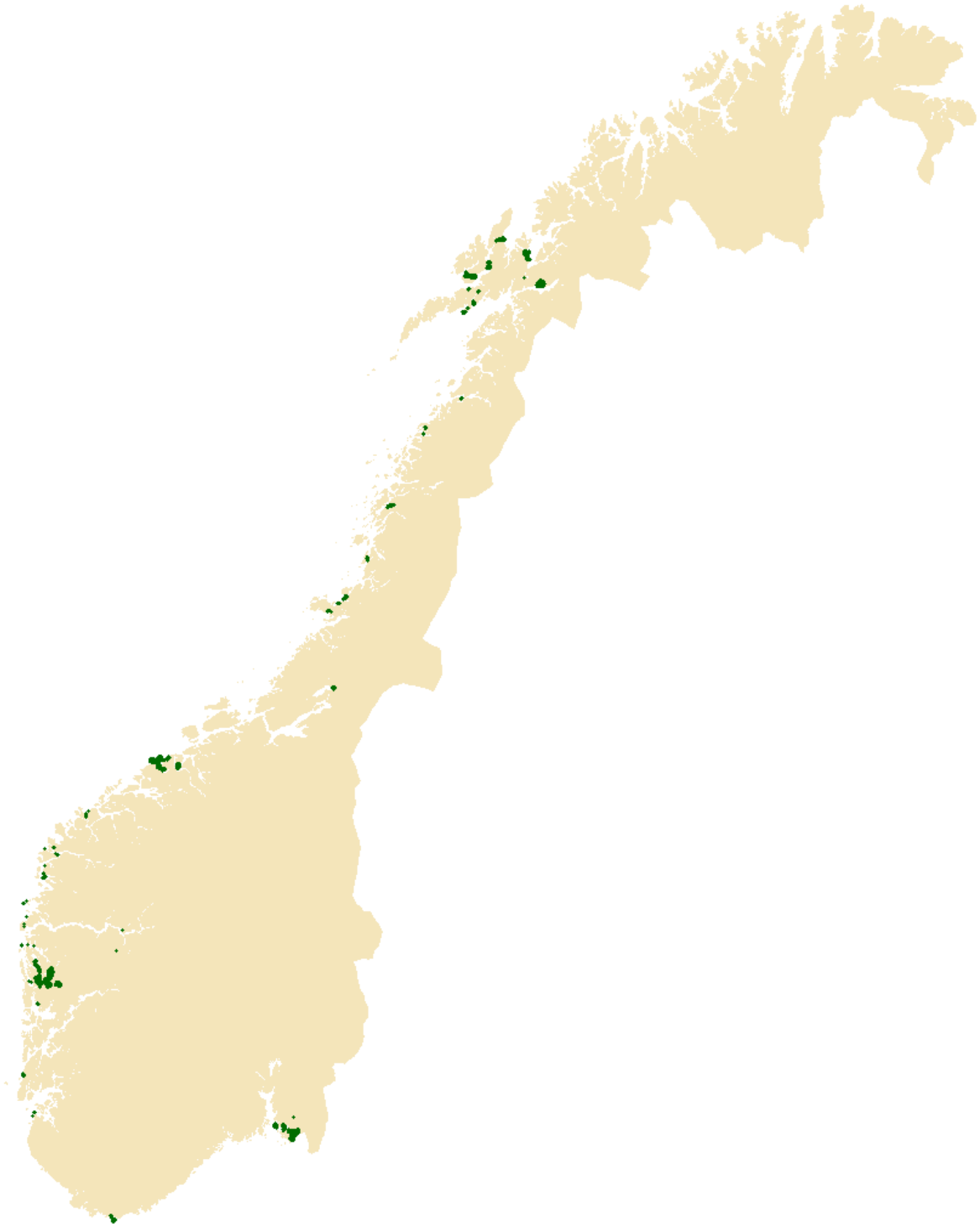


Figure 2 Area surveyed in territorial waters during the actual period. Please note that the area sizes are exaggerated to make the smaller areas visible on the plot.

Svalbard
The 2022 surveying around Svalbard was focussed on improving the fairways of the area. Very little sea ice made it possible to survey a route around Nordaustlandet - one of the major islands of Svalbard. The surveys are still ongoing. We do not have the details of the survey, but more than 2000 km^2 are covered so far.

Figure 3 An indication of the survey areas at Svalbard in 2022

2.2 External conducted surveying 2020 / 2021

Only surveys within the MAREANO program were contracted to external companies. The 2020 MAREANO surveys were conducted by Fugro Germany Marine on Spitsbergen bank in the Barents Sea. The 2021 MAREANO surveys were conducted by Arctia Meritaito Oy. The 2022 Mareano surveys are ongoing and are conducted by Clinton Marine Survey AB in the North Sea.

2.3 The Mareano Programme

Background: Mareano is a multidisciplinary marine mapping and documentation programme aiming at providing the foundation for ecosystem based sustainable management of the Norwegian coastal and sea areas. The primary focus has been The Management plan for the Barents Sea and the management plan for the Norwegian Sea, but in 2022 Mareano has started surveying in the North Sea (see figure 3 below). The North Sea has become relevant due to opening of offshore wind farm areas. The aim of the Mareano mapping is to bridge the knowledge gap in poorly mapped areas. High quality multibeam bathymetry is regarded as a premise for further geological, biological and chemical investigations. The NHS is responsible for bathymetric data acquisition (including backscatter and water column data), and effective data management and distribution of survey data, derived products and map services. An important facet of the programme is the web-based geodata distribution, and distributed data management as part of a National Spatial Geodata Infrastructure (NSDI). Mareano makes a significant effort in making data FAIR (Findable, Accessible, Interoperable, Reusable). Mareano works to emphasize environmental- and climate requirements in upcoming tenders.

Organization: The NHS is a programme partner in the Mareano Executive Group with the Institute of Marine Research (IMR, programme management) and the Geological Survey of Norway (NGU).

Results 2021: The Mareano program received NOK 100,2 mill in total through earmarked funding. NHS received NOK 22.6 mill. 1 090 km^2 was surveyed. In addition, it was surveyed in transit to contribute to crowd sourcing bathymetry.

Data distribution: The multibeam data has been modeled in digital terrain models with grids of various resolutions. The terrain is visualized through shaded relief maps as a Web Map Service included in the map services on the MAREANO webpage www.mareano.no.
NSDI: According to the MAREANO data policy all geodata from the Mareano programme will be published in the Norwegian spatial data infrastructure; *Geonorge* www.geonorge.no and www.dybdedata.no .

Mareano will be a major undertaking for the NHS in the years to come, and the programme is mainly aimed at non-navigational purposes.

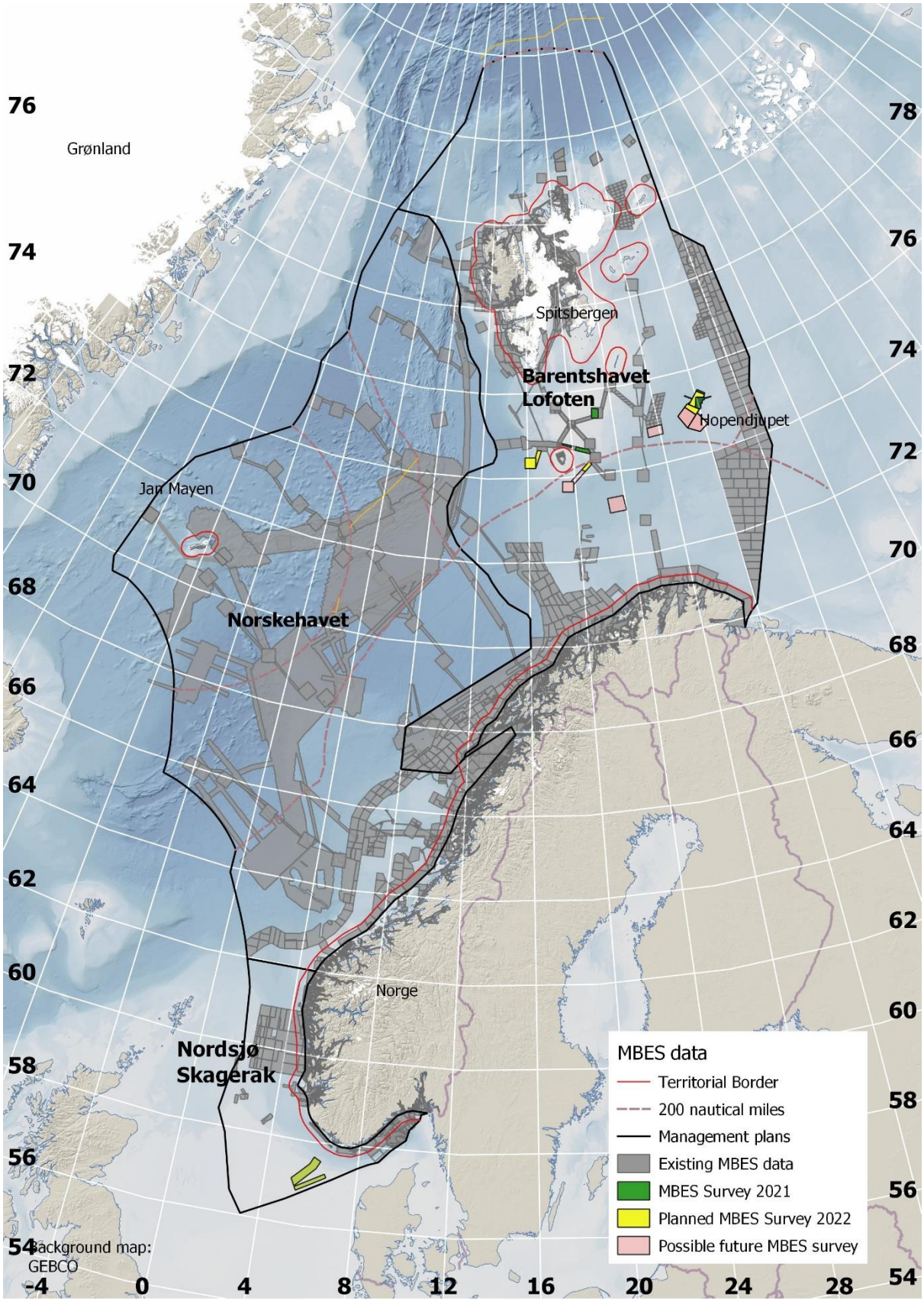


Figure 3. The Management plan areas and coverage of multi beam echo sounder data.

2.4 Marine Base Maps in Norway

Marine base maps in Norway is all about gathering detailed information and boosting the knowledge of the seabed and marine coastal systems along Norway's coast. The aim is to provide new business opportunities, stimulating and/or optimizing the growth of industries, better public administration and effective coastal zone management. Marine base maps in Norway (i) maps on a large scale the seabed's physical, biological and chemical environments (ii) analyses the data and (iii) distributes a set of standardized products. The products can be combined with other datasets.
It is a cooperation project with 3 partners: The Norwegian Hydrographic Service (leading the project), Geological Survey of Norway and the Institute of Marine Research. This cooperation allows for a streamlined process from data collection to distribution. It also has the added advantage of better coordination and management of resources.

We are running a pilot project in three pilot areas along the coast for a 3-year period 2020-2022. The budget for the 3-year pilot is NOK 84,6 mill. The pilot projects investigates and tests new technology for data collection and processing and, in addition, develop a cost-effective model for the implementation of a program for Marine base maps in Norway.

Workshops have been held in three pilot areas with planning staff of municipalities and provinces, government agencies and industry / commercial actors. Results have been used for many purposes and user cases are documented.

A proposal for a national program starting in 2023 has been send to the Ministry of Local Government and Regional Development.

2.5 FAIR-principles

The FAIR-principles provide a set of defined guiding principles and practices that enable both machines and humans to find, access, interoperate and re-use digital assets.
(FAIR = **F**indability, **A**ccessibility, **I**nteroperability, and **R**eusability)

The Mareano programme and **Marine Base Maps in Norway** have decided that all datasets collected and processed by the collaborating partners, shall be evaluated and adapted according to these FAIR-principles. An initial FAIR-implementation guide has been worked out to support ongoing activities, in accordance with relevant national infrastructures like Geonorge and NMDC (Norwegian Marine Data Center). The aim is to ensure that information pertaining to the seabed is made easily available to all who will benefit from its use, including those engaged in research, management and business ventures. An online status register has been developed within Geonorge to keep current track on the various dataset's fulfillment of the FAIR principles as well as other requirements from the NSDI. Ref. Mareano Status Register.

See also chapter 9 Spatial Data Infrastructures.

3. Nautical Charts

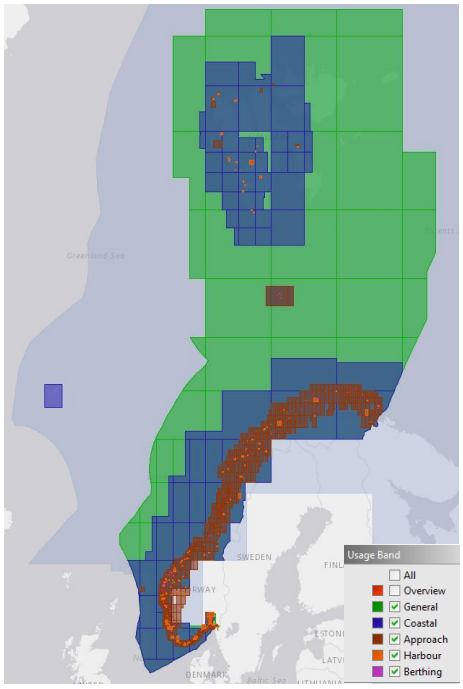
NHS has covered the Norwegian coast with ENCs and modernised paper charts. In the Arctic and Antarctic waters, there are still areas without any coverage. The NHS production department has been concentrating on replacing areas with old survey data with new data. NHS prioritize these areas based on safety of navigation and economic benefit to society.

ENC coverage, gaps and overlaps

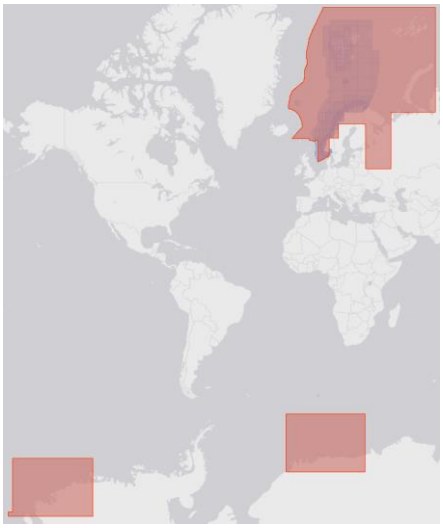
We have a total of 1212 ENCs at the end of July 2022.

	Usage Band	Compilation scale	No of ENCs
1	Overview	< 1:1 499 999	3
2	General	1:350 000 – 1:1 499 999	70
3	Coastal	1:90 000 – 1:349 999	84
4	Approach	1:22 000 – 1:89 999	765
5	Harbour	1:4 000 – 1:21 999	219
6	Berthing	> 1: 4 000	71

Table above: Number of ENCs in each usage band per 31 July 2022.



Figur 4 ENC coverage for the Norwegian coastal waters (ENCs in User Bands 2-6).



Figur 5 ENC coverage in User Bands 1.

From last ARHC-meeting to July 2022, existing ENCs in several major- and most important fairways from Rogaland to Trøndelag are updated with multibeam survey (Sandsfjorden, Stokksund, Fanafjorden-Raunefjorden, Sotra-Askøy-Hauglandsosen, Sørfjorden Hamarsneset, Sørfjorden-Kvisti, Radfjorden, Osterfjorden, Lerstadholmen-Stokkholmen).

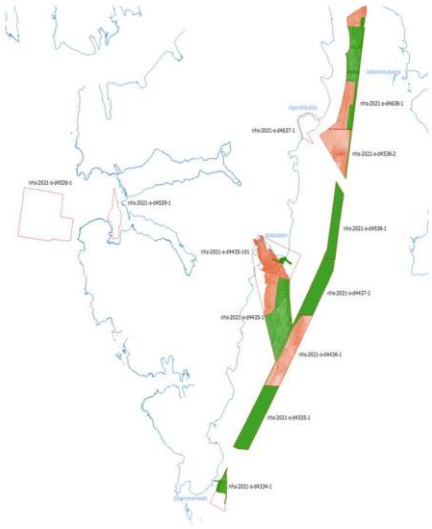
The cells NO4M1309 and NO4E1309 are fully replaced with new survey.

Also in small parts of other existing ENCs along the Norwegian coast old bathymetry have been replaced with new survey based on request from users.

In Svalbard sparse bathymetry with poor quality was replaced with multi-beam surveys in parts of existing ENCs in Forlandssundet and Kongsfjorden.

Figur 6 Multi-beam surveys within the red polygons were released in ENCs in 2021.

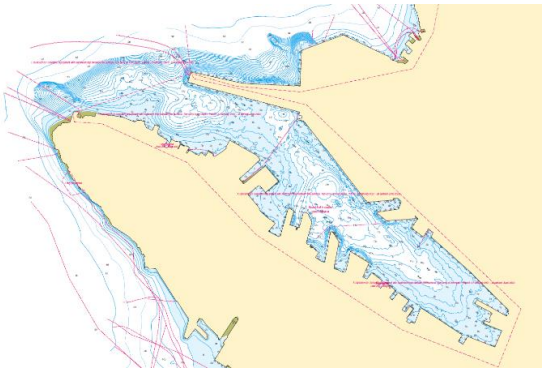
We are now working on expanding the multi-beam corridor in the ENCs in Storfjorden Svalbard with surveys from 2021.



Figur 7 Multi-beam surveys within the green and red polygons are now in progress in ENC.

This spring we have established a new production line for high density-ENC (HD ENC). HD ENC for Stavanger harbour was released in May and HD ENC for Bergen harbour was released in July 2022.

Figur 8 HD ENC Stavanger harbour



Figur 9 HD ENC Bergen harbour

In 2021 a total of 2901 ER files and NE were issued as part of the continuous maintenance of the ENCs. From October 2020 NHS publish all reported corrections based on priority. All important updates, included Temporary (T) and Preliminary (P) notices, are released within 7 days.

RNCs

The Norwegian Hydrographic Office is not producing Raster navigational charts.

INT Charts

Norway has 23 INT-charts in the chart portfolio. Most of them are small-scale charts (general and coastal charts). Last year (August 1st 2021 – July 31st 2022) two new INT-chart were issued as New Charts. This was:

Chart No.	Title	Scale
1. 313	**INT 9316** / Lopphavet – Mehamn	1:350 000
2. 314	**INT 9317** / Mehamn – Grense Jakobselv	1:350 000

INT Charts, new editions with new survey data published last year (August 1st 2021 – July 31st 2022)

Chart No.	Title	Scale
1. 505	**INT 9311**, Svalbard	1:700 000
2. 507	**INT 9313**, Svalbard. Nordsvalbard	1:700 000

National Paper Charts

A total of 32 new editions of national charts were issued last year (August 1st 2021 – July 31st 2022) due to updates from new surveys. 6 harbour charts, 24 main charts and 2 charts for Svalbard.

National charts, new editions with new survey data published last year (August 1st 2021 – July 31st 2022)

Chart No.	Title	Scale
1. 4	Oslo – Rødtangen – Drammen	1:50 000
2. 9	Lillesand – Ny-Hellesund	1:50 000
3. 10	Ny-Hellesund – Lista	1:50 000
4. 15	Ryfylkefjordane. Sjernarøyane – Sauda	1:50 000

Chart No.	Title	Scale
5. 19	Ryvarden – Selbjørnsfjorden	1:50 000
6. 21	Selbjørnsfjorden – Bergen	1:50 000
7. 23	Bergen – Fedje	1:50 000
8. 24	Fensfjorden – Sognesjøen	1:50 000
9. 25	Sognesjøen – Stavenes	1:50 000
10. 26	Håsteinen – Batalden	1:50 000
11. 31	Breidsundet – Fjørtoft	1:50 000
12. 32	Steinshamn – Hustadvika	1:50 000
13. 38	Trondheimsleia. Terningen – Kyrksæterøra – Ørlandet	1:50 000
14. 43	Agdenes – Lauvøya	1:50 000
15. 65	Fleinvær – Bodø – Landegode	1:50 000
16. 77	Tjeldsundet – Harstad – Lavangen	1:50 000
17. 100	Ytre Sørøya	1:50 000
18. 111	Berlevåg – Båtsfjord	1:50 000
19. 119	Osterfjorden og Sørfjorden	1:50 000
20. 120	Hjeltefjorden. Stureterminalen – Mongstad	1:50 000
21. 121	Ytre Sognefjorden	1:75 000
22. 126	Storfjorden. Ytre del med Hjørundfjorden	1:50 000
23. 136	Beiarn – Saltfjorden	1:50 000
24. 142	Narvik – Skjomen – Rombaken	1:50 000
25. 456	Ålesund havn	1:20 000
26. 460	Bergen havn	1:10 000
27. 461	Narvik havn	1:10 000
28. 472	Drammen havn	1:10 000
29. 476	Bodø havn	1:10 000
30. 487	Harstad havn	1:10 000
31. 513	Svalbard havner: Sveagruva, Forlandsrevet, Adventfjorden og Ny Ålesund	1:15 000 – 1:50 000
32. 522	Forlandsrevet – Femtebreen	1:100 000

Other charts, e.g. for pleasure craft

NHS do not produce any other charts than the official paper charts and ENCs for navigation, but are distributing S-57-cells (derived from the official ENCs) for use in charts and maps e.g. for the leisure boat marked.

Challenges and achievements

This year (2022) NHS established a new production line for high density-ENC (HD ENC). The first HD ENCs were covering Stavanger harbour and the second was covering part of Bergen harbour. More HD ENCs will be produced in other ports along the Norwegian coast in order of priority.

Primary and secondary fairways up to western Norway have been updated with multibeam surveys, and on Svalbard, existing ENCs in western part (Forlandssundet and Kongsfjorden) were updated in 2022 with new surveys.

A major challenge in working with high-density bathymetry is still the current Norwegian classification regime, but we have got some specific areas degraded for use in our HD ENCs. We are still expecting a change of this regime and expect a release of detailed depth information inside the 0-30m depth area.

4. Nautical Publications

By digitizing the Norwegian pilot we had to develop a new national port data standard. In 2020 the standard was used to collect port data from 17 ports in Norway. The digital port data is stored in a common map database. A registration document has been prepared in Norwegian, so that all ports can register data themselves. The standard is available in Norwegian and English. The registration document is currently only in Norwegian, but will be translated into English in 2022.

There is currently ongoing standardization work with the port data standard. Based on experiences and feedback from the survey's in 2020 (and adaptations to the marine harbour infrastructure (S-131) that are being developed by IHO/NIPWG) there has been revisions and improvement to the standard. The UML-data model and the registration document are now published in version 2.0, and we are working to a standardized product specification (version 3.0), expected to be completed by the end of 2022.

There has been great interest in port data from many parties, both private business, the ports themselves and other public or governmental agencies. There has been written a user needs report, with an analysis of the need and interest to the various stakeholders present in a port. This report has been used with regards to further adaptations to the standard. This work is expected to be completed first half of 2022.

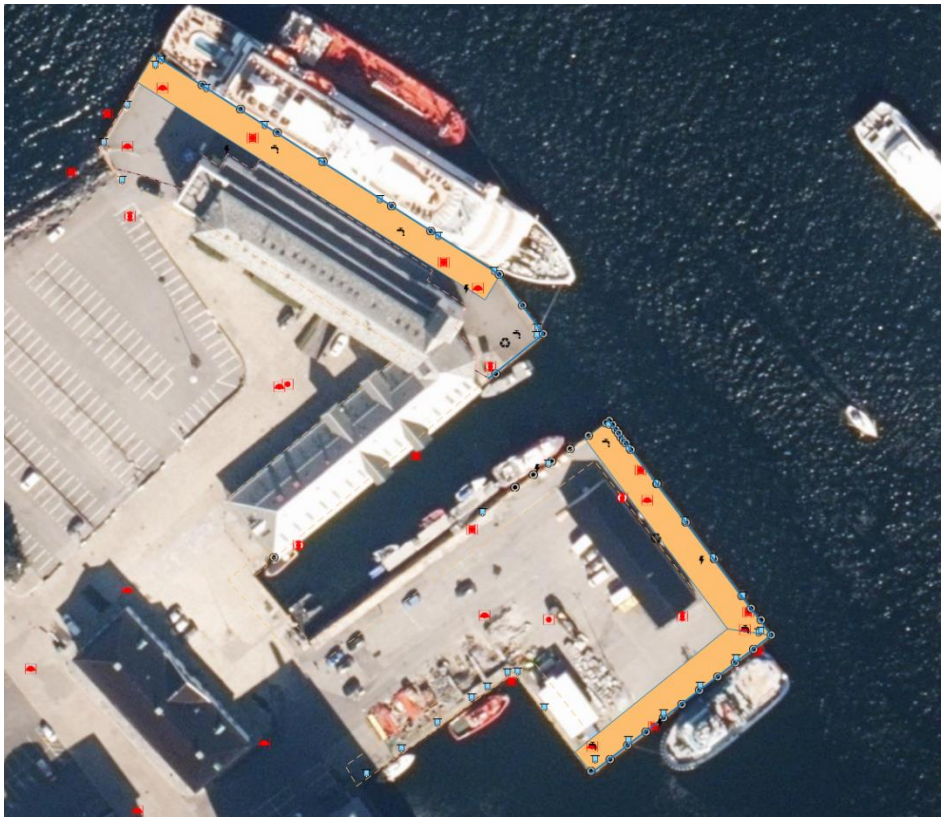


Figure 9 Example updated drawing rules (Port of Bergen)

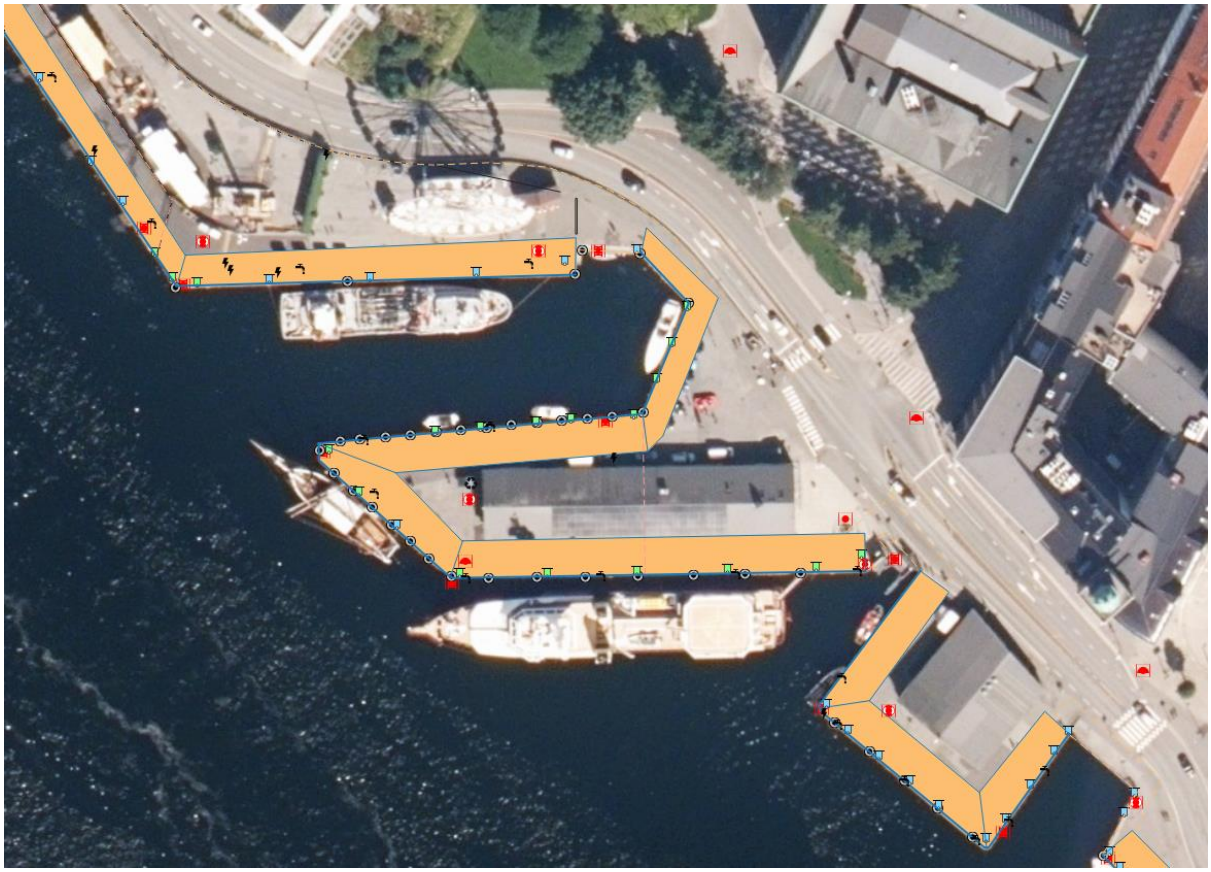


Figure 10 Example updated drawing rules (Port of Bergen)

Drawing rules have been made and new symbols are being prepared.

Efforts are being made to get more ports to register the data themselves. The goal is that the ports keep their port data updated and quality check their data. This can be done through plug-in developed for the open source GIS-application QGIS, for easy access directly in the database hosted by the Norwegian Mapping Authority.

The data will be displayed in the Norwegian pilot guide, but can also be downloaded as a dataset in our national geoportal, Geonorge. By compiling the data into a common map database based on port information, we will have all the information in one place, which means that all information is correct and continuously updated. It is also desirable to expand the database with more port data from several more ports in Norway.

In 2021 a project which is a collaboration between 9 major ports in Norway started up. The port of Oslo is project owner, and the Norwegian Mapping Authority is project leader. Accurate port data is a key component for success of this project. Port data can be used to develop tools for more efficient and easier management and planning of the daily operations in the port.

5. MSI

The Norwegian Maritime Directorate is the responsible body for MSI in Norway.

6. C-55

The last update of C-55 was sent to IHB in January 2022

7. Capacity building

Norway chaired the annual meeting of the IHO Capacity Building Sub-Committee in May 2022. The IRCC and the CBSC encourage Member States from the most developed regions to be involved in capacity building by assisting CBSC activities or by other means.
Norway has finalized its capacity building project with the Albanian Hydrographic Service.

8. Oceanographic activities

The tide gauge network in Norway consists of 25 gauges including one in Ny-Ålesund at Spitsbergen. We do short-term water level measurements at locations between the permanent gauges. These are used to construct the tidal zones used to provide water level data and information for most places along the Norwegian coast. Professional users can download data from an API directly. Our website Se havnivå provides tide tables, observed water level and water level forecast for 5 days (from a model run by the Norwegian Meteorological Institute). We also present figures showing different tide levels, land levelling datum and return periods (up to 1000 years). The information in the figures are very important in coastal planning.

To increase the use of water level observations and water forecasts instead of only tidal predictions, from 2022 the official Norwegian tide tables are no longer published as a separate publication. All necessary information is available in the web pages.

In 2022 the national models describing the relation between the different datums; Chart Datum, the land levelling datum, Mean Sea Level and the ellipsoid were further developed. Even models for Spitsbergen are now available. These models facilitate, among others ellipsoidally referenced surveying. The models are available at Geonorge.

In 2022 the aim is to install 3 new permanent tide gauges. One in the southwestern part of Norway, in an area where low tidal amplitudes and large phase differences together with relatively large surge has made it difficult to make good water level data available. The remaining two stations will be installed in the outer and inner part of one of the long fjords in the western part of Norway. This is to increase the knowledge about the tides in the fjords.

The new tide gauges will consist of radar sensors for water level monitoring and geodetic sensors for land movement monitoring and will be installed in closed collaboration with the Geodetic institute. Figure 11 shows the locations that have been identified so far, but both locations and the number of new permanent tide gauges might change over the duration of the project.

Figure 11 Map showing location of existing permanent tide gauges along the Norwegian coast (red dots) and the areas that are identified as of interest for new permanent tide gauges.

We have delegates in the IHO-working groups "North Sea Hydrographic Commission Tidal Working Group (NSHC-TWG)", "Tides, Water Level and Current Working Group (TWCWG)" and an observer in “Baltic Sea Hydrographic Commision - Chart Datum Working Group” (BSHC CDWG). In addition we participate in the GLOSS Group of Experts and the EuroGOOS Tide gauge task team.

9. Spatial Data Infrastructures

MSDI is an integrated component of the national SDI in Norway. The cooperation Norway digital counts for more than 600 organizations, where over 50% are involved in coastal and/or offshore activities. NHS is a key player in the development of relevant collaboration arenas between data owners, service providers and end-users to improve the user-value of marine and maritime geospatial services to society.

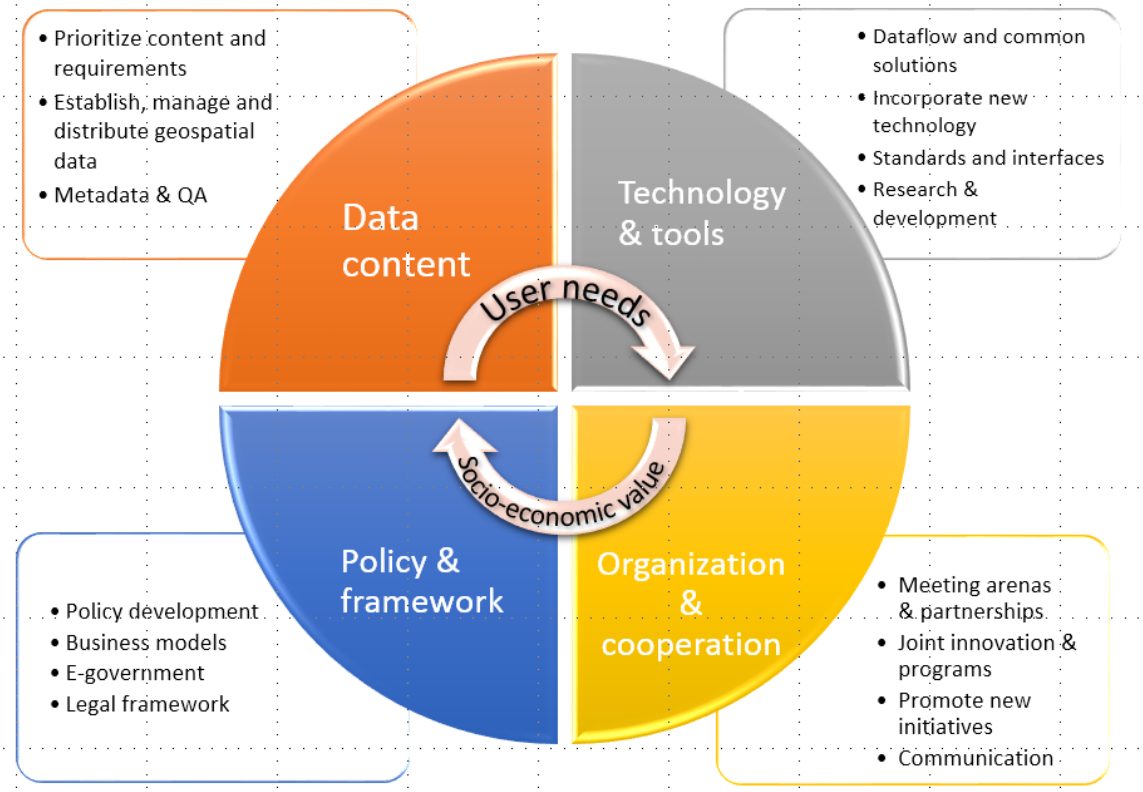


Fig.9 Norwegian SDI approach

A national governmental geospatial strategy, "Everything happens somewhere", has the ambition to improve the value of geospatial information and its usefulness to society in Norway. The primary objectives for this strategy is to:

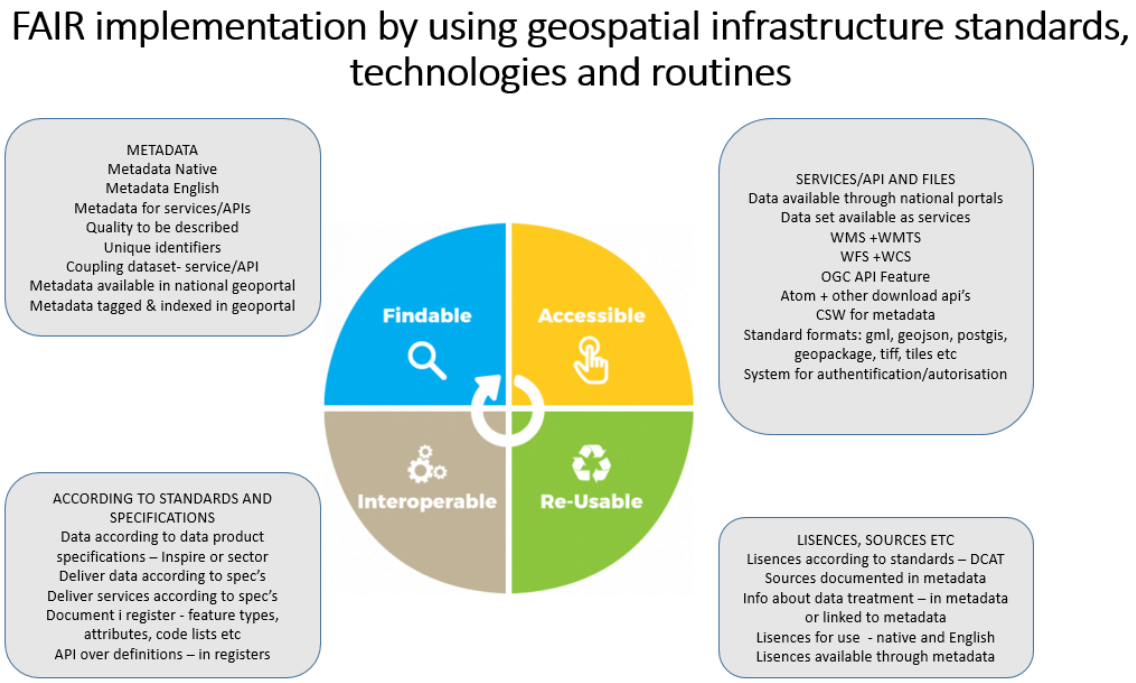
- Offer a national knowledge base of geospatial information that meets important societal needs and user-priorities
- Incorporate technological tools and improve interoperability to increase interaction, efficiency and innovation
- Improve and further develop cross-sectorial cooperation and collaboration arenas between both public and private sector
- Adapt policies and framework conditions to meet the challenges within geospatial infrastructure, e-governmental services and the digital society in general

A yearly revised national action plan supports this strategy with more detailed descriptions on where and how to improve the national SDI.

FAIR

The FAIR-principles provide guidelines to improve
the **F**indability, **A**ccessibility, **I**nteroperability, and **R**euse of digital assets

The Norwegian Mapping Authority is leading the FAIR working group of MAREANO which aims to enhance the FAIRness of MAREANO data to the benefits of users. A key approach is to build on top of existing components of the NSDI:



The project has established a registry in the national geoportal (Geonorge) containing all datasets from MAREANO. A FAIR assessment tool to automatically assess the FAIRness of the data registered is developed and is being evaluated for further improvement.

10. Innovation

NAUTILUS - New Hydrographic Infrastructure

NHS requires to renew its management, storage and processing system for bathymetric and misc. marine geo data in order to:

- more effectively serve existing and future users
- support new data formats, standards and products
- meet future requirements for automation, machine learning, quality and lead time

NHS have therefore established a project “Nautilus” (earlier named *New Hydrographic Infrastructure*) with the aim and goal to renew existing Hydrographic management systems/solution.

Norwegian governmental strategi set clear expectations to the solution and support an effective dissemination of various Marine Geodata and, at the same time, answer well to user needs and grow their values.

Expected changes to the data classification act, for bathymetric data and bottom objects, is understood to allow and define production and dissemination of new high-resolution geodata for the public, which also set requirements to the need for a greater degree of automation. NHS’s nautical product users expect navigation-critical data to be released faster and more efficiently. International commitments along with the need to support new nautical standards will come in effect in the coming years.

Requirements and processes for current management and production system for bathymetric data are largely based on and defined by nautical production and products. This will change to a more data and service generic solution, whilst maintaining a high quality nautical products portfolio.

The new system is expected to be an integrated and complete management solution supporting effective preparation and dissemination of a broad range of marine geodata, including bathymetric and derived bathymetric products. The solution must/shall ensure an effective production of authorized nautical products.

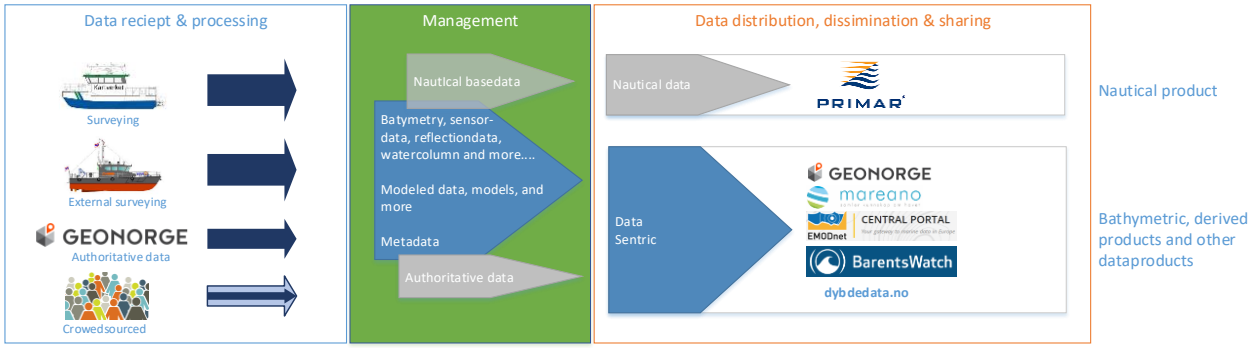


Fig.13. Concept of Nautilus

The new solution will be based on a modern technological platform that supports:

- an efficient and integrated nautical production
- multiple/various digitization and data sharing solutions
- fast data access and effective bathymetric production (short processing time / increased automation)

- layered services and functional structure (allowing algorithmic, AI/ML, production etc. processes to run on top off the data)
- an integrated metadata management
- management of complete and original data (no or minimum generalization required)
- integrated product and data sharing solutions (machine-to-machine, APIs, etc.).

NHS has identified the following processes that will be supported in the new solution, whereas processes within the yellow frame are given priority within Nautilus program:

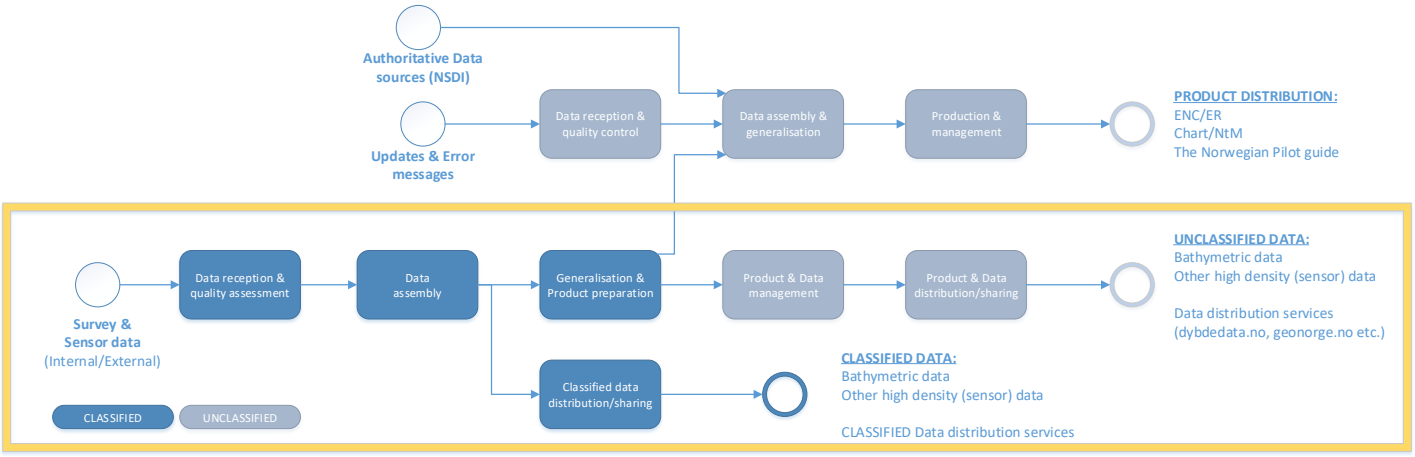


Fig.14 New Hydrographic Infrastructure, the Nautilus project

The Nautilus project (as scoped) is planned to take 5 years to complete (period 2022 – 2026), has an estimated total cost of appr. €13.5 Mill. EUR and has received full funding over the national budget from 2022. The project will include organizational as well as technological changes.

Nautilus 2022-2026 development activities started to take a place. With the Nautilus principles in focus the new management system for closed environment is being tested and planned to go-live in October 2022. That will be followed by migration of the bathymetric data from the old data management system which will be sunset when migration process completed. In parallel the relationship between closed and open environment is investigated in order to automate and improve the process. Activities to establish automation on the open environment will start in 2023 with the focus on user and effective dissemination of the various Marine Geodata. Internal and external cooperation is securing effective progress of the project.

Nautilus Cooperation

Nautilus Project is seeking cooperation with other Hydrographic Offices in order to ensure common approach towards standardized deliverables, services as well as interfaces. FAIR approach stays in the high focus.

11. Other activities

International activities

The NHS is involved in several Working Groups, Committees and Commissions related to IHO. Norway has representatives in the following Sub-Committees and Working Groups: IHO Council, S-100, DQ, ENC, NC, NIP, TWC, IEN, MSDI, CSB and WEND. We have participated in the HSSC and the IRCC meetings in 2022. Norway is actively participating in 5 Hydrographic Commissions: ARHC, HCA, NHC, NSHC and SAIHC.

The NHS is a member of the UN-GGIM Working Group on Marine Geospatial Information, actively contributes to the Seabed 2030 project and chairs the GEBCO Guidance Committee, the CBSC and the DQWG

As operator of Primar we participate in all related meetings.

NHS is an active partner in EMODNet.