

Cross sector collaboration on Arctic and Ocean Databases for sustainable management.

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1. SUMMARY

Sustainable management of the ocean and value creation linked to the sea and arctic areas will play a vital role for the world's ability to realize the totality of the Sustainable Development Goals by 2030. The SDG specifically addressing the ocean, SDG 14, stresses the urgent need to “conserve and sustainably use the ocean, seas and marine resources for sustainable development”.

Mareano represents a cornerstone of Norway’s marine knowledge infrastructure through the last 20 years. Through systematic seabed mapping and open dissemination of data, the programme enables sustainable use, protection, and understanding of marine environments. Its applications, from spatial planning and conservation to industry and climate adaptation, demonstrate the broad societal value of comprehensive marine mapping. As pressures on the oceans increase, initiatives like Mareano provide an essential foundation for informed and responsible ocean governance.

Coastal Zone Base Maps is a similar program for the coastal sea and started with three pilot areas in 2020 and now is a program in Finnmark County.

Arctic areas are dependent on accessible geographic information for efficient governance. Now the situation in the Arctic is tender both in the long term with the threats of climate change but now especially with the actual political situation. Surveying the Arctic provides the spatial foundation necessary to manage environmental risks, support sustainable economic activity, balance the various interests and uphold national and international responsibilities in the High North. Strengthening the role of geographic information in Arctic policy is essential for ensuring long-term stability, sustainability, and legitimacy of Norwegian Arctic governance.

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2. MAREANO

Norway has a vast marine territory both in boreal and arctic areas and harvests great wealth from the sea. The fishing industry has been the heart of the Norwegian economy for centuries, and revenue from the oil and gas industry now contributes immensely. The last decades aquaculture has contributed with increased value and become much larger than the original fishing industry. Despite this dependency on the sea, our knowledge of the seabed environment has remained poor. Discoveries over the last decade, such as the presence of numerous large coral reefs on the continental shelf off central Norway, highlight how much remain unknown. 20 years ago, the Government established the programme Mareano to fill the gaps in our knowledge of depth and topography, geology and sediment composition, biodiversity, habitats and biotopes as well as pollution in the seabed in Norwegian offshore areas. Mareano provides an authoritative knowledge base for sustainable management of marine areas.

The primary objective of Mareano is to generate detailed knowledge of seabed conditions in Norwegian waters, particularly on the continental shelf and slope. The programme focuses on areas where management needs are greatest, such as regions with intensive fisheries, petroleum activity, future renewable energy potential or high ecological value.

Key goals include: - Mapping seabed depth and morphology at high spatial resolution. - Characterizing seabed geology and sediment types. - Documenting benthic habitats, species distributions, and biodiversity. - Assessing environmental status, including pollution and vulnerability to human impact.

Mareano has lasted for 20 years and at a cost of annually 10 million Euro about 13% of the vast Norwegian sea area is covered. <https://www.mareano.no/en>

2.1 Organisation and Collaboration

Mareano is a collaboration between several Norwegian governmental institutions. The programme has a Steering Group that comprises representatives from four ministries. A program group, responsible for the progress of the project, consists of government representatives with management responsibilities for the sea areas as well as management representative from the partner agencies. The executive group consisting of The Norwegian Mapping Authority Hydrographic Service (NHS), The Geological Survey of Norway (NGU) and the Institute of Marine research (IMR) carry out the map production.

The Norwegian Mapping Authority is responsible for bathymetric data acquisition, the Geological Survey of Norway contributes geological and sediment analyses, and the Institute of Marine Research leads biological mapping and habitat classification. This interdisciplinary structure ensures that physical, geological, and biological datasets are integrated within a common spatial framework.

2.2 SDG 14 and Norway's priorities

Norway's main priorities for the 80th session of the UN General Assembly related to SDG 14 are to pinpoint

- the resolutions on oceans and the law of the sea,
- sustainable fisheries,
- combatting plastic pollution and marine litter,
- the Third UN Ocean Conference,
- support knowledge-based ocean management,
- supporting the UN Decade of Ocean Science
- incorporation of the Ocean Panel's recommendations.

Ocean-based solutions and sustainable management can help mitigate climate change and enhance food security. Increase international recognition of the importance of the oceans for the economy, food security, energy production and job creation, and of the role that sustainable use of marine resources and clean and healthy oceans play in enhancing value creation. It is important to ensure that women have the same opportunities as men to benefit from the development of new industries.

Enhance coordination between the UN's ocean-related efforts and the ongoing work under the UN Climate Change Convention (UNFCCC) and the Convention on Biological Diversity.

The Mareano programme can contribute to;

“Increase scientific knowledge, develop research capacity and transfer marine technology, considering the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries.” Sustainable Development Goals, 14.a

2.3 Mareano Data Products and their Management Value

Mareano Data Products.

Mareano produces a range of data products, including: - Bathymetric maps and terrain models. - Seabed substrate and sediment maps. - Habitat classification and biodiversity indicators. - Environmental chemistry datasets, such as contaminants in sediments. A key principle of the program is open access. Most datasets and maps are made publicly available through digital platforms, enabling reuse across sectors and disciplines. Marine Spatial Planning in the Barents Sea

One of the most important applications of Mareano data is marine spatial planning. Authorities use seabed maps to balance different uses of marine space, identify suitable areas for development, and avoid conflicts with vulnerable habitats. High-resolution bathymetry and habitat data help planners designate shipping routes, fishing zones, and protected areas based on ecological sensitivity and seabed conditions.

Barents Sea is a region characterized by high biological productivity, important fisheries, and petroleum activity. Increased sea temperatures have also moved important southern fisheries into the Barents Sea. Mareano mapping in this area has provided detailed information on seabed habitats, including cold-water coral reefs and sponge aggregations. By using Mareano data early in the planning process, management authorities have been able to reduce conflicts between conservation and resource extraction. This has increased efficiency by shortening planning timelines and reducing the need for costly project redesigns following environmental assessments.

2.3.1 Identification and Protection of Coral Reefs on the Norwegian Shelf

Mareano has played a key role in identifying previously unknown cold-water coral reefs along the Norwegian continental shelf. High-resolution bathymetry combined with video documentation has enabled precise mapping of reef locations and extent. These data have been used by fisheries authorities to establish restrictions on trawling and by environmental agencies to designate protected areas. The targeted nature of these measures made possible by detailed Mareano maps represents an efficient form of management: protection is focused where it is most needed, while allowing continued activity in less sensitive areas.

Fisheries Management and Reduced Gear Damage

In several offshore fishing areas, Mareano sediment and terrain data have been used to identify rough seabed conditions with high risk of gear damage. By integrating these maps into fisheries planning and advisory services, fishers can avoid hazardous areas, reducing economic losses and safety risks.

From a management perspective, this application demonstrates how Mareano data contribute to both economic efficiency and sustainability. Better knowledge of seabed habitats also supports the protection of essential fish habitats, improving long-term resource management.

Offshore Infrastructure Planning and Cost Efficiency

Mareano data has been widely applied in the planning of offshore infrastructure such as pipelines, subsea cables, and energy installations. Detailed seabed geology and stability information reduce uncertainty during route selection and foundation design. This has resulted in significant cost savings and reduced environmental disturbance, as fewer adjustments are required during later project phases. Funds from future wind farm licenses have been used for extra Mareano mapping in designated wind farm zones.

2.3.2 Pollution Assessment and Environmental Status Evaluation

Sediment chemistry datasets from Mareano are used by authorities to assess contamination levels and environmental status in offshore areas. These data support national reporting obligations and provide a baseline for detecting changes over time.

By integrating chemical data with sediment type and habitat information, managers gain a better understanding of environmental risk. This is especially important in the Barents Sea, where there is “natural” pollution from open coal deposits.



Marine Geospatial information is important for good Governance

3. GEOSPATIAL DATA FOR GOVERNANCE IN ARCTIC AREAS

The Arctic is undergoing rapid environmental, economic, and geopolitical change. For Norway, which holds significant responsibilities and interests in Arctic and High North areas, effective governance depends on access to reliable, up-to-date, and integrated geographic information. Spatial data, maps, satellite observations, and geographic information systems

(GIS) provide essential decision-support tools for sustainable management, environmental protection, safety, and economic development.

Norway is a key Arctic nation with jurisdiction over large marine and terrestrial areas in the High North, including the Barents Sea and the Svalbard archipelago. These regions are characterized by high ecological value, increasing human activity, and heightened strategic importance. Climate change is progressing faster in the Arctic than in most other parts of the world, amplifying both risks and opportunities.

In this context, Norwegian Arctic policy emphasizes knowledge-based, integrated, and precautionary management. Geographic information plays a fundamental role in achieving these objectives by providing a shared spatial framework for policy development, regulatory enforcement, emergency preparedness, and international cooperation.

3.1 Norwegian Governance Challenges in the Arctic

Arctic governance in Norway faces several interconnected challenges: -

Climate change impacts: Sea ice retreat, coastal erosion, glacier melt, permafrost.

Environmental vulnerability: Sensitive ecosystems with limited resilience.

Increased activity: Growth in shipping, fisheries, tourism, research, energy operations.

Long distances and limited infrastructure: Complicating monitoring, enforcement, emergency response.

International obligations: Including environmental agreements and cooperation under the Arctic Council.

These challenges require spatially explicit information to ensure coherent and adaptive policy responses.

3.2 Geospatial information critical for good Governance

Geospatial information is important as knowledge carrier to understand where activities take place, how they interact with natural systems, and what consequences policy decisions may have spatially. Key components include: - National and marine base maps - Bathymetric and topographic data - Satellite and remote sensing data - Environmental and climate datasets - Infrastructure and activity data (shipping, fisheries, energy) - Geographic Information Systems (GIS) for analysis and visualization

For Norwegian authorities this is critical elements of the infrastructure supporting Arctic governance.

3.2.1 National Mapping and Earth Observation

The Norwegian Mapping Authority (Kartverket) plays a central role in providing geospatial data, including nautical charts, bathymetry, and geodetic reference systems. In Arctic waters,

accurate seabed and depth data are essential for safe navigation, search and rescue, and environmental preparedness.

Institutions such as the Norwegian Polar Institute, the Institute of Marine Research, and the Norwegian Environment Agency contribute geospatial basemaps, spatial data on ecosystems, species distribution, and environmental pressures. Programs like integrated marine mapping provide a spatial basis for ecosystem-based management in Arctic seas.

Satellite-based Earth observation, supported by national and European initiatives, enables continuous monitoring of sea ice, weather conditions, and vessel traffic. Such data are indispensable in remote Arctic areas where in situ observations are limited.



The Norwegian Mapping Authority's Geodetic Earth Observatory ranks as the northernmost facility of its kind. Photo: Bjorn Owe Holmberg

The Norwegian Mapping Authority also publishes electronic navigational charts (ENC) in the S-100 series for several ports in the arctic. The S-100 series are a more versatile standard for exchanging digital hydrographic data than the traditional S-57 ENC that focuses solely on navigation, and gives data on such topics as currents, bathymetric surfaces, Under Keel Clearance etc.

3.2.2 Arctic Council

The Arctic Council’s Strategic Plan 2021- 2030 guides its work towards the arctic as a “region of peace, stability and constructive cooperation, that is a vibrant, prosperous, sustainable and secure home for all its inhabitants, including Indigenous Peoples, and where their rights and wellbeing are respected”. The work is carried out from various working groups and expert groups. The Council has also provided a forum for the negotiation of three important legally binding agreements among the eight Arctic States:

1. Agreement on Cooperation on Aeronautical and Maritime Search and Rescue in the Arctic (2011)
2. Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic (2013)
3. Agreement on Enhancing International Arctic Scientific Cooperation (2017)

The working groups are dependent on updated and relevant geospatial and environmental data and the Arctic Spatial Data Infrastructure (Arctic SDI) <https://geoportal.arctic-sdi.org/> is the collaborative partnership-based work of the National Mapping Agencies of the eight Circumpolar States. This is endorsed by the Arctic Council as a part of the general scientific and technical collaboration among the Arctic Nations.

3.3 Applications in Norwegian Arctic Policy

Geographic information underpins Norway’s ecosystem-based management plans for Arctic marine areas. Spatial analyses allow authorities to balance environmental protection with economic activities such as fisheries and shipping.



Spatial data are crucial for identifying areas exposed to climate-related risks, including coastal erosion and infrastructure instability on permafrost. Geographic information supports proactive adaptation measures and long-term planning.

Accurate and up-to-date geographic information is vital for search and rescue operations, oil spill response, and maritime safety in Arctic waters. Common spatial data frameworks improve coordination among civilian and military actors.

Norway actively promotes data sharing and harmonization through international forums such as the Arctic Council. Geographic information serves as a neutral and transparent basis for cooperation, confidence-building, and joint environmental stewardship.

4. MARINE BASE MAPS IN THE COASTAL ZONE OF FINNMARK

Marine base maps (“Marine grunnkart”) are a central knowledge foundation for public administration and spatial planning in Norway’s coastal and marine areas. In Finnmark, northern Norway, these integrated spatial datasets play a particularly important role due to the region’s environmental sensitivity, long coastline, and dependence on marine-based industries. Marine base maps are important tools for coastal zone governance and support municipal and regional planning, sector-based management, environmental impact assessment, and sustainable use of marine resources in Finnmark. These are also tools related to climate change, increasing spatial conflicts, and requirements for knowledge-based decision-making. New technology such as LIDAR seabed mapping is being used to cut the cost of extensive mapping of the craggy coast and linking land and sea terrain models. New systems of data management also streamline dataflow from mapping to processing and end user.

The coastal zone of Finnmark represents one of Norway’s most extensive and strategically important marine regions. The area is characterized by rich natural resources, sensitive ecosystems, and a strong reliance on fisheries, maritime transport, and coastal settlement. At the same time, coastal municipalities in Finnmark face increasing planning pressures related to new industries, environmental protection, and climate adaptation. Aquaculture is less developed here than in the rest of the country, which makes it easier for optimal location of new facilities. As of 2026 a new program for mapping the coast of Finnmark has started, using some new funding and diverting resources from Mareano.

For public authorities, effective governance of the coastal zone requires access to reliable, up-to-date, and spatially explicit knowledge. Marine base maps have been developed as a national knowledge infrastructure to support such decision-making. They provide standardized environmental information that can be directly applied in municipal coastal zone plans, regional plans, sector permitting processes, and environmental assessments. They are designed to serve as a common knowledge base for public authorities, industry, researchers, and other stakeholders.

In Norway, marine base maps typically include information on: - Seabed topography and bathymetry - Sediment types and seabed geology - Physical oceanographic conditions - Habitat types and biodiversity - Human activities and infrastructure. Marine base maps may include information on currents, temperature, salinity, and wave exposure. In the Finnmark coastal zone, strong tidal currents and seasonal variability influence biological productivity and dispersal of organisms. Due to security concerns, some of the bathymetric data collected for marine base maps are not accessible in full detail, but these are of interest to other government agencies and the program is built around making that the final product is sufficient for public use.

The coastal zone of Finnmark is vital for:

Commercial and small-scale fisheries

Aquaculture, particularly salmon farming

Maritime transport and ports

Coastal settlements

Indigenous Sámi use of marine resources

These activities depend on healthy marine ecosystems and predictable environmental conditions, underscoring the need for reliable marine spatial data.

4.1 Municipal Coastal Zone Planning

Marine base maps are a key tool for municipalities when preparing coastal zone plans under the Planning and Building Act. In Finnmark, where large sea areas fall under municipal planning authority, marine base maps provide essential information on seabed conditions, habitats, and environmental values. This supports zoning decisions, identification of suitable areas for aquaculture, and avoidance of environmentally sensitive areas.

At the regional and national level, marine base maps support sector authorities responsible for fisheries, aquaculture, nature management, and maritime safety. The maps contribute to coordinated management by providing a shared factual basis across sectors, reducing conflicts and improving transparency in decision-making processes. They can serve as important tools by sector authorities to assess cumulative impacts from fisheries, shipping, and coastal development. The maps have helped clarify where additional activities may pose unacceptable risks to vulnerable habitats.

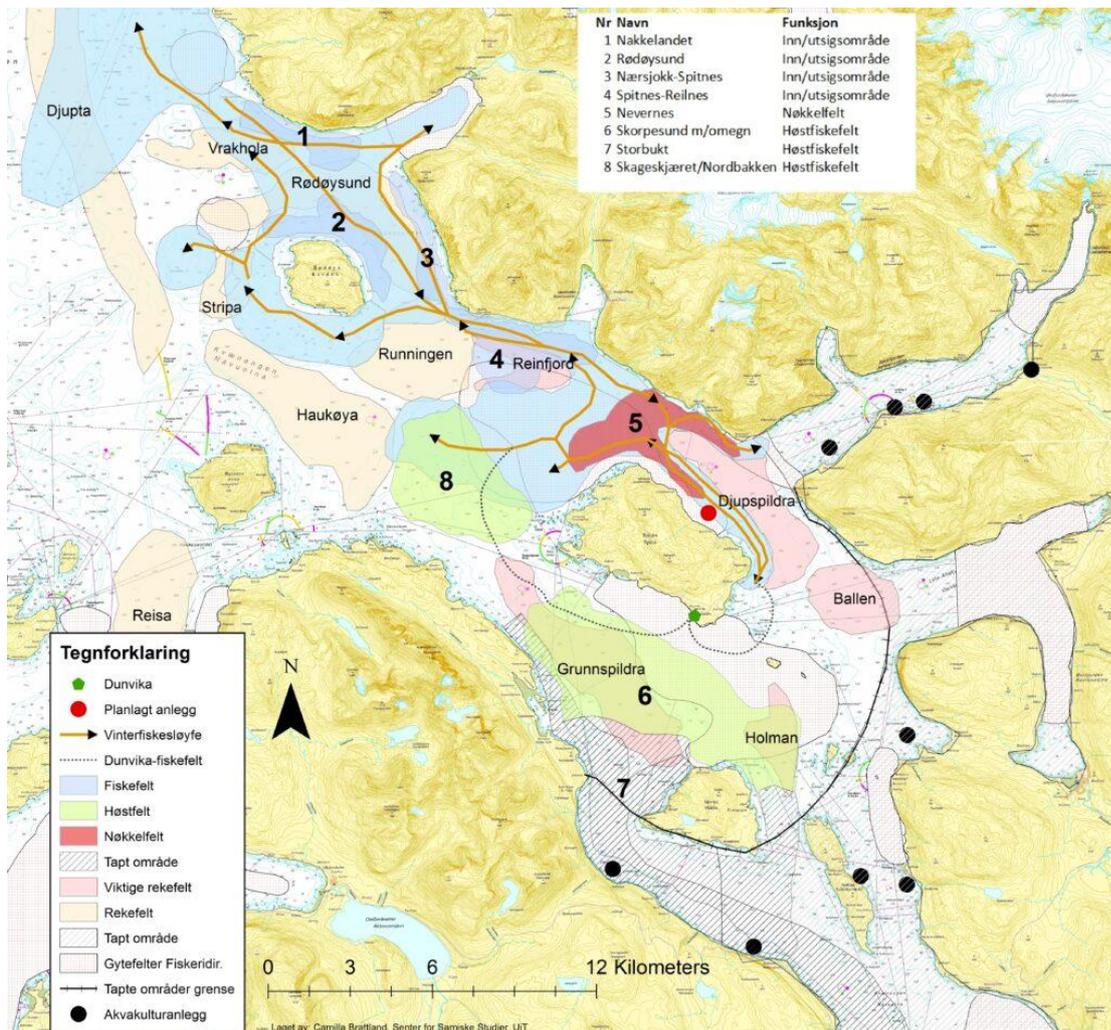


Illustration on Coastal Zone Plan Data in Finnmark. Source: Naturvernforbundet.no

4.2 Environmental Impact, Nature Conservation and Climate Adaption.

Marine base maps are important in environmental impact assessments (EIAs) and permitting processes. In Finnmark, proposed developments such as aquaculture facilities, harbor expansions, and subsea infrastructure rely on marine base maps to assess impacts on seabed habitats, biodiversity, and physical conditions. Early access to high-quality spatial data can reduce uncertainty and improve the quality of assessments.

Marine base maps that show current exposure, depth conditions, and seabed sediments have been applied in site assessments for salmon farming. These data have supported decisions to avoid areas with poor water exchange and high vulnerability to organic loading, thereby reducing environmental pressure on the fjord ecosystem.

Marine base maps support the identification of valuable and vulnerable marine areas, which is essential for nature conservation planning. They also contribute to climate adaptation by providing baseline data against which environmental change can be assessed.

Mapping of kelp forests in exposed coastal areas of western Finnmark has been used to assess ecosystem services such as carbon storage, biodiversity support, and coastal protection. These maps are increasingly relevant in climate adaptation planning, as changes in temperature and storm patterns may affect kelp distribution and resilience.

Despite their value, the use of marine base maps in public administration faces several challenges: - **Incomplete coverage:** Significant parts of the Finnmark coastal zone still lack high-resolution mapping, limiting their direct applicability in local planning. - **Data interpretation:** Planning authorities may require additional guidance to interpret complex marine datasets correctly. - **Integration in planning systems:** Ensuring seamless integration of marine base maps into municipal GIS systems and planning workflows remains an ongoing task.

The Government increased the Fund for Marine Coastal Basemaps for 2026 and there is a need to expand the mapping of shallow and nearshore areas relevant for municipal planning. It is also important to integrate marine base maps with climate projections and risk assessments for sea-level rise, increased storm exposure, and changes in ecosystem distribution. Developing user-oriented map products and guidance for planning authorities is also essential to get the optimal benefit of the use of marine base maps.

Such developments will improve the usability of marine base maps as a practical tool for adaptive and knowledge-based management.

From a management and planning perspective, marine base maps are a cornerstone of knowledge-based governance in the coastal zone of Finnmark. They enable public authorities to make informed, transparent, and consistent decisions across administrative levels and sectors. By providing a shared spatial understanding of the marine environment, marine base maps support sustainable development, environmental protection, and conflict reduction.

As demands on coastal and marine areas continue to increase, the continued development and effective use of marine base maps will be essential for robust coastal zone planning and public administration in northern Norway.

REFERENCES

Geological Survey of Norway (NGU). (2020). *Seabed geology and sediment mapping within the MAREANO programme*. Trondheim: NGU Report Series.

Institute of Marine Research (IMR). (2019). *MAREANO – Mapping of biodiversity and habitats on the Norwegian seabed*. Bergen: IMR Report.

Norwegian Ministry of Climate and Environment. (2011). *Integrated Management Plan for the Barents Sea–Lofoten Area*. Oslo: Government White Paper.

Norwegian Mapping Authority. (2018). *High-resolution bathymetry and its applications in marine management*. Hønefoss: NMA Technical Report.

United Nations. (2017). *The First Global Integrated Marine Assessment (World Ocean Assessment I)*. New York: United Nations.

Mareano web: <https://www.mareano.no/>

Arctic Council web: <https://arctic-council.org/>

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