

Making the Green Wave Blue

Position paper, October 2022

Coastal and Arctic ocean research
& innovation for a sustainable future



UNIVERSITY OF BERGEN

NORCE

Introduction

In this position paper, the University of Bergen (UiB) and NORCE Norwegian Research Centre AS contribute to the elaboration of priorities in the Horizon Europe Strategic plan for 2025-2027 and subsequent calls and initiatives. We raise coastal seas and regions and the Arctic as critical focal points for future investments. This aligns with the Science, Research and Innovation Performance of the EU 2022 report, which identifies shifting global politics as one of two immediate challenges and presents ‘Think the unthinkable (and be ready for it)’ as one of the six main policy guidelines for the EU’s research and innovation.

Europe faces complex challenges and dilemmas: we aim to increase seafood production (harvesting of wild resources and aquaculture), deploy an offshore wind farm capacity of 300GW, produce green hydrogen, utilize the North Sea for sub-seabed storage of CO₂ and hydrogen, and explore deep sea mining. At the same time, we aim to restore the ocean from pollution and protect biodiversity, and devise and implement appropriately adapted measures of ocean governance. A balance between conservation and restoration on the one hand and sustainable use on the other must be found. UiB and NORCE have a strong knowledge base and are able to contribute to the collective quest to achieve this balance.

Norway has the longest coastline in Europe and is a main gateway to the Arctic for Europe. Norwegian actors are key partners in the efforts to meet the EU’s policy guidelines and to succeed in the “blue” ocean- and coast-related efforts necessary to achieve the Green Deal.

Norway also has the highest proportion of ocean scientists per capita in the world and among them, researchers at UiB and NORCE are well represented. Our scientists contribute to the knowledge base needed to realize Norway’s and other European countries’ plans for sustainable use of the ocean. Together UiB and NORCE have a critical mass of scientific expertise along the value-chain from fundamental research to innovation and across disciplines that is central to our mutual strategic collaboration with Europe.

SEAS

Shaping European Research Leaders
for Marine Sustainability



- SEAS is a Marie Skłodowska-Curie COFUND-project, co-funded by the EU and UiB
- Shaping European Research Leaders within Marine Sustainability
- Recruiting 37 post-docs for 3-year positions within marine sustainability at 6 faculties
- Bottom-up projects within selected marine fields

In this joint position paper, we set out three key messages for the upcoming Horizon Europe programme period 2025-2027:

1. There is a critical need for coordinated interdisciplinary and intersectoral research in order to increase our understanding of coastal processes under multiple stressors. This is fundamental to achieve the European Green Deal's ambitions. The linkages between land and coastal areas and seas are continuously changing – therefore, research on the dynamics of, and interconnections between, these systems and border zones is urgently needed.
2. Under pressure from climate change, the Arctic is high on the political agenda in terms of security, stability, environmental pressure, access to marine resources, and societal development. Dedicated investment in research and innovation in relation to a warmer and ice-free Arctic is urgent. Collaboration between the EU and Norway is particularly important in this context.
3. There is a need to prioritize the development of evidence-informed decision-making tools (observing systems and integrated simulation models) supporting conservation, restoration, and sustainable use (energy, food, bioresources, transport) of coastal areas and the Arctic. To develop such tools, basic process studies as well as sharing of data and infrastructure to reveal fundamental mechanisms and causation are crucial.

In support of the above, UiB and NORCE jointly call for continued, increased, and more strategic investment in ocean research.

We propose that strategic investment should come through calls that support the broadest range of multi- and interdisciplinary collaboration to foster connection between topics such as ecosystem processes, biodiversity, and climate, and incorporate sustainability principles, governance (including regulatory and legislative framework), stability and security as well as societal aspects.

With such investments, Europe will contribute efficiently to the new International Ocean Governance agenda and a sustainable blue economy, while also extracting more food and energy from the ocean. Ocean knowledge is key to fight climate change, halt and reverse the loss of marine biodiversity and marine pollution, protect the seabed from harmful practices, and ensure security and safety at sea and compliance with inter-national rules and standards.

While we acknowledge the European Commission's existing and planned investments,¹ we propose that the Commission consider strengthening targeted investments in support of integrated research and innovations for the above-mentioned oceanic challenges.

¹ €1 billion for ocean, coastal biodiversity and climate, including for the high seas in 2021-2027, the annual fund of €350 million to fund marine and maritime issues, through the Horizon Europe 2021-2027 programme, the annual €110 million to the European Mission 'Restore our Ocean and Waters by 2030' for the period 2021-2023 and the contributions of the EU and its Member States to promote ocean governance in third countries.

1. Common use of ocean space in coastal and shelf sea regions

Coastal and shelf sea regions emerge as a focal point of the multiple impacts of climate change, land use, freshwater discharge, and land-based and sea-based human activities. At the same time, coastal regions sustain large populations and economies. Most of the blue economic activities are located in coastal and shelf sea areas, with conflicting interests between fisheries, aquaculture, energy production, sub-seabed gas storage, leisure, transport, and similar. Coastal regions and shelf seas are expected to contribute significantly to fulfilling the ambitions of securing 6 times more food and 40 times more energy from the sea, as stated by world leaders at the recent UN Ocean Conference (Lisbon, June 2022). A key question is how to reconcile the necessity of restoration and biodiversity conservation with the need for provision of more energy, food, and bioresources from the sea.

This question is critical in the context of the Green Deal and is partly and fragmentally addressed through specific initiatives such as the Mission: *Restore our Ocean and Waters* and other Horizon Europe actions. Key knowledge, innovation and decision-making tools are still missing to support the agenda of the Green Deal and the missions.

Challenges and Needs:

Sufficient scientific knowledge on coupled coastal ecosystem processes, their dynamics, adaptability, variability, and resilience, under various climate and anthropogenic stressors and their combinations is lacking. Some actions under the European Green Deal call 2020 have been targeting this, but this is far from the investment in research needed to provide the basic knowledge and process understanding necessary to develop reliable models and simulation tools. In addition, there is a complicated interplay between the domestic regulatory and legal frameworks and the EU-/EEA-legislation. The framework should cover potential conflicts between public and private actors, as well as between citizens, and should also protect the environment while paving the way for sustainable use of natural resources.

Research focus: More Energy from the ocean

- Better and faster legal processes for decisions about new marine energy production
- Marine spatial planning based on consistent evaluation of conflicting interests, legal aspects, and various types of impact
- More studies on the full CCUS-value chain
- Integrated approach to offshore wind
- Marine renewable energy and multi-use-"islands"
- Digital solutions for monitoring environmental impact and preservation of biodiversity
- Offshore production and storage of hydrogen
- Models to optimize the grid layout: Research on variation in time and space in solar radiation, wind (onshore and offshore), and precipitation in Europe
- Sustainable exploitation of marine minerals — an emerging ocean industry

Accordingly, we have identified the following challenges and needs:

- More focus is needed on integrated understanding of variability, changes, and resilience in coastal systems, including ocean physics, ecosystem functioning, human uses, and impacts of multiple stressors.
- More data and process studies that support robust and objective decision-making on environmental conservation, climate change effects, sustainable exploitation, coastal and ocean governance, and security are required. This includes monitoring and observing the state of pelagic and benthic systems for long-term changes and increasing our ability to predict how human activities influence marine organisms and ecosystems.
- More research is needed on area- and resource-efficient food- and energy-production systems in coastal and shelf sea regions seen in connection with various other activities, such as Carbon Capture, Utilisation and Storage (CCUS), tourism, and the local communities on which these activities have impact.
- More research on cross-border governance and management principles and governance innovation is needed, especially in relation to pollution and its downstream impacts.
- More research is needed on the regulatory and legislative framework and its implementation and enforcement as well as on areas for legal engineering or improvements due to faults or flaws in the existing system.
- Opportunity: Citizen engagement and citizen science should be focused on coastal areas, to which citizens can easily relate and where individual behaviour can have a visible positive impact.

Research focus: More food from the ocean

- More research on seafood production, supply chains, and consumer behaviour
- Better fish farming; with reduced environmental footprint, optimized production methods, and circularity principles
- Synergies and enhanced production through marine multi-use/co-use
- Nature-inclusive design for nature restoration and enhanced marine production
- Sustainable and novel feed ingredients for aquaculture
- More innovations through both fundamental and applied research on sustainable low trophic- and integrated multitrophic aquaculture (IMTA)

Recommendations:

The needed capacity for holistic simulation of “what if” scenarios for coastal regions is still at an early stage of development. We therefore urge a stronger focus on research on the processes and mechanisms that underpin these needs. We recommend more long-term investments to increase knowledge about these complex coastal processes under various climate and anthropogenic stressors in support of both the European Green Deal and the Mission: *Restore our Ocean and Waters*.

Concretely, we call for:

- Dedicated funding for research and innovation, including fundamental research, to fill in knowledge gaps and provide the understanding required for the development of a Digital Twin of the coastal and shelf sea regions within the European Digital Twins of the Ocean and the Earth System.
- A dedicated European coastal and shelf sea observation and prediction capacity at European level, to be developed from existing components such as the JERICO-RI² (with contribution from DANUBIUS³, ICOS-ERIC [NORCE is leading the Ocean Thematic Centre in ICOS],⁴ and EMBRC⁵). This is important for coastal in-situ observations and predictive capacity in coastal regions and land-sea interactions but is not yet part of the ESFRI roadmap⁶ nor addressed appropriately through COPERNICUS (CMEMS)⁷ and is urgently needed.
- Support for key stakeholders to map needs for additional regulation and more harmonized and efficient legislation across borders and across industrial sectors (e.g., aquaculture and offshore energy).
- Systematic inclusion of ocean literacy elements in EU funded projects.
- More research on ocean governance.
- Funding of a Knowledge and Innovation Community on Ocean (KIC Ocean) under the European Institute of Innovation and Technology (EIT) to facilitate and link research, innovation, and management in coastal development.

² [JERICO-RI Home](#) — the European gateway to long-term scientific observations and related services for European coastal marine systems at the convergence between the land, open ocean, and atmosphere.

³ [DANUBIUS-RI](#) – a pan-European distributed research infrastructure supporting interdisciplinary research on River-Sea Systems.

⁴ [ICOS – Integrated Carbon Observation System \(icos-cp.eu\)](#) – a European-wide greenhouse gas research infrastructure. ICOS produces standardised data on greenhouse gas concentrations in the atmosphere, as well as on carbon fluxes between the atmosphere, the earth and oceans.

⁵ [European Marine Biological Resource Centre | EMBRC](#) – provides access to marine resources, as well as cutting-edge services and facilities that allow researchers, from both academia and industry, to study the ocean and develop innovative solutions to tackle societal issues.

⁶ [ESFRI Roadmap | www.esfri.eu](#)

⁷ [CMEMS \(copernicus.eu\)](#)



SFI SMART OCEAN

SFI Smart Ocean is a Centre for research-based innovation developing a wireless, smart, low-power sensor network providing data for fact-based and sustainable management of the ocean resources and industrial equipment and structures. The centre is hosted by UiB, and NORCE, Western Norway University of Applied Sciences, the Institute of Marine Research, the Norwegian Defence Research Establishment and the Nansen Environmental and Remote Sensing Center are research partners. Additional partners are industry clusters, industrial companies and governmental observers.

BJERKNES CENTRE
for Climate Research



Bjerknes Centre for Climate Research is a research collaboration focused on the Earth's climate system. The researchers at the centre use observations, models, and theory to study past, present and future climate change. More than 250 international scientists are working together and contributing through one of the four partner institutions: The University of Bergen, NORCE, Institute of Marine Research, and the Nansen Environmental and Remote Sensing Centre.

The Bjerknes Centre has in-house leading expertise in climate understanding, modelling, predictions, and future scenarios for climate changes. Oceanographers, meteorologists, geologists, computer scientists and researchers in several other disciplines investigate the various processes in the climate system – where the ocean is a major player. The fastest changes now occur in the Arctic, a focus area for the centre's research.

Research focus: The Arctic

- Implications of Arctic sea-ice loss on ocean overturning and carbon uptake
- Life and harvestability in the new Arctic
- What will it take to minimize damages caused by climate change?
- Size and stability of permafrost carbon and methane reservoirs
- Impacts of Arctic change on mid-to-low latitudes
- Arctic tipping points, thresholds, and reversability
- Arctic Amplification and Atlantification – the ocean influence
- The intensified hydrological cycle and the Land Ocean Aquatic Continuum (LOAC) in the new Arctic
- Social and international political dimensions
- Ocean governance

2. Climate, governance, and the international politics of a future ice-free Arctic

The Arctic is one of the most climate-sensitive ocean areas, with high political importance and high risk of conflict. A climate change-driven ice-free Arctic will open new challenges in international relations, governance issues, joint conservation and exploitation of pristine areas, and societal development around the Arctic basin. It is also likely to shift ecologies and resource access, which can also challenge international relations in the decade to come.

Arctic regions are warming two to four times faster than the global average (the 'Arctic Ocean Amplification'), a phenomenon driven by an increase in the poleward ocean heat transported through main ocean current patterns. This has marked effects on Arctic Sea ice concentration and extent and may affect the structure of Arctic ecosystems and feed back into the climate through a shrinking ice cap and albedo. Climate research must remain prioritised in the coming years with a focus not only on the impacts of single stressors but also on the interconnected impacts of multiple stressors.

Equally important is Sustainable Development in and around the Arctic. The Arctic region is the focus of growing attention, with increasing interests related to energy, minerals, and utilization of marine resources. To move forth with business ventures without taking into consideration the immediate impacts on the peoples of the north, flora and fauna, and the longer-term global impacts would be irresponsible. Among the peoples affected are indigenous peoples, holding a special legal status in international law, and whose areas have a special legal status in several countries in the Arctic. However, knowledge about the region lags behind the ambitions for development. For example, more research is needed towards renewable energy production, energy storage, deep sea mining, aquaculture and fisheries – and their environmental and societal footprints. This is vital for the development of knowledge-based management strategies coupling ecosystem functioning, connectivity, resilience, and monitoring.

International cooperation on Arctic issues is crucial. It will be important to develop synergies between research in the Arctic and European funding mechanisms and ensure coordinated use of existing infrastructure to maximize cost-benefit. The Svalbard Integrated Earth Observing System (SIOS) is one infrastructure where better coordination can increase the value of existing time-series for physical and biological variables in new research projects.

Challenges and Needs:

International cooperation in research and innovation in the region covers safeguarding the Arctic environment and sustainable development in and around the Arctic. While researchers at UiB and NORCE are unanimous that this research is fundamental and indispensable, we are also in agreement that more research is needed on the consequences of climate change on governance and international relations. There is an urgency in ensuring international policies that enable safe and sustainable development in the region. To achieve this, Arctic and Polar research must be strengthened to provide a more comprehensive understanding of the consequences of an ice-free Arctic.

Accordingly, we have identified the following challenges and needs:

- The global climate system is a complex and dynamic system where the Arctic plays a crucial role impacting climate regionally and globally. It is pivotal to understand all underlying subsystems, such as ocean, atmosphere, cryosphere, and biosphere, and therefore, continued and strengthened research on all drivers, and their interconnectedness to the climate system must be prioritized.
- The Arctic is at present under substantial change and continued and strengthened support is required for development of (autonomous) observing systems to secure time series to better observe manmade changes and the natural variability of the climate system.
- More research is needed that allows predictions of future climate scenarios to show possible cascading effects that an ice-free Arctic will bring.
- More research is needed on the consequences of various climate scenarios for questions of sovereignty, security, stability, adaptation to climate change, conservation of the Arctic's pristine environment as well as maritime, leisure, exploitation, and societal and cultural questions.
- More research is needed on conditions for democratic structures and participation, both at the local and international levels.

Recommendations:

UiB and NORCE call for more focus on Arctic research under the EU Mission: *Restore our Ocean and Waters*, which is well-suited to bring together a critical mass of actors with transdisciplinary perspectives to deliver tangible results in a short timeframe. To date, funding opportunities under this Mission support topics related to climate change and in a few select regions such as the Danube, Mediterranean, Baltic and North Sea basins and Atlantic and Arctic basins. We suggest and push for dedicated actions to address climate change, governance, and international relations in the Arctic region, which need immediate attention.

Concretely, we call for:

- Investment in the development of a dedicated Digital Twin of the Arctic contributing to the European Digital Twins of the Ocean and the Earth system, because the faster rate of climate change in the Arctic warrants the development of a digital infrastructure that will permit data availability for local users and all potential end-users, including managers, decision-makers, and researchers.
- Increased investment in models supporting regional downscaling of climate scenarios and decision-making on adaptation measures. Further development of models that include climate processes relevant for all Arctic subsystems.
- Increased inclusion of societal and political aspects in Arctic-related research projects.



UNIVERSITY OF BERGEN

The University of Bergen (UiB) is an internationally recognized research university located in the city of Bergen on the West coast of Norway. The university comprises seven faculties and has around 21 000 students. UiB has a highly international profile and employs more than 4200 faculty and staff from more than 90 countries. Academic diversity, academic freedom, and high quality are fundamental values for UiB.

UiB contributes to society with excellent research, education, interdisciplinary cooperation, and dissemination of knowledge and innovation. Our researchers carry out basic and interdisciplinary research across a range of disciplines and participate in many international networks and research and innovation projects. In Horizon 2020 UiB had the highest success rate for grant proposals among Norwegian universities and was the second most successful measured by funding per academic staff.

UiB has defined three priority areas for the university's research, innovation, and education activities:

- Ocean
- Climate and energy transitions
- Global challenges

UiB is an internationally leading university in Oceanography (Shanghai Global rank 2021 number 10), in Fisheries including aquaculture (CWUR Global rank number 2), and in Marine and Freshwater Biology (CWUR Global rank number 9). UiB hosts marine centres such as Smart Ocean working on subsea communication, the Sars International Centre for Marine Molecular Biology, and a Centre for Deep Sea Research with advanced ROV equipment for exploratory cruises. We further host advanced infrastructure for aquaculture including both run-through and recirculation tanks on campus. We also have strong research environments in climate, arctic, and polar research, and have an interdisciplinary Polar Sciences Network.



UiB was appointed SDG14 Hub for United Nations Academic Impact (UNAI) in 2018 and will hold this distinction for another term until 2024. We are further the SDG 14 Hub for the International Association of Universities (IAU).

UiB's wide range of disciplines allows several interdisciplinary centres to approach complex challenges with perspectives from different fields. Examples are the Centre for Climate and Energy Transformation, which aims to produce actionable knowledge for sustainable transformation of society to prevent climate change, and the Bergen Offshore Wind Centre, where researchers address aspects related to resources, environment and technical solutions, as well as legal, economic and social aspects of offshore wind energy.

UiB aims to maintain its leading position in ocean-related research, both in basic disciplinary research and across a broad range of multi- and interdisciplinary collaborations, and in this way contribute to the knowledge needed to ensure a sustainable development, where the ocean is a key factor.



NORCE Norwegian Research Centre is Norway's leading independent research institute with a presence along the entire Norwegian coast. Research and innovation at NORCE cover areas within Climate, Energy, Environment, Technology, Society and Health that are organized into four interdisciplinary and interconnected priorities: Sustainable Seas and Coasts, Climate and Environmental Risk, Energy of the Future and Safe and Healthy Societies. This unique scientific breadth and depth is utilised to provide new perspectives for innovative and holistic solutions for societal challenges. NORCE conducts its research and innovation activities in collaboration with businesses, public administration and society. This ensures applied use, knowledge development and knowledge-driven research and innovation-driven development of new enterprises, innovative solutions for public and industry and commercialisation of products and services where appropriate.

Our Vision

Passion for knowledge - Together for sustainability

Our Mission

The research conducted by NORCE contributes to addressing societal challenges and to increasing sustainable value creation at local, national and global levels.

NORCE achieves its vision and mission through national, European and international public and private sector collaborations.

NORCE was the second most successful Norwegian research institute in H2020. In Horizon Europe, NORCE is already gaining ground with 25 projects in the first years of the programme.

NORCE participation in European Research and Innovation Programmes in Ocean Sciences

In contribution to our strategic priority on Sustainable Seas and Coasts, NORCE conducts research on ocean climate, the marine environment and ecosystems functioning, aquaculture, marine biotechnology, renewable marine energy, maritime transport, ocean observation and prediction, marine technology and digitalisation, to contribute to solutions and innovations for growth in the future marine economy within sustainable frameworks. NORCE aims to

- Contribute to the green transition in the blue economy
- Provide targeted knowledge and decision basis for sustainable resource management
- Describe and monitor the effects of both climate change and human activities at sea – such as how new ocean-based industries e.g., offshore wind, aquaculture and deep-sea mineral extraction affect biodiversity and habitats
- Maintain our world leader standing in research and innovation on sustainable fish- and algae farming and related technology development (e.g., digitizing of the aquaculture sector), with an increasing focus on making the blue economy more circular and resource efficient.

NORCE's research portfolio on ocean includes research and innovation projects at TRL 1 to 9, with contributions from H2020, Horizon Europe (INFRA, cluster 4, 5 and 6), Digital Europe and JPI-Ocean. In addition, several projects inform the IPCC process.

Examples of marine projects where UiB and/or NORCE are involved:

- H2020-[COMFORT](#): Our common future ocean in the Earth system, UiB (coordinator) and NORCE (partner)
- H2020-[ASTRAL](#): All Atlantic Ocean Sustainable, Profitable and Resilient Aquaculture, NORCE (coordinator)
- H2020-[IFishIENCi](#): Intelligent Fish-feeding through integration of Enabling technologies and circular principles, NORCE (Science & Technology manager) and UiB (partner)
- H2020-[SponGES](#): Deep-sea Sponge Grounds Ecosystems of the North Atlantic: an integrated approach towards their preservation and sustainable exploitation, UiB (coordinator)
- HORIZON-OCEAN-ICU: Improving Ocean Carbon Understanding, NORCE (coordinator), UiB (partner)

UiB and/or NORCE contributions in infrastructure central to ocean and Arctic research

- [ICOS-ERIC](#) Ocean Thematic Centre, UiB and NORCE (coordinator)
- Horizon Europe ERO-GoShip: European GO-SHIP node – Towards a sustained Global survey of the ocean interior, NORCE (coordinator) and UiB (partner)
- [Svalbard Integrated Arctic Earth Observation System \(SIOS\)](#)
- The Norwegian Research Vessel fleet (UiB)
- [Airborne observing platforms](#) (Drones and aircraft) (NORCE)
- Advanced deep water ROV, *Ægir 6000* (UiB)
- [INES National Earth System Modelling platform](#) NORCE (coordinator), UiB (partner)
- Marine research stations: [Espegrend Marine Biological station](#) (UiB), [Mekjarvik Marine Station](#) (NORCE)
- [Marineholmen innovation district](#) for marine technology (UiB, NORCE)
- More than 200 aquaculture research tanks, including [RAS systems](#)
- [National AlgaePARC Mongstad](#) (UiB, NORCE)

Examples of Arctic projects where NORCE and/or UiB are involved:

- [APPLICATE](#): Advanced Prediction in Polar regions and beyond, UiB and NORCE (partners)
- [Blue action](#): Arctic Impact on Weather and Climate, UiB and NORCE (partners)
- [INTAROS](#): Integrated Arctic observation system, UiB and NORCE (partners)
- [Arctic PASSION](#): Pan-Arctic observing System of Systems: Implementing Observations for societal Needs, UiB (partner)
- [PolaRES](#): Polar regions in the Earth system, NORCE (coordinator)

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