# Review on how to preserve space for the future uses of the seas:

## what methods can we apply to address the needs of future generations?

Background Technical Study

Produced by the European MSP Platform under the Assistance Mechanism for the Implementation of Maritime Spatial Planning - *January 2023*

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European Climate, Infrastructure and Environment Executive Agency
Unit D.3 – Sustainable Blue Economy

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## ACRONYMS

| | |
|---|---|
| BWMC | Ballast Water Management Convention |
| BSEC | Organization of the Black Sea Economic Cooperation |
| CBD | Convention on Biological Diversity |
| CCRF | Code of Conduct for Responsible Fisheries |
| CEAF | Common Environmental Assessment Framework |
| CFP | Common Fisheries Policy |
| CLC/FUND | Civil Liability Convention |
| CNSS | Clean North Sea Shipping |
| DG MARE | Directorate-General Maritime Affairs and Fisheries |
| EEDI | IMO Energy Efficiency Design Index |
| EEZ | Exclusive Economic Zone |
| EGD | European Green Deal |
| EPC | Engineering, Procurement, and Construction |
| ESPOO | Convention on Environmental Impact Assessment in a Transboundary Context |
| EU | European Union |
| EUSBSR | EU Strategy for the Baltic Sea Region |
| EWEA | European Wind Energy Association |
| GBF | Global Biodiversity Framework |
| GFCM | General Fisheries Commission for the Mediterranean |
| HNS | Hazardous and noxious substances |
| ICZM | Integrated coastal zone management |
| ICES | International Council for the Exploration of the Sea |
| ICT | Information and Communication Technology |
| IMSBC | International Maritime Solid Bulk Cargoes |
| IOC-UNESCO | Intergovernmental Oceanographic Commission of UNESCO |
| IMO | International Maritime Organization |
| IMP | Integrated Maritime Policy |
| IOG | Integrated Ocean Governance |
| IPBES | Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services |
| IPCC | Intergovernmental Panel on Climate Change |
| JRC | Joint Research Centre |
| MARPOL | International Convention for the Prevention of Pollution from Ships |
| MCL | Maritime Labour Convention |
| MCSD | Mediterranean Commission on Sustainable Development |
| MEDREG | Association of Mediterranean Energy Regulators |
| MENBO | Mediterranean Network of Basin Organizations |
| MPA | Marine Protected Area |
| MSFD | Marine Strategy Framework Directive |
| MSP | Marine/Maritime Spatial Planning |
| MSPD | Maritime Spatial Planning Directive |
| NSAC | North Sea Advisory Council |
| OECD | Organisation for Economic Co-operation and Development |
| OPRC | IMO International Convention on Oil Pollution Preparedness, Response and Co-operation |
| ORE | Offshore renewable energy |
| OSPAR | Convention for the Protection of the Marine Environment of the North-East Atlantic |
| PSMA | Agreement on Port State Measures |
| RFMO | Regional fisheries management organizations |
| RGI | Renewables Grid Initiative |
| R&D | Research and Development |
| SDG | Sustainable Development Goal |
| SOLAS | International Convention for the Safety of Life at Sea |
| STCW | Standards of Training, Certification and Watchkeeping |
| UN | United Nations |
| UNCLOS | United Nations Convention on the Law of the Sea |
| UNDRR | United Nations Office for Disaster Risk Reduction |
| UNFSA | United Nations Fish Stocks Agreement |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UNEP | United Nations Environment Programme |
| WFD | Water Framework Directive |
| WMO | World Meteorological Organization |

| | |
|---|---|
| WOA | World Ocean Assessment |
| WTO | World Trade Organization |

# 1. INTRODUCTION

## 1.1. Study background

We, as a population, are making more use of our marine space and resources than ever before. The intensity and diversity of interest in sea space has accelerated dramatically in the last two decades with the Blue Economy continuing to develop alongside our need for food, energy, transportation and recreation from our seas.[1] At the same time, challenges are emerging because of climate change, biodiversity loss, pollution and overuse/degradation of the environment by activities in the marine and coastal areas. Whilst the cumulative effects of these impacts exacerbate challenges relating to food security and livelihoods, the need to produce food, provide transport routes and communication provide opportunities for economic development. Though, they often bring with them additional challenges, particularly to the social and environmental pillars of the sustainable development paradigm.

Today maritime industries continue to innovate, with emerging activities that are reshaping and diversifying maritime interests.[2] These include offshore aquaculture, seabed mining and marine biotechnology, which will increasingly appear at bigger scales and in deeper waters, offering long-term potential for innovation and economic growth.[3] New technologies for offshore renewable energy and shipping, such as floating offshore wind farms and autonomous vessels utilising low-emission fuels will change the seascape in the decades to come. It is recognized that national maritime investments for the use of sea space occur in relation to the development of the sustainable blue economy and green transition. However, they also appear as an essential element of national security strategies, in relation to improving energy security and maritime safety[1,4] along with other priorities, such as decarbonisation of maritime industries and securing sustainable food.

The mismatch between the drive for economic gain and long-term prosperity, and a healthy, resilient ocean is apparent. The European Union's (EU) marine policies[5] and the global ocean governance goals by the United Nations (UN) conventions and agreements, such as the UN Sustainable Development Goals (SDGs) of the 2030 Agenda, seek to address the aforementioned conflict. Addressing global challenges alongside the growth prospects for the blue economy requires technological innovations to support the development of maritime industries, mitigate their environmental impacts and emphasize their potential contribution to green growth. Maritime Spatial Planning (MSP) emerges in these considerations as a tool to enable better coordination across sectors and sea basins, to balance economic growth and environmental protection, ensure safety, prevent conflicts, anticipate change, and tap into synergies through a structured process.[6]

In the previous study "Addressing conflicting spatial demands in MSP", produced by the European MSP Platform in 2018,[7] it was found that spatial conflict management is an ongoing effort and a learning process, where lessons from one country can be applied in other countries. With the adoption of the European Green Deal (EGD) and the EU Biodiversity Strategy for 2030, new aspects need to be taken into consideration in the management of spatial conflicts.

**In view of how increasingly crowded and competitive marine space has become with overlapping sectoral activities, consideration of how to preserve space for additional future uses is vital.** MSP plays a crucial role in linking uses and allocating marine space effectively to accommodate and coordinate appropriate planning, mitigation and adaptation measures, and it is supported by several available planning tools. For example, the application of a multi-use approach to space and resources can be applied, such as the pilot studies undertaken by the Community of Practice Multi Use in the North Sea 2030.[8] Innovation and economic growth in marine sectors can be mutually promoted in the long term to safeguard sustainable development and to address the needs of future generations (Box 1). Thus, various methods can be considered for planning future uses of

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[1] European Commission, 2022
[2] OECD, 2016
[3] OECD, 2019
[4] The High-Level Panel for a Sustainable Ocean Economy, 2020
[5] Including: EU Integrated Maritime Policy (2007) https://ec.europa.eu/info/research-and-innovation/research-area/environment/oceans-and-seas/integrated-maritime-policy_en; the Marine Strategy Framework Directive (2008) https://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/marine-strategy-framework-directive/index_en.htm; Directive for Maritime Spatial Planning (2014) https://ec.europa.eu/oceans-and-fisheries/ocean/blue-economy/maritime-spatial-planning_en; the European Green Deal (2019) https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en
[6] https://ec.europa.eu/maritimeaffairs/policy/maritime_spatial_planning_en
[7] European MSP Platform, 2018
[8] https://www.noordzeeloket.nl/beleid/interdepartementaal/idon-nieuwsbrief/nr-29/community-practice-multi-use-noordzee-2030/

the seas that go beyond sectoral views and can be addressed through the cross-sectoral approach of MSP in integrated ocean management.[9]

***Box 1: Future development needs and scenarios in a view of MSP and Sustainable Blue Economy***

*Future needs and long-term prospects for the growth of maritime sectors are closely linked to current trends and are based on estimates of demands for marine resources. These needs vary across sea basins and they reflect local specificities, technical innovations and the overarching policy for environmental protection. Various tools, including scenario methodologies and strategies, exist to estimate future needs and the ability of ecosystem services to provide them.[10] Scenarios are envisaged at national (e.g., in the Gulf of Finland and Archipelago Sea;[11] the Netherlands 2050 Spatial Agenda[12]) and sea-basin level (e.g., in the North Sea NorthSEE project[13]). Methods have been developed to assist with estimating future needs, such as Scenario Development (e.g., Scenarios for MSP and Sustainable Blue Economy Opportunities in the Western Mediterranean[14]), analysis of future conditions (e.g., MSP Good Practices by UNESCO/IOC[15]), and studies to understand the relationships between marine growth, technological innovation, and industrial development. Finally, digital tools, such as Digitwin North Sea,[16] enabling interactive mapping, and the MSP Challenge[17] simulation game illustrating where offshore energy installations, shipping routes and environmental protection may all be situated in real-life sea areas, offer stakeholders an understanding of how future needs may be managed and accommodated.*

## 1.2. Study objectives

This background Technical Study delivers a review of practices to preserve space for future uses of our sea space. The study presents a general overview of the future needs in a context of maritime sectoral demands, policy requirements, and local specificities guided by national priorities and regional development. Specifically, the study:

- Summarizes demand and future growth and needs, and the overarching policy;
- Introduces various methods for planning to address future needs per sector; and
- Illustrates the geographical context, highlighting differences among sea basins in EU.

A preliminary mapping of potential future activities in different sea basins is presented.

***Outline:***

**Chapter 2** introduces the demands and needs regarding such topics as natural resources, safety, security of living and non-living marine resources, conservation and restoration of habitats.

**Chapter 3** presents future sectoral growth, including the analysis of future needs and international policy of relevance to the maritime sectors.

**Chapter 4** introduces local specificities of the EU sea basins, with their local needs and relevant policies.

**Chapter 5** presents recommendations on the main instruments and methods in planning to address the needs of future generations.

***Sources:*** The literature review for this study has used various sources, including the reports of the European Commission, such as "The EU Blue Economy Report 2020, 2021 and 2022"[18] by the Directorate-General Maritime Affairs and Fisheries (DG MARE) and the Joint Research Centre (JRC), "The Communication on the Sustainable Blue Economy",[19] "Blue Growth Scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts" (2012);[20] "Global Marine Trends 2030" (2013);[21] ocean-related reports and publications of the Organisation for Economic Co-operation and Development (OECD, 2016, 2019, 2021),[22] overviews and publications by the Sustainable Ocean

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[9] Steins N., et al. 2021
[10] UNESCO/IOC, 2021a.
Valmer Project http://valmer.marinebiodiversity.org/about/
[11] https://www.syke.fi/en-US/Research__Development/Research_and_development_projects/Projects/Maritime_Spatial_Planning_for_Sustainable_Blue_Economies_PLAN4BLUE/Scenarios
[12] https://www.noordzeeloket.nl/en/policy/noordzee-2050/
[13] For work of the NorthSEE project on the impact of future shipping activities in the North Sea Region see: https://northsearegion.eu/northsee/s-hipping/conclusions-future-trends-shipping/
[14] UNESCO/IOC, 2021b
[15] Ehler, C., & Douvere, F., 2009
[16] https://www.digishape.nl/projecten/digitwin-noordzee
[17] https://www.mspchallenge.info/
[18] European Commission, 2020a; European Commission, 2021; European Commission, 2022
[19] https://oceans-and-fisheries.ec.europa.eu/ocean/blue-economy/sustainable-blue-economy_en
[20] https://webgate.ec.europa.eu/maritimeforum/system/files/Blue%20Growth%20Final%20Report%2013082012.pdf
[21] https://www.futurenautics.com/wp-content/uploads/2013/10/GlobalMarineTrends2030Report.pdf
[22] https://www.oecd.org/ocean/

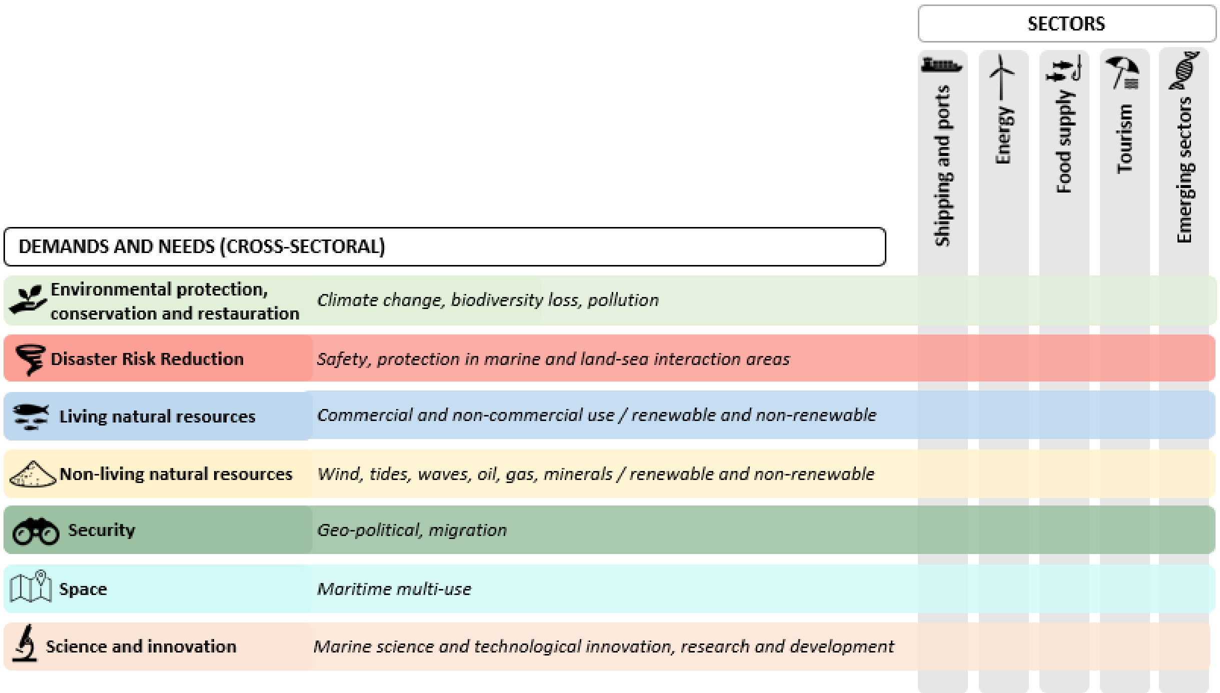
Business Action Platform of the UN Global Compact (2019, 2020, 2021),[23] reports and papers by the High Level Panel for Sustainable Ocean Economy (2019, 2020, 2021, 2022),[24] as well as EU sea basin/national overviews, industrial overviews and peer-reviewed scientific papers.

In addition, various parts of this study link to the other background technical studies produced by the European MSP Platform under the Assistance Mechanism for the Implementation of MSP, including "The implications of the Ocean Governance framework established by the United Nations for the implementation of the EU MSP Directive",[25] and "Best Practice guidance in multi-use issues and licensing procedures".[26]

## 2. Demand and Needs

Future needs and prospects for the growth of maritime sectors are intertwined with demands such as those for the conservation and restoration of natural living and non-living resources from the sea, safety, security, science and technological innovation. They reflect the local specificities of the different European sea basins, investments and the overarching international objectives of sustainable development. This chapter introduces global drivers related to the environment, marine resources and economic growth, which lead to sectoral demands for commercial and non-commercial developments in maritime zones. For each of these 'Demands and Needs' a brief state of play is provided, and suggestions are made for methods to address them.

Figure 1 summarizes key demands and needs that influence the future sectoral growth of selected maritime sectors through investments and regulatory regimes, providing the foundation for long-term operational strategies that enable economic growth in national sectors. The examples of methods that are used for planning of the cross-sectoral demands and needs are presented in this chapter. These methods will play a continuous role for future use of the seas, and they will gradually evolve to accommodate future needs. As such, policies can be later amended by strategies and/or protocols (e.g., the European Green Deal developed two strategies with the objective to preserve




space for offshore renewable energy and space for conservation - Box 2), while science and technological innovations will be progressing depending on investments and regulatory regimes guided by the policies. Examples of the five sectors are described in Chapter 3.

[23] https://unglobalcompact.org/library
[24] https://www.oceanpanel.org/
[25] https://maritime-spatial-planning.ec.europa.eu/sites/default/files/hz0622215enn.en_.pdf
[26] https://www.msp-platform.eu/sites/default/files/best_practice_guidance_in_multi-use_issues_and_licensing_procedures.pdf

**Figure 1: Cross-cutting demands and needs that play a role in the future sectoral growth of selected maritime sectors (@MSP-Platform)**

***Box 2: The European Green Deal strategies to preserve space at sea for the short- to long-term***

*In Europe, a European Green Deal (EGD)[27] is supported by the Strategy on Offshore Renewable Energy (2020)[28] and the Biodiversity Strategy for 2030 (2020),[29] which play a role in supporting the Paris Agreement,[30] the UN Sustainable Development Goals (SDGs),[31] and the forthcoming Global Post-2020 Biodiversity framework.[32] They will help to meet the EU's goal of climate neutrality by 2050 and will put Europe's biodiversity on a path to recovery by 2030. In the short- to long-term, they will also stimulate national and regional development, and investments for technological innovation to address the nexus of ocean, climate and nature.*

## 2.1. Environmental protection, conservation, and restoration

The global assessments, including the First and Second Global Integrated Marine Assessments (2015, 2021),[33] the Special Report on the Ocean and Cryosphere in a Changing Climate (2019, IPCC),[34] and the Global Assessment Report on Biodiversity and Ecosystem Services (2019, IPBES),[35] describe the current state of the marine environment, and highlight climate change and overexploitation as major challenges threatening communities and the natural capital required to support ocean economies.

In Europe, there are no Exclusive Economic Zones (EEZ) that are isolated entirely from anthropogenic influence affecting natural restoration and regeneration of biodiversity. As the maritime industry grows, competition for sea space will intensify, leading some regions to become saturated.

In the future, this situation is likely to get worse, with more intensive uses resulting in busier and more impacted sea basins. The global ocean governance framework of the UN (Convention on the Law of the Sea (UNCLOS)) and other relevant instruments and international processes, address the need for marine environmental protection, conservation and restoration.[36] These frameworks serve Member States as the basis for regional and national planning at sea, including policy and regulations, governance and cooperation. In turn, this leads to sectoral adjustments to fulfil the regulatory regimes and meet the needs for environmental protection, e.g., through industrial upgrade for technological innovation in the mass-scale offshore windfarms, energy transition infrastructure, and the green transition of the shipping sector, that require investments and development of national strategies and new business plans by industries. That also stimulates development of planning approaches such as MSP and Integrated Ocean Governance (IOG). Examples of methods are presented in Table 1 and the policy overview is included in Table 8.

| Table 1: Environmental protection, conservation, and restoration – examples of methods |
|---|
| ▪ Global assessments of marine environmental status: e.g., WOA, IPCC, IPBES |
| ▪ Global conventions, agreements, processes: e.g., UNCLOS, The Biodiversity of areas beyond national jurisdiction (BBNJ) Intergovernmental Conference; IMO, UNFCCC, CBD, Regional Seas Conventions |
| ▪ EU policy, legislation, regulations: e.g., European Green Deal, Strategy on Offshore Renewable Energy, Biodiversity Strategy 2030, IMP, MSP Directive, MSFD, EU emission trading system, Habitats Directives, ICZM Recommendations |
| ▪ Ecosystem integrity through ecosystem-based governance: e.g., IOG, MSP, MPA, ICZM; seabed protection measures |
| ▪ Policy integration through equitable governance and participation in space planning approaches |
| ▪ Environmental monitoring, evaluation and evidence-based adaptive management: e.g., Strategic Environmental Assessment, cumulative impact assessment, national monitoring and reporting - MSFD |
| ▪ Data and information collection systems for monitoring and assessments: ocean observation systems, programmes and projects such as EuroGOOS, EMODnet, Euro-ARGO, CMEMS, Jerico, AtlantOS, JPIOcean, EOOS, GEMS Oceans, etc. |
| ▪ Technological innovations for monitoring and assessments to guide the policy including new projects |
| ▪ Technological innovation to address marine pollution: e.g., bubble curtain (Great Bubble Barrier), filtering solutions (PlanetCare), Cleaning Litter by Developing and Applying Innovative Methods in European Seas (CLAIM project) |

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[27] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en
[28] European Commission, 2020b
[29] https://ec.europa.eu/environment/strategy/biodiversity-strategy-2030_en
[30] https://unfccc.int/sites/default/files/english_paris_agreement.pdf
[31] https://sdgs.un.org/goals
[32] https://www.cbd.int/conferences/post2020
[33] The World Ocean Assessment I (WOA I): https://www.un.org/regularprocess/content/first-world-ocean-assessment; The Second World Ocean Assessment (WOA II): https://www.un.org/regularprocess/woa2launch
[34] by the Intergovernmental Panel on Climate Change https://www.ipcc.ch/
[35] by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services https://www.ipbes.net/
[36] They are addressed in more detail in the technical background study by the European MSP Platform, 2022: "The implications of the Ocean Governance framework established by the United Nations for the Implementation of the EU MSP Directive" (https://maritime-spatial-planning.ec.europa.eu/sites/default/files/hz0622215enn.en_.pdf)

| |
|---|
| ▪ Nature based Solutions to protect and restore marine and coastal habitats: sustainable project design for long-term viability and effectiveness in ecological, economic, social, infrastructural, and financial terms |
| ▪ EU funded projects: Strengthening common reaction capacity to fight sea pollution in Adriatic Sea (HAZADR), Guiding Improvements in the Black Sea Integrated Monitoring System (MISIS), PHAROS4MPAs, Improved transdisciplinary science for effective ecosystem-based maritime spatial planning and conservation in European Seas (MarinePlan), Improved Science-Based Maritime Spatial Planning to Safeguard and Restore Biodiversity in a Coherent European MPA Network (MSP4Bio), and Marine Systems Approaches for Biodiversity Resilience and Ecosystem Sustainability (Marine SABRES). |

## 2.2. Disaster Risk Reduction

Projections of future climate change[37] indicate increasing risks associated with weather and climate extremes.[38] Models predict significant potential losses and damages to marine and coastal areas, with subsequent impacts to those maritime sectors affected. Extreme sea level events are projected to occur more frequently. They will be exacerbated by increases in the intensity of extreme storm surges and waves associated with extreme winds, which are projected to further exacerbate coastal hazards including flooding, erosion, as well as saline intrusion of groundwater and soil in coastal and delta areas. In turn, this will have impacts on agriculture and other economic activities, including coastal tourism and port operability. Offshore, increased storm severity will have direct effects on maritime infrastructure, such as windfarms, ships, pipelines and cables. The redistribution of marine ecosystem services due to climate change and pollution will also impact a number of sectors, including fishing and aquaculture.[39]

Risk management response methods, used as part of disaster risk reduction (DRR), will need to be factored-in to MSP and other approaches to plan the future use of marine space. These require a clear understanding of the risks, both climate-related and other, for the planning of windfarms, shipping, navigation, subsea cables, port design, coastal defences and the location of tourist and recreational facilities. Meteo-hydrological assessments, together with high quality data for operational forecasting (mid- and long-term projections), will be needed to guarantee safety of operations, services and infrastructure planning; to support policy and governance for real-time decision-making and monitoring programmes; and to track the effectiveness of management actions.[40] Global monitoring and assessments of hydro-meteorological conditions, and global scenarios and projections of global temperature and sea-level rise, e.g. by IPCC and the World Meteorological Organization (WMO),[41] provide a basis for DRR methods for planning at sea. Examples of methods are provided in Table 2.

| Table 2: Disaster Risk Reduction – examples of methods |
|---|
| ▪ Global monitoring and assessments of hydro-meteorological conditions, global scenarios: e.g., IPCC, WMO |
| ▪ Global conventions, agreements and other processes: e.g., Sendai Framework for DRR (UNDRR), UNFCCC |
| ▪ International mechanisms for resilience-building: e.g., Build Back Better by the Sendai Framework |
| ▪ International mechanisms: e.g., Climate Risk and Early Warning Systems (CREWS) by WMO |
| ▪ EU policy: e.g., Flood Directive, MSPD, MSFD, ICZM Recommendations, integration of DRR in various EU policies, the amended Environmental Impact Assessment Directive |
| ▪ Programmes to reduce the impact of natural disasters on populations and allowing early warning and early action: e.g., DIPECHO, Copernicus Emergency Monitoring Service (CEMS), the European Copernicus Coastal Flood Awareness System (ECFAS) |
| ▪ Coordinated integrated cross-sectoral approaches: e.g., MSP, ICZM, MPA |
| ▪ International partnerships: e.g., GOOS 2030 Strategy, Decade of Ocean Science (2021-2030) |
| ▪ Ocean observation technology: e.g., GLOSS, Satellite Altimetry, EuroGOOS, EMODnet, Jerico, Euro-ARGO |
| ▪ Geospatial technology: e.g., high-resolution satellite imagery and digital elevation models (DEMs) of high resolution and elevation accuracy for time series of historical geospatial records (regional/local trends) |
| ▪ Numerical simulation models to predict weather and ocean conditions, and flood and coastal erosion, to build historical records and to observe trends and define design conditions for civil structures or identify risks to human populations and human activities: e.g., XBeach, WaveWatch III, SWAN, WRF to compute future extreme scenarios to design infrastructure including coastal defences, bridges, wind farms, etc. |
| ▪ Technologies for generating socioeconomic information to determine exposure, vulnerability and conduct risk assessments. |
| ▪ Methods for risk assessments concerning the technical characteristics of hazards (i.e., their location, severity, frequency and likelihood of occurrence); the level of exposure of people/structures or other assets to those hazards; |

[37] IPCC, 2014; IPCC, 2022
[38] WMO, 2022
[39] UNESCO/IOC, 2021c
[40] UN Global Compact, 2021
[41] WMO, 2021

| | |
|---|---|
| | the susceptibility of people/assets to harm from a hazard (vulnerability); and an evaluation of the effectiveness of prevailing/alternative coping capacities with respect to risk scenarios. |
| ▪ | Structural technologies to protect and prevent risks: e.g., seawalls, storm surge barriers and closure dams, dykes, TetraPods, riprap, etc.; hybrid technologies |
| ▪ | Nature-based solutions using marine/coastal ecosystems for prevention, mitigation, adaptation, recovery |
| ▪ | Adaptive management and adaptive pathways taking cost-effective corrective actions in accordance with the future pace of climate change and regional development |
| ▪ | Stakeholder engagement: interactive decision-support tools, e.g., MSPChallenge, Sustainable Delta game |
| ▪ | Early warning systems based on the operational forecasting system and the trend analysis and decision-support system: e.g., Developing a Flood Early Warning System (Delft-FEWS) software package |
| ▪ | International mechanisms: Climate Risk and Early Warning Systems (CREWS) by WMO |
| ▪ | Funding measures and financial strategies: e.g., Green Climate Fund, InsuResilience Solutions Fund; green and blue bonds |
| ▪ | EU funded projects: Coastal Governance and Adaptation Policies in the Mediterranean (COASTGAP), Climate cHallenges on coAstal and traNsitional chanGing arEas: WEaving a Cross-Adriatic REsponse (CHANGE WE CARE), Coastal-Climate Overall Vulnerability and Exposure Risk - Protection Strategy for the Maltese Islands (Coastal-COVER) |
| ▪ | Other methods: e.g., legal and regulatory measures, resource management, awareness- and capacity-building, land-use planning and management, contingency planning, community-based approaches |

## 2.3. Living natural marine resources

Global food demand is rising together with the need to protect marine living resources. The increasing demand on seafood products at the global level creates dependency on countries which traditionally export marine products, including the EU.[42] A study[43] in 2020, found that under the projected demand shifts and supply scenarios (which account for policy reform and technological improvements), edible food from the sea could increase by 21–44 million tonnes by 2050, a 36–74% increase when compared to current yields, with the most pronounced increase for mariculture. However, anthropogenic pressures together with impacts associated with climate change (e.g., ocean acidification, ocean deoxygenation, the redistribution of marine biodiversity) will have serious implications for living natural resources. In turn, this will have implications for food supply, security and livelihoods. Changing ocean conditions combined with future production potential and shifts in demand, will significantly impact the state of marine natural resources. Planning methods that incorporate appropriate legislation and regulation, policy reform, integrated management and technological innovation, will be essential in ensuring that protection is afforded to habitats and species but that opportunities for development are enabled. An example may be sectoral marine planning to consider where aquaculture can be best situated in association with local environmental conditions and other maritime activities. Other examples are shown in Table 3.

| Table 3: Living natural marine resources – examples of methods | |
|---|---|
| ▪ | Global policy and regulations: e.g., UNCLOS, UNFSA, RFMOs, PSMA, CCRF, WTO negotiations on fisheries, MARPOL, London Convention, OPRC, OPRC-HNS Protocol |
| ▪ | EU policy: e.g., Biodiversity Strategy, MSFD, MSPD, Common Fisheries Policy (CFP), 7th EAP, HBD, BWD, Farm/Fish to Fork Strategy (EU Green Deal), EU strategic guidelines for sustainable and competitive EU aquaculture |
| ▪ | sustainable management of fisheries, aquaculture and tourism (SDG target 14.7) |
| ▪ | Voluntary Guidelines for Securing Sustainable Small-scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines) |
| ▪ | Integrated ocean governance: e.g., MSP, MPAs, ICZM |
| ▪ | Measuring and accounting marine ecosystem services: e.g., Common International Classification of Ecosystem Services (CICES), Economics of Ecosystems and Biodiversity (TEEB), UN SEEA EEA, 7th EAP, EU Biodiversity strategy, Natural Capital Accounting (NCA), Technical Guidance on Ocean Accounting for Sustainable Development (UN), Knowledge and Innovation Project on an Integrated system for Natural Capital and ecosystem services Accounting (KIP INCA), |
| ▪ | Valuating marine ecosystem services: study on the benefits of MPAs and Spatial Protection Measures |
| ▪ | Ecosystem services assessments such as Valmer project[44] |
| ▪ | Institutional Capacity Development to enable direct development and adaptive management of actions, projects and programmes for ecosystem-based adaptation and mitigation in marine and coastal areas |
| ▪ | Technological innovations: e.g., biotechnology including genetics, Autonomous systems, new technologies to increase moving aquaculture into land-based recirculating systems using recirculating aquaculture systems (RAS); offshore aquaculture systems using marine net pens; multitrophic aquaculture installations; new technologies to power aquaculture with renewable energy |

[42] European Commission, 2021; European Commission, 2022
[43] Costello, C., et al., 2020
[44] Valmer Project http://valmer.marinebiodiversity.org/about/

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| ▪ EU Funded projects: Mapping and Assessment for Integrated ecosystem Accounting (MAIA), From MARine Ecosystem Accounting to integrated governance for sustainable planning of marine and coastal areas (MAREA), Demonstration of large-scale seaweed cultivation at open sea and the positive effects thereof on the ocean (ALGAEDEMO) |

## 2.4. Non-living natural marine resources

The exploitation of Europe's seas for non-living natural marine resources has increased over the last decade and is projected to continue growing, especially in relation to offshore renewable energy (ORE) and seabed mining. It is expected that offshore exploitation of oil and gas will decline given the aim to be carbon neutral by 2050, although natural gas will continue to be extracted and used in the short and medium term as the energy transition takes place. Achieving national targets to decarbonize and increase the share of ORE in Member States' energy portfolios will accelerate the deployment of sea-based energy systems. This will require more space for these activities, including construction, more grid infrastructure (in some cases artificial energy islands), new low-carbon technologies and energy efficiency mechanisms. Marine aggregate extraction is also expected to rise in importance alongside the demand for resources such as sand and gravel (used for beach nourishment, construction, reclamation fill, port construction, etc.). There are also likely to be increasing demands for drinking water with an anticipated growth in desalination. The sectoral uses of desalination, dredging, beach nourishment and sand reclamation, are likely to intensify due to climate change, leading to increased conflicts with other maritime sectors. Regulatory policies, technologies, infrastructure and operational skills are increasing as methods for addressing preservation of space with regards to non-living marine resources. Synergies with other maritime activities, for example ports and shipbuilding, and ORE are being explored for multi-use approaches.

| Table 4: Non-living natural marine resources – examples of methods |
|---|
| ▪ Global policy and regulations: e.g., UNCLOS, Paris Agreement |
| ▪ EU policy: e.g., European Green Deal, EU offshore renewable strategy 2020 |
| ▪ Regional guidelines: e.g., OSPAR Guidelines for the Management of Dredged Material at Sea |
| ▪ National binding regulation applicable to offshore energy and other subsectors |
| ▪ Planning approaches in the maritime areas: e.g., IOG, MSP |
| ▪ Policies that promote a stable business framework encouraging low-carbon investments for a period of 20-60 years: enhancing and implementing governance frameworks and regulations e.g., to reduce emissions, adopting offshore renewable energy as core parts of strategies to decarbonize energy systems. |
| ▪ Investments in new low-carbon technologies, renewable energies, energy efficiency, and grid infrastructure, hydrogen production, carbon capture and storage |
| ▪ Technologically innovative capabilities for research and technologies for developing strategic national roadmaps for zero-carbon economy in 2050 |
| ▪ Detailed mapping of renewable energy resources, technical potential, and technology to advance storage capacity in the marine space |
| ▪ Technological innovations: autonomous underwater vehicles (AUVs), remotely operated underwater vehicles (ROVs) and autonomous surface vehicles (ASVs) for underwater mapping |
| ▪ Geological mapping of the seabed and/or habitat mapping: e.g., EMODnet Geology and EMODnet Seabed Habitats |
| ▪ Imaging and physical sensors, satellite technologies, smart sensors, techniques and platforms for measurement of the marine environment |
| ▪ EU Funded projects: e.g., WinWind, Baltic InteGrid, Blue Nodules, Blue mining |

## 2.5. Security

Geopolitical interests for national security, energy security and natural marine resources, together feed into discussions about the future use of sea areas and forward planning for associated spatial requirements. The disruption to supply-side capacity during the unprecedented circumstances of the Covid 19 pandemic resulted in limited access to ports and reductions in demand for goods, services (e.g., tourism) and foodstuffs (e.g., fish and seafood). The inter-connection between global trade and international supply chains have been exposed by Covid-19, which has limited the throughput of container ports causing vessels to be diverted. This has resulted in vessels and containers being out of place for their onward journeys, causing additional problems for global logistics. Current planning methods are being revised to avoid such problems being encountered again, whilst aiding economic recovery. Such methods often take an integrated approach, where economic and environmental parameters are mainstreamed at national and regional levels. For example, the EU's Biodiversity Strategy supports a green recovery from the Covid-19 pandemic (Table 5). Additional challenges, including migration, energy security, impacts of climate change, highlight the need for maritime surveillance and the need for effective data collection and efficient dissemination.

| Table 5: Security – examples of methods |
|---|
| ▪ Global policy and regulations: e.g., Agenda 2030 |
| ▪ EU policy: e.g., EU Maritime Security Strategy, EU's biodiversity strategy for 2030, EGD, EU offshore renewable strategy 2020 |
| ▪ Resilience building/increasing of the maritime sectors and adaptation of the national production model in the context of the blue circular economy: e.g., within MSP that aims at building/increasing resilience of the maritime sectors by providing a systemic approach for efficient and integrated resilience |
| ▪ Strengthened harmonized cooperation and coordination by Member States |
| ▪ Technological innovations: e.g., in maritime surveillance and data collection – Copernicus services - the Copernicus Maritime Surveillance system (CMS), European Maritime Security Agency EMSA's integrated maritime services (IMS), The Common Information Sharing environment (CISE) |
| ▪ Cross-sectoral collaborations for blue recovery: e.g., areas where sectors and science can work together to increase resilience through cooperation/synergies between sectors and R&D |
| ▪ Information and communication technology (ICT), big data analytics, European Blue Economy Observatory |

## 2.6. Space

Sectoral growth in tourism, ORE, ports and shipping, marine aquaculture and other blue economy sectors is leading to a shortage of available sea space, especially in some EU sea basins. The multiple use of space will become more important in the next decades due to the increased spatial demands for both energy and nature, thus countries will be increasingly required to combine different uses where possible. Various approaches for the multi-use of sea space and infrastructure including multi-technologies, are being developed, that combine two or more activities such as aquaculture and tourism or tidal energy and seaweed production, under a variety of projects in the EU.[45] The focus of these initiatives is largely on ORE production combined with seafood production[46] and nature conservation with offshore wind, allowing for the transit of smaller vessels within offshore wind farms.[47] There are also pioneering technologies in the energy transition sector. Multi-use infrastructure has been designed for renewable energy production and desalination, combined with a floating refuelling station.[48] The multi-use approach aims to meet the growing need for energy, food, water and space, to identify synergies, as well as to provide efficiency and to lower the impact on the marine environment.[1] To address future demands on maritime space, cross-sectoral policies and regulations are being strengthened, and multi-use approaches are expected to be integrated in maritime policies. Maritime spatial competition indices for future projections (e.g. 2050)[49] will increasingly be applied by governments, businesses and investors in planning processes.

| Table 6: Space – examples of methods |
|---|
| ▪ Global policy and regulations: UNCLOS, Joint Roadmap to accelerate Maritime/Marine Spatial Planning processes worldwide |
| ▪ EU policy: e.g., EU's biodiversity strategy for 2030, EGD, EU offshore renewable strategy 2020, Pandemic Emergency Purchase Programme, Roadmap and Action plan to support the recovery of the European economy (Covid-19), MSPD, MSFD |
| ▪ Resilience building/increasing of the maritime sectors and adaptation of the national production model in the context of the blue circular economy: e.g., within MSP that aims at building/increasing resilience of the maritime sectors by providing a systemic approach for efficient and integrated resilience |
| ▪ Maritime zoning: MPAs, Spatial Protection Measures, MSP, ICZM |
| ▪ Cross-sectoral collaborations for blue recovery: e.g., areas where sectors and science can work together to increase resilience through cooperation/synergies between sectors and R&D |
| ▪ Data collection systems and GIS tools: EMODnet, Common information sharing environment (CISE), Aquaspace tool, IH-MSP Platform, Pegaso Spatial Data Infrastructure, SEANERGY Spatial Tool |
| ▪ Data collection: maritime surveillance data, environmental monitoring |
| ▪ Industrial energy multi-use innovations: reuse of existing oil/gas infrastructure in a hydrogen supply chain; platforms storing captured carbon emissions in depleted offshore fields and functioning as hubs for hydrogen power networks in the proximity of the offshore wind turbines, desalination systems with renewable energy production |
| ▪ Spatial competition forecasts: DNV Ocean Spatial Competition Index 2050 |
| ▪ Investments: Coronavirus Response Investment Initiative, Recovery Fund (Covid-19) |

[46] COEXIST Project https://www.coexistproject.eu/
[47] Schultz-Zehden, A., et al., 2018
[48] MUSICA Project https://www.h2020united.eu/images/Webinar_Reports/UNITED-2020-06-03-Webinar_PRESENTATION_MUSICA_project_DALTON.pdf
[49] DNV, 2023

| |
|---|
| ▪ EU Funded projects: e.g., MUSES, MUSICA, MULTIFRAME, COEXIST, TROPOS, MERMAID, SPACE@SEA, MARIBE, UNITED |

### 2.7. Science and innovation

Science and innovation are at the forefront of developing solutions to address technological and space-saving challenges. They will increasingly be required to play key roles in providing spatial planning solutions, closing knowledge gaps, and resolving conflicts and uncertainties linked to impacts from the presence of large-scale maritime infrastructure in the sea space.[50] Floating wind technology enables wind parks to be moved further offshore into deeper waters. However, this brings additional challenges, such as long-distance transmission back to shore. Encouraging innovation into the co-location of technologies could help with expanded storage capacity and create more stable grid connections, making better use of the available sea space.

Collecting data to better understand marine resources and ecosystems is an important aspect to aid and inform decision-making in marine resource management. However, as essential as marine data is for assessments and environmental monitoring, developing knowledge about multi-stressors in the marine environment is also vital for the preservation of sea space and better management of marine and coastal resources. More inclusive approaches to designing and conducting marine scientific research will support sustainable planning of marine space through management actions aimed at protecting sea space and encouraging long-term stewardship of marine resources. Partnerships with maritime industries for data and knowledge exchange will expand the knowledge base and support sustainable planning of marine space as well as planning and management actions.[51]

| Table 7: Science and innovation – examples of methods |
|---|
| • Decade of Ocean Science for Sustainable Development (2021-2030)[52] supports the development of new innovative strategies and methodologies to improve the use of ocean resources and marine space |
| • Methods for data assimilation for MSP: Proposal for making harmonized MSP plan data available across Europe[53] |
| ▪ The methods are summarized in Chapters 2, 3 and 4 of this study - in tables under the EU-funded projects; The Horizon Europe Framework Programme, Horizon 2020, European Partnership for a climate-neutral, sustainable and productive Blue Economy |

## 3. FUTURE SECTORAL GROWTH

As outlined in Chapter 2, the demands and needs for the future growth of maritime sectors are closely linked with international policy for environmental protection and sustainable development. European and global policies, together with examples of international frameworks of relevance to future maritime development, are presented in Table 8. These include key policies and their application to the five sectors outlined in Figure 1. The policies are described in the background technical study produced by the European MSP Platform: "The implications of the Ocean Governance framework established by the United Nations for the Implementation of the EU MSP Directive".[54]

**Table 8: Key policies and regulations that play a role in the future sectoral growth of maritime sectors**

| Global and European policy and regulations of relevance to maritime future development | Shipping and Ports | Energy | Food Supply | Tourism | Emerging Sectors |
|---|---|---|---|---|---|
| **International** | | | | | |
| UN Convention on the Law of the Sea (UNCLOS) | X | X | X | X | X |
| BBNJ Intergovernmental Conference | X | X | X | X | X |
| Paris Agreement of the UN Framework Convention on Climate Change | X | X | X | X | X |
| IMO MARPOL Convention for the Prevention of Pollution from Ships | X | | | | |
| IMO London Convention and London Protocol on marine pollution in seas | X | | | | |
| IMO's Energy Efficiency Design Index (EEDI) | X | X | | | X |

[50] UN Global Compact, 2021a
[51] UN Global Compact, 2021b
[52] https://www.oceandecade.org/
[53] https://www.msp-platform.eu/sites/default/files/hz0121216enn.en_.pdf
[54] https://maritime-spatial-planning.ec.europa.eu/sites/default/files/hz0622215enn.en_.pdf

| | | | | | |
|---|---|---|---|---|---|
| Ballast Water Management Convention (BWMC) | X | | | | |
| UN Fish Stocks Agreement (UNFSA) | | | X | | X |
| Code of Conduct for Responsible Fisheries | | | X | | X |
| Convention on Biological Diversity (CBD) | | X | X | | X |
| The Global Post-2020 Biodiversity framework (GBF) | X | X | X | X | X |
| Maritime Labour Convention (MLC) | X | X | X | X | X |
| Regional Seas Conventions | X | X | X | X | X |
| 2030 Agenda for Sustainable Development | X | X | X | X | X |
| The Sendai Framework for Disaster Risk Reduction 2015–2030 (UNDRR) | X | X | X | X | X |
| **European** | | | | | |
| *European regulatory frameworks* | | | | | |
| EU strategy on offshore renewable energy (2020) | | X | | | X |
| Biodiversity strategy for 2030 (2020) | X | X | X | X | X |
| Directive on establishing a framework for MSP (MSP Directive 2014) | X | X | X | X | X |
| Directive on port reception facilities for the delivery of waste from ships (2019) | X | | | X (cruise) | |
| The Marine Strategy Framework Directive (MSFD, 2008) | X | X | X | X | X |
| The Water Framework Directive (WFD, 2000) | X | X | X | X | X |
| EU Floods Directive 2007 | X | | | X | X |
| Habitats & Birds Directives (Regulatory) | X | X | X | X | X |
| The INSPIRE Directive | X | X | X | X | X |
| *European strategies* | | | | | |
| An Integrated Maritime Policy for the EU (IMP, 2007) | X | X | X | X | X |
| European Green Deal (2020) | X | X | X | X | X |
| Recommendation concerning the implementation of ICZM in Europe (2002) | X | X | X | X | X |
| The Directive on the reduction of the impact of certain plastic products on the environment (2019) | X | | X | X | X |
| Climate Strategies and Targets | X | X | X | X | X |
| A European Strategy for Plastics in a Circular Economy (2018) | X | | X | X | X |
| Common Fisheries Policy | | | X | | X |

Future sectoral growth is considered in this chapter, relating to shipping, ports, offshore energy, marine fisheries, aquaculture, recreation, and emerging sectors. All will require additional sea space given their projected strong growth. Consideration is given to mitigation components of sectors as well as adaptation and resilience elements.

## 3.1. Shipping and Ports

Shipping plays a key role in the EU economy and trade, estimated to represent between 75-90% of the EU's external trade. Seaborne trade is anticipated to expand,[55] and sufficient space will need to be preserved to ensure safe corridors for shipping traffic. As demand for global freight increases, maritime trade volumes are set to triple by 2050.[56] This will result in higher levels of marine traffic, more transit lanes, and frequency of passages. Given the size and global nature of maritime shipping, the industry endeavours to reduce its environmental impact.[57]

Green port development in relation to energy and fuels includes addressing the existing energy use of the ports, increasing the use of renewable energy, the availability of alternative fuel-bunkering infrastructure and provision of onshore power supply to ships. As a consequence of increasing seaborne trade, the shipbuilding and port development markets are expected to expand to accommodate the projected economic growth. The main developments in maritime transport in coming years will be related to lowering emissions from fuel sources and the development of more eco-friendly vessels, which will significantly affect shipbuilding and port activities. Furthermore, in view of adverse impacts of climate change and increasing coastal flood risk, there is an urgent need for ports and waterway operators to adapt, along with vital connecting transport infrastructure and global supply-chain networks, in order to avoid significant trade disruption.[58] Timely and effective preparation for adaptation planning for ports will be required to: decrease the probability of incidences of damage or structural failures; lower downtime, disruption and operational delays; and decrease impact on the safety of personnel and equipment.

In connection with the expansion of ORE production and natural gas projects, as well as to support the decommissioning of oil/gas platforms, port facilities will be required to continually modernise and

[55] https://www.ics-shipping.org/shipping-facts/shipping-and-world-trade
[56] https://www.oecd.org/ocean/topics/ocean-shipping/
[57] UN Global Compact, 2021c
[58] PIANC, 2020

develop. For example, the Port of Rotterdam is evaluating the expansion of its existing facilities to include decommissioning facilities as part of its Maasvlakte 2 port upgrade project. In the future, shipping used to transport green fuels from areas with abundant energy resources to areas where it is required, could become as important as LNG transport is today. Expansion of ports and possible creation of new shipping lanes are thus important considerations for future uses of the seas. When identifying specific shipping routes consideration should be given to existing/future infrastructure projects such as subsea pipelines (e.g., shipping lanes should be crossed perpendicularly and in the shortest possible way; anchoring on cables and pipelines should be avoided)[59] and dredging activities (e.g., near ports).

| Table 9: Shipping and ports – examples of methods |
|---|
| ▪ Global policy and regulations: e.g., UNCLOS, SOLAS, EEDI, BWMC, MARPOL, BWMC, HNS, IMSBC, BUNKER, STCW, MCL, CLC/FUND, London Convention and London Protocol, Hong Kong Convention |
| ▪ Regional EU policy: e.g., Directive 2014/94 on the deployment of alternative fuels infrastructure |
| ▪ EPC (Engineering, Procurement, and Construction) opportunities |
| ▪ Research calls/projects: e.g., Ports of the Future, LOOP-Ports project |
| ▪ Technological innovations: green ships, PIANC Report: Climate Change Adaptation Planning for Ports and Waterways |
| ▪ Technical methods: e.g., motion response simulations of ships, computerization and big data analytics, combination with AIS data and metocean forecast |
| ▪ Information and communication technology (ICT) |
| ▪ Stakeholder engagement process: through interactive decision-support tools e.g., Port of the Future Serious Game |

## 3.2. Energy

The offshore wind industry has grown rapidly over the last 20 years and the development of the industry is likely to play a key role in meeting the demands for clean energy, whilst hitting decarbonization targets outlined in the Paris Climate Agreement.[60] Global offshore wind capacity is projected to increase significantly over the next two decades: total global capacity is expected to reach around 120GW by 2030, the vast majority of which will be fixed-bottom installations. By 2040, current capacity is projected to have increased fifteen-fold[61] through the development of large scale floating offshore windfarms, using larger turbines and in areas of deeper water. Other technological developments include innovative capabilities for developing energy storage capacity and improving performance and transmission back to onshore markets.

The European Green Deal emphasizes the key role offshore renewable energy will play in the transition to a carbon-neutral economy and the EU Offshore Renewable Energy Strategy (2020) confirms offshore renewable energy objectives. National targets to fulfil energy policy requirements and increase the share of renewable energy in Member States' energy mix will inevitably lead to an accelerated deployment of sea-based energy systems[62] in territorial waters and shared sea basins.

As part of a sustainable transition towards Net Zero $CO_2$ emissions, technologies that combine new and old sources of energy will be essential to help countries adjust. For example, a combined-cycle gas turbine, with carbon capture technology is a viable solution that could be developed at scale in sea areas to provide low carbon power. However, a variety of multi-uses will need to be considered to maximise the use of available sea space by maritime sectors. Detailed mapping of renewable energy resources and their technical potential, as well as their proximity to areas that might be affected by natural disasters, will also help with the short-, medium- and long-term forecasting of opportunities for wind energy. In the longer term, there is also the issue of climate change and the uneven distribution around the globe of potential changes in wind regimes induced by global warming. Robust estimations and high-resolution information are essential for projecting possible impacts on wind farms.

Early identification of risks from offshore wind farms to biodiversity will come from screening processes as part of project planning. Various methods are summarized in Table 10.

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[59] https://www.noordzeeloket.nl/functies-gebruik/
[60] https://gwec.net/
[61] IEA, 2019a; IEA, 2019b
[62] The Ocean Renewable Energy Action Coalition (OREAC) is calling on governments to install 1,400 GW of offshore wind generating capacity worldwide by 2050. https://gwec.net/oreac/

| Table 10: Energy – examples of methods |
|---|
| ▪ Global policy and regulations: e.g., Paris Agreement, Agenda 2030 |
| ▪ EU policy: e.g., European Green Deal, EU Offshore Renewable Energy Strategy |
| ▪ Policies: Promotion of Research and Development (R&D) roadmaps and strategies to facilitate an offshore renewable energy roadmap for national research and industry development institutions. |
| ▪ R&D strategies to build knowledge: R&D roadmaps including topics needed to advance the sector further environmental assessment and impact, electrical safety, mooring and anchoring systems, project development knowledge for offshore conditions; reusing the decommissioned infrastructure for hydrogen |
| ▪ Licensing and consent for all offshore developments |
| ▪ Scientific assessment, inspection and monitoring involved in the decision-making and implementation of rig and wind turbine |
| ▪ Technologies: subsea engineering for underwater grid methods, power transmission from deep-water, subsea power systems, pipeline safety, moorings and anchoring for floating structures, etc.; multi-uses to maximize use of sea space by various sectors and to maximize the possibilities for energy transition; pioneering technologies of combined-cycle gas turbine facilities with carbon capture technology to provide low carbon power next to wind turbines; the use of technologies to utilize sectoral synergies and repurposing existing sea infrastructure to support energy transition; |
| ▪ Satellite technologies: remote sensing for assessments of spatial areas and potential offshore wind energy resources; aquaculture site selection, mapping of fish farm locations and surrounding area, as well as environmental monitoring and the identification and tracking of toxic algal blooms |
| ▪ Numerical simulation methods for the energy resource evaluations and spatial locations/planning |
| ▪ Development of innovative hybrid offshore renewable energy systems: promoting systemic approaches to decrease the levelized cost of electricity for offshore energy technologies |
| ▪ Innovation of colocation of renewable offshore technologies for technologies to benefit from spatial colocation, enhance the water space use and at the same time enable a more stable power generation in the grid |
| ▪ Improving voltage grids, in the future building a high-voltage grid that will help to transport electricity to other regions, save space and avoid renewable energy curtailment |
| ▪ Reducing negative impacts from offshore infrastructure: assessments of impacts; risk screening of all projects; defining no go investment policies; SEAs for identifying appropriate sites for renewable development away from areas of high biodiversity sensitivity; identification of No Go areas (areas that due to their conservation values should not be used for offshore wind projects); integrating landscape zoning into the energy planning process; on-site habitat enhancement to biodiversity (wind energy developments providing opportunities to create biodiversity benefits); |
| ▪ Marine Protected Areas and other relevant types of exclusion zones or controlled areas, e.g., Key Biodiversity Areas (KBAs), Ecologically or Biologically Sensitive Areas (EBSAs) |
| ▪ Coupling with other maritime sectors (multi-uses): desalination, space cooling, shipping, and tourism, aquaculture, green hydrogen generation, ocean observation (to power environmental equipment for monitoring), underwater vehicle charging, etc. |
| ▪ Open and transparent communication and sharing of monitoring results to help developers comply with regulations and as good practice that can help generate credibility and support for offshore project and help contribute to wider conservation efforts. |
| ▪ EU-funded projects, e.g., EU-SCORES, UNITED |

## 3.3. Food supply

The EU is currently the largest importer of seafood in the world and is the fifth largest producer of fishery and aquaculture products.[1] In order to satisfy the increasing demand for seafood products, the growth of the aquaculture industry will compete for access to space with other maritime sectors. Therefore, the sector will need to combine scientific and technological innovations in ways that can contribute significantly to both economic and marine-ecosystem sustainability. Future fish farming methods will need to become more sophisticated with knowledge-driven approaches.[63] Innovative aquaculture approaches are currently being developed under several EU funded projects. These initiatives are promoting practical engineering solutions that synergise aquaculture operations[64] (new technologies for low-carbon economy) with offshore windfarms.

New, integrated approaches and incentives for the reduction of the environmental impact of fish farms in coastal regions are also being tested. Capture fisheries may remain viable in the coming years, mainly due to the measures being undertaken to improve the health and status of fish stocks.[65] Important contributions are made by such methods as regulations and international agreements, and improvements in the EU's Common Fisheries Policy towards a more integrated approach across and between sectors (Table 11).

[63] Føre, M., et al., 2018
[64] OECD, 2016
[65] European Commission, 2021

| Table 11: Food supply – examples of methods[66] |
|---|
| ▪ Global policy and regulations: e.g., UNCLOS, UNFSA, RFMOs, PSMA, CCRF, WTO negotiations on fisheries, MARPOL, London Convention, OPRC, OPRC-HNS Protocol |
| ▪ EU policy: e.g., Biodiversity Strategy, MSFD, MSPD, Common Fisheries Policy (CFP), 7th EAP, HBD, BWD |
| ▪ European Commission's Scientific Technical and Economic Committee for Fisheries |
| ▪ National regulatory frameworks: e.g., countries' aquaculture laws and regulations |
| ▪ Integrated ocean governance: e.g., MSP, MPA, Blue corridors |
| ▪ Governance by different regulatory bodies: e.g., bodies responsible for regional planning, spatial planning, industrial development, environmental issues, food safety |
| ▪ Scenarios of food demand and supply: e.g., tools and models for fisheries management, Intelligent Oceanographically Based Short-Term Fishery Forecasting Applications (GOFORIT project) |
| ▪ Systems to trace throughout the value chain for sea food products |
| ▪ Integrated environmental assessments |
| ▪ Licensing approaches |
| ▪ Measuring and accounting marine ecosystem services: e.g., Common International Classification of Ecosystem Services (CICES), Economics of Ecosystems and Biodiversity (TEEB), UN SEEA EEA |
| ▪ Technological innovations: e.g., biotechnology in aquaculture (e.g., algal biofuels); the engineering and technologies required for offshore aquaculture operations; open ocean aquaculture; technologies increasing offshore aquaculture systems using for example marine net pens, multitrophic aquaculture installations; technologies to power aquaculture with renewable energy to transform systems |
| ▪ Synergies with offshore windfarms (e.g., multi-use platforms) and mix interactions with other sectors, such as tourism |
| ▪ EU-funded projects: e.g., ECOAST, MUSES, MAREFRAME, COEXIST, CREAM, UNITED |

## 3.4. Tourism

Coastal tourism is the biggest mature and growing sector across the EU Blue Economy in terms of Gross Value Added and employment. It plays an important role in many Member State's economies and EU policy aims to maintain Europe's standing as a "leading tourist destination while maximizing the industry's contribution to growth and employment".[1] The success of this sector is inextricably linked to the status of the surrounding environment (water quality, natural beauty, and well-maintained beaches, etc.). However, these will increasingly be affected by climate change impacts, such as sea level rise, coastal flooding and coastal erosion, saline intrusion, increases in air and seawater temperatures, biodiversity loss, and other climate-induced effects, as well as pollution. Whilst coastal protection is of prime importance to counter coastal erosion and flooding and maintain tourism facilities and activities, but hard-engineering solutions can have detrimental impacts upon aesthetic benefits. Soft engineering, such as managed retreat methods and nature-based solutions, may offer alternatives that have environmental benefits and can themselves provide tourist attractions, e.g., creation of habitat for wildfowl or waterfowl.

Spatial conflicts between tourism and other maritime sectors, may include fishing, although tourists are also an important driver for the demand for fresh, locally caught fish products. Synergies can be developed with eco-tourism initiatives and MPAs that ensure ecosystem conservation and protection. Despite the continuous growth of tourism in the last few decades, unpredictable events, such as the COVID-19 pandemic, can have substantial impacts on the leisure and tourism industry.

Holistic and integrative coastal management approaches with a comprehensive protection strategy will be increasingly needed to address key coastal risk management issues. Examples of these are the currently developed national coastal protection strategies in Spain and for the Maltese Islands. In Malta, the project "Coastal-Climate Overall Vulnerability and Exposure Risk – Protection Strategy for the Maltese Islands" (Coastal-COVER) is funded by the EU Technical Support Instrument upon request of the Maltese Public Works Department, the Ministry of Public Works and Planning, and the Malta Tourism Authority. It aims at developing a coastal protection strategy for the Maltese Islands at national level and it considers climate change impacts and coastal tourism. Furthermore, methods for the inclusion of the underwater cultural heritage will be considered in planning in order to overcome threats to the underwater cultural heritage.[67]

[66] More information is provided by the fishing sector fiche on the MSP Platform: https://www.msp-platform.eu/sites/default/files/sector/pdf/mspforbluegrowth_sectorfiche_fishing.pdf

[67] https://maritime-spatial-planning.ec.europa.eu/sites/default/files/hz0622216enn.en_.pdf

| Table 12: Tourism – examples of methods[68] |
|---|
| ▪ Global conventions, agreements, processes: e.g., Agenda 2030, UNCLOS, CBD, Regional Seas Conventions |
| ▪ EU policy, legislations, regulations: e.g., Biodiversity Strategy 2030, IMP, MSP Directive, MSFD, WFD, Habitats Directives, EU Habitat Action Plan, ICZM Recommendations |
| ▪ Investments in modernization and innovation: regional and structural EU funds and EU instruments financing tourism project planning and implementation |
| ▪ Partnerships: e.g., a pan-European between coastal tourism stakeholders, cruise operators and ports to enhance synergies in the sector, target best practice sharing in innovation, competitiveness and sustainability strategies |
| ▪ Technological innovations: smart solutions such as reinforcements of coastlines by building dykes into the dunes (e.g., NL) to satisfy the needs and interests of different stakeholders including authorities and businesses; financing |
| ▪ Structural methods: strengthening protection measures along coastlines to reduce coastal flood losses |
| ▪ Nature-based solutions: to mitigate erosion and flood risk under current sea levels |
| ▪ Multi-use and synergies with other sectors: e.g., eco-tourism and marine protected areas, tourism and windfarms, pesca-tourism |
| ▪ Holistic and integrative coastal management approaches: ICZM with a comprehensive protection strategy for tackling important risk management issues, such as coastal erosion, and pandemics such as COVID-19 |
| ▪ EU-funded projects: e.g., CO-EVOLVE, AMPAMED, MUSES, Coastal-COVER |

## 3.5. Emerging sectors

Emerging sectors, including aggregate extraction, next generation offshore facilities (floating offshore windfarms, floating solar photovoltaic energy, offshore hydrogen generation, wave and tidal energy),[69] blue biotechnology, offshore aquaculture and seaweed production, and desalinization, will play a more prominent role in the future in all EU sea basins. Some of these emerging sectors, e.g., offshore energy renewables, are expected to develop quickly to meet the requirements of the European Green Deal and will require considerable areas of sea space, possibly in combination with offshore construction such as artificial energy islands.

Many of these innovations and new maritime sectors requiring space are not included in current approaches to MSP planning. This will need to change in the future given the demand for green transition, large scale renewable energy sources, seabed minerals, food supply and geopolitical security. Submarine cables[70] will also be given more consideration in the future given their economic importance and crucial role in channelling over 99% of international data transfer and communication, and for energy transmission between countries.[71]

Emerging sectors, such as aggregate extraction, pose new environmental challenges e.g., to MPAs, requiring further development of the regulatory framework to incorporate the spatial requirements of proposed developments.[72] New and more specialized approaches for addressing spatial complexity will be required for emerging sectors, for example, for offshore hydrogen generation, where spatial optimalization will be linked to new hydrogen networks and existing electricity grids for transporting offshore energy to shore, as explored in a recent study for the North Sea.[73]

Remote sensing and numerical simulation models are useful quantitative tools used to estimate the spatial areas required for emerging sectors. Further development of these systems will be necessary to deliver more accurate estimations as the spatial landscape becomes saturated. R&D, blue-tech innovation and robotics are increasing as key enablers for the sustainability transition and the digital twin ocean[74].[1] Floating offshore windfarms can be installed in deeper waters off the continental shelf to exploit higher winds speeds. This requires longer transmission cables to reach onshore substations. Concessions need to be made for these routes in future planning due to their potential to interact with other maritime activities such as fishing, dredging and nature conservation interests.

[68] More information is provided by the coastal and maritime tourism sector fiche on the MSP Platform: https://www.msp-platform.eu/sites/default/files/sector/pdf/mspforbluegrowth_sectorfiche_tourism.pdf

[69] More information is provided by the tidal and wave sector fiche on the MSP Platform: https://www.msp-platform.eu/sites/default/files/sector/pdf/mspforbluegrowth_sectorfiche_tidalwave.pdf

[70] More information is provided by the cable and pipeline sector fiche on the MSP Platform: https://www.msp-platform.eu/sites/default/files/sector/pdf/mspforbluegrowth_sectorfiche_cablespipelines.pdf

[71] As illustrated by the first submarine power line between France and Spain: https://www.ree.es/en/activities/unique-projects/submarine-interconnection-with-france

[72] For example, the regulatory framework of seabed mining for the deep seabed and on continental shelves is currently under development. A draft regulation for exploitation of minerals was issued in 2017 and has been through a hearing for stakeholder submission.

[73] Brosschot, S., 2022

[74] The Digital Twin Ocean is a consistent, high-resolution, multi-dimensional and near real-time virtual representation of the ocean which give governments, researchers, businesses, activists, and citizens alike the power to make informed decisions, backed by science and data, to restore marine and coastal habitats, support a sustainable blue economy and mitigate and adapt to climate change. Digital Twin Ocean (mercator-ocean.eu).

| Table 13: Emerging sectors – examples of methods |
|---|
| ▪ Global policy and regulations: e.g., UNCLOS (Part XI), International Seabed Authority, Paris Agreement |
| ▪ EU policy and legislation, strategies: e.g., new approach for a sustainable Blue Economy in the EU (2021), Renewable Energy Directive, EGD, Offshore Renewable Energy Strategy (2020), Hydrogen Strategy (2020), Bioeconomy Strategy, New strategy for a more sustainable and competitive aquaculture; EU instruments and initiatives: InvestEU, the Connecting Europe Facility, the Innovation Fund, EU Algae Initiative; The European Commission's Knowledge Centre for Bioeconomy |
| ▪ Technological innovations: Floating solar photovoltaic (FPV) installations, floating wind farms, Blue Bioeconomy Forum; SMART-HATCHERY; DEMO-BLUESMARTFEED (Demonstration project of a smart technology for monitoring the delivery of feed for a sustainable aquaculture); Underwater Robotics Market - Remotely Operated Vehicles (ROV), Autonomous Underwater Vehicles (AUV); the Digital Twin Ocean |
| ▪ Research, development, and innovation: e.g., for floating offshore platforms (spar-buoy, spar-submersible, and tension leg platform, barge; technically sophisticated methods for future fish farming requiring knowledge-driven approaches with scientific and technological innovation on multiple fronts, Blue Bioeconomy Forum |
| ▪ Remote sensing for assessments of spatial areas and potential offshore wind energy resources; aquaculture site selection, mapping of fish farm locations and surrounding area, as well as environmental monitoring and the identification and tracking of toxic algal blooms |
| ▪ Numerical simulation methods to the energy resource evaluations and spatial locations/planning |
| ▪ GIS-based mapping for the purpose of site selection for offshore aquaculture - for fish farm operators on availability of potential sites, and on key factors such as environmental interactions and the presence of other, possibly competing ocean users |
| ▪ GIS-based mapping with advanced modelling that provides further essential information such as predictions on oceanography, currents, animal growth, productivity, and ecological environmental effects |
| ▪ Subsea engineering and technology (underwater grid technology, power transmission from deep-water, subsea power systems, pipeline safety, moorings and anchoring for floating structures) |
| ▪ EU funded projects: MUSICA, MARINA Platform, OFFSHOREGRID, REvivED water, EU-SCORES (European Scalable Offshore Renewable Energy Source), FLAGSHIP (FLoAtinG offSHore wInd oPtimization for commercialization), COREWIND, FLOTANT, PivotBuoy, SeaTwirl, SATH, EDOWE, ASSO, FLOAWER, STEP4WIND, SEAFLOWER, ITEG, PHARES, GoJelly, DESEACROP |

# 4. Geographic Areas

Different EU Sea basins will have their own demands and requirements for blue growth development determined by their geography, prevailing biodiversity and governance. Local requirements, driven by scientific and industrial projects, will call for different spaces for future uses in the distinct sea basins. While EU policy, legislation and R&D framework programmes apply to all sea basins equally (Box 3), specialized methods of implementation are found in different basins due to the unique local settings (institutional, bio-physical and socio-economic). They are summarized in this section.

The detailed Blue Economy facts and figures for each sea basin is provided in the EU Blue Economy Report 2022, which specifies that the largest sea basin in terms of Gross Added Value is the Mediterranean Sea, followed by the North Sea. In terms of the Blue Economy employment, the largest is in the Mediterranean, in particular within the Adriatic-Ionian Sea. The smallest size of the Blue Economy is in the Eastern Mediterranean and the Black Sea, relative to the overall EU Blue Economy.

***Box 3: European policy framework applied to all sea basins in the EU***

*EU policy, legislation, regulations and measures, such as the MSPD and MSFD (Table 8), apply in all sea basins, along with the policies agreed by the Regional Sea Conventions. In compliance with the MSP Directive, all coastal Member States are required to transpose the MSP Directive into their national legislation and were required to produce national MSP plans for the identification of the spatial and temporal distribution of relevant maritime activities by 31 March 2021. The Directive provides a non-exhaustive list of sectoral uses75 to be considered to ensure that the planning processes result in comprehensive planning and encourages Member States to take into consideration land-sea interactions and long-term changes due to climate change. The process of MSP development by Member States is ongoing in all European sea basins and Member States have taken different approaches in developing MSP, such as binding (statutory) documents and strategic/vision-based planning/development documents that are considered in more general national planning/development programmes. Additionally, in some Member States the national ICZM plans, which may be statutory, are also developed, supported by the regional instruments as in the case of the ICZM Protocol in the Mediterranean.*

*The EU policy encourages Member States to share experiences and develop approaches transnationally in sea basins through EU-funded projects. The EU Programmes, including H2020 RIA and IA, Horizon Europe and Interreg Europe, enable knowledge development and exchange across Europe through projects having case studies in all sea basins. Examples include the H2020 research project UNITED (Multi-Use offshore platforms demoNstrators for boostIng cost-effecTive and Eco-friendly proDuction in sustainable marine activities)76 with pilots in the North Sea and the Mediterranean, and the MULTI-FRAME77 project on ocean multi-use systems.*

## 4.1. Baltic Sea

The Baltic Sea contains maritime activities such as shipping, fisheries and aquaculture, tourism and energy production.[78] Maritime traffic is expected to increase significantly in the Baltic Sea driven by regional development, including the expansion of gas terminals in Poland,[79] Estonia[80] and Latvia,[81] and the development of cruise ship tourism.[1] Offshore wind energy production is projected to develop rapidly.[82] The renewable energy sector is also likely to develop due to the high wave energy available in localized areas and a high potential for emerging technologies such as floating windfarms. In the last decade, several methods have been developed for planning in the Baltic Sea by the public authorities, research institutes and other stakeholders, especially under VASAB and HELCOM,[83] or through the regional projects, such as the Pan Baltic Scope Project[84] or Land Sea Act.[85] These tools and methods provide opportunities for more efficient planning and collaboration on MSP (Table 14). The tools developed under the framework of the BONUS BASMATI project (e.g. handbook, ecosystem services framework) provide decision support tools and integrated and innovative solutions for MSP in the Baltic Sea basin. The methods compiled by the Capacity4MSP project aimed at creating a practical and interactive collaboration platform for MSP stakeholders, decision and policy makers that informs, supports and enhances planning works.

[75] Such as maritime transportation routes and traffic flows, installations and infrastructure for the production of energy from renewable sources, aquaculture and fishing areas, installations and infrastructure for the exploration, tourism with underwater cultural heritage, nature and species conservation sites and protected areas.

[76] https://www.h2020united.eu/

[77] MULTIFRAME, Assessment Framework for successful development of viable ocean multi-use systems: https://www.submariner-network.eu/multi-frame

[78] More information is provided on the European MSP Platform - Baltic Sea page: https://www.msp-platform.eu/sea-basins/baltic-sea-0; and European Commission, 2022

[79] E.g., the LNG terminal in Świnoujście

[80] https://baltigaas.eu/planeeringud/

[81] https://www.skultelng.lv/en/

[82] On 30 September 2020, the Energy Ministers for the 8 EU countries in the Baltic Sea region and Commissioner Kadri Simson signed a declaration committing themselves to closer cooperation on offshore wind in the Baltic Sea. On 28 October 2021, the BEMIP high-level group adopted a work programme for offshore wind development in the region thus operationalising the declaration. https://energy.ec.europa.eu/topics/infrastructure/high-level-groups/baltic-energy-market-interconnection-plan_en

[83] HELCOM (Baltic Marine Environment Protection Commission – Helsinki Commission) is the governing body of the "Convention on the Protection of the Marine Environment of the Baltic Sea Area," also known as the Helsinki Convention: https://helcom.fi/ HELCOM, 2018

[84] http://www.panbalticscope.eu/

[85] https://maritime-spatial-planning.ec.europa.eu/projects/land-sea-interactions-advancing-blue-growth-baltic-sea-coastal-areas

| Table 14: Baltic Sea basin - examples of methods |
|---|
| ▪ Sea basin legal and regulatory policies, and frameworks: HELCOM & VASAB recommendations and guideline, EU Strategy for the Baltic Sea Region (EUSBSR) – Horizontal Action "Spatial Planning'', CPMR Baltic Sea Commission, Convention on the Protection of the Marine Environment of the Baltic Sea Area, Baltic Sea Common Regional Maritime Spatial Planning Framework |
| ▪ Measures developed by organizations: e.g., International Baltic Sea Fisheries Commission (IBSFC), Baltic Sea Advisory Council, Baltic Sea States Sub-Regional Co-operation, Council of the Baltic Sea States (CBSS), HELCOM Group on ecosystem-based sustainable Fisheries, CPMR Baltic Sea Commission – Renewable Energy Working Group, Baltic Sea Fisheries (BALTFISH) Forum, BEMIP - The Baltic energy market interconnection plan |
| ▪ Technological innovations: e.g., Green Infrastructure Concept for MSP and Its Application Within Pan Baltic Scope Project; Innovative practices and technologies for developing sustainable aquaculture in the Baltic Sea region (AquaBest) |
| ▪ Scenarios: e.g., Alternative scenarios for blue economies in the Gulf of Finland and Archipelago Sea, HELCOM Maritime Assessment 2018, SHEBA Project, WWF Future Trends in the Baltic Sea, Climate refugia in the Baltic Sea, Offshore wind in Europe – key trends and statistics 2020 |
| ▪ Technical methods: e.g. Cumulative Impact Assessment for Maritime Spatial Planning in the Baltic Sea Region, availability, and harmonization of marine environmental data (BALANCE project, MAREA project), The ecosystem-based approach in MSP - the Latvian recipe (BalticScope project), Guide on available geo-data for coastal and marine planning ("Sea meets land" project), GIS tools for MSP and management (BALANCE project, Land Sea Act, Plan4Blue) |
| ▪ Projects: e.g. Capacity4MSP, Pan Baltic Scope, BONUS BASMATI, BalticLines, BalticScope, Seanergy 2020, BALTSPACE, Sea meets land, BALANCE, PartiSEApate, Plan Bothnia, BaltSeaPlan, PlanCoast, BaltCoast, East-West Window, BalticRIM, Grass, Land Sea Act, eMSP NBSR, MAREA, Blue Platform. |

## 4.2. North Sea

The North Sea[86] basin has extensive shipping, fishing, aggregate extraction and energy production, such as hydrocarbon and offshore wind, with the highest concentration of offshore windfarms in the EU.[1] This sea basin comprises the busiest container ports in Europe: Rotterdam (The Netherlands), Antwerp (Belgium), Hamburg and Bremen-Bremerhaven (Germany). The significance of these large ports makes maritime transport and the associated port activities the main sector in terms of Gross Value Added, resulting in intensive maritime traffic within the basin. With the inevitable expansion of shipping and offshore renewable energy in the future, together with the creation of hydrogen pipelines, solutions to the spatial conflicts that will likely arise are needed.

The application of multi-use approaches[87] is expected to grow in the North Sea basin. Innovative projects are currently under discussion in Member States, for example artificial energy islands in Denmark[88] and Belgium[89], and offshore projects are being developed for construction of a transportation and storage system to collect and store industrial carbon dioxide beneath the sea. Ports in the North Sea are adapting rapidly to decarbonization targets in shipping and energy sectors with, for example, expansion areas for plant and component manufacturers and heavy-duty terminals and berths for special ships in the sector. Equally, grid integration and carrying capacity is being modernized to accommodate the continual growth of offshore wind in the region.

The high volume of maritime activities taking place in the North Sea basin, means that the installation of additional infrastructure, such as hydrogen pipelines, is likely to be spatially challenged. Offshore aquaculture is an emerging sector with plans for developing the cultivation of seaweed. As the energy transition accelerates, activities related to the decommissioning of oil and gas infrastructure will increase and new maritime activities, such as hydrogen production and transport[90] or carbon capture and storage[91] will emerge and increasingly demand more space. Finally, the opening of new Arctic shipping routes may bring new trade and research opportunities, leading to increased maritime traffic. Several methods have been developed for addressing multi-use and MSP in the North Sea (Table 15).[86] The methods increasingly address the multi-hazard and multi-sector issues, such as the North Sea pilot of the MYRIAD EU project that researches trade-offs between the demand for the use of space in the North Sea and synergies in a multi-sectoral way for the energy, infrastructure, transport and ecosystems sectors.

[86] More information is provided on the European MSP Platform - North Sea page: https://www.msp-platform.eu/sea-basins/north-sea-0; and European Commission, 2022
[87] See Multi-Use in European Seas Project (MUSES Project): https://www.msp-platform.eu/projects/multi-use-european-seas
[88] https://ens.dk/en/our-responsibilities/energy-islands/denmarks-energy-islands
[89] Elia, 2022
[90] See PosHYdon Project: https://www.neptuneenergy.com/esg/climate-change-and-environment/poshydon-hydrogen-pilot
[91] See Net Zero Teesside Project: https://www.netzeroteesside.co.uk/

| Table 15: North Sea basin - examples of methods |
|---|
| ▪ Sea basin legal and regulatory policies, and frameworks: The Convention for the Protection of the Marine Environment of the North-East Atlantic ("OSPAR Convention"), Maritime Spatial Planning in the North Sea (MASPNOSE), European Commission Maritime Forum (North Sea); The North Sea regional 'Esbjerg Offshore Wind Declaration' (May 2022), a Joint Statement on the North Seas Energy Cooperation (September 2022); the North Sea(s) MSP Collaboration Group |
| ▪ Measures developed by organizations: e.g., North Sea Commission, North Sea Marine Cluster, North Sea Advisory Council (NSAC), North Sea Hydrographic Commission, OSPAR North Sea Conference, OSPAR Commission for the North Sea Region, Clean North Sea Shipping (CNSS) |
| ▪ Participatory approaches: Community of Practice Multi Use North Sea 2030 |
| ▪ Technological innovation: e.g., Renewables Grid Initiative (RGI), Can multi-use of the sea be safe? A framework for risk assessment of multi-use at sea, hydrogen production with offshore wind farm (Denmark) |
| ▪ Scenarios: e.g., the future of the North Sea (policy exchange - scenarios for the Netherlands 2050 Spatial Agenda and Scenario study on future of the North Sea)[92], MSP Challenge simulation game: Combining ecosystem modelling with serious gaming in support of transboundary maritime spatial planning, Belgian Vision for the North Sea 2050, Offshore wind in Europe – key trends and statistics 2020 |
| ▪ Tools and methods: for interactive mapping e.g. Digitwin North Sea; for energy systems and hydrogen pipelines infrastructure design e.g. the North Sea Energy Programme, the North Sea Energy Roadmap, the North Sea Energy Atlas, the North Sea Energy's projects on spatial planning to optimize the routing of hydrogen pipelines considering current use functions and existing infrastructure |
| ▪ Technical methods: e.g. International Council for the Exploration of the Sea (ICES) Data Centre NORDREGIO – Nordic Centre for Spatial Development, Testing CEAF (Common Environmental Assessment Framework) in SEANSE case studies (SEANSE Project), Improving the co-existence of Offshore Energy Installations & Shipping (North SEE Project), Cumulative impact assessment for ecosystem-based marine spatial planning |
| ▪ Projects: e.g.: C-SCOPE, PISCES, BLAST, NorthSEE, SEANSE, eMSP NBSR, MYRIAD EU (North Sea Pilot) |

## 4.3. Atlantic

Shipping is an important sector in the region encompassing several major ports including, Saint Nazaire (France), Le Havre/Rouen (France), Brest (France), Sines (Portugal), Vigo (Spain), Cork (Ireland), Lisbon (Portugal), Las Palmas (Spain) and Bilbao (Spain). An increase in port connectivity was highlighted in the Atlantic strategy "Atlantic Action Plan 2.0"[93] as an area of growth in the region, recognising the importance that ports have in the blue economy. Furthermore, established aquaculture facilities are present throughout the region, where the industry is expected to expand further. Coastal tourism, living resources and port activities generate the majority of the Gross Value Added and employment for the sea basin.

The Atlantic has a high potential for the development of offshore renewable energy, in particular offshore wind farms (floating and fixed), and wave and tidal energy.[94] Future trends will be shaped by decarbonisation targets (e.g., French Renewable Energy Plan)[95] together with the advancement of the energy grid in the Atlantic. Sectoral growth will be influenced by the development of joint actions by socio-economic and institutional actors, such as maritime clusters,[96] and scientific research (e.g., biotechnology). Several methods have been developed for planning in the Atlantic by public authorities, research institutes and other stakeholders, and several initiatives focused on transboundary issues, such as SIMCelt, SIMAtlantic and SIMNORAT.[97] These planning tools and methods enable more efficient planning and collaboration at the basin level (Table 16). For example, the methods developed in the framework of the MarSP project aimed at developing planning schemes in the three Outermost Regions of Macaronesia (Azores, Madeira and Canary Islands), in line with the EU MSP Directive and following an Ecosystem Based Approach.

| Table 16: Atlantic Sea basin - examples of methods |
|---|
| ▪ Sea basin legal and regulatory policies, and frameworks: The Convention for the Protection of the Marine Environment of the North-East Atlantic ("OSPAR Convention"), Atlantic Action Plan 2.0, Atlantic Strategy |
| ▪ Measures developed by organizations: e.g. Atlantic Arc Commission Fisheries and Aquaculture Working Group, Energies Working Group, European Wind Energy Association (EWEA), OR's Ocean Governance Hub |
| ▪ Technological innovations: innovation for offshore aquaculture and offshore floating windfarms |

92 https://www.noordzeeloket.nl/en/policy/noordzee-2050/ and European Commission, 2022
93 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0329&from=EN
94 Atlantic Action Plan 2.0 : https://oceans-and-fisheries.ec.europa.eu/news/atlantic-action-plan-20-revamped-maritime-strategy-foster-sustainable-blue-economy-and-eu-green-deal-2020-07-23_en
95 https://www.ecologie.gouv.fr/sites/default/files/4pages_PPE_GB_DEF_Web.pdf
96 Atlantic Power Cluster: https://atlanticstrategy.eu/en/best-practices-database/atlantic-power-cluster
97 More information is provided on the European MSP Platform - Atlantic Ocean page: https://www.msp-platform.eu/sea-basins/atlantic-ocean ; and European Commission, 2022

| |
|---|
| ▪ Scenarios: e.g. Offshore wind in Europe – key trends and statistics 2020, Spatial demands and future trends for maritime sectors (SIMNORAT), Role of the regions: Future prospects and recommendations for the MSP directive implementation (SIMATLANTIC) |
| ▪ Technical methods: e.g. Data management guidance document (SIMNORAT), Cumulative Impacts and Strategic Environmental Assessment: Literature review (SIMAtlantic), A novel approach for cumulative impacts assessment for marine spatial planning, FISHRENT (Coexist project), Marine Planning for Wales - Strategic Scoping Exercise |
| ▪ Projects: SIMCelt, TPEA, Celtic Seas Partnership, SIMNORAT, EU-ATLAS: A trans-Atlantic assessment and deep-water ecosystem based spatial management plan for Europe, SIMAtlantic, MarSP: Macaronesian Maritime Spatial Planning, MSP-OR, REGINA-MSP |

## 4.4. Mediterranean Sea

The Mediterranean Sea[98] is a highly industrialised basin, with numerous industries operating in the area. The Blue economy in the sea basin is dominated by coastal tourism, with a high level of pressure on coastal zones that is likely to increase over the next decades due to the adverse effects of climate change. Maritime transport and port activities are other important economic sectors, with some of the biggest ports in terms of cargo capacity: Valencia (Spain), Algeciras (Spain), Barcelona (Spain), Gioia Tauro (Italy), Marsaxlokk (Malta), and Genoa (Italy).[1] Gas extraction is currently being explored in the Cypriot and Greek EEZs[99] and developers are increasingly looking for opportunities for generating energy from offshore wind, particularly from floating devices.

The extension of the continental shelf is limited in the Mediterranean, meaning that much of the basin is characterised by deeper water. As a result, developers are trialling several floating offshore wind farm projects off the coast of France (Gulf of Lion)[100] and Italy (Sicily Strait). Innovative approaches of coupling desalination and water reuse are being tested to supply fresh water for drinking and irrigation for a large proportion of the population around the Mediterranean Sea. Maritime surveillance and security will be an increasing consideration.

Several approaches for planning have been developed in the Mediterranean basin,[98] such as UNEP/MAP Ecosystem approach (EcAp) and ICZM Protocol, MSP Global (Westmed) and WestMed Initiative related actions, and through regional projects such as SUPREME, SIMWESTMED, MSP-MED and REGINA-MSP (Table 17). These tools and methods enable more structured planning in the basin. For example, the methods developed in the framework of the PHAROS4MPAs project, such as decision support tool for Blue Economy in MPAs, aimed to enhance management effectiveness and networking for Mediterranean MPAs, in order to contribute to the conservation of marine biodiversity and natural ecosystems.

| Table 17: Mediterranean Sea basin - examples of methods |
|---|
| ▪ Sea basin legal and regulatory policies, and frameworks: Mediterranean Action Plan (MAP) Barcelona Convention, Ecosystem Approach (EcAp) and its 11 Ecological Objectives, ICZM Protocol articulated with MSP (UNEP/MAP Conceptual Framework for ICZM/Marine Spatial Planning), The Protocol on the Protection of the Mediterranean Sea against Pollution from Land-Based Sources (2006), SPA/BD Protocol, LBS Protocol, Prevention and Emergency Protocol, Offshore Protocol, Hazardous wastes Protocol, Dumping Protocol, Mediterranean Strategy for Sustainable Development (MSSD, 2016-2025), Initiative for the sustainable development of the Blue Economy in the Western Mediterranean (WestMED) |
| ▪ Measures developed by organizations: e.g. UNEP MAP, Working group on IMP-MED, Union for the Mediterranean (UfM) Blue economy working group (including the second Ministerial declaration on Sustainable Blue Economy), UNEP-MAP Mediterranean Commission on Sustainable Development (MCSD), Mediterranean Network of Basin Organizations (MENBO), General Fisheries Commission for the Mediterranean (GFCM), Association of Mediterranean Energy Regulators (MEDREG), Westmed Initiative, EU Strategy for the Adriatic and Ionian Region (EUSAIR) |
| ▪ Technological innovations: e.g., Multi-use: MUSICA Project, floating offshore windfarm; clean ports (electrification) and shipping (ECA), UNITED Project - sustainable aquaculture, diving tourism |
| ▪ Scenarios: diagnostic: Report on Environment and Development in the Mediterranean (RED 2020, MAP/Blue Plan), Med2050 (MAP/Blue Plan), MSP Global (Westmed MSP scenarios), Offshore wind in Europe – key trends and statistics 2020, Blue economy working group (UfM), Medcities. Future prospects and recommendations for the MSP directive implementation (SIMWESTMED) |
| ▪ Technical methods: IMAP (EcAp), Quality Status Report 2023, Mediterranean Environment and Development Observatory (MAP/Blue Plan), CLIMAGINE (MAP/Blue Plan), Spatial Data Infrastructure (PEGASO project), ICZM |

[98] More information is provided on the European MSP Platform - Mediterranean Sea page: https://www.msp-platform.eu/sea-basins/east-mediterranean (east Mediterranean) and https://www.msp-platform.eu/sea-basins/west-mediterranean (west Mediterranean); and European Commission, 2022

[99] More information on European Council on Foreign Relations page: https://ecfr.eu/special/eastern_med/gas_fields

[100] Currently there are three pilots in France's Mediterranean area

| | |
|---|---|
| | Common Regional Framework (MAP/PAP-RAC), Adaptive Marine Policy (AMP) Toolbox (PERSEUS project), Decision Support Tool for Blue Economy in Marine Protected Areas (PHAROS4MPAs project) |
| ▪ | Projects: e.g. MEDTRENDS, MAREMED, COCONET, PERSEUS, PEGASO, MESMA, Coastal Area Management Programme – CAMP, COASTGAP, COASTANCE, Co-Evolve, PHAROS4MPAs, PANACEA, SUPREME, SHAPE, ADRIPLAN, THAL-CHOR 1 (ΘΑΛ-ΧΩΡ), Paving the Road to MSP in the Mediterranean: MSP MED – Greece, PLANCOAST, COEXIST, PORTODIMARE,MARISCA, PROTOMEDEA, DORY, Med-Iamer, AMPMED, SIMWESTMED, SwitchMed, THAL-CHOR 2, REGINA-MSP |

## 4.5. Black Sea

Currently the major maritime sectors in the Black Sea[101] are shipping, tourism, port activities, fisheries, and gas exploration. Aquaculture and renewable energy (bottom-fixed and floating wind farms) are emerging sectors in the region, currently in early stages and are expected to develop pilot projects in the coming years. For example, there are some initiatives to develop mariculture in Romanian and Bulgarian waters in the future, as well as similar initiatives, including legislative changes, to support the development of offshore wind in the Black Sea basin.

The growth of future activities will be determined, in part, by the level of environmental degradation currently affecting the sea basin, and the wider geopolitical landscape shaped by the commercial and strategic importance of the Black Sea. Several methods for planning have been developed (Table 18), in particular under the Common Maritime Agenda for the Black Sea, and as part of projects, such as MARSPLAN. The EU has only two Member States in the Black Sea, Bulgaria and Romania, so attempts at marine planning have a unique transboundary approach.

| Table 18: Black Sea basin - examples of methods | |
|---|---|
| ▪ | Sea basin legal and regulatory policies, and frameworks: Common Maritime Agenda (CMA) for the Black Sea, Black Sea Strategic Research and Innovation Agenda, Convention on the Protection of the Black Sea Against Pollution ("Bucharest Convention"), EU Joint Operational Programme Black Sea Basin 2014-2020, Agreement on the Conservation of Cetaceans in the Black Sea Mediterranean Sea and Contiguous Atlantic Area, EU Black Sea Synergy |
| ▪ | Measures developed by organizations: e.g., Black Sea Commission, Organization of the Black Sea Economic Cooperation (BSEC), Black Sea Cross-Border Cooperation, Black Sea Commission Activity Centres, Black Sea SCENE: Black Sea Scientific Network, GFCM Working Group on the Black Sea |
| ▪ | Scenarios: e.g. Offshore wind in Europe – key trends and statistics 2020, , Maritime spatial plan for the cross-border area (Mangalia-Shabla) – for Romania and Bulgaria; Assessment of the Black Sea Offshore Potential – Wind Power Generation in Bulgaria |
| ▪ | Technical methods: e.g. Tool for the identification and assessment of Environmental Aspects in Ports (TEAP), Maritime spatial plan for the cross-border area (Mangalia-Shabla), MSP Methodology for Black Sea, MISIS Black Sea Marine Atlas (MISIS) – for Romania and Bulgaria |
| ▪ | Projects: e.g. PlanCoast: PEGASO, COCONET, MARSPLAN-BS, MARSPLAN-BS-II, ECOAST (COFASP), MISIS, SymNet/CBC-Black Sea, ICZM/CBC-Black Sea, SRCSSMBSF, CREAM, MARSEA, ANEMONE |

More examples of the EU-funded projects in different sea basins can be found at the European Climate, Infrastructure and Environment Executive Agency (CINEA) Maritime Datahub.

# 5. Conclusions

The principal spatial planning methods used to accommodate emerging sectors and developments across the territorial marine waters of EU Member States have been reviewed as part of this study. Key instruments have been presented, which are currently available for planning activities and developments at sea, considering current and future use functions. By providing a spatial perspective to the planning process, these methods offer great potential to support the preservation of space in the future, and to address possible gaps and identify conflicts (or synergies) between future uses. Based on this review, key opportunities are outlined in Section 5.3. Final remarks.

## 5.1. Key instruments

The EU has holistic policies in relation to marine areas and has developed advanced tools and methods for planning activities and developments. The EU's Integrated Maritime Policy and EGD, together with the MSPD, MSFD, the Strategy on ORE and the Biodiversity Strategy for 2030, provide a basis for strategic planning in the European territorial waters and their coastal areas.

[101] MSP Platform, Black Sea page: https://www.msp-platform.eu/sea-basins/black-sea-0 ; and European Commission, 2022

Having the EU policy framework in place allows Member States to advance their national policies, regulations and methods for country-level planning, considering the priority spatial uses in their sea basin that are important to them. That also includes the incorporation of new infrastructure, such as large-scale offshore wind farms and other forms of offshore infrastructure, together with associated pipelines and cables. These policies provide certainty to developers who are willing and able to invest in new and often risky maritime technologies, such as renewable energy and offshore hydrogen production, which are nevertheless key to addressing climate change and promoting the sustainable use of marine resources. Furthermore, the EU policy encourages Member States to share experiences and develop approaches transnationally within sea basins, e.g., through EU-funded pan-European/regional projects and bilateral collaboration, that enable further knowledge development, transboundary capacity building and experience exchange in all European sea basins.

The methods presented here encompass a variety of approaches and tools that can be grouped into three main categories:

- ***Organizational methods*** pertaining to the institutional arrangements for the preservation of space, including legal and regulatory policies and governance structures, and the strategic planning of space through integrated and holistic approaches. These can be international, regional and national policies and legislation, regulations not permitting construction, institutional mechanisms, coordinated cross-sectoral and community-based planning approaches. For example: UNCLOS, Regional Seas Conventions, EGD, Strategy on Offshore Renewable Energy, Biodiversity Strategy 2030, MSPD, MSFD, Habitats Directives, ICZM Recommendations.
- ***Technical methods*** for developing spatial plans considering current and future uses and existing (or planned) infrastructure; monitoring and estimating hazards and vulnerability and embedding these into spatial planning. These are marine observation data collection and management systems and infrastructure (such as public data infrastructure e.g. EMODnet, Copernicus/CEMS), geospatial tools (e.g. DigiTwin), models for offshore/coastal risk assessment and derived information catalogues (e.g. European Coastal Flood Awareness System ECFAS), adaptive measures and infrastructure for offshore/ports/coastal structures and protection (e.g. PIANC Report: Climate Change Adaptation Planning for Ports and Waterways), DRR methods for energy producers and installations/assets, early warning systems, environmental assessments (e.g. EIAs and SEAs) and ecosystem-based approaches to planning (e.g. Improved transdisciplinary science for effective ecosystem-based MSP and conservation in European Seas - MarinePlan), technological innovations for industrial advancement, and simultaneous multi-use (e.g. UNITED).
- ***Process methods*** referring to the processes and knowledge required to use the technologies. These can be innovative financing instruments (e.g., InvestEU, the Innovation Fund, public-private partnerships), and capacity-building in planning methods and new technologies (e.g., EU-funded projects such as EU-SCORES, MSP4Bio), improving efficiency for MSP.

With the anticipated growth in the maritime sectors across Europe, an integrated approach incorporating all three categories will be necessary for the effective preservation of space for the future uses of the seas. They offer a way to address future challenges related to restricted space and climate change, among other global environmental challenges, as well as providing opportunities for synergies between different sectors. Participatory processes and capacity building, as well as short-term decision-making with a long-term perspective for the development of each maritime sector and sea basin are needed to make these methods more effective.

The integration of these methods and the capacity to deliver them need to be strengthened at the regional and national level. Planning methods will need to adopt a more holistic approach, incorporating socioeconomic activities with the natural dynamics of marine areas and the increased need for biodiversity conservation, all whilst considering the uncertainty surrounding new technologies and uses of the sea, that will require space in the future. Discussion on maritime industrial development associated with marine economic growth and technological innovation is an important element within this action. Even more so, given the need for more long-term and strategic approaches to be anchored in spatial planning for the future, including strengthening resilience and adapting critical maritime assets, operations, and systems.

## 5.2. Key challenges and future needs

While coordination among maritime industries and planning approaches is necessary to enable the preservation of space for future activities, some sectoral analysis, for example a study to identify trends in ship building, will still need to be applied independently. However, these sectoral methods alone will not be sufficient to develop appropriate planning strategies to cope with economic growth and ensure space for nature in European marine waters. Furthermore, disparate level of digitalization and approaches by maritime sectors presents a challenge for driving cross-sectoral considerations in planning of future needs. Therefore, a better understanding of the spatial requirements for each industry and sector; sectoral unifying digitalization principles enabling cross-sectoral leveraged input (e.g. standardized data) into whole system planning; as well as understanding of the interaction between spatial complexities,[102] will need to be enhanced in order to optimize the sustainable development of blue economy sectors through maritime planning, by considering future prospects of spatial claims and avoiding conflicting interests.

For example, with the expansion of installed offshore wind farms,[103] transmission of significantly increased levels of energy to shore in the future will require optimisation of a spatial network for offshore hydrogen and electricity networks in the sea basins.[104] For this, it will be necessary to apply new/upgraded methods for analysing offshore infrastructure routing options that could be used as inputs to update MSPs with social and environmental considerations, and ensure inclusion of nature and biodiversity protection within the large infrastructure networks. Also, application of methods to designate internationally interconnected electricity corridors for an offshore electricity grid will increase in the future to limit the routing deviations and thus decrease both the costs and spatial footprint of connections at sea. Currently, infrastructure corridors are for example defined in the Belgian and German MSPs, but it would be needed on a bigger scale using MSP at a European level. Planning uses, such as clean energy transportation systems, will need to accelerate the application of dynamic spatio-temporal aspects of supply and demand in planning to reach decarbonisation goals at low costs. The current challenge of over-investment in capacity could be reduced in the future, for example, with the application of a stepwise approach to methods where information on infrastructure that varies annually, becomes available, and by researching the real cost savings of reusing corridors and preferred cable/pipeline routes which are defined in MSPs. Methods, such as modelling (e.g. of offshore connections to onshore energy sinks), will be increasingly used to reduce the cost in offshore investments that could lead to more efficient and cost-effective network arrangements at sea.

In view of the energy, climate and biodiversity crises, broad interconnection corridors for future infrastructure as well as allocated ecologically or biologically significant marine areas (for conservation and restoration) at various scales in seas, between countries and in different sea basins, will increasingly require development and utilization of new/upgraded methods for planning at sea. For example, to play a vital commercial and societal role, the maritime sectors such as ports, navigable waterways and coastal tourism, will need to apply risk-informed planning methods, including a stepwise process to climate change adaptation planning, in order to ensure their resilience to climate change.[105] Careful risk-informed planning for coastal infrastructure resilience as a method for planning at sea uses risk in the planning process to improve the effectiveness of coastal protection plans and disaster reduction plans, while addressing the socio-economic development, natural requirements and impact of sustainable design in the long-term. The use of these approaches for risk-informed planning and risk-based designs will be further supplemented using other methods, such as decision-making tools, to support the risk-based planning process of decisions and investments in the face of present and future uncertainties. Spatial complexities of the ever-growing need for coastal protection interventions in the land-sea interaction areas where other maritime activities claim space, will increase, such as in the North Sea where dredging and sand nourishment can overlap with areas of windfarms' cables and pipelines. Innovative adaptive approaches will therefore need to be developed on a bigger scale to deal with uncertainties in a transparent and sensible way to support decision making with regards to planning, spatial uses and infrastructural investments that link current decision making to future choices.

Equally, a need for blue economy development and deployment of offshore infrastructure in a space-efficient and nature-friendly way, will increasingly require application of methods that give priority to environmental and social criteria to address the twin crises of climate and biodiversity. For example, an ecosystem-based MSP approach could act as a foundation to a centralized approach to tendering for offshore renewable energy projects.[106] That would allow for a shift away from being based principally on price and move towards a broader framework that gives priority to environmental and social criteria. The benefits of an ecosystem-based approach are evident for the aquaculture sector where problems facing optimal planning processes in marine aquaculture development usually relate to inadequate planning methods and human capacity, as well as information and data gaps. An ecosystem-based approach to aquaculture, with a range of

[102] DNV, 2023 - Spatial Competition Forecast - Ocean's Future to 2050
[103] https://www.weforum.org/agenda/2020/11/offshore-wind-energy-to-double; https://energy.ec.europa.eu/system/files/2022-09/220912_NSEC_Joint_Statement_Dublin_Ministerial.pdf
[104] Brosschot, S., 2022
[105] For example, the PIANC´s technical working group introduces a four-stage methodological framework to help port and waterway operators prepare strategies and select measures aimed at adapting assets and operation to climate change.
[106] WWF, 2022

instruments for access to space, is needed to ensure the long-term economic, environmental and social sustainability of the sector, and its ultimate contribution to blue economic growth.[107]

Environmental and social aspects will need to be increasingly considered in all methods for preserving space for the future uses of the seas and addressing the needs of future generations, for aligning climate change mitigation with the biodiversity strategy targets, and other urgent challenges at sea. For example, within the planning sites, spatial distribution of EBA-metrics will need to be produced at adequate spatial scales to quantitatively assess dispersal and movement corridors of different life stages (i.e., structural and functional connectivity) as well as spatial conservation and restoration of biodiversity. Development and application of decision tools for prioritization of conservation and restoration sites within planning is foreseen at a larger scale than today, considering the linkages between environmental, economic and social elements and identifying the potential risks of adverse effects for biodiversity.

Overall, integrated planning will require development of future planning scenarios encompassing all aspects of the socio-ecological system and based on the 10-tenets: ecological, technological, economic, political, social, administrative, legislative, cultural, ethical/moral, communication aspects. This will enable assessment of how complex interactions among many drivers may affect the integration of ecological` and socio-economic objectives in planning prioritization. Developing and implementing integrated planning in order to accommodate for the importance of interlinkages between activities at sea, increasing uses of marine space and resources, marine environmental dynamics, biodiversity loss and climate change, will require sustained collaboration of many actors where various participatory methods will be increasingly implemented and will be further developed. They will range from the local to the national and sea-basin levels, but also in a transboundary context and at the EU scale to ensure complementarity in Europe, which currently presents a key challenge. Today, sea basins such as the North Sea and Baltic Sea, start planning their space in an adaptive manner. They can respond to climate change within sea-level planning,[108] by commissioning detailed risk assessments, advanced offshore and coastal adaptation and mitigation approaches and by investing in developing technologies and innovative approaches. In other sea basins, Member States are likely to implement these innovative interventions. Development of Communities of Practice[109] and the European Blue Forum[110] will support joint efforts by all European maritime stakeholders.

Furthermore, providing information to feed policies and regulation in countries is urgently required for harmonization. Improved blue economy statistics with reliable data to deliver robust evidence for the performance of the blue economy and its development, will also support decision-making for planning, management and protection of the seas. The current work of the European Blue Economy Observatory[111] with future input of data from national administrations, international organizations, and private sector sources, will give more consideration to marine environment-economy linkages and ecosystem services to provide a comprehensive base for application methods for preserving space for the future uses of the seas.

## 5.3. Final remarks

**Considerations for future developments from the viewpoint of today's methods for planning at sea:**

In recent years, the capacity for planning and conflict resolution has improved substantially allowing Member States to implement more effective spatial planning and tracking and monitoring techniques.

The long-term development of the sustainable use of the seas is expected to positively affect methods for preserving space at sea for future uses, especially by encouraging the development of innovative technologies. It is, therefore, necessary for the links between the development of sustainable blue economy and the development of methods for preserving space at sea to be continuously strengthened, along with technological advancements across maritime sectors. It is likely that a string of enabling methods and tools will stimulate improvements in planning and the efficiency of maritime activities. These include climate-smart MSP, scientific research and innovation, ocean/

[107] European MSP Platform, 2022 *Access to space and water for marine aquaculture*: https://maritime-spatial-planning.ec.europa.eu/sites/default/files/access_to_space_and_water_for_marine_aquaculture.pdf
[108] The Netherlands is a good example of this. Because of its high vulnerability to sea level rise this country has a rich history of planning, and this for long-term horizons and for the highest levels of sea-level rise.
[109] For example, the Communities of Practice of the EU project eMSP NBSR 'Emerging ecosystem-based Maritime Spatial Planning topics in North and Baltic Sea Regions': https://www.emspproject.eu/project-activities/community-of-practice/
[110] The European Blue Forum will be launched by the European Commission in 2023.
[111] European Blue Economy Observatory was launched in May 2022: https://blue-economy-observatory.ec.europa.eu/index_en

marine observation as essential for the knowledge base of the European Green Deal, environmental monitoring, ecosystem analysis, as well as planning of established and emerging sectors.

For example, in addition to technological advances in remote sensing and information technology, there is the prospect of emerging technologies to expand the capabilities and coverage of existing ocean observation systems. Such advances would progress from the conventional single node, static and short-term modalities to multiple nodes, dynamic and long-term modalities, to increase the density of both temporal and spatial samplings at the sea,[112] that results in a paradigm shift in MSP. Also, the current methods for planning largely focus on the short-term (to medium-term) perspective, while for preserving marine space for the future, a range of methods will need to be progressively developed and improved, to capture medium- and long-term forecasting of changes at the sea and its resources. The increased installation of structures at sea will lead to changes in both the abiotic and biotic components of the marine ecosystem, however, the scale and significance of these changes are currently not clear. Already today, the evidence base available to quantify actual effects is limited due to the difficulties encountered in collecting relevant data, and in some cases the lack of clearly defined post-installation monitoring.[113] With the increased development of maritime activities and expanded uses of the seas, cumulative impact assessments for all marine activities will require more detailed data, together with the development of practical approaches and guidance on ecosystem level cumulative impacts and transboundary effects assessments. The need for evidence-based cumulative impact assessments based on availability of data from industrial projects will also increase at various temporal and spatial scales, to address knowledge gaps and uncertainties concerning potential effects from individual and multiple activities.[114]

Furthermore, applying adaptive management tools to continuously evolve planning methods as new data becomes available, will be required to assist environmental assessments and cumulative impact assessments to include suitable long-term scenarios. That is of particular importance in view of the ongoing technological development and advancements in monitoring and assessment methodologies that are inevitable for planning of the future uses of seas. Clear and significant benefits would accrue from improved access to data from all relevant sources. Pushing innovation into spatial co-location of technologies will further make best use of the physical space available at sea. Innovation is an important element of sectoral development when considering the efficient use of space for maritime activities, such as technological developments in communications and maritime navigation for example. It will become increasingly important to understand the life cycle of infrastructure from production to end-use, to effectively accommodate spatial use claims in planning for future developments. Considerations for economic, environmental and social constraints will need to form part of the next generation of planning at sea.

Therefore, from the perspective of preserving space for the future uses of the seas, the key implications include the need to further develop methods, training and financial incentives, while continuously enhancing policy and legal regulations for marine and land-sea interaction areas.

**Recommendations:**

There are many uncertainties to consider but, based on indications of future maritime growth, existing methods, and the projected increase in risks to marine areas from climate change, biodiversity loss and other environmental issues, key recommendations for preserving space for future uses of the seas across sectors and sea basins are presented as outcomes of this study:

- **Enhance application and development of methods for more long-term, programmatic and adaptive approaches to planning, including application of planning methods in a space-efficient and nature-friendly way.** This needs to be done in a systematic way to strengthen their application across all sea basins to effectively address the needs of future generations in Europe. For example, use adaptive management tools to continuously advance planning at sea with new regulatory frameworks and available data, and apply an ecosystem-based approach for giving priority to environmental and social elements in planning.

- **Strengthen capacities for the integration of methods encompassing all aspects of the socio-economic and ecological system for a full understanding of the interaction between spatial complexities through proactive planning.** This aims to safeguard and enhance the resilience of sea basins and maritime sectors by taking into account socio-economic

[112] OECD, 2019
[113] https://www.ices.dk/sites/pub/Publication%20Reports/Advice/2019/Special_Requests/ospar.2019.05.pdf
[114] The topic of industrial data sharing is currently addressed by multi-stakeholders in the UN Global Compact Ocean Stewardship Coalition Working Group 'Ocean Business Leadership for Sustainable Ocean Management: Offshore Renewables and Sustainable Ocean Planning' - '*Improving data-sharing and harmonization across borders: Offshore Renewables and MSP*'.

activities, the dynamics of marine areas, and the unforeseeable nature of the future for prospects of spatial claims as well as avoiding conflicting interests. As such, in the development of planning strategies: develop dynamic solutions to planning, flexible to adapt and address changes; ensure inclusion of marine environment-economy linkages and ecosystem services; and consider cross-sectoral input into whole system planning and detailed sectoral methods.

- **Incorporate information to feed policies, regulation and decision-making to achieve harmonization at a national, sea-basin and EU level towards integrated planning at sea attuned for the development of the sustainable blue economy in Europe.** As such, provide support with reliable data for improved blue economy statistics as a comprehensive base for supporting decision-making for planning, management and protection of the seas. This will enable assessment of how complex interactions may affect the integration of ecological and socio-economic objectives in planning at sea and will optimize the sustainable development of blue economy sectors. Develop more inclusive approaches to data sharing for planning at sea that should play an integral role in the future planning of industrial projects and protected areas for which enhanced industry-policy-science collaboration and cross-industry collaboration in the new value chain and multi-use approaches are needed. Further, contribute to the harmonization of planning at the sea-basin and EU-level through application of international mechanisms, such as the Espoo Convention, allowing for the assessment of the effects of cross-border projects, including in cross-sectoral settings.

- **Continue experience sharing within Europe across all sea basins in a more coordinated manner** to benefit from knowledge and learning exchanges between Member States and multiple stakeholders. Developing and implementing integrated planning to address interlinkages between activities at sea, increasing uses of marine space and resources, marine environmental dynamics, biodiversity loss and climate change, will require sustained collaboration of many actors with active participation of all sectors in multi-stakeholder collaborations and exchanges on environmental and socio-economic aspects. These exchanges and dialogues will range from the local to the national and sea-basin levels, and also in a transboundary context and at the EU scale to ensure future complementarity in Europe.

These key recommendations encapsulate the knowledge and the experience related to the use and application of the methods and tools that were presented in this document. While some of them are not new and have been discussed for some time, in the context of the current global challenges, including the energy crisis, climate crisis, biodiversity crisis and pollution crisis, these recommendations are reiterated strongly for Member States to act. Planning needs to embrace future considerations and concerns, which today emerge from international policies and processes,[115] allowing countries to plan sustainably for their future through careful designation, monitoring, and management within the national jurisdictions and in the cross-basin domain, and to provide coherence across thematic areas and cross-cutting challenges.

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[115] More information can be found in the background technical paper by the European MSP Platform (2022): "The implications of the Ocean Governance framework established by the United Nations for the implementation of the EU MSP Directive". https://maritime-spatial-planning.ec.europa.eu/sites/default/files/hz0622215enn.en_.pdf

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