



BRIDGE-BS

Blue Growth Incubators | Service Dynamics | Empowered Citizens

D8.4 2030 BLUE ROADMAP FOR THE BLACK SEA



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DELIVERABLE	
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Executive Summary

The **2030 Blue Roadmap for the Black Sea** outlines how BRIDGE-BS scientific results can be translated into long-term policy, management, and innovation benefits for the region in response to the persistent environmental pressures affecting the Black Sea. It provides a structured set of actions to strengthen science-policy interface and to improve monitoring and assessment, while supporting a sustainable blue economy.

The Roadmap offers two main components:

- **Assessment of BRIDGE-BS contribution to the Black Sea Strategic Research and Innovation Agenda (BS-SRIA) implementation.**

Since BRIDGE-BS was designed to implement the BS-SRIA, the Roadmap assesses the project's contribution across its four pillars. Under **Pillar 1**, BRIDGE-BS advances fundamental knowledge on ecosystem processes, multi-stressor impacts, and climate projections, supported by data infrastructures, modelling tools, and new assessment methodologies. Under **Pillar 2**, it fosters innovation and sectoral development through business acceleration, blue biotechnology demonstrators, and advanced sensor technologies. **Pillar 3** benefits from integrated observation efforts, harmonised standards, the Black Sea Digital Twin demonstrator, and shared data platforms that improve regional interoperability. Through **Pillar 4**, the project strengthens human and institutional capacity, offering training tools, open-access education, youth engagement programmes, and stakeholder-driven governance approaches.

- **Action plan for the exploitation of the project results.**

Building on a structured knowledge transfer methodology, the Roadmap identifies project results with potential to support evidence-based policies, and proposes a set of actions organised into eight thematic areas: climate projections; ecosystem resilience; integrated environmental observation; cumulative effects assessment and adaptive management; development of the Black Sea Digital Twin; blue economy innovation; capacity building and social engagement; and science-based policymaking. Each action outlines objectives, implementation approaches, necessary actors, geographic scope, timelines, funding options, and policy relevance.

Together, these actions address regional challenges such as fragmented data systems, limited interoperability, and uneven national capacities. They also connect BRIDGE-BS results with wider regional, EU and global priorities, including the Marine Strategy Framework Directive, Maritime Spatial Planning Directive, Nature Restoration Regulation, the EU Mission “Restore our Ocean and Waters”, the EU Ocean Pact, and the 2025 EU Strategic Approach to the Black Sea.

The Roadmap aims to **guide further action**, support policy design and implementation and inform future research and funding priorities. Its impact will rely on effective communication and dissemination, targeted engagement with regional and national authorities, and its use across policy, science, and innovation communities to support a more resilient and sustainable future for the Black Sea.



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1. Background and rationale

The Black Sea is a distinctive semi-enclosed basin with unique habitats, abundant resources and rich cultural heritage. At the same time, it is highly susceptible to increasingly negative impacts from several human-induced stressors, which, combined with the effects of climate change, amplify ecosystem and biodiversity vulnerabilities and put the well-being and livelihoods of coastal communities at risk.

Launched in 2021 under Horizon 2020, **BRIDGE-BS** has produced **new evidence on ecosystem processes, climate change and multi-stressor impacts**, while also developing **tools, data infrastructures and engagement approaches** to **address policy needs, support sustainable blue economy opportunities and strengthen science-policy-society interactions in the Black Sea region**.

The project was designed to implement the **Black Sea Strategic Research and Innovation Agenda (BS-SRIA)**¹, adopted in 2019 and jointly endorsed by the Black Sea countries and the European Commission as the scientific pillar of the Common Maritime Agenda for the Black Sea (CMA) (CMA, 2019)². Together with the Convention on the Protection of the Black Sea Against Pollution (Bucharest Convention, 1992)³, which sets the main regional governance framework for environmental protection and monitoring, both documents provide the basis for coordinated action in the region.

Developed through a broadly participatory process, the BS-SRIA is a consensus document that sets out shared priorities to advance scientific knowledge, policy support and sustainable blue innovation. BRIDGE-BS was established as the flagship Horizon 2020 project to contribute to the implementation of these priorities by delivering knowledge, tools and stakeholder engagement. In this roadmap, the **BS-SRIA is used as a basis for the analysis of BRIDGE-BS results to understand the project's contribution to, and further recommended actions towards achieving the agreed regional objectives and wider European policy commitments**.

BRIDGE-BS has revealed that scientific and policy progress in the Black Sea is currently constrained by fragmented data systems, limited interoperability of monitoring efforts, and uneven capacity across countries, while demonstrating how these challenges could be addressed. The project has shown that there is a strong basis to build on: regional cooperation mechanisms are in place, alignment with EU strategies is increasing and digitalisation is creating new opportunities for observation and modelling for policy support. These lessons have helped shape the focus of this Roadmap, which aims to overcome barriers while capitalising on the opportunities identified.

At national level, not all Black Sea countries have adopted national strategies and specific policies targeting the marine environment and all blue economy sectors. Rather than a lack of interest, this is indicative of a gap in capacity to implement knowledge-based policy making and in translating European and international guidelines into national policies. The main challenges are still located in the national regulatory and monitoring frameworks of non-EU member states,

¹ Black Sea SRIA 2023 http://connect2blacksea.org/wp-content/uploads/2024/01/Black-Sea-SRIA_2023.pdf

² Common Maritime Agenda for the Black Sea (CMA) <https://black-sea-maritime-agenda.ec.europa.eu/>

³ Bucharest Convention <https://www.blackseacommission.org/Official%20Documents/The%20Convention/full%20text/>



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which are not obliged to translate existing EU Directives (e.g. the Marine Strategy Framework Directive, the Maritime Spatial Planning Directive) into national and local policies⁴.

In May 2025, the European Commission launched the **Joint Communication “The European Union’s Strategic Approach to the Black Sea Region”**⁵, *aiming to boost connections and growth by linking Europe with the South Caucasus, Central Asia and beyond*⁶. This strategy provides a complementary layer and strengthens the political cooperation and alignment between the European Union and the Black Sea region, adapted to its evolving geopolitical landscape. The document states that **“The EU enlargement countries of the Black Sea, including Ukraine, the Republic of Moldova, Georgia, and Türkiye (within the framework of EU enlargement), as well as Armenia as an associated partner, have committed to the EU water and marine environment legislation and achieving global goals on oceans protection, including restoring 30% of all degraded ecosystems and conservation of land, waters and seas by 2030”**. This means that, beyond the regional frameworks, the Black Sea is directly connected to the EU’s wider marine policies. While Bulgaria and Romania are legally bound, countries that are not EU member states are committed to align their national policies, strategies and objectives towards achieving the EU targets. Therefore, in this Roadmap, EU marine strategies and policies complete the reference framework for assessing how BRIDGE-BS results can inform and support science-based policymaking in the Black Sea.

Many of the **proposed actions in this roadmap can be embedded within broader regional or European frameworks**, rather than as stand-alone initiatives. Each action identifies the actors whose participation would be needed for implementation and to ensure its relevance within existing mechanisms. Regional organisations such as the **Black Sea Commission (BSC)** and the **Organisation of the Black Sea Economic Cooperation (BSEC)** can play an important role in this regard, while the **Common Maritime Agenda (CMA)** provides a suitable platform to mobilise support for the implementation of the suggested actions. This approach helps ensure that the knowledge and tools developed through BRIDGE-BS **remain aligned with ongoing regional and European processes and contribute to long-term impact in the Black Sea**.

References to specific organisations under the proposed actions do not imply any commitment on their part. Their eventual involvement would depend on the context and could be considered desirable or required if and when the actions are taken forward.

⁴ Georgia, Chantzi, Besi Elpida, Perez Maria, and Fernandez Rosa. (2023). D8.1 Integrated Policy Review and Dialogue in the Black Sea. Zenodo. <https://doi.org/10.5281/zenodo.14808149>

⁵ JOIN(2025) 135 Final <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52025JC0135>

⁶ EC Press Release https://ec.europa.eu/commission/presscorner/detail/en/ip_25_1348



2. Objectives

Purpose of the Roadmap

The purpose of the 2030 Blue Roadmap for the Black Sea is to provide a structured framework that connects science, policy, and innovation in the region. It is conceived as a guidance document that identifies concrete actions to **secure the long-term exploitation of BRIDGE-BS outputs** beyond the project's duration and to **ensure their alignment with regional and European priorities**. In doing so, the Roadmap positions BRIDGE-BS results within the broader landscape of marine governance and blue economy development, helping decision-makers and stakeholders to translate scientific advances into practice.

Overall objective

The Roadmap sets a **framework for the comprehensive implementation and exploitation of BRIDGE-BS outputs by policy and decision makers**. By building on the collaborations and capacities developed during the project, the Roadmap seeks to **maximise the impact of its outputs, ensuring that they inform evidence-based policymaking, support adaptive governance, and contribute to improving the environmental status of the Black Sea**. At the same time, it aims to **create enabling conditions for a sustainable blue economy in the region, fostering innovation, resilience, and inclusive cooperation among countries and sectors**.

Specific objectives

The Roadmap defines specific objectives in line with the BS-SRIA Pillars, capitalising BRIDGE-BS results to support its implementation:

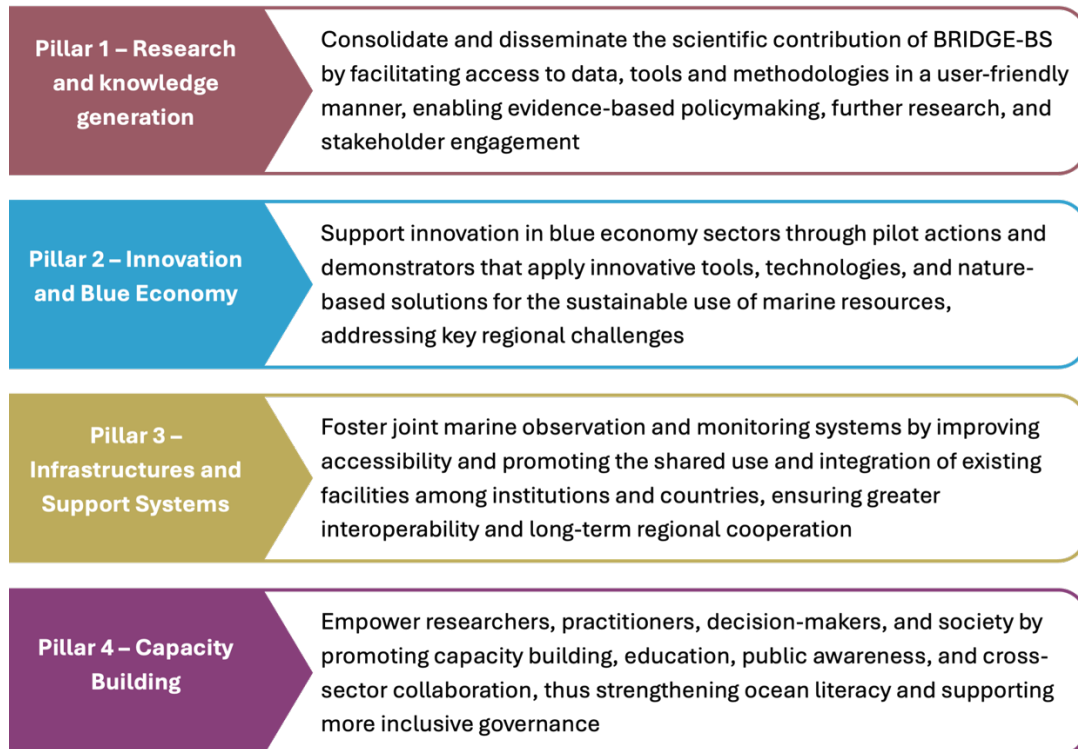


Figure 1: BRIDGE-BS Roadmap Specific Objectives



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3. Methodological approach

Knowledge Transfer and its Relevance

Knowledge Transfer (KT) refers to the **structured process of conveying knowledge from those who generate it to those who can apply it**. It goes beyond communication and dissemination by actively tailoring research results to the needs of potential users, fostering understanding, adaptation, and uptake. KT is therefore not a one-directional, or linear process, but a dynamic, adaptive interaction between knowledge generators and users.

In research and innovation contexts, **effective KT is essential to ensure that scientific results** do not remain confined to scientific publications or project reports but instead **create tangible benefits for society**. By linking science to policy, industry, and civil society, KT fosters innovation, informs decision-making, and supports capacity building. At the same time, it enables research priorities to evolve in response to actual users' needs, creating a two-way process where knowledge is both transferred and co-developed.

Relevance for BRIDGE-BS

Strengthening the science-policy dialogue to boost science-based policymaking in the Black Sea region has been a priority for BRIDGE-BS throughout the project lifetime. Addressing this priority requires research results to be accessible, understandable, and ready to be effectively used by policy and decision makers. In this context, KT methodologies offer suitable tools for bridging the gap between both groups of stakeholders and ensuring that scientific knowledge is presented, communicated, and applied in ways that respond to actual policy needs.

BRIDGE-BS based its approach on established KT methodologies adapted to marine science results, in particular building on the framework developed in the COLUMBUS Horizon 2020 project⁷. Rather than applying it in its original form, it served as a reference to develop a specific approach to the Black Sea's context, governance structures, needs and knowledge gaps. With a focus on identifying the project outputs with the highest potential for uptake, the selected results were assessed in terms of their alignment and expected contribution to policy implementation in the region. Through this adapted approach, BRIDGE-BS aims to **support the exploitation of its results and facilitate their application in regional strategies and national policies, ultimately contributing to regional, EU, and global environmental goals**.

The Roadmap presented here is the outcome of a thorough analysis of the project results and a careful planning of the knowledge transfer strategy, offering a structured set of actions to support the long-term exploitation and uptake of BRIDGE-BS outputs.

Methodology

The KT approach applied in BRIDGE-BS was designed to ensure that research results are systematically identified, assessed, and prepared for uptake by relevant users. Central to this process is the **Knowledge Output (KO)** concept, defined as **a unit of transferable knowledge that may derive from major findings, new or improved tools or methods, adapted processes, new insights, or alternative applications of existing knowledge**.

⁷ Columbus Project Monitoring, *Managing and Transferring Marine and Maritime Knowledge for Sustainable Blue Growth* (2018). COLUMBUS Blue Society Knowledge Transfer Handbook https://www.columbusproject.eu/D8.5%20Handbook_v2_Final.pdf



The methodology followed a structured set of steps:

1. Collection framework – A Knowledge Output Table (KOT) was created and tailored to the specific context of BRIDGE-BS, according to types of results generated and the target users of the knowledge. This allowed each KO to be clearly defined, linked to related results and connected to potential applications in policymaking.
2. Identification of results – Results were compiled from project documents and through interviews with researchers, covering both completed and ongoing activities. Complex findings were broken down into manageable KOs to highlight those with potential policy relevance in the Black Sea.
3. Characterisation of KOs – Each KO was described in terms of novelty, application, complementarity and policy relevance. Researchers and work package leaders played a key role in validating and refining these descriptions.
4. Analysis of transfer potential – KOs were assessed in relation to policy priorities, expected impact, potential end-users, timelines, maturity, links to other KOs, and contextual factors. The Black Sea SRIA and its associated actions were taken as the main reference to identify knowledge needs and frame how BRIDGE-BS results could contribute to evidence-based policymaking.
5. Definition of actions – Based on this analysis, a set of actions was formulated to guide the application and exploitation of BRIDGE-BS results. While not detailed transfer pathways, these actions form a structured starting point for future initiatives. Additional work will be required to turn them into actionable plans with the necessary resources and operational detail.

The final steps of the knowledge transfer process involve the implementation of the proposed actions and the assessment of their uptake, application and impact through suitable indicators. This monitoring allows to adapt strategies and learn from experience, ensuring that knowledge transfer remains effective. Due to time constraints, BRIDGE-BS could not implement these actions, and therefore the impact assessment could not be conducted. Both steps remain to be undertaken in future initiatives or follow-up activities.

While the KT methodology is presented as a sequence of steps, in practice it is an iterative process rather than strictly linear one. Once results are characterised (Step 3) or analysed for transfer potential (Step 4), new information may emerge that requires updating earlier descriptions or refining the collection framework. Similarly, when defining proposed actions (Step 5), feedback from researchers or policy stakeholders may lead to revisiting earlier steps. This flexibility ensures that the process remains accurate, responsive, and aligned with the evolving context of the project. This is particularly relevant in the case of BRIDGE-BS, where the process was carried out in parallel to the scientific work and most knowledge outputs were still in progress. This meant that the definition and validation of KOs was highly dependent on ongoing input from the researchers and required revisiting several steps as scientific developments progressed and new information emerged.



4. BRIDGE-BS contribution to the Black Sea Strategic Research and Innovation Agenda implementation

This section presents the **analysis of how BRIDGE-BS results support the implementation of the Black Sea Strategic Research and Innovation Agenda (BS-SRIA)** across its four pillars and associated goals. It outlines the specific contribution of each knowledge output from the project in advancing scientific understanding, supporting sustainable innovation, and strengthening regional cooperation.

Beyond and in connection with the BS-SRIA, the **BRIDGE-BS contribution is also described in relation to policy frameworks relevant in the region**. These are grouped into three categories: **(a) Regional Cooperation Frameworks**, which provide the structures for coordination and joint action in the Black Sea; **(b) EU Regulatory Frameworks**, which are binding for EU member states (Bulgaria, Romania) and to which the other Black Sea countries have committed to alignment; and **(c) EU Strategic Frameworks**, which set policy priorities and investment agendas but are not legally binding. While BRIDGE-BS results have the potential to inform a broad range of marine and maritime policies, the analysis focuses on those aspects that can offer feasible opportunities for application in relation to BS-SRIA priorities and regional governance.

The table below provides an overview of the project results (Knowledge Outputs, or KOs) as formulated for the analysis presented in this document. A full description of each is included in Annex 1 for clarity.

Table 1: Overview of BRIDGE-BS results

Knowledge Outputs (KOs) ⁸	
KO_1.1	Identification of information gaps and data readiness
KO_1.2	Black Sea BRIDGE-BS Portal and Database
KO_1.3	Black Sea Digital Twin Demonstrator
KO_1.4	Harmonized methodologies and quality control standards
KO_1.5	Black Sea Blue Economy Observatory
KO_1.6	Blue Economy Imaginaries
KO_2.1	Black Sea physical, biogeochemical and ecosystem state under climate and non-climate, stressors including scenarios of changes
KO_2.2	Simulated distributions of past and projected GES indicators for policy support
KO_2.3	Selected ecosystem services (food provisioning, climate regulation) under interacting multiple stressors

⁸ **Knowledge Output (KO)** is defined as a unit of transferable knowledge that may derive from major findings, improved tools or methods, adapted processes, new insights, or alternative applications of existing knowledge.

Columbus Project Monitoring, Managing and Transferring Marine and Maritime Knowledge for Sustainable Blue Growth (2018). COLUMBUS Blue Society Knowledge Transfer Handbook https://www.columbusproject.eu/D8.5%20Handbook_v2_Final.pdf



Knowledge Outputs (KOs) ⁸	
KO_2.4	Boundaries for a safe operational space
KO_3.1	Interactions between multiple stressors
KO_3.2	Socio-ecological factors contributing to ecosystem service resilience (Pressure-state indicators + Indicators or resilience)
KO_3.3	Resilience landscape for the Black Sea
KO_3.4	Methods and tools to assess ecosystem service resilience in data poor systems
KO_3.5	Future projections of ecosystem resilience and recovery potential
KO_4.1	Integrated machine learning/ AI-based risk assessment framework
KO_4.2	Cumulative effects assessment (CEA) tool
KO_4.3	CEA-based risk assessment and scenario analysis
KO_4.4	Recommendations for adaptive management, planning and policy implementation
KO_5.1	Improved knowledge and understanding on the state of ecosystem health and ecosystem processes and interactions in the Black Sea
KO_5.2	Next generation genomic tools for biodiversity monitoring
KO_5.3	Integrated method for monitoring phytoplankton biodiversity and harmful algal bloom species
KO_5.4	Black Sea microbial biotechnology demonstrator
KO_5.5	Sensor systems for a multiple stressors' early warning systems in the Black Sea
KO_6.1	Valuation of ecosystem services
KO_6.2	2050 Stakeholders' vision and blue economy transformative pathways for the Blue Economy
KO_6.3	Stakeholders' engagement for developing Blue Economy sustainable development strategies
KO_7.1	Business acceleration platform on Black Sea blue economy
KO_7.2	Business models and initiatives around BRIDGE-BS
KO_7.3	High Tech Summit for the Black Sea (HTS4BS)
KO_7.4	Black Sea roadmap for "Industry 4.0" acceleration
KO_8.1	Integrated policy review and dialogue in the Black Sea
KO_8.2	Guiding Manual for Policymakers and Knowledge Transfer in the Black Sea
KO_8.3	BRIDGE-BS International Policy Brief: Reinforcing the implementation of marine EU and international policies in the Black Sea Region



Knowledge Outputs (KOs)⁸

KO_9.1	Science-Technology-Policy English language Massive Open Online Course (MOOC) on Blue Economy
KO_9.2	Summer School programme
KO_9.3	Black Sea Young Ambassadors programme
KO_9.4	Black Sea Literacy Network



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BS-SRIA PILLAR 1: Addressing fundamental Black Sea research challenges

BS-SRIA Pillar 1 focuses on advancing integrated knowledge of the Black Sea's ecological functioning and environmental challenges. It calls for coordinated, multidisciplinary research to investigate basin-specific features, stressor interactions, and ecosystem processes, while promoting data sharing and scientific collaboration at regional level as a foundation for long-term sustainability and informed policy development.

MAIN GOAL 1.1

Developing innovative **multi-disciplinary research** from coastal systems to the deep basin including seafloor processes, **building on existing initiatives**, including **data sharing mechanisms** that will generate the knowledge needed to increase ecosystems resilience and assess ecosystem services

Goal 1.1 under BS-SRIA Pillar 1 addresses the production of **scientific knowledge** necessary to understand complex ecosystem dynamics of the Black Sea, from coastal systems to the deep basin and seafloor. BRIDGE-BS responds to this challenge by advancing **multidisciplinary research**, filling critical **data and monitoring gaps**, and developing **new tools, methodologies, and indicators** tailored to the region. The project has built a solid scientific and technical **knowledge base** to assess ecosystem functioning, resilience, and delivery of ecosystem services.

Overall BRIDGE-BS Contribution to BS-SRIA Goal 1.1 Implementation

Understanding the **combined impacts of multiple environmental stressors**, such as eutrophication, deoxygenation, pollution, and invasive species, **on ecosystem health** is a key research challenge in the Black Sea. BRIDGE-BS addresses this challenge [[BS-SRIA Action 1.1-1 – addressing multiple stressors](#)] by filling data gaps, improving monitoring capacity, and advancing integrated, multidisciplinary research tailored to the region's specific conditions. The research carried out within the project has focused on improving the understanding of these pressures and their interactions, from coastal areas to the deep sea, by generating new data and developing methodologies and tools tailored to the specific needs and distinctive characteristics of the Black Sea.

The availability of a robust data foundation constitutes a key enabler for tackling challenges posed by multiple stressors. The **identification of information gaps and the analysis of data readiness (KO_1.1)** conducted during the project revealed that existing datasets are often incomplete or lack the necessary detail, limiting the capacity to accurately evaluate key stressors that need to be monitored. This analysis informed the development of the **BRIDGE-BS portal and database (KO_1.2)**, which provides centralised access to harmonised environmental data. Despite geopolitical constraints limiting the ability to carry out expeditions and sampling campaigns, **multidisciplinary research cruises and field surveys** were conducted across the western and southern areas of the Black Sea, covering both pilot sites and offshore areas. This work significantly contributed to expanding the available data on physical, chemical, and biological parameters, including temperature, oxygen, nutrients, pollutants, and biological indicators (**KO_3.1, KO_5.1**). Additionally, **advanced sensor systems** were adapted and deployed to enhance the capacity for continuous, high-resolution environmental monitoring (**KO_5.3, KO_5.5**). These sensors support data collection on parameters such as acidification, phytoplankton variability, and marine faunal distributions, strengthening the knowledge base required to understand multiple stressors' dynamics and ecosystem responses. The potential for enhancing monitoring capabilities through the application of next-generation genomic



methodologies has also been addressed, with promising results in applying **eDNA for biodiversity monitoring (KO_5.2)**.

The collected datasets currently amount to approximately 400 000 individual records, which have been verified and analysed by contributing institutes, constituting a detailed, shared inventory that is essential for advancing the understanding and management of the Black Sea ecosystem.

The project has also deepened scientific understanding of **interactions between multiple stressors (KO_3.1)**, exploring how combined pressures can lead to non-linear and sometimes unpredictable ecosystem responses. By analysing how environmental indicators respond to overlapping drivers, the research shows that stressors can interact in complex ways, either reinforcing or mitigating their respective individual effects. This integrated approach provides a more realistic basis for evaluating ecosystem resilience and vulnerability and supports the development of more accurate models that inform management-relevant research, taking into account the complexity of multiple overlapping pressures across spatial and temporal scales. This understanding is also critical for evaluating the resilience of food webs and the reliability of provisioning ecosystem services in the context of changing environmental conditions [*BS-SRIA Action 1.1-2 – enhanced food systems*].

Research on **harmful algal blooms and phytoplankton biodiversity (KO 5.3)** also contributes to a better understanding of key biological processes that influence food web dynamics and ecosystem health. Enhancing the monitoring capacity of relevant phytoplankton species by combining molecular and morphological techniques supports early detection of ecological shifts that can degrade water quality, alter trophic dynamics, and negatively impact fish stocks and the viability of aquaculture activities.

Another aspect that requires a multidisciplinary approach, as applied in BRIDGE-BS, is understanding the evolution of the Black Sea, its ecosystem dynamics, and resilience, as it is essential for assessing long-term changes, anticipating critical thresholds, and safeguarding the delivery of ecosystem services [*BS-SRIA Action 1.1-3 – Understanding the evolution of the BS*]. Addressing this need, BRIDGE-BS has developed a comprehensive modelling framework, which combined with resilience assessments and scenario-based analyses (also conducted under BRIDGE-BS), support the description of long-term trends and the evaluation of emerging risks in both environmental and socio-ecological systems. The outputs from these models (**KO_2.1, KO_2.2**) complement field data by providing spatially and temporally consistent datasets on physical and ecological conditions in the Black Sea, supporting a more comprehensive understanding of ecosystem structure and dynamics. Although this constitutes a significant contribution, the geological evolution over broader (millennial) timescales envisaged by the BS-SRIA has not been addressed yet.

BRIDGE-BS incorporates Black Sea-specific physical and biogeochemical features into its scientific approach to better understand the processes that influence ecosystem functioning and resilience. Region-specific features, such as strong stratification, limited vertical mixing, and naturally occurring low-oxygen layers, were considered in the development of resilience indicators and conceptual frameworks (**KO_3.1**). This work provides insights into how local dynamics influence nutrient cycling, biological stability, and the maintenance of key ecosystem functions in the face of environmental stress [*BS-SRIA Action 1.1-5 – Resilience under BS specific features*].

Understanding how environmental drivers and human-induced pressures interact also requires integrated socio-economic data and a systems-based perspective on human–nature interactions [*BS-SRIA Action 1.1-4 – Socio-economic data collection and analysis*]. BRIDGE-BS responds to this need by producing socio-economic evidence and applying participatory methods that link ecosystem change with the realities, priorities and dependencies of coastal communities in the



Black Sea region. The **Blue Economy Observatory for the Black Sea (KO 1.5)** represents the first regional effort to present harmonised socio-economic indicators covering blue economy sectors, governance, education, and environmental performance in the Black Sea. It addresses key data gaps by centralising national information, revealing monitoring inconsistencies, and improving access to policy-relevant evidence, thus enabling a more coordinated understanding of the human dimensions of marine pressures.

MAIN GOAL 1.2

Providing new knowledge to **mitigate the impacts of global climate change** and the **multiple environmental and anthropogenic stressors** in the Black Sea from land-sea interface to the deep basin

Goal 1.2 of BS-SRIA Pillar 1 addresses **knowledge application** in support of efforts to **mitigate the impact** of climate change and multiple environmental and human-induced stressors. To do so, BRIDGE-BS delivers applied outputs such as **modelling solutions, scenario-based projections, risk assessments, and policy recommendations**. The project contribution focuses on producing knowledge to **inform decision-making**, and support and promote **adaptive and integrated management of marine and coastal areas**.

Overall BRIDGE-BS Contribution to BS-SRIA Goal 1.2 Implementation

Quantifying the sources of stressors in the Black Sea system requires knowledge of how natural and anthropogenic inputs reach the marine environment through land-sea and atmosphere-ocean interfaces [*BS-SRIA Action 1.2-1 – Quantify sources of multiple stressors*]. BRIDGE-BS has consolidated a **comprehensive base of relevant environmental data (KO_1.2)**, deployed sensor systems and collected **targeted observations (KO_3.1, KO_5.1, KO_5.5)**, and applied **scenario-based modelling** to trace the **spatial and temporal distribution of selected inputs (KO_2.1, KO_2.2, KO_2.3)**. Measurements taken at two pilot sites—Varna–Burgas Bay and the Danube Delta— were specifically focused on seasonal nutrient and pollutant loads, gas fluxes, and floating litter from land-based and maritime sources. At basin scale, high-resolution data collected along coastal-to-offshore transects provide reference datasets to support model validation. The resulting outputs allow for a more precise characterisation of where and how stressors enter the system, although additional work is still needed to cover under-monitored sources and to better link observed pressures to upstream drivers.

The **Digital Twin of the Black Sea (BS-DT) demonstrator (KO_1.3)** represents one of the first initiatives to create a digital twin system for a regional sea [*BS-SRIA Action 1.2-2 – Digital Twin of the Black Sea*]. This platform aims to combine physical and biogeochemical models with harmonised environmental data and other observational outputs into a user-friendly interface to support scenario-based, ecosystem-informed decision-making. The integration of Cumulative Effects Assessment (CEA) would allow system users to assess interactions between environmental and human-induced pressures, enabling cross-sector analysis, spatial risk identification, and the evaluation of alternative development trajectories while considering trade-offs, to design coordinated management responses.

BRIDGE-BS also provides **model-based projections** that identify **links between climate-related pressures and ecosystem disruption** to support safety and resilience in coastal areas [*BS-SRIA Action 1.2-3 – Climate impacts and geohazards/ ‘One Health’ approach and improved safety for BS coasts*]. Simulation results (**KO_2.1, KO_2.2**) estimate **impacts from climate change** such as extreme temperature events, acidification, and oxygen loss, offering a system-level view of evolving risk conditions and supporting the identification of spatially explicit Good Environmental Status (GES) indicators. These projections are complemented by **field measurements (KO_5.1)** and **sensor-based monitoring (KO_5.5)**, which detect site-specific changes in water quality,



acidification, and stress signals, including algal blooms and pollutant presence. The concept of a **“safe operational space”** is addressed by identifying critical thresholds for key processes and defining ecosystem boundaries to support adaptive policy development (**KO_2.4, KO_3.3**).

The reconstruction of the **Black Sea’s environmental history** from 1950 to the present, supported by future projections to 2100 under different pressure scenarios, sheds light on recent biogeochemical evolution [*BS-SRIA Action 1.2-4 – Enhance BS paleoclimate archive – proxy tools and advanced models*]. Model simulations (**KO_2.2**) generate consistent time series on physical and ecological parameters such as fish distribution, eutrophication dynamics, and pollutant dispersion. By capturing long- and short-term variability, these simulations contextualise current conditions with regard to natural variability and human influence.

The combined effect of multiple stressors on ecosystem functions and resilience has also been addressed by BRIDGE-BS [*BS-SRIA Action 1.2-5 – Interactions between multiple stressors/ Biodiversity/ Marine ecosystem functioning*]. Results from a set of **resilience-focused assessments (KO_3.1 to KO_3.5)** provide spatial and temporal patterns of social-ecological vulnerability and evaluate how slow and fast stressors—such as nutrient buildup or fishing pressure—affect ecosystem stability. **Artificial Intelligence (AI)-based models (KO_4.1)** have been applied to identify stressor-response relationships and early signs of change. Furthermore, a **Cumulative Effects Assessment (CEA) framework** adapted to the Black Sea context (**KO_4.2, KO_4.3**) enables spatially explicit risk analysis and scenario comparison to support decision-making. Applied at both basin and pilot site scales, helps identify priority risk areas, highlight where land- and sea-based pressures converge, and evaluate context-specific management options [*BS-SRIA Actions 1.2-5, 1.2-7 – Integrated coastal and marine management*]. Findings from these assessments support the formulation of **adaptive management recommendations (KO_4.4)** tailored to local ecological conditions, sectoral pressures, and sustainability goals.

Complementary **ecosystem service valuation** studies (**KO_6.1**) conducted in pilot sites estimate societal willingness to pay for targeted measures supporting sustainable fisheries management, marine habitat protection, and pollution control. The results provide a quantifiable basis that could inform decision-making and help prioritise actions aligned with stakeholders’ preferences.

These contributions establish a robust framework for cross-scale and cross-sector coordination, enhancing the capacity to assess cumulative risks, design adaptive strategies, and ensure long-term ecosystem health and sustainability in the Black Sea region.

BRIDGE-BS Policy Relevance under BS-SRIA Pillar 1: Contribution to regulatory and strategic frameworks

The project advances scientific understanding of Black Sea ecosystems and delivers tools for monitoring, modelling, and assessment. These results directly support the policy frameworks mentioned below, focused on environmental protection, ecosystem resilience, and evidence-based decision-making, contributing to more effective marine governance and long-term sustainability in the region.

Black Sea Regional Frameworks

Common Maritime Agenda (CMA) and Black Sea BS-SRIA

- Support CMA priorities on ecosystem protection and science–policy integration through scenario-based tools, cumulative effects methodologies, and sustainability foresight approaches (KOs 2.1–2.4, 3.3, 3.5, 4.1–4.4, 6.2)
- Contribute to data-sharing infrastructure and regional governance alignment via the BRIDGE-BS Portal and harmonised data standards (KOs 1.2, 1.4, 1.5)



This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 101000240

- Reinforce knowledge base with stakeholders' vision and proposed action plans (pathways) (KOs 6.1, 6.2)

Bucharest Convention and Black Sea Integrated Monitoring and Assessment Program (BSIMAP)

- Strengthen regional coordination through harmonised monitoring methodologies, shared indicators, and spatially relevant ecosystem assessments (KOs 1.1, 1.4, 3.1, 3.3, 5.1, 5.5)
- Enhance BSIMAP implementation by providing data, models, and risk-based outputs relevant to multiple stressors impacts and pollution (KOs 2.1, 4.3)

EU Regulatory Frameworks

Marine Strategy Framework Directive (MSFD)

- Support Good Environmental Status (GES) assessment through improved indicators for biodiversity, eutrophication, food webs, and hydrographical conditions (KOs 3.1, 3.2, 5.1–5.3)
- Provide scenario-based modelling and risk-based approaches to assess cumulative pressures and long-term ecological change (KOs 2.1, 2.2, 2.4, 3.3, 3.5, 4.1–4.4)
- Enhance regional capacity for coordinated monitoring and reporting through harmonised data infrastructures and shared assessment methodologies (KOs 1.2, 1.4)

Water Framework Directive (WFD)

- Provide site-specific data from pilot areas on nutrient inputs, oxygen, phytoplankton, and benthic indicators to support ecological status assessment (KOs 2.1, 5.1, 5.2, 5.3, 5.5)
- Enhance understanding of land–sea interactions and stressor impacts through spatial modelling and multiple stressors assessments (KOs 2.2, 4.3)
- Support risk-based classification of ecological status and mitigation planning through ecosystem assessments and stressor-response analysis (KOs 3.1, 3.3, 4.3, 5.5)

Nature Restoration Regulation (NRR)

- Inform the development of National Restoration Plans through baseline mapping, site-level ecosystem condition assessments, and ecosystem service analyses (KOs 3.1, 3.2, 3.3, 5.1, 5.5)
- Support prioritisation of restoration areas and tracking of recovery progress through scenario-based modelling and vulnerability mapping (KOs 2.1, 2.2, 2.4, 3.5, 4.2, 4.3, 4.4)
- Contribute to restoration planning by integrating ecosystem service assessments and stakeholder-informed sustainability pathways (KOs 3.1, 3.2, 3.3, 6.1, 6.2)

Maritime Spatial Planning Directive (MSPD)

- Support evidence-based spatial planning with cumulative effects assessment, risk analysis, and resilience assessments to inform zoning, compatible uses, and mitigation measures (KOs 4.2–4.4, 3.1).
- Provide scenario-based modelling of environmental change to compare management options and anticipate conflicts/synergies across sectors (KOs 2.1–2.3, 4.3).
- Contribute to coherence across plans through harmonised datasets and shared indicators (KOs 1.2, 1.3, 5.1, 5.5).

Nature Directives (Habitats and Birds)

- Contribute to the assessment and planning of marine Natura 2000 sites through spatial indicators, habitat condition data, and biodiversity monitoring tools (KOs 3.1, 5.1, 5.2, 5.3, 5.5)
- Support adaptive conservation under environmental change with model-based projections and risk mapping (KOs 2.1, 2.2, 3.5, 4.3)
- Enable prioritisation of conservation actions through ecosystem service valuation and resilience analysis (KOs 3.2, 6.1)



EU Strategic Frameworks

EU Mission “Restore our Ocean and Waters”

- Contribute to the Mission’s restoration objectives through spatial diagnostics, ecological modelling, and scenario-based planning (KOs 2.2, 2.4, 3.3, 3.5, 4.3, 4.4)
- Support risk anticipation and adaptive restoration via resilience thresholds, safe operating space indicators, and co-developed management options (KOs 3.1, 3.3, 4.1–4.4)
- Provide digital platforms for integrated planning and knowledge transfer, including the BRIDGE-BS Portal and the Black Sea Digital Twin demonstrator (KOs 1.2, 1.3)

EU Biodiversity Strategy for 2030

- Support biodiversity protection and restoration targets with spatial assessments of ecosystem condition, cumulative pressures, and ecological resilience (KOs 2.2, 2.4, 3.2, 4.3)
- Provide tools for spatial prioritisation and policy-relevant valuation of ecosystem services to guide decision-making (KOs 4.3, 6.1)
- Contribute to long-term planning through stakeholder-informed sustainability pathways and co-developed strategies (KO 6.2)

Potential contribution to recent policy initiatives

BRIDGE-BS results also hold a strong potential to inform and support the most recent EU strategies on marine policy and Black Sea cooperation:

EU Strategic Approach to the Black Sea (2025 Joint Communication)

- Provide evidence for environmental protection and climate resilience through integrated monitoring, stressor mapping, and early-warning components (KOs 2.1–2.4, 3.1–3.5, 5.1, 5.5).
- Aligned with the call to expand joint monitoring/data exchange and connect to EMODnet⁹/Copernicus and the Black Sea Water Quality Database¹⁰ (KOs 1.2, 1.4, 1.3).
- Contribute inputs for a Black Sea Digital Twin linked to the EU DTO, supporting multiple stressors monitoring, biodiversity protection, and resilience analysis (KO 1.3; links to 2.1–2.4, 4.2–4.4).

European Ocean Pact (2025)

- Provide knowledge to strengthen a science-based approach to marine policies under a basin-specific approach, including indicators, modelling tools, and risk assessment that can inform the proposed Ocean Act (KOs 2.1–2.4, 3.1–3.5, 4.1–4.4).
- Potential to contribute to the future Ocean Observation Initiative and for coordinated reporting through shared methods, data services, and time-series that can feed other foreseen initiatives and tools at EU level (KOs 1.1–1.4, 5.1–5.3, 5.5).
- Potential and willingness to further develop a source-to-sea approach (nutrients, pollutants, plastics) (KOs 2.1–2.3, 5.1, 5.5).

⁹ <https://emodnet.ec.europa.eu/en>

¹⁰ https://imdis.seadatanet.org/content/download/122196/file/IMDIS_2018_submission_23.pdf



	SRIA PILLAR 1: Addressing fundamental Black Sea research challenges											
	MAIN GOAL 1					MAIN GOAL 2						
	1.1-1	1.1-2	1.1-3	1.1-4	1.1-5	1.2-1	1.2-2	1.2-3	1.2-4	1.2-5	1.2-6	1.2-7
KO_1.1 - Identification of information gaps and data readiness	+											
KO_1.2 - Black Sea BRIDGE-BS Portal and Database	+					+						
KO_1.3 - Black Sea Digital Twin Demonstrator							+					
KO_1.5 - Black Sea Blue Economy Observatory				+								
KO_2.1 - Black Sea physical, biogeochemical and ecosystem state under climate and non-climate, stressors including scenarios of changes			+			+		+		+		
KO_2.2 - Simulated distributions of past and projected GES indicators for policy support			+			+		+	+	+		
KO_2.3 - Selected ecosystem services (food provisioning, climate regulation) under interacting multistressors						+						
KO_2.4 - Boundaries for a safe operational space			+									
KO_3.1 - Interactions between multiple stressors	+	+								+		
KO_3.2 - Socio-ecological factors contributing to ecosystem service resilience					+					+		
KO_3.3 - Resilience landscape for the Black Sea					+					+		
KO_3.4 - Methods and tools to assess ecosystem service resilience in data poor systems										+		
KO_3.5 - Future projections of ecosystem resilience and recovery potential										+		
KO_4.1 - Integrated machine learning/ AI-based risk assessment framework										+		
KO_4.2 - Cumulative effects assessment (CEA) tool										+		+
KO_4.3 - CEA-based risk assessment and scenario analysis										+		+
KO_4.4 - Recommendations for adaptive management, planning and policy implementation										+		+
KO_5.1 - Improved knowledge and understanding on the state of ecosystem health and ecosystem processes and interactions in the Black Sea	+					+		+				
KO_5.2 - Next generation genomic tools for biodiversity monitoring	+											
KO_5.3 - Integrated method for monitoring phytoplankton biodiversity and harmful algal bloom species	+	+										
KO_5.5 - Sensor systems for a multistressors' early warning systems in the Black Sea	+					+		+				
KO_6.1 - Valuation of ecosystem services				+								+

Figure 2: Overview of BRIDGE-BS contribution to BS-SRIA Pillar 1



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

BS-SRIA PILLAR 2: Developing innovations, solutions and clusters underpinning Black Sea blue economy

BS-SRIA Pillar 2 supports the development of sustainable, low-impact marine and maritime activities in the Black Sea by promoting innovation, circular economy principles, and cross-sector collaboration. It defines key areas for technological development, including renewable energy, aquaculture, biotechnology and smart infrastructures.

MAIN GOAL 2.1

Supporting **marine and maritime research and innovation** domains of all the Black Sea countries **to create synergy, develop ecosystem based, carbon neutral sustainable economy, mitigate hazard impacts** for resilient Black Sea communities.

Goal 2.1 addresses the need for stronger collaboration between research, industry, and policy to support sustainable marine and coastal innovation in the Black Sea. It promotes shared frameworks and cross-sector cooperation to advance sustainable blue economy activities and enhance regional resilience.

Overall BRIDGE-BS contribution to BS-SRIA Goal 2.1 implementation

Enhancing interaction between research, innovation actors, and local stakeholders, including policymakers, is essential for transforming scientific and technological knowledge into practical solutions that support a sustainable blue economy. BRIDGE-BS contributes to setting the basis for enabling stakeholders' engagement and participation by providing methodologies and tools and facilitating active collaboration [*BS-SRIA Action 2.1-1 – Stakeholders engagement and participation*]. Practical **methodologies for stakeholders' engagement (KO 6.3)** were selected, tailored to local needs and capacities, and put into practice through the project's activities. These experiences are broadly documented, including step-by-step guidance for implementing sustainability-oriented living labs, tools for selecting appropriate engagement formats, and recommendations based on feedback from community stakeholders. The result is a flexible framework that guides inclusive co-creation processes and helps ensure that innovation efforts reflect the priorities and needs of coastal communities.

The **Black Sea Accelerator (KO 7.1)**, implemented in collaboration with the DOORS Black Sea project¹¹, contributes to building a participatory framework by providing a structured space where actors from research, business, and policy can interact and exchange knowledge across blue economy sectors [*BS-SRIA Action 2.1-3 – Science-business interaction*]. By offering tailored guidance, expert advice, and opportunities for early-stage innovators to present their work in relevant regional forums, the accelerator helps to strengthen connections between stakeholder groups and supports ongoing dialogue. It also facilitates collaboration across sectors by bringing together solution providers, technical experts, and support organisations, creating opportunities for shared learning and the uptake of innovative practices across sectors. The two editions of the **High Tech Summit for the Black Sea (KO 7.3)** complement this effort by offering a space where these innovations were presented and discussed, with a wider regional audience. These events reinforced visibility for early-stage innovative solutions and creates conditions for dialogue among diverse blue economy actors, including entrepreneurs, researchers, policymakers, and investors.

BRIDGE-BS has also developed a set of methodologies and tools that help decision-makers assess the environmental and socio-economic implications of different management options for marine and coastal activities in the Black Sea. This work combines modelling, scenario

¹¹ DOORS Black Sea (Developing Optimal and Open Research Support for the Black Sea), developed between June 2021 and May 2025, was the sister project of BRIDGE-BS, funded by the European Commission under the same call and topic.



development, stakeholder-informed planning, economic valuation, and policy support to inform more integrated and forward-looking planning processes [BS-SRIA Action 2.1-4 – Science-based policymaking, foresight and socio-economic analyses].

Foresight methodologies have been applied at multiple levels. At the sea-basin scale, a set of **2050 sustainable socio-economic imaginaries (KO 1.6)** were developed to explore different combinations of governance and innovation approaches, and their potential implications for blue economy sectors and marine sustainability. Based on the EEA Scenarios for a sustainable Europe in 2050¹² and adapted to the blue economy in the Black Sea context, these imaginaries are intended to support reflection and discussion among regional stakeholders about different development trajectories towards long-term sustainability. At the local scale, blue **transformative pathways (KO 6.2)** were co-designed with stakeholders in all pilot sites. These pathways include a set of milestones and actions, along enabling conditions to support the transformation of key blue economy sectors towards sustainability, with an emphasis on maintaining or achieving good environmental status.

The **Cumulative Effects Assessment (CEA) tool (KO 4.2)** and the **CEA-based risk assessment and scenario analysis (KO 4.3)** offer ready-to-use insights to guide policy stakeholders in applying adaptive management approaches. Evidence on **multiple stressors interactions and ecosystem resilience (KOs 3.1, 3.3)** strengthen this knowledge base. Building on these results, a set of **recommendations for adaptive management (KO 4.4)** helps to translate analytical outputs into practical guidance, supporting the application of ecosystem-based strategies in sectors such as aquaculture, fisheries, and coastal tourism.

The ecosystem service valuation study (KO 6.1), applied in selected pilot sites, provides additional insight for ecosystem management. Focused on selected ecosystem services – fisheries, tourism, and habitat protection, this study estimates the willingness to pay for specific management actions as an indicator of the perceived societal value of ecosystem conservation and restoration efforts. These findings can inform both policy prioritisation and the design of financing instruments.

To encourage practical uptake, BRIDGE-BS also developed a **policy-oriented reference guide (KO 8.2)**, which summarises key results and offers guidance for applying them in different governance and decision-making contexts.

MAIN GOAL 2.2

Developing innovation in existing and emerging blue economy sectors

Goal 2.2 focuses on advancing innovation across key blue economy sectors by promoting the development and uptake of sustainable technologies and practices. It supports applied solutions tailored to the specific needs of industries such as renewable energy, aquaculture, fisheries, biotechnology, maritime transport, and coastal tourism, aiming to foster sectoral transformation through a balanced integration of environmental and economic objectives.

Overall BRIDGE-BS contribution to BS-SRIA Goal 2.2 implementation

BRIDGE-BS supports innovation in the Black Sea by providing knowledge, methods, and tools that may respond to the needs of the blue economy sectors. The project has developed a coherent portfolio of initiatives to directly support innovation across blue economy sectors. The **Black Sea Accelerator (KO 7.1)** supports early-stage innovators by facilitating access to tailored advisory services, funding opportunities, and strategic partnerships. Complementing this, a comprehensive assessment maps the innovation landscape in key sectors, identifying entry

¹² <https://www.eea.europa.eu/en/analysis/publications/imagining-sustainable-futures-for-europe>



points for **sustainable business models** and highlighting barriers to knowledge uptake (**KO_7.2**). Regional collaboration is further reinforced through the **High Tech Summit (KO_7.3)**, which brought together researchers, entrepreneurs, and policymakers to exchange knowledge and showcased practical solutions. A shared **Roadmap for Industry 4.0 (KO_7.4)** outlines guidelines to advance digitalisation and smart technologies in support of blue economy development. Collectively, these efforts strengthen the innovation ecosystem of the region by aligning research with industry needs, facilitating the uptake of new solutions, and promoting collaboration across science, business, and policy.

Beyond these targeted actions, a broader set of project outputs contributes to enabling innovation by improving sector-specific knowledge, enhancing monitoring capacity, and supporting informed decision-making across key areas of the blue economy.

The **Digital Twin of the Black Sea demonstrator (KO 1.3)** is a suite of modelling and analysis tools integrating environmental, climatic, and socio-economic data. It could support the assessment of different management options in areas such as marine energy, aquaculture, and coastal infrastructure by helping to anticipate cumulative impacts and possible trade-offs. The **Black Sea Blue Economy Observatory (KO 1.5)** provides access to harmonized socio-economic indicators across the blue economy sectors, which can support priority setting, investment planning, and policy development at both national and regional levels.

A set of **2050 foresight imaginaries (KO 1.6)** adds a forward-looking dimension by illustrating how different governance models and innovation pathways could influence the development of sectors such as sustainable fisheries, marine renewable energy, and blue biotechnology. They support strategic thinking and coordination across initiatives by depicting possible long-term trajectories and system-wide implications.

BRIDGE-BS progress in environmental monitoring creates new opportunities for developing nature-based businesses. **Innovative tools for biomonitoring (KO 5.2, KO 5.3)** expand the ability to assess biodiversity through methods such as eDNA and combined microscopy-genomics approaches. Additionally, **new sensors and smart monitoring systems (KO_5.5)** improve real-time detection of key environmental parameters—including acidification, pollution levels, and biological activity—enhancing the capacity for early warning and informed response. Enhanced monitoring can support essential processes such as fish stocks assessment, screening of suitable aquaculture or marine renewable energy sites, or assessing environmental suitability for nature-based tourism in sensitive areas. These advances make it possible to deliver specialised, high-resolution monitoring solutions tailored to the needs of different blue economy sectors.

An alternative source of innovation emerges from the **identification of microbial enzymes with potential for industrial use (KO_5.4)**, which opens opportunities in sectors such as bioremediation, pharmaceuticals, and bio-based manufacturing. These findings offer a basis for industrial research and broaden the scope of innovation beyond traditional maritime activities.

Understanding societal preferences and economic feasibility helps ensure that innovation efforts align with community needs and values. **Ecosystem service valuation studies (KO 6.1)** reflect how local populations value key services such as fisheries, tourism, and habitat protection. This information can guide investment decisions and contribute to shaping markets for ecosystem-based services. **Co-created development strategies at the local level (KO 6.2)** support the identification of innovation pathways for the blue economy, helping stakeholders define practical steps, enabling conditions, and financial mechanisms for sustainable development.

Altogether, these results support innovation by addressing **critical enablers such as data availability, monitoring technologies, policy tools, and stakeholder engagement**, all of which are essential for a sustainable Black Sea blue economy.



BRIDGE-BS Policy Relevance under BS-SRIA Pillar 2: Contribution to regulatory and strategic frameworks

The project supports sustainable blue economy innovation by delivering sector-relevant data, models, technologies, and planning tools. Its results contribute to policy frameworks guiding maritime spatial planning, environmentally sustainable economic activities, and transition towards a climate-resilient and biodiversity-positive sustainable blue economy.

Black Sea Regional Frameworks

Common Maritime Agenda (CMA) and Black Sea BS-SRIA

- Support regional innovation ecosystems by providing tools for technology uptake, entrepreneurship, and cross-sector collaboration (KOs 7.1–7.4, 6.2)
- Contribute to policy coherence and adaptive planning through cumulative effects methods, scenario tools, and co-designed development strategies (KOs 4.2–4.4, 6.2)
- Strengthen science–policy–business interfaces with stakeholder engagement frameworks, knowledge integration tools, and policy-oriented guidance (KOs 6.1, 6.2, 7.1–7.4, 8.2)

EU Regulatory Frameworks

Common Fisheries Policy (CFP)

- Contribute to ecosystem-based fisheries and aquaculture management through modelling of trophic dynamics, ecosystem stress indicators, and resilience diagnostics (KOs 3.1, 3.3, 4.2, 4.3, 5.1, 5.5)
- Inform sustainable resource use and spatial management with tools for cumulative pressure assessment and ecological threshold identification (KOs 4.2, 4.3)
- Support aquaculture zoning and impact monitoring through water quality data, benthic indicators, and stressor-response analyses (KOs 4.2, 4.3, 5.1, 5.5)
- Enable integrated planning by linking ecosystem services valuation with coastal development scenarios (KO 6.1, 6.2)

Maritime Spatial Planning Directive (MSPD)

- Support ecosystem-based maritime spatial planning through spatial indicators, stressor mapping, and cumulative effects tools (KOs 4.2–4.4)
- Enable forward-looking MSP through scenario-based models and resilience thresholds, helping identify ecological limits for sectoral development (KOs 4.2–4.4)
- Provide ecosystem service valuation and stakeholder-informed pathways to balance economic use and sustainability (KOs 6.1, 6.2)

EU Strategic Frameworks

Sustainable Blue Economy Strategy

- Support innovation in key sectors by providing tools to identify environmental thresholds and assess cumulative impacts (KOs 3.3, 4.2, 4.3)
- Showcase the region's biotechnological potential (KO 5.4)
- Advance technological development with sensor systems for real-time biodiversity and pollution monitoring (KO 5.5)
- Foster entrepreneurship and innovation (KO 7.1–7.4)



Potential contribution to recent policy initiatives

EU Strategic Approach to the Black Sea (2025 Joint Communication)

- Inform public and private investment and Smart Specialisation priorities with basin-specific indicators, forward-looking scenarios, and policy-oriented guidance (KOs 1.5–1.6, 6.1–6.3, 7.1–7.4).
- Provide relevant knowledge for sustainable fisheries and aquaculture management and spatial planning (KOs 2.2–2.4, 4.2–4.4, 5.1, 5.5).
- Demonstrate how integrated environmental data and model outputs can be combined into a shared digital environment, the Black Sea Digital Twin demonstrator, to support coordinated assessments and risk analysis, and to lay the foundations for interoperability with EU digital ocean systems (KO 1.3; links to 4.2–4.4).

European Ocean Pact (2025)

- Boost sustainable competitiveness of the blue economy with regionally tailored decision-support tools and targeted recommendations to address priority challenges to blue innovation in the Black Sea (KOs 4.2–4.4, 5.4, 7.1–7.4).
- Provide tools and analyses aligned with the MSP Directive implementation that could inform the development of the proposed Ocean Act (KOs 4.2–4.4, 1.3).

Linking blue economy innovation with marine environmental policies

BRIDGE-BS supports the development of a sustainable blue economy by providing knowledge and tools that help align innovation with environmental regulations. Project results enable public authorities and private actors to anticipate ecological constraints, reduce environmental risks, and design compliant marine activities and technologies.



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	SRIA PILLAR 2: Developing innovations, solutions and clusters underpinning Black Sea blue economy												
	MAIN GOAL 1					MAIN GOAL 2							
	2.1-1	2.1-2	2.1-3	2.1-4	2.1-5	2.2-1	2.2-2	2.2-3	2.2-4	2.2-5	2.2-6	2.2-7	2.2-8
KO_1.3 - Black Sea Digital Twin Demonstrator						+	+			+	+		
KO_1.5 - Black Sea Blue Economy Observatory	+	+	+	+	+	+	+	+	+	+	+	+	+
KO_1.6 - Blue Economy Imaginaries				+									
KO_4.2 - Cumulative effects assessment (CEA) tool				+									
KO_4.3 - CEA-based risk assessment and scenario analysis				+									
KO_4.4 - Recommendations for adaptive management, planning and policy implementation				+									
KO_5.2 - Next generation genomic tools for biodiversity monitoring							+	+					
KO_5.3 - Integrated method for monitoring phytoplankton biodiversity and harmful algal bloom species							+		+				
KO_5.4 - Black Sea microbial biotechnology demonstrator								+				+	
KO_5.5 - Sensor systems for a multistressors' early warning systems in the Black Sea							+			+	+		
KO_6.1 - Valuation of ecosystem services				+					+				+
KO_6.2 - 2050 Stakeholders' vision and blue economy transformative pathways for the Blue Economy				+		+	+	+	+				+
KO_6.3 - Stakeholders' engagement for developing Blue Economy sustainable development strategies	+												
KO_7.1 - Business acceleration platform on Black Sea blue economy			+			+	+	+	+	+	+	+	+
KO_7.2 - Business models and initiatives around BRIDGE-BS						+	+	+	+	+	+	+	+
KO_7.3 - High Tech Summit for the Black Sea (HTS4BS)			+			+	+	+	+	+	+	+	+
KO_7.4 - Black Sea roadmap for "Industry 4.0" acceleration						+	+	+	+	+	+	+	+
KO_8.2 - Guiding Manual for Policymakers and Knowledge Transfer in the Black Sea				+									

Figure 3: Overview of BRIDGE-BS contribution to BS-SRIA Pillar 2



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

BS-SRIA PILLAR 3: Building of critical support systems and research infrastructures for the benefit of the Black Sea communities

BS-SRIA Pillar 3 aims to improve the systems and tools that support marine research and innovation by promoting better coordination in monitoring, shared scientific practices, new technologies and innovation opportunities.

MAIN GOAL 3.1

Developing **smart, integrated observing and monitoring systems** in support of addressing scientific and socio-economic challenges of the Black Sea, towards governance for a sustainable ecosystem, mitigation of climate change impacts, and accurate forecasting for adaptive management.

Goal 3.1 under BS-SRIA Pillar 3 addresses the development of integrated observing and monitoring systems to collect and deliver reliable environmental and socio-economic data. This goal supports long-term strategies, innovative technologies, and data platforms designed to improve forecasting, inform policy, and enable adaptive management.

Overall BRIDGE-BS contribution to BS-SRIA Goal 3.1 implementation

BRIDGE-BS integrates key components to improve the collection, accessibility and use of environmental information in the Black Sea. It combines efforts to develop joint monitoring strategies, advance sensor technologies, and enhance data infrastructure and forecasting tools, with the aim of supporting more coordinated and informed marine management.

The identification of existing **data gaps** and the **assessment of data readiness (KO 1.1)** informed the formulation of monitoring needs and helped guide proposals for optimising sea expeditions. The analysis also helped to identify critical gaps where additional efforts are needed to integrate datasets and ensure compliance with FAIR principles (Findable, Accessible, Interoperable, and Reusable data). **Protocols for harmonising environmental data acquisition and quality control practices** were developed (**KO 1.4**), including a comprehensive set of **Standard Operating Procedures (SOPs)** across 42 biological, chemical, genetic, and marine litter parameters. These harmonised methods were validated through intercomparison exercises and collaborative cruises, ensuring consistency and comparability in data collection and analysis across Black Sea countries. This effort strengthens the basis for implementing coordinated monitoring and facilitates the development of collaborative observation strategies [*BS-SRIA Action 3.1-2 – Joint observing systems and strategies*].

To ensure long-term access and reusability, the **BRIDGE-BS Portal and Database (KO 1.2)** has been designed to consolidate and provide access to existing datasets and new knowledge generated by the project. The database builds upon the Black Sea Water Quality Database, providing enhanced functionality to accommodate multidisciplinary environmental data, including physical, chemical, biological, and modelled data. Its architecture complies with interoperability standards and FAIR principles and offers a user-friendly web interface. Connection with SeaDataNet has been established, allowing BRIDGE-BS datasets to be uploaded and accessed through the SeaDataNet infrastructure, increasing visibility and reusability [*BS-SRIA Action 3.1-3 – Open access FAIR data*].

The socio-economic dimension is addressed through the **Blue Economy Observatory for the Black Sea (KO 1.5)**, which provides harmonised indicators for blue economy sectors across countries and maritime sectors. Built as an interactive platform, it enables regional comparison, identifies monitoring gaps, and facilitates access to project outputs and recommendations.



As a singular integrative platform, the **Digital Twin of the Black Sea demonstrator (KO 1.3)** aims to combine these components into a coherent, user-oriented system to enhance forecasting and decision-support capacity for sustainable marine governance *[BS-SRIA Action 3.1-4 – Monitoring, modelling and forecasting capacities – Digital Twin of the Black Sea]*.

MAIN GOAL 3.2

Advancing a **harmonised set of working methodologies, standards and procedures** on all aspects of coastal and marine research.

Goal 3.2 addresses the need for shared standards and protocols to align scientific practices across the region. It reflects the relevance of consistent and interoperable data and methods to enable more coordinated research and monitoring efforts.

Overall BRIDGE-BS contribution to BS-SRIA Goal 3.2 implementation

BRIDGE-BS contributes to advancing coordination in marine research by developing shared methodologies and testing innovative monitoring approaches across the region *[BS-SRIA Action 3.2-1 Monitoring standards and research infrastructures]*. A **common framework for environmental data collection and quality control was developed (KO 1.4)** and validated through intercomparison exercises and collaborative field campaigns to ensure regional comparability. To support alignment in biological monitoring, next-generation methods such as eDNA metabarcoding for fish (**KO 5.2**) and integrated molecular–morphological techniques for phytoplankton (**KO 5.3**) were applied and evaluated as promising tools for scalable, replicable approaches to biodiversity assessment. The work carried out to design and adapt sensor technologies to the specific conditions of the Black Sea (**KO 5.5**) further contributes to building interoperable and policy-relevant monitoring systems, adapted to the region’s environmental and operational context.

The Cumulative Effects Assessment (CEA) tool developed in BRIDGE-BS (**KO 4.2**) provides a framework that supports spatial analysis of the combined effects of human uses and environmental pressures. Based on this tool, a targeted **risk assessment (KO 4.3)** was carried out to analyse the interaction of multiple stressors across selected pilot sites and the wider Black Sea. The process integrates spatial data, scenario modelling, and ecosystem service indicators to support spatial planning decisions aligned with ecosystem-based principles *[Action 3.2-2 – MSP under ecosystem approach]*. Outputs such as pressure heatmaps, impact maps, and comparative scenario analysis help to identify priority areas and assess different management options. Building on these results, alongside ecosystem service analysis and stakeholder input, a set of area- and sector-specific **policy recommendations** was produced to guide planning processes across different scales (**KO 4.4**). These recommendations offer practical advice for addressing key pressures, promoting consistency across countries, and aligning management efforts with long-term sustainability objectives.

MAIN GOAL 3.3

Developing **new marine-based technologies** by benefiting from the latest innovations for the Black Sea to promote safe and sustainable economic growth of the marine and maritime sectors, the conservation and valorisation of marine cultural heritage.

Goal 3.3 focuses on developing and applying innovative technologies suited to the specific conditions of the Black Sea. It connects scientific progress with operational solutions that enhance monitoring, enable sustainable management and use of marine resources, and support the protection of cultural and ecological assets.



Overall BRIDGE-BS contribution to BS-SRIA Goal 3.3 implementation

A range of innovative monitoring technologies has been developed and adapted within BRIDGE-BS to improve environmental data collection and ecosystem assessment in the Black Sea [BS-SRIA Action 3.3-1 – *New monitoring technologies*]. **Sensor systems** tailored to regional conditions (KO 5.5) were advanced to enable high-resolution monitoring of key environmental stressors such as acidification, pollution, and biological activity. Technologies tested included enhanced sensors for pH and pCO₂, flow cytometry adapted for plankton dynamics, and acoustic tools for marine fauna detection—some of which represent first-time applications in the basin.

Molecular approaches were also tested as complementary tools for biodiversity monitoring. **eDNA metabarcoding (KO 5.2)** proved effective for assessing fish communities in diverse habitats, including those difficult to monitor with traditional methods. A **combined molecular–morphological approach (KO 5.3)** was applied to improve phytoplankton detection and track harmful algal bloom species with higher sensitivity and taxonomic precision. Metagenomic screening carried out in BRIDGE-BS (KO 5.4) applied **molecular techniques to characterise microbial diversity in the Black Sea** and detect enzyme groups of industrial relevance. This work illustrates how such approaches can support marine monitoring and contribute to unlocking the region’s biotechnology potential.

Together, these innovations strengthen the region’s capacity to translate scientific progress into practical applications for the blue economy. An improved understanding of environmental conditions and ecosystem dynamics can reduce uncertainty for sectors that depend on them, helping operators to adjust practices and plan with greater confidence.

MAIN GOAL 3.4

Mechanisms to **create, support and promote start-ups**, entrepreneurs oriented towards the circular and blue economy in the Black Sea region

Goal 3.4 addresses the need to support start-ups and entrepreneurial initiatives that can drive a sustainable blue and circular economy in the Black Sea. It promotes the development of enabling structures—such as incubators, dedicated funding mechanisms, and regional networks—that help turn scientific and technological advances into practical, market-ready solutions.

Overall BRIDGE-BS contribution to BS-SRIA Goal 3.4 implementation

BRIDGE-BS has focused significant effort on strengthening the support environment for innovation and entrepreneurship in the Black Sea blue economy [BS-SRIA Action 3.4-2 – *Incubators and techno parks for the blue economy*]. A key contribution in this direction is a strategic overview of **innovation readiness and business model maturity across key blue economy sectors (KO 7.2)** provided by the project. This analysis identifies promising areas — such as ocean monitoring, sustainable aquaculture, and blue biotechnology— and highlights persistent barriers that limit the uptake of innovative and sustainable business models. It also provides guidance on how public support mechanisms can better trigger private investment, offering practical input for the development of incubators and funding instruments aligned with regional priorities.

Additionally, the experience gained through the **Black Sea Accelerator (KO 7.1)** demonstrates the benefit of a coordinated support ecosystem in the Black Sea region, setting the basis for longer-term innovation infrastructure. The **High Tech Summit for the Black Sea (KO 7.3)** further reinforces it by fostering knowledge exchange, networking, and showcasing early-stage innovations, facilitating connections between start-ups, researchers, investors, and policymakers, amplifying the impact of the accelerator and contributing to a more connected support landscape.



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Together, these efforts advance the creation of regionally grounded mechanisms to identify, nurture, and scale up innovative business ideas — a necessary step toward building integrated incubation and acceleration pathways for a Black Sea sustainable blue economy.

BRIDGE-BS Policy Relevance under BS-SRIA Pillar 3: Contribution to regulatory and strategic frameworks

The project enhances the infrastructure and system capacity needed for coordinated marine monitoring, cross-border data exchange, and innovation-driven governance in the Black Sea. It strengthens the foundational elements of marine policy implementation, such as protocols, standards, data platforms, and digital forecasting tools that enable generation, access, and use of environmental information in a consistent and integrated way. These efforts support the long-term operationalisation of marine strategies and contribute to the region's ability to manage shared marine resources through harmonised, evidence-informed approaches.

Black Sea Regional Frameworks

Common Maritime Agenda (CMA) and Black Sea BS-SRIA

- Strengthening the region's observation capacity and fostering shared monitoring strategies (KOs 1.4, 1.5, 5.1–5.5)

Bucharest Convention and BSIMAP

- Improve coordination of monitoring across Black Sea countries (KOs 1.4, 5.1, 5.5)

EU Regulatory Frameworks

Marine Strategy Framework Directive (MSFD)

- Improve monitoring at national level and coordination across countries (KOs 1.1, 1.2, 1.4, 5.1, 5.5)
- Support Member States' reporting and programme implementation with shared digital platforms and next-generation monitoring technologies adapted to the Black Sea (KOs 1.3, 5.2–5.5)
- Enable integration of biological, chemical, and physical parameters through harmonised observation systems and connected forecasting tools (KOs 1.3, 4.2–4.4)

Nature Restoration Regulation (NRR)

- Contribute to the operational foundation for restoration planning by delivering regionally standardised monitoring methods, spatial diagnostics, and data infrastructures (KOs 1.1, 1.2, 1.4, 4.2, 5.1)
- Provide shared digital tools that facilitate the integration of restoration planning across ecological and administrative boundaries (KOs 4.3, 6.1)

Water Framework Directive (WFD)

- Support better integration of coastal and marine assessments through interoperable data platforms and cross-domain monitoring strategies (KOs 1.2, 1.4)
- Strengthen the technical capacity for assessing chemical and biological quality elements with sensor-based systems adapted to regional needs (KOs 5.2, 5.5)

Maritime Spatial Planning Directive (MSPD)

- Facilitate evidence-based planning with interoperable models and tools that can be applied at multiple scales (KOs 4.2, 4.3)
- Promote consistent data use in MSP across Black Sea countries through standardised indicators and observation protocols (KOs 1.4, 5.1, 5.5)



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Common Fisheries Policy (CFP)

- Enable the integration of fisheries-relevant parameters into monitoring systems through the development of tailored sensors and molecular tools (KOs 5.1, 5.5)
- Support data infrastructure relevant to ecosystem-based fisheries management through standardised protocols and interoperable monitoring tools (KOs 1.2, 1.4, 5.1, 5.5)

Other Nature Directives (Habitats and Birds)

- Support cross-border alignment in monitoring practices for protected areas (KOs 1.4, 5.1, 5.5)

EU Strategic Frameworks*EU Biodiversity Strategy for 2030*

- Contribute to regional data harmonisation for biodiversity indicators through interoperable platforms and shared monitoring methodologies (KOs 1.1, 1.2, 1.4)
- Enable progress monitoring on protection and restoration targets through spatial diagnostics, ecological modelling, and Digital Twin applications (KOs 1.3, 4.3)

EU Mission “Restore our Ocean and Waters”

- Support digital infrastructure development through the Black Sea Digital Twin demonstrator and the BRIDGE-BS Portal (KOs 1.2, 1.3)

Sustainable Blue Economy Strategy

- Support the creation of innovation-enabling structures in the Black Sea through accelerator models, networking platforms, and targeted capacity-building efforts (KOs 7.1, 7.3)

Potential contribution to recent policy initiatives*EU Strategic Approach to the Black Sea (2025 Joint Communication)*

- Implement the call to expand joint monitoring, data exchange and assessment by linking regional platforms with EMODnet and Copernicus Black Sea-Monitoring and Forecasting Centre¹³ (KOs 1.2–1.4).
- Contribute to preparedness and early warning through sensor networks and risk assessments that can inform prevention and potential impact mitigation of maritime incidents and environmental hazards (KOs 5.5, 4.3).
- Potential of the Black Sea Digital Twin demonstrator to provide resilience, pollution, and biodiversity applications, enabling data sharing and environmental management under a sea-basin approach (KO 1.3).

European Ocean Pact (2025)

- Contribute to the Ocean Observation Initiative by developing joint observation campaigns, common standards, and interoperable systems (KOs 1.1–1.4, 1.5, 5.1–5.5).
- Deliver a Black Sea Digital Twin aligned and interoperable with the EU DTO to support for forecasting, risk assessment, and sea-basin level management (KO 1.3; KOs 4.2–4.4).

¹³ <https://marine.copernicus.eu/about/producers/bs-mfc>



	SRIA PILLAR 3: Building of critical support systems and research infrastructures for the benefit of the Black Sea communities									
	MAIN GOAL 1				MAIN GOAL 2		MAIN GOAL 3		MAIN GOAL 4	
	3.1-1	3.1-2	3.1-3	3.1-4	3.2-1	3.2-2	3.3-1	3.3-2	3.4-1	3.4-2
KO_1.1 - Identification of information gaps and data readiness		+	+							
KO_1.2 - Black Sea BRIDGE-BS Portal and Database			+							
KO_1.3 - Black Sea Digital Twin Demonstrator				+						
KO_1.4 - Harmonized methodologies and quality control standards		+	+	+	+					
KO_1.5 - Black Sea Blue Economy Observatory			+	+						
KO_4.2 - Cumulative effects assessment (CEA) tool						+				
KO_4.3 - CEA-based risk assessment and scenario analysis						+				
KO_4.4 - Recommendations for adaptive management, planning and policy implementation						+				
KO_5.1 - Improved knowledge and understanding on the state of ecosystem health and ecosystem processes and interactions in the Black Sea		+	+							
KO_5.2 - Next generation genomic tools for biodiversity monitoring			+		+		+			
KO_5.3 - Integrated method for monitoring phytoplankton biodiversity and harmful algal bloom species			+		+		+			
KO_5.4 - Black Sea microbial biotechnology demonstrator							+			
KO_5.5 - Sensor systems for a multistressors' early warning systems in the Black Sea		+	+		+		+			
KO_7.1 - Business acceleration platform on Black Sea blue economy										+
KO_7.2 - Business models and initiatives around BRIDGE-BS										+
KO_7.3 - High Tech Summit for the Black Sea (HTS4BS)										+

Figure 4: Overview of BRIDGE-BS contribution to BS-SRIA Pillar 3



BS-SRIA PILLAR 4: Education and capacity building

MAIN GOAL 4.1

Supporting **formal and informal learning, education, training and use of knowledge and technologies** for established and emerging marine and maritime jobs.

Goal 4.1 focuses on developing the skills and knowledge needed to prepare future professionals for a sustainable blue economy. It calls for a mix of formal, informal, and lifelong learning opportunities, supported by training, mentoring, and mobility schemes to build a capable and adaptable workforce across marine and maritime sectors.

Overall BRIDGE-BS contribution to BS-SRIA Goal 4.1 implementation

BRIDGE-BS has developed a **Science-Technology-Policy MOOC on the Blue Economy (KO_9.1)** as an informal learning programme aligned with BS-SRIA priorities and tailored to the Black Sea context. The course draws on key project results to offer accessible content on major environmental, economic, and governance dimensions of the blue economy. It provides a flexible, open-access learning tool for students, educators, and professionals involved or interested in marine science, environmental policy, and sustainable blue economy practices [*BS-SRIA Action 4.1-1 – New programmes and coordination*]. The MOOC also supports digital literacy by promoting the use of virtual learning environments and encouraging self-directed engagement with complex topics. Its online format makes it suitable for flexible, independent learning relevant to marine sustainability and governance [*BS-SRIA Action 4.1-3 – Promote digital literacy*].

Mentoring and training activities targeting business development in the regional blue economy have been advanced through a combination of acceleration support and interactive events [*BS-SRIA Action 4.1-4 – Mentoring and training for business*]. The **Black Sea Accelerator (KO_7.1)** addresses regional needs for mentoring and coaching by offering customised support to start-ups and early-stage businesses across the Blue Economy. It aims to foster their growth potential by providing guidance on scaling up and increasing market readiness, with a strong focus on sustainable and circular innovation. This support contributes to strengthening the required entrepreneurial capacity for advancing environmentally responsible business solutions in the region. The **High Tech Summit for the Black Sea (KO_7.3)** complements this effort by facilitating direct engagement between innovators and potential investors through pitching sessions and matchmaking activities, creating opportunities for visibility, dialogue, and partnership-building across the regional innovation ecosystem. Additionally, the **Summer School programme (KO_9.2)** has included dedicated sessions on blue biotechnology and sustainable business models, offering participants initial insights into the application of scientific knowledge in business-oriented contexts.

Opportunities to acquire blue skills and engage in mobility activities have been integrated across several BRIDGE-BS initiatives targeting students and Early-Career Ocean Professionals (ECOPs) from the Black Sea region [*BS-SRIA Action 4.1-5 – Promote/support blue skills and blue mobility*]. Participation of ECOPs in **research expeditions and sampling campaigns (KO_5.1)** enabled practical, field-based training in oceanographic monitoring, supporting technical skill development and international knowledge exchange. The **Summer School programme (KO_9.2)** offered intensive, multidisciplinary training in areas such as Black Sea ecosystem resilience, fisheries, renewable energy, and blue biotechnology. Through expert-led lectures, interactive workshops, and collaborative group work, participants gained both sector-specific knowledge and practical experience in addressing challenges relevant to Blue Economy sectors. Complementing these efforts, the **Black Sea Young Ambassadors Programme (KO_9.3)** fostered



youth engagement and capacity building through training, mentorship, and participation in scientific events, exchanges, and expeditions.

MAIN GOAL 4.2

Empowering **ocean-engaged citizens** contributing to a climate resilient, clean, plastic free, healthy and productive Black Sea.

Goal 4.2 supports a community of informed citizens actively engaged in maintaining and restoring the Black Sea ecosystems. It promotes ocean literacy, public participation, and regional identity by fostering citizen science initiatives, educational outreach, ambassador programmes, and community-led activities.

Overall BRIDGE-BS contribution to BS-SRIA Goal 4.2 implementation

The **Black Sea Literacy Network (BSLN) (KO_9.4)**, initiated under BRIDGE-BS, fosters understanding of the ocean's role and value by developing and disseminating educational materials and organizing interactive activities that engage diverse audiences—from primary school children to university students [*BS-SRIA Action 4.2-1 – Promote Ocean literacy & citizen science*]. This network aims to raise awareness about the Black Sea's distinctive marine ecosystems, including its biodiversity, environmental pressures such as pollution and eutrophication, and the importance of promoting sustainable practices. Through interactive learning experiences and citizen science initiatives, it mobilises local communities, empowering people to actively participate in protecting and preserving the Black Sea environment. Beyond this, the network fosters a shared cultural and scientific identity for the Black Sea region [*BS-SRIA Action 4.2-2 – BS cultural/scientific identity*] by connecting marine scientists, educators, policymakers, industry stakeholders, and local communities. By facilitating knowledge exchange and collaboration, it supports integrated formal and informal education programmes and work-oriented activities that strengthen regional cohesion and promote pride in the basin's unique natural heritage, acting as both a resource and collaboration platform.

Complementing the activities of the Black Sea Literacy Network, the **Black Sea Young Ambassadors Programme (KO_9.3)** provides early-career ocean professionals (ECOPs) with the skills to communicate the significance of the Black Sea basin and promote its protection [*BS-SRIA Action 4.2-3 – Black Sea (young) ambassadors*]. Through mentorship in science communication and leadership, capacity building in stakeholder engagement, and active participation in key regional and international events such as International Black Sea Day and European Maritime Day, the programme supports their outreach efforts, broadening public engagement across diverse communities.

MAIN GOAL 4.3

Contributing to **enhanced science-policy dialogue** in formulating coastal and marine policies and programmes.

Goal 4.3 promotes science-policy dialogue to improve marine governance based on the best available knowledge. It addresses collaboration between the research community and decision-makers to enhance the uptake of research results in policy and management decisions.

Overall BRIDGE-BS contribution to BS-SRIA 4.3 implementation

Effective science-policy dialogue requires more than simply sharing scientific results with policymakers; they must be equipped to understand and apply scientific knowledge. Capacity



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building plays a key role in bridging the gap between research and policy communities and fostering mutual understanding. To support this, BRIDGE-BS has developed a **Guiding Manual for enhanced science-policy synergy (KO_8.2)**, which equips policy stakeholders with practical tools and recommendations to effectively apply scientific knowledge throughout diverse governance contexts, facilitating informed decision-making and supporting the translation of research into actionable policies [*BS-SRIA Action 4.3-2 – Train policy and decision makers*].

Additionally, the project provides a set of outputs that can contribute to enhance policymakers' capacity and foster their interaction with the scientific community. The **Blue Economy Imaginaries (KO_1.6)** provide a structured approach to explore potential futures, presenting contrasting governance scenarios that help to identify shifts in governance, economy and innovation. By illustrating different possible developments, these scenarios serve as a reference for stakeholders to assess emerging risks and opportunities, supporting informed updates of research priorities. The **Cumulative Effect Assessment (CEA)-based scenario analysis (KO_4.3)** offers projections of realistic and preferred futures for sustainable marine and coastal activities, including climate projections and cumulative environmental impacts, enabling decision makers to anticipate emerging challenges. Based on this, and complemented by other project results, **policy recommendations for adaptive management (KO_4.4)** provide practical guidance to address risks and promote the sustainable use of marine resources. The **2050 Stakeholders' Vision and Transformative Pathways (KO_6.2)**, developed in collaboration with local stakeholders, identify priorities, key actions needed for sustainable development, including milestones and necessary changes to achieve the desired vision for sustainable development.

While supporting effective communication between science and policy communities, the integration of strategic foresight and expert analysis lays the groundwork for the co-identification of new priorities and emerging topics to inform the periodic update of the BS-SRIA [*BS-SRIA Action 4.3-1 – Update BS-SRIA*]. There is a need for policy and decision makers to understand where to focus the efforts, and the project provides a set of outputs to support the identification of future research and policy needs.

The analysis of **Business models and innovation potential in the Black Sea blue economy (KO_7.2)** identifies current challenges for innovation and the most promising sectors in terms of innovation potential. Based on this, the **Roadmap for Industry 4.0 acceleration (KO_7.4)** highlights emerging technological trends digital transformation pathways relevant to the region. Together, these two elements provide a clear picture of where innovation efforts should focus, and which technologies offer highest-potential opportunities.

The **Integrated Policy Review and Dialogue (KO_8.1)** provides a comprehensive overview based on desk research and interaction with policy stakeholders. It includes existing policies and governance frameworks, identifying gaps, bottlenecks, and areas for potential improvement to enhance cross-sectoral coordination and better address governance challenges in the area. Alongside this, the **International Policy Brief (KO_8.3)** synthesizes key project findings and provides future research and policy recommendations to assist policymakers in adapting national strategies and frameworks to meet international standards. These policy-oriented results offer a clear understanding of the Black Sea policy landscape, contextualising the project achievements within the policy context, thus providing useful input for a BS-SRIA update.

The present **Roadmap** complements these results by setting out how BRIDGE-BS knowledge can be translated into practice, presenting specific actions that facilitate interaction with policymakers and provide guidance to integrate scientific results into policy and decision-making.

BRIDGE-BS Policy Relevance under BS-SRIA Pillar 4: Contribution to regulatory and strategic frameworks



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The project advances marine policy implementation by strengthening human and institutional capacity, promoting ocean literacy, and facilitating science-policy engagement in the Black Sea. It provides tools and frameworks to support training, public awareness, participatory governance, and stakeholder-informed planning. These contributions help ensure that policies are more inclusive, better understood, and grounded in co-produced knowledge and long-term engagement strategies.

Black Sea Regional Frameworks

Common Maritime Agenda (CMA) and Black Sea BS-SRIA

- Build the regional capacity needed to advance blue skills, sustainable innovation, and multi-actor cooperation in marine education and governance (KOs 7.1–7.4, 9.1–9.4)
- Reinforce regional cooperation by supporting participatory approaches to developing shared visions, updating the existing ones, planning policies, and engaging stakeholders (KOs 6.2, 6.3, 8.1–8.3)
- Strengthen public engagement and shared stewardship through the Black Sea Literacy Network and the Black Sea Young Ambassadors programme (KOs 9.3, 9.4)

EU Strategic Frameworks

EU Ocean Literacy and Public Engagement Frameworks

- Mobilising youth, educators, and civil society around Black Sea sustainability challenges (KOs 9.3, 9.4)
- Support the future EU Ocean Literacy Action Plan by delivering scalable education models (e.g. MOOC, Summer School) and regional collaboration platforms (KOs 9.1–9.4)
- Advance the goals of the European Blue Schools Initiative through outreach materials and student-engagement programmes developed by the Black Sea Literacy Network (KO 9.4)

Sustainable Blue Economy Strategy

- Promote skills development and business mentoring to support entrepreneurship and sustainability transitions across blue economy sectors (KOs 7.1–7.3, 9.2)
- Contribute to inclusive and innovation-ready policy environments through stakeholder engagement frameworks and co-designed Roadmaps (KOs 6.2, 6.3)

EU Mission “Restore our Ocean and Waters”

- Contribute to the Mission’s public mobilisation objectives through ocean literacy campaigns, youth engagement, and open-access educational materials (KOs 9.1, 9.3, 9.4)
- Support Mission governance goals by fostering science-policy alignment and training policymakers to navigate complex sustainability challenges (KOs 8.1–8.3)

Potential contribution to recent policy initiatives

EU Strategic Approach to the Black Sea (2025 Joint Communication)

- Provide practical resources for regional capacity building, stakeholders engagement and enhanced science-policy interaction (KOs 1.5–1.6, 4.3–4.4, 6.2–6.3, 8.2).

European Ocean Pact (2025)

- Support empowerment of coastal communities through their involvement in co-creation and joint foresight processes (KOs 6.2, 4.3, 4.4)
- Support enhanced science-policy dialogue (8.1, 8.2, 8.3).
- Establish a Black Sea node for the upcoming EU Ocean Youth Ambassador and Interregional Network (KO 9.3)



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- Contribute to the scaling up of the European Coalition for Ocean Literacy (EU4Ocean) (KO 9.4)

Supporting the implementation of environmental policy frameworks

Capacity building, education and science–policy dialogue initiatives promoted by BRIDGE-BS create the conditions for better understanding, wider engagement with, and more inclusive application of environmental policies such as the Marine Strategy Framework Directive, the Nature Restoration Regulation, and the EU Biodiversity Strategy. In addition to providing essential scientific knowledge, the project strengthens institutional and societal capacity to understand, apply, and engage with these frameworks. It supports early-career professionals, empowers citizens through ocean literacy and public engagement initiatives, and provides practical guidance and policy-oriented tools that support the use of scientific evidence and help align decisions with current knowledge and governance needs. These contributions help ensure that marine environmental policies are more widely understood, more inclusively implemented, and better connected to regional priorities and actors.

	SRIA PILLAR 4: Education and capacity building									
	MAIN GOAL 1					MAIN GOAL 2			MAIN GOAL 3	
	4.1-1	4.1-2	4.1-3	4.1-4	4.1-5	4.2-1	4.2-2	4.2-3	4.3-1	4.3-2
KO_1.6 - Blue Economy Imaginaries									+	+
KO_4.3 - CEA-based risk assessment and scenario analysis									+	+
KO_4.4 - Recommendations for adaptive management, planning and policy implementation									+	+
KO_5.1 - Improved knowledge and understanding on the state of ecosystem health and ecosystem processes and interactions in the Black Sea					+					
KO_7.1 - Business acceleration platform on Black Sea blue economy				+						
KO_7.2 - Business models and initiatives around BRIDGE-BS									+	
KO_7.3 - High Tech Summit for the Black Sea (HTS4BS)										+
KO_7.4 - Black Sea roadmap for "Industry 4.0" acceleration									+	
KO_8.1 - Integrated policy review and dialogue in the Black Sea									+	
KO_8.2 - Guiding Manual for Policymakers and Knowledge Transfer in the Black Sea										+
KO_8.3 - BRIDGE-BS International Policy Brief: Reinforcing the implementation of marine EU and international policies in the Black Sea region									+	
KO_9.1 - Science-Technology-Policy English language MOOC on Blue Economy	+		+							
KO_9.2 - Summer School programme					+					
KO_9.3 - Black Sea Young Ambassadors programme					+			+		
KO_9.4 - Black Sea Literacy network						+	+			

Figure 5: Overview of BRIDGE-BS contribution to BS-SRIA Pillar 4



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Pillars	SRIA PILLAR 1: Addressing fundamental Black Sea research challenges												SRIA PILLAR 2: Developing innovations, solutions and clusters underpinning Black Sea blue economy																SRIA PILLAR 3: Building of critical support systems and research infrastructures for the benefit of the Black Sea communities								SRIA PILLAR 4: Education and capacity building											
Main Goals	MAIN GOAL 1					MAIN GOAL 2							MAIN GOAL 1					MAIN GOAL 2											MAIN GOAL 1				MAIN GOAL 2				MAIN GOAL 3											
Actions	1.1-1	1.1-2	1.1-3	1.1-4	1.1-5	1.2-1	1.2-2	1.2-3	1.2-4	1.2-5	1.2-6	1.2-7	2.1-1	2.1-2	2.1-3	2.1-4	2.1-5	2.2-1	2.2-2	2.2-3	2.2-4	2.2-5	2.2-6	2.2-7	2.2-8	3.1-1	3.1-2	3.1-3	3.1-4	MAIN GOAL 2		MAIN GOAL 3		MAIN GOAL 4		4.1-1	4.1-2	4.1-3	4.1-4	4.1-5	4.2-1	4.2-2	4.2-3	MAIN GOAL 3				
KO_1.1 - Gap analysis and assessment	+																											+	+																			
KO_1.2 - Portal & DB	+					+																							+																			
KO_1.3 - BS-DTO							+												+	+			+	+					+																			
KO_1.4 - Harmonized methodologies and QC																												+	+	+	+																	
KO_1.5 - BEO				+									+	+	+	+	+	+	+	+	+	+	+	+	+	+			+	+																		
KO_1.6 - BE Scenarios																+																													+	+		
KO_2.1 - BS state under multistressors				+		+		+		+																																						
KO_2.2 - Sumulated past and projected GES				+		+		+	+	+																																						
KO_2.3 - Selected ES						+																																										
KO_2.4 - Boundaries safe operational space				+																																												
KO_3.1 - Interactions between multiple stressors	+	+									+																																					
KO_3.2 - Socio-ecological factors for resilience						+					+																																					
KO_3.3 - Resilience landscape BS						+					+																																					
KO_3.4 - ES resilience in data-poor systems											+																																					
KO_3.5Projections resilience and recovery potential											+																																					
KO_4.1 - Integrated ML/IA-based risk assessment											+																																					
KO_4.2 - CEA tool											+																																					
KO_4.3- CEA-based analysis											+																																					
KO_4.4 - Policy recomms for adaptive management											+																																					
KO_5.1 - Improved knowledge ecosystem BS	+					+		+																				+	+																			
KO_5.2 - e-DNA	+																												+																			
KO_5.3 - Phytoplankton monitoring	+	+																											+																			
KO_5.4 - Biotech potential																																																
KO_5.5 - Sensor systems	+					+		+																					+	+																		
KO_6.1 - Valuation ES				+								+																																				
KO_6.2 - Transformative pathways																																																
KO_6.3 - Stakeholders engagement														+																																		
KO_7.1 - BS Accelerator																+																																
KO_7.2 - Business models																																																
KO_7.3 - HTS4BS																+																																
KO_7.4 - Roadmap Industry 4.0																																																
KO_8.1 - Policy review																																																
KO_8.2 - Manual sci-pol interaction																+																																
KO_8.3 - Policy brief																																																
KO_9.1 - MOOC																																																
KO_9.2 - Summer school																																																
KO_9.3 - BSYA programme																																																
KO_9.4 - BS Literacy network																																																

Figure 6: Overview of BRIDGE-BS contribution to BS-SRIA

5. Exploitation outline

The actions presented in this section are designed to bring BRIDGE-BS results closer to their exploitation in policy processes, operational frameworks, and innovation ecosystems across the Black Sea. They aim to translate the project's scientific and technical outputs into concrete contributions to governance, planning, monitoring and capacity building.

Grouped into eight thematic areas (A-H), these actions reflect the cross-sectoral nature of BRIDGE-BS and its alignment with regional and European policies and strategies. Building on one or more knowledge outputs (KOs), each action contributes to the BS-SRIA implementation across the different pillars and goals.

This set of actions offers a **flexible framework to support the transition from knowledge generation to application**. It is intended to guide future initiatives, facilitate partnerships, and inform funding strategies that can **sustain and expand the impact of BRIDGE-BS beyond the project's duration**.

A) Climate projections for the Black Sea

Understanding and anticipating the impacts of climate change in the Black Sea requires robust, regionally tailored projections that can inform adaptation and planning. BRIDGE-BS has advanced the scientific basis for climate modelling in the region, producing data and scenarios that can support policy processes and cross-sectoral decision-making. The action proposed in this section aims to strengthen the relevance, interoperability, and usability of these outputs for risk assessment, design and adoption of mitigation and adaptation measures, and regional policy alignment.

- A.1) Align BRIDGE-BS climate modelling framework and projections with European and global downscaling initiatives

B) Black Sea ecosystem resilience in the face of multiple stressors

Assessing the performance and resilience of marine and coastal ecosystems is essential for effective environmental management. BRIDGE-BS has developed and tested, for the first time in the Black Sea, innovative approaches for assessing multiple stressors, spatial analyses, and resilience indicators that can support more adaptive and forward-looking governance. While some of these results could be suitable for short- to mid-term application in policy and planning contexts, others remain at academic stage and require further research before being ready for implementation.

The actions below aim to support the uptake of the most advanced outputs, while identifying next steps to progress advance the scientific and technical maturity of emerging approaches.

- B.1) Facilitate the regional replication of BRIDGE-BS multiple stressors and resilience assessment methods
- B.2) Strengthen the scientific basis and promote the adoption of resilience thinking in the Black Sea context.

C) Towards a Black Sea integrated environmental observation

Improved observation and data systems are critical to understanding the environmental trends, detecting emerging risks, and supporting timely policy responses. BRIDGE-BS has advanced knowledge on monitoring gaps, demonstrated innovative observation technologies and contributed to the development of harmonised methods for data collection and ecosystem assessment.

The actions in this section, mentioned below, aim to consolidate and expand these collaborative efforts, supporting the operational uptake of advanced tools, the alignment of methods, and the long-term coordination of observation activities across the Black Sea region.

- C.1) Support improved ecosystem assessments in the Black Sea through data gap identification and readiness analysis
- C.2) Deployment and integration of advanced sensor systems for Black Sea observation
- C.3) Advance harmonised approaches for phytoplankton monitoring in the Black Sea
- C.4) Advance the integration of eDNA metabarcoding into the Black Sea biodiversity monitoring/ tracking programmes
- C.5) Strengthen regional collaboration for harmonised environmental monitoring
- C.6) Foster alignment and long-term cooperation for enhanced marine observation in the Black Sea

D) Cumulative Effects Assessment & Adaptive Management for the BS

Effective management of marine and coastal ecosystems and resources requires tools that account for the combined impacts of human activities and environmental change.

BRIDGE-BS has developed a decision-support framework tailored to the Black Sea context, enabling scenario-based planning and cumulative effects assessment. Improving the quality and usability of these tools will strengthen the capacity of decision-makers to implement ecosystem-based and adaptive management approaches.

- D.1) Improve the quality of the Cumulative Effects Assessment (CEA) tool
- D.2) Support further application of the CEA approach for adaptive and sectoral planning
- D.3) Deliver targeted training on ecosystem-based approaches and tools

E) Black Sea Digital Twin Ocean demonstrator

The European Digital Twin Ocean (EU DTO) is expected to provide relevant support for marine governance in the mid- to long-term, enabling more informed, transparent, and anticipatory decision-making. The Black Sea Digital Twin Ocean (BS-DTO) demonstrator initiated under BRIDGE-BS represents a key step in the region, aiming to combine environmental and socio-economic data, modelling tools, and interactive visualisation.

This section outlines the strategic actions needed to advance the development of the BS-DTO demonstrator as a regional reference system, fully aligned with European digital infrastructures.

- E.1) Consolidate BRIDGE-BS results into the BS-DTO demonstrator and enhance it with new scenarios and functionalities



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

- E.2) Ensure sustainability and institutional coordination of the BRIDGE-BS portal as a regional reference platform for marine data
- E.3) Ensure alignment of the BS-DTO demonstrator with the European Digital Twin Ocean (EU DTO)
- E.4) Sustain and expand the strategic communication and visibility of the BS-DTO demonstrator
- E.5) Promote early engagement of potential (policy) users to provide feedback and support the development of the BS-DTO demonstrator
- E.6) Define a portfolio of potential environmental services based on BRIDGE-BS data and tools for potential delivery through the BS-DTO demonstrator
- E.7) Establish long-term management and funding pathways for the BS-DTO demonstrator

F) Blue economy potential in the Black Sea region

Unlocking the sustainable development potential of the Black Sea blue economy relies on data availability, targeted support for innovation, and strong regional cooperation. BRIDGE-BS has made a significant effort in this direction, supporting more coordinated, knowledge-based development across sectors.

The actions in this section aim to consolidate this progress and reinforce the conditions needed for long-term investment, innovation, and policy integration.

- F.1) Complete and consolidate the Black Sea Blue Economy Observatory for the Black Sea (BEO-BS) by addressing data gaps and promoting harmonisation in socio-economic monitoring
- F.2) Unlock the biotechnological value of marine genetic resources in the Black Sea
- F.3) Strengthen the Black Sea blue innovation ecosystem
- F.4) Consolidate the High-Tech Summit as a sustainable reference forum for Black Sea research and innovation

G) Capacity building, social engagement and participation

Building long-term capacity for sustainable ocean governance requires inclusive approaches that strengthen skills, foster dialogue, and empower a wide range of actors. BRIDGE-BS has contributed to this by developing open learning tools, training formats, and participatory methods tailored to the Black Sea context.

The actions mentioned below aim to ensure continuity, increase outreach, and support broader societal involvement in marine science and policy processes across the region.

- G.1) Promote the uptake of the BRIDGE-BS MOOC in regional capacity-building and policy processes
- G.2) Consolidate the BRIDGE-BS Winter and Summer Schools as permanent capacity building and networking initiatives
- G.3) Promote participatory approaches in coastal and marine governance
- G.4) Consolidate the Black Sea Young Ambassadors programme as a regional framework for sustained youth engagement in Black Sea science, policy, and the blue economy
- G.5) Ensure the continuity and expand the outreach of the Black Sea Literacy Network



H) Science-based policymaking in the Black Sea region

Bridging the gap between scientific knowledge and decision-making is essential for effective and adaptive marine governance. BRIDGE-BS has generated policy-relevant knowledge, tools and recommendations, while also exploring approaches to improve the usability and visibility of scientific outputs.

The actions below focus on strengthening science-policy interfaces, promoting timely and targeted knowledge transfer, and supporting more informed and coordinated decision-making across the region.

- H.1) Translate climate modelling results into policy-relevant knowledge for the Black Sea
- H.2) Streamline environmental status updates for the Black Sea
- H.3) Support the development of National Nature Restoration Plans under the EU Nature Restoration Regulation in Romania and Bulgaria
- H.4) Facilitate science-policy dialogue and cooperation
- H.5) Promote foresight approaches in support of strategic dialogue and planning
- H.6) Facilitate the implementation of transformative pathways in national and regional policy frameworks
- H.7) Update and promote the Integrated Policy Review to inform national and regional Blue Economy strategies
- H.8) Update research needs for a sustainable management of the Black Sea



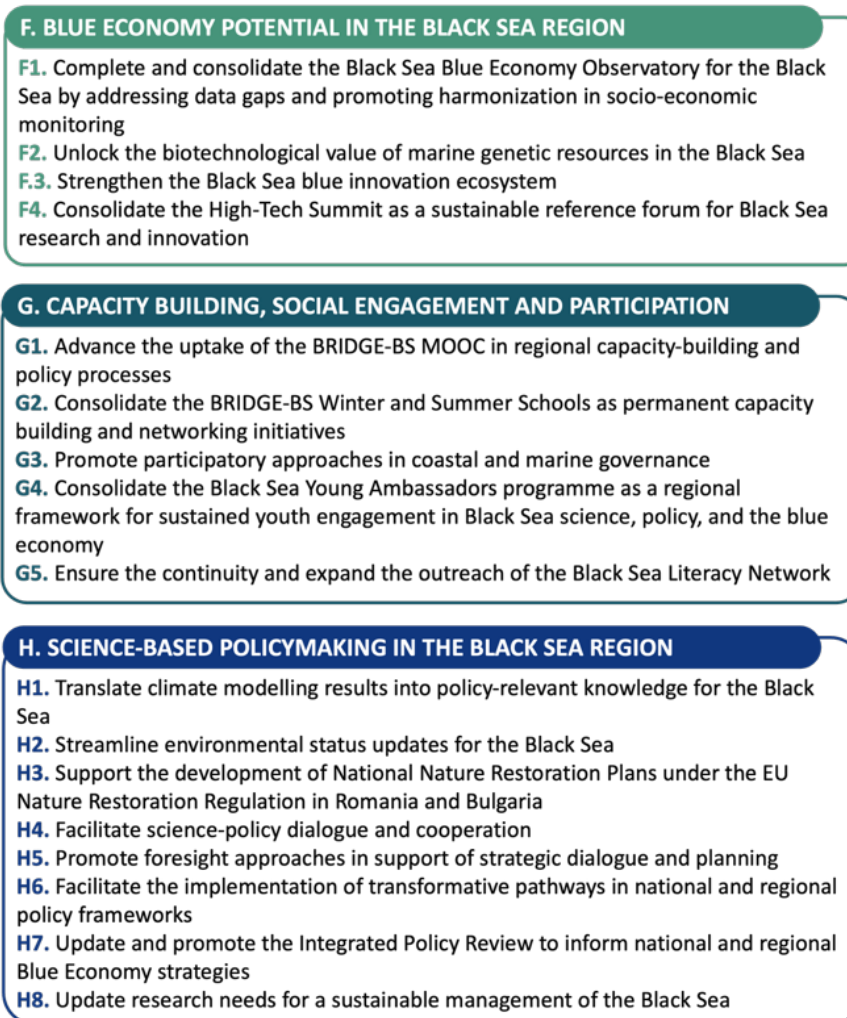
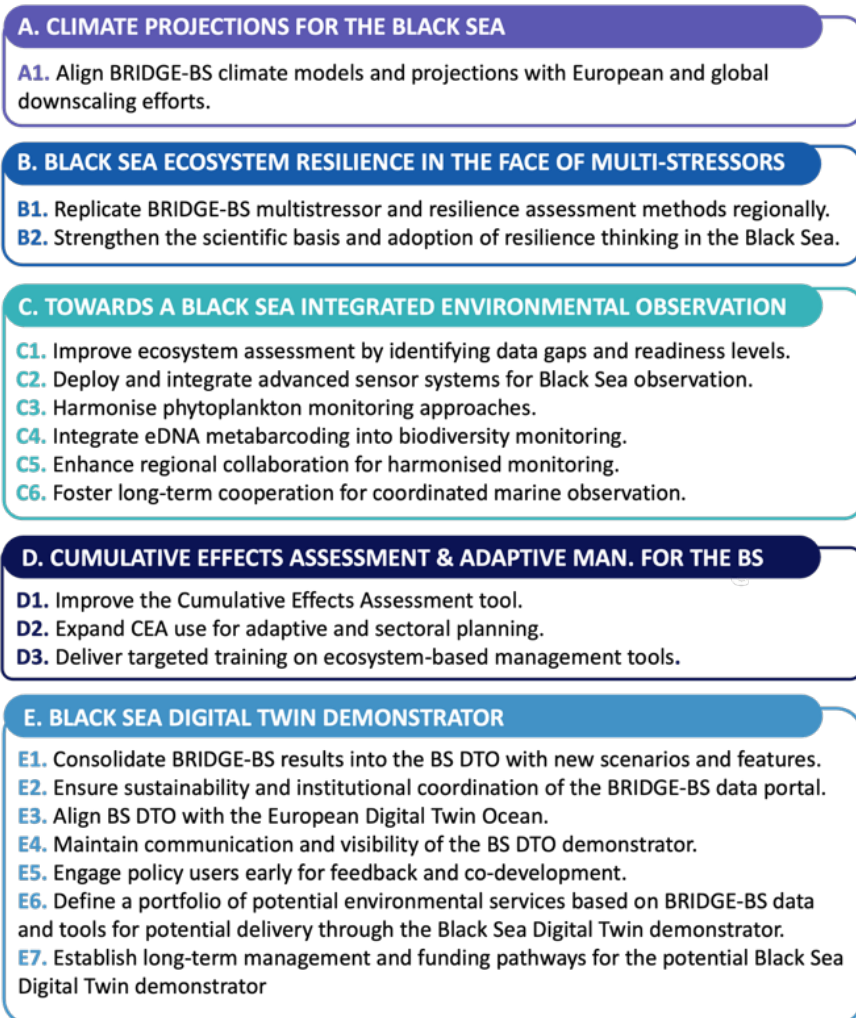


Figure 7: 36 Exploitation Actions under 8 Thematic Groups

6. Actions' description

6.1 Actions rationale and structure

Each action proposed in this Roadmap is designed to **help advance BRIDGE-BS results towards their practical application in policy, management, or innovation**. Turning knowledge into action requires careful planning on how, by whom and under what conditions implementation can be undertaken. To support this, each action is presented in a structured format that makes it easier to understand and complete this planning to put it in practice.

The structure includes:

- a clear objective linked to BRIDGE-BS results;
- a description of how the action could be implemented;
- a suggested approach, outlining suitable formats such as research or pilot projects, coordination actions, or targeted training, as well as relevant funding instruments to be considered;

Additional elements identified are the required actors to be involved in the process, the suitable geographic scope, expected timing, links to relevant BS-SRIA goals and policy relevance, referring to the specific policies and strategies the action contributes to. For practical reasons, the required actors are referred to by their acronyms. Their full names can be consulted in the Glossary section below.

This format is intended to **help partners and other relevant institutions to plan the next steps, adapt actions to their specific context, and connect them with funding or collaboration opportunities**.

Rather than being proposed as stand-alone projects, **actions may be embedded within broader research or coordination initiatives, adapted to national or regional contexts, or implemented through targeted components of larger programmes**.

A) Climate projections for the Black Sea

Action A.1: Align BRIDGE-BS climate modelling framework and projections with European and global downscaling initiatives

Objective: Strengthen the scientific interoperability and visibility of BRIDGE-BS projections by linking them with international frameworks

Relevant KOs	2.1	Other related KOs	1.3
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Description

Placing BRIDGE-BS climate modelling framework within established downscaling and climate data infrastructures will increase its visibility, comparability, and uptake in adaptation planning. Aligning with key international initiatives will also ensure interoperability and facilitate integration with European and global climate services.

This action includes:

- Identifying entry points in the Coordinated Regional Climate Downscaling Experiment (CORDEX) framework, particularly Med-CORDEX and Euro CORDEX);
- Initiating cooperation with the Copernicus Climate Change Service (C3S) to align data formats, facilitate exchange, and explore joint service development;
- Engaging with international workshops, forums, and working groups (e.g. IPCC Lead Author meetings, European Climate Adaptation Conference, regional CORDEX workshops) to present Black Sea-specific modelling framework and ensure alignment with shared technical standards;
- Coordinating with the European Digital Twin Ocean (EU DTO) to ensure compatibility and integration with the Black Sea Digital Twin (BS DTO) demonstrator.
- Liaising with the forthcoming Implementation Platform for the EU Mission on Adaptation to Climate Change, to be launched under a CINEA-funded service contract, to connect regional climate modelling outputs with European adaptation knowledge systems and policy support.

Suggested approach:	Bi/Multilateral interactions with specific actors: strategic coordination and networking with international initiatives. Research project.
	<i>Funding to consider:</i> Horizon Europe, European Climate, Infrastructure and Environment Executive Agency (CINEA), Copernicus C3S National Collaboration Programme.

Geographic scope:	Regional, European, International	Timeframe:	2025-2027 (short-term priority)
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Required actors

Research/ Academia
ULiege, METU, IBER-BAS, HCMR, CNR, DTU

Contribution to BS-SRIA

Pillar 1, Goal 2 – Providing new knowledge to mitigate the impacts of global climate change and multiple stressors

- Enhance the interoperability of Black Sea modelling framework with European and international reference systems
- Support consistent and comparable risk assessment for adaptation and mitigation planning.

Policy relevance

EU Mission: Adaptation to Climate Change, EU Climate Adaptation Strategy, , EU Climate Law, EU Mission: Restore our Ocean and Waters, EU Ocean Pact, Marine Strategy Framework Directive (MSFD), United Nations Framework Convention on Climate Change (UNFCCC); Common Maritime Agenda for the Black Sea (CMA); 2025 EU Joint Communication on the Strategic Approach to the Black Sea.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

B) Black Sea ecosystem resilience in the face of multiple stressors

Action B.1: Facilitate the regional replication of BRIDGE-BS multiple stressors and resilience assessment methods

Objective: Enable the replication of multiple stressors and resilience assessment methods tested in BRIDGE-BS Pilot Site 2 (Varna and Burgas, BG) to improve ecosystem evaluations and support adaptive management at national and basin scale levels

Relevant KOs	3.1	Other related KOs	3.4
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Description

Work in Pilot Site 2 integrated modelling and spatial analysis methods to examine the effects of multiple stressors on ecosystem condition and resilience. These included habitat quality assessment, ecosystem service (ES) hotspot mapping, regime shift identification, and ecosystem bundle analysis to characterise the spatial distribution of ecosystem service combinations.

Replication of these approaches in other areas of the Black Sea can improve the consistency of ecosystem evaluations and support their integration into policy and planning. It should be based on collaboration with national experts and the availability of the necessary data to run the models and perform the assessments. Sharing of tools and methodologies with regional partners should be accompanied by guidance for improving relevant datasets and adapting to specific monitoring contexts. Qualitative methods to assess ecosystem resilience in data poor systems are also available from the project.

These approaches can be applied in support of policy processes such as maritime spatial planning, national environmental monitoring and reporting (MSFD), development and revision of national marine strategies, and the identification of multifunctional areas and restoration priorities by linking ecological condition with societal benefits.

Suggested approach:	Coordination and support action. Knowledge transfer and capacity building
	<i>Funding to consider:</i> Interreg NEXT BSB; specific EMFAF calls; NDICI – Global Europe (Neighbourhood, Development and International Cooperation Instrument); national funding programmes for actions in specific pilot sites

Geographic scope:	Regional	Timeframe:	2026-2028
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Required actors

Research/ Academia
IBER-BAS, NIMRD, METU, GEOECOMAR, TUBITAK, TSU, SU
BRIDGE-BS Pilot Site leaders

Contribution to BS-SRIA

Pillar 1, Goal 2 – Providing new knowledge to mitigate the impacts of global climate change and multiple stressors

- Facilitate broader application of integrated methods developed under BRIDGE-BS to assess ecosystem response to cumulative stressors.
- Contribute to a shared understanding of resilience across the region and informs mitigation strategies.

Policy relevance

Marine Strategy Framework Directive (MSFD); EU Biodiversity Strategy for 2030; Nature Restoration Regulation; Common Maritime Agenda for the Black Sea (CMA); 2025 EU Joint Communication on the Strategic Approach to the Black Sea; national marine strategies and environmental assessment frameworks.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action B.2: Strengthen the scientific basis and promote the adoption of resilience thinking in the Black Sea context

Objective: Create the conditions for the future application of resilience-based approaches within marine governance frameworks in the Black Sea region

Relevant KOs	3.2, 3.3, 3.4, 3.5	Other related KOs	1.3
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Description

BRIDGE-BS has explored ecosystem stability, resilience dynamics, and potential regime shifts in the Black Sea through different approaches. While the results produced so far offer a strong scientific basis, further research is needed to enable their practical application in environmental management and policy processes.

To support this process, two complementary components are proposed:

- Consolidation of research results and identification of next steps: key data gaps, dependencies on modelling outputs, and areas that require further research or methodological refinement.
- Design of suitable information materials to support policy and stakeholder dialogue. Scientific concepts and exploratory findings reflecting a holistic understanding of the Black Sea as a coupled socio-ecological system can support the introduction of resilience thinking into policy and management contexts. Formats to consider include a concise visual summary of key concepts related to stability, resilience, and tipping behaviour, complemented by selected indicators or assessment elements with brief guidance on interpretation and potential future use.

Selected outputs can also be prepared for display through the Black Sea Digital Twin Ocean (BS-DTO) using a 3D dashboard

Suggested approach:	Research project; awareness raising actions
	<u>Funding to consider:</u> Horizon Europe (Cluster 6, including EU Mission: Restore our Ocean and Waters lighthouse calls), Interreg NEXT Black Sea Basin, and national research programmes

Geographic scope:	Regional, relevance for national-level application	Timeframe:	2026-2030
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Required actors

Research/ Academia	National Policymakers
SU, IBER-BAS, GEOECOMAR, NIMRD, METU, TUBITAK, TSU	Environment and Research Agencies/ Ministries/ Departments
BRIDGE-BS Pilot Site leaders	

Contribution to BS-SRIA

Pillar 1, Goal 2 – Providing new knowledge to mitigate the impacts of global climate change and multiple stressors

- Support the development of system understanding and resilience-oriented perspectives

Pillar 4, Goal 3 – Contributing to enhanced science-policy dialogue in formulating coastal and marine policies and programmes

- Facilitate early communication and forward thinking on complex system dynamics to support long-term policy development

Policy relevance

Marine Strategy Framework Directive (MSFD); EU Biodiversity Strategy for 2030; Nature Restoration Regulation; Mission “Restore our Ocean and Waters”; Common Maritime Agenda for the Black Sea (CMA), 2025 EU Joint Communication on the Strategic Approach to the Black Sea; Relevant national marine strategies.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

C) Towards Black Sea integrated environmental observation

Action C.1: Support improved ecosystem assessment in the Black Sea through data gap identification and readiness analysis

Objective: Improve the availability and usability of marine data based on BRIDGE-BS results, to enhance the effectiveness of Black Sea environmental policies and ecosystem-based governance.

Relevant KOs	1.1	Other related KOs	1.2, 1.3, 4.2, 5.1, 5.2, 5.3, 5.4, 5.5, 3.1
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Description

BRIDGE-BS provides a critical assessment of the availability, quality, and suitability of datasets relevant to marine observation and ecosystem assessments in the Black Sea. Key gaps in variables, geographic coverage, and accessibility were identified, offering targeted recommendations to improve regional data infrastructures and monitoring frameworks. Some of these gaps have been partially addressed by BRIDGE-BS, while others have emerged during the project development in relation to the specific data needs of the newly implemented tools and methodologies.

These findings are relevant for enhancing the monitoring programmes in the Black Sea, particularly the BSIMAP. The analysis is also relevant for marine data infrastructures and modelling initiatives, both at regional and European level, including EMODnet, Copernicus and EU DTO, where the identification of data gaps is a prerequisite for integration and alignment. Recommendations to progress in this area include:

- Engage with the Black Sea Commission to assess the relevance of this approach within the framework of the Bucharest Convention and explore its potential to enhance the BSIMAP.
- Engage with Mercator Ocean International to support the development of the Black Sea DTO demonstrator in alignment with EU DTO.

Suggested approach:	Bi/ Multilateral interaction with specific actors. Coordination and support action
	<i>Funding to consider:</i> EU DTO – related calls, Horizon Europe (Cluster 6), Interreg NEXT BSB, national research programmes

Geographic scope:	Regional	Timeframe:	2025-2027
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Required actors

Research/ Academia	Regional Organisations	National Policymakers	Others
METU, NIMRD, CNR, SU, IBER-BAS, GEOECOMAR, TUBITAK	Black Sea Commission	Environment and Research Agencies/ Ministries/ Departments	Mercator Ocean International

Contribution to BS-SRIA

Pillar 1 – crosscutting

- Strengthen the foundation for coordinated marine observation by identifying and addressing critical data gaps
- Improve alignment between regional data frameworks and emerging European infrastructures such as the Digital Twin Ocean

Policy relevance

Bucharest Convention; 2025 EU Joint Communication on the Strategic Approach to the Black Sea; Marine Strategy Framework Directive (MSFD); EU Ocean Pact – Ocean Observation Initiative; Copernicus Marine Service; EMODnet; EU DTO; National marine monitoring and data strategies.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action C.2: Deployment and integration of advanced sensor systems for the Black Sea observation

Objective: Development of a more coordinated and responsive Black Sea observation system by enabling the use of emerging sensor technologies in support of data needs

Relevant KOs	5.5	Other related KOs	1.1, 1.2, 1.3, 7.1, 7.2, 7.3, 7.4
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Description

BRIDGE-BS demonstrated the potential of a range of advanced sensor-based systems to enhance high-frequency, real-time monitoring of key environmental parameters in the Black Sea. These include technologies for detecting key chemical parameters (e.g. pH, pCO₂, H₂S), in situ phytoplankton analysis, UAV-based jellyfish monitoring, radionuclide detection, and underwater bioacoustics. The maturity of these systems is uneven, with some of them reaching higher readiness levels (TRL 7+) while others still need some further development.

Building on these results, this action proposes a tailored approach based on the readiness level of each element:

- High-TRL technologies (TRL 7-9): facilitate uptake by the scientific community and monitoring agencies through their integration into existing infrastructures and platforms. The market potential and business opportunities associated to these technologies can be further explored through [actions F.3 and F.4](#), considering the capacity of marine institutes to develop spin-offs and potential of calls for pre-commercial procurement and public procurement of innovation.
- Mid- to low-TRL technologies (TRL 3-6): conduct pilot trials within selected Black Sea sites to address specific technical challenges and assess their potential for integration into regional observation frameworks.

Efforts in this regard should be aligned with the advancement of common monitoring approaches, as proposed in the [actions that follow in this section](#). Additionally, the potential for combining ocean observation advanced systems with maritime security surveillance should be explored, in line with Flagship 1 of the 2025 Joint Communication on the EU's Strategic Approach to the Black Sea Region.

Suggested approach:	Pilot projects. Demonstration projects. Innovation actions. Public procurement
	<i>Funding to consider:</i> Horizon Europe Cluster 6 and EU Mission: Restore our Ocean and Waters Lighthouse calls, Interreg NEXT BSB, Pre-commercial Procurement, Public Procurement of Innovation

Geographic scope:	Regional, site-specific implementation at national level	Timeframe:	2025-2028
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Required actors

Research/ Academia	National Policymakers	Others
METU, IO-BAS, IBER-BAS, GEOECOMAR, NIMRD, TSU, TUBITAK MAM, DTU, UkrSCES	National Monitoring Agencies	Private investors with experience in large scale public contracts
Other marine research institutes	Ministries in charge of environment, infrastructures, research, maritime affairs	
	National funding agencies – Operational Network of Funders	

Contribution to BS-SRIA

Pillar 3, Goal 1 – Developing smart, integrated observing and monitoring systems

- Supports the uptake of novel sensor technologies to expand the scope, resolution, and responsiveness of marine observation across the Black Sea region.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Policy relevance

Bucharest Convention and BSIMAP; Marine Strategy Framework Directive (MSFD); EU Ocean Pact – Ocean Observation Initiative; EU DTO; Mission “Restore our Ocean and Waters”; Common Maritime Agenda for the Black Sea (CMA) (CMA); 2025 Joint Communication on the EU’s Strategic Approach to the Black Sea Region (Flagship 1).



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action C.3: Advance harmonised approaches for phytoplankton monitoring in the Black Sea

Objective: Facilitate the development, uptake, and convergence of phytoplankton and harmful algal bloom (HAB) monitoring methods to improve data comparability and support coordinated environmental assessment across the Black Sea region

Relevant KOs	5.3	Other related KOs	5.1, 5.2, 5.4, 5.5
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Description

BRIDGE-BS demonstrated the potential of enhancing phytoplankton monitoring through combined strategies integrating microscopy and molecular methods. This work, carried out in Bulgaria, has set the basis for an ongoing collaboration at regional level involving PhD students' mobility and training, joint research papers and academic dialogue.

Further progress in this regard should include:

- Extending the application of advanced phytoplankton monitoring approaches to new locations across the western and southern Black Sea;
- Supporting the convergence of national practices by testing and refining shared methodologies in cross-border areas;
- Enabling practical exchanges between institutions to strengthen technical capacity and promote consistent application of both conventional and emerging techniques.

This action contributes to broader regional efforts under **Action C.6** (below), focusing on practical alignment and the gradual convergence of specific monitoring practices across countries.

Suggested approach:	Research project. Staff mobility
	<u>Funding to consider:</u> Interreg NEXT BSB (possibility of resubmission of an enhanced proposal), national funding programmes

Geographic scope:	Regional	Timeframe:	2026-2029
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Required actors

Research/ Academia IO-BAS, METU, NIMRD, GEOECOMAR, TUBITAK, TSU	National Policymakers Environment and Research Agencies/ Ministries/ Departments Operational Network of Funders
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Contribution to BS-SRIA

Pillar 3, Goal 1 – Developing smart, integrated observing and monitoring systems

- Advance methodological innovation and regional alignment in phytoplankton monitoring
- Contribute to early detection of HAB events, improve the scientific basis for ecological status assessments, and facilitate transboundary environmental reporting

Policy relevance

Marine Strategy Framework Directive (MSFD); EU Ocean Pact – Ocean Observation Initiative; EU Biodiversity Strategy; 2025 EU Joint Communication on the Strategic Approach to the Black Sea; National marine monitoring and data strategies.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action C.4: Advance the integration of eDNA metabarcoding into Black Sea biodiversity monitoring/ tracking programmes

Objective: Position eDNA-based approaches as a complementary tool to traditional biodiversity and fisheries monitoring, enabling faster, less-invasive, and cost-effective assessment strategies

Relevant KOs	5.2	Other related KOs	5.1, 5.3, 5.4, 5.5
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Description

BRIDGE-BS demonstrated the potential of eDNA metabarcoding to detect species presence and biodiversity trends in the Black Sea. While these approaches offer promising opportunities to enhance existing monitoring systems, their current limitations – including data interpretation challenges, dependence on the quality of available databases, and the lack of standardised protocols – mean they require a cautious and well-contextualised application. Combining eDNA methods with conventional monitoring can help address these gaps and strengthen overall system performance.

Further development should focus on:

- Engaging regional and national stakeholders (e.g. BSC, GFCM, RCG Med&BS) to assess the potential integration eDNA approaches into national data collection programmes and monitoring frameworks. Special attention should be given to aligning outputs with end-user needs and legal requirements.
- Identifying priority areas and specific use cases for pilot activities, such as early detection of invasive species, baseline assessments in areas targeted for specific blue economy sectors (e.g. aquaculture, marine renewable energies) and tracking of species that are difficult to observe using traditional methods. These efforts could inform management measures under the MSFD, CFP, and NRR.
- Promoting pilot projects in selected Black Sea areas, designed in coordination with fisheries and environmental authorities to generate practical evidence for future policy uptake.

By generating context-relevant evidence and fostering institutional dialogue, this action supports the progressive adoption of eDNA methods as part of flexible, responsive and policy-relevant biodiversity monitoring strategies in the region. It also contributes to broader regional efforts under [Action C.6](#) (below).

Suggested approach:	Research project. Pilot project. Bi/ Multilateral interaction with specific actors
	<i>Funding to consider:</i> Horizon Europe (EU Mission: Restore our Ocean and Waters, Biodiversity), Interreg NEXT BSB, national funding programmes

Geographic scope:	Regional site-specific implementation at national level	Timeframe:	2026-2029
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Required actors

Research/ Academia IO-BAS, HCMR, METU, TUBITAK, UkrSCES, NIMRD, GEOECOMAR, TSU	Regional Organisations Black Sea Commission General Fisheries Commission for the Mediterranean – Working Group on the Black Sea Regional Coordination Group Mediterranean & Black Sea	National Policymakers National environmental and research agencies/ ministries departments. Operational Network of Funders
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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Contribution to BS-SRIA*Pillar 3, Goal 1 – Developing smart, integrated observing and monitoring systems*

- Enhance flexibility and responsiveness of biodiversity monitoring systems
- Contribute to more efficient tracking of ecosystem changes, species distributions, and potential threats

Policy relevance

Marine Strategy Framework Directive (MSFD), Common Fisheries Policy (CFP), EU Biodiversity Strategy, EU Ocean Pact – Ocean Observation Initiative; Nature Restoration Regulation, 2025 EU Joint Communication on the Strategic Approach to the Black Sea; National marine monitoring and data strategies.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action C.5: Strengthen regional collaboration for harmonised environmental monitoring

Objective: Support the progress, long-term implementation, and institutional uptake of harmonised monitoring protocols and quality control standards by promoting convergence, capacity building, and policy alignment

Relevant KOs	1.4	Other related KOs	9.1, 9.2
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Description

BRIDGE-BS has made significant progress in promoting harmonised environmental monitoring across the Black Sea by developing common protocols, advancing quality control standards, and identifying key capacity and coordination gaps. Collaborative work among project partners has supported convergence in methods and contributed to shared understanding of monitoring priorities and implementation needs.

Designating national coordination focal points could support the uptake and practical implementation of these common protocols. Integrated within national agencies, these focal points would facilitate implementation at national level while contributing to regional alignment through structured cooperation. Key responsibilities of these focal points would include:

- Promoting the institutional adoption of harmonised protocols and quality control standards by presenting them to the relevant national bodies and to the BSC, ensuring alignment with the BSIMAP. Engagement with relevant authorities responsible for environment policy and monitoring implementation is essential to achieve long-term uptake and national-level ownership.
- Coordinating national-level capacity-building activities, including targeted training for early-career researchers, new monitoring staff, and technical personnel. These may be delivered through workshops, summer schools, or e-learning platforms in collaboration with scientific institutions and regional initiatives.
- Facilitating peer exchange and knowledge sharing on implementation challenges, data quality, and reporting requirements, aligned with [actions C.2. and C.6.](#)

Suggested approach:	Coordination and support actions. Training programmes. Bi/Multilateral interaction with specific actors
	<u>Funding to consider:</u> Interreg NEXT BSB, national funding programmes

Geographic scope:	Regional, with national level application	Timeframe:	2026 onwards
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Required actors

Research/ Academia	Regional Organisations	National Policymakers
GEOECOMAR, UkrSCES, NIMRD, METU, TUBITAK, IO-BAS, IBER-BAS, TSU, SUMAE, SU, TUDAV	Black Sea Commission working groups BSEC work group on environment	Environment and Research Ministries Environmental monitoring agencies and MSFD national authorities Operational Network of Funders

Contribution to BS-SRIA

Pillar 3, Goal 2 – Advancing common approaches to monitoring and assessment

- Promote the long-term uptake of harmonised protocols and quality control standards
- Support alignment of national and regional frameworks with international standards

Policy relevance

Bucharest Convention and Black Sea Integrated Monitoring and Assessment Programme (BSIMAP); 2025 EU Joint Communication on the Strategic Approach to the Black Sea; EU Ocean Pact – Ocean Observation Initiative; Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD), EU Biodiversity Strategy, Nature Restoration Regulation; National marine monitoring and data strategies



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action C.6: Foster alignment and long-term cooperation for enhanced marine observation in the Black Sea

Objective: Advance the coordination of regional marine observation efforts in the Black Sea by fostering convergence around priorities, methodologies, and capacity-building needs, drawing on BRIDGE-BS efforts

Relevant KOs	5.1	Other related KOs	1.3, 1.1, 1.2, 1.4, 5.5
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Description

BRIDGE-BS has contributed to more coordinated marine observation across the Black Sea by identifying key monitoring gaps, demonstrating advanced in situ technologies, and promoting regional dialogue on standards and data needs. Improved observation systems yield richer and more accurate data, increasing the demand for joint investment, capacity development, and policy adaptation to fully benefit from the new available knowledge.

As a next step, progress is needed towards sustained coordination strategies that support convergence in monitoring approaches and create enabling conditions for a joint observation strategy in the region.

This action proposes aims to advance regional cooperation by:

- Mapping current and planned national observation initiatives to identify areas of alignment and complementarity;
- Facilitating technical exchange on standardised methodologies and quality control procedures (linked to [action C.5](#));
- Promoting the uptake of innovative monitoring technologies demonstrated under BRIDGE-BS, particularly in situ sensor systems that address the limitations of other data sources (e.g. satellite), in coordination with [action C.2](#);
- Explore the role of grey literature, expert-based inputs, and context-specific approaches to address data gaps in areas where structured datasets are limited or unavailable.
- Encouraging regional dialogue among monitoring institutions from each Black Sea country to improve coordination of national observation efforts and explore opportunities for coordinated research campaigns, as well as mobility and training activities for early-career researchers (linked to [action G.2](#)). This could take the form of a panel of directors or senior representatives from these institutions, meeting regularly to exchange knowledge, align priorities, and foster cooperation;
- Drafting a non-binding concept note outlining potential components of a future joint observation framework, to serve as a reference for regional discussions.

The action could initially focus on coordination among Bulgaria, Romania, and Türkiye, with flexibility for wider engagement as institutional and geopolitical conditions allow.

Suggested approach:	Coordination and support actions. Bi/Multilateral interaction with specific actors
	<u>Funding to consider:</u> Interreg NEXT BSB, national funding programmes

Geographic scope:	Regional	Timeframe:	2026-2030
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Required actors

Research/ Academia NIMRD, METU, TUBITAK, IO-BAS, IBER-BAS, TSU, DTU, Ifremer	Regional Organisations Black Sea Commission working groups BSEC work group on environment	National Policymakers Environment and Research Ministries Environmental monitoring agencies and MSFD national authorities Operational Network of Funders
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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Contribution to BS-SRIA*Pillar 3, Goal 2 – Advancing common approaches to monitoring and assessment*

- Promote regional alignment in marine observation approaches, methodologies and technologies
- Contribute to a more coherent and interoperable marine observation system in the Black Sea, enhancing the comparability of collected data across national programmes and internationally

Policy relevance

Bucharest Convention and Black Sea Integrated Monitoring and Assessment Programme (BSIMAP); 2025 EU Joint Communication on the Strategic Approach to the Black Sea; EU Ocean Pact – Ocean Observation Initiative; Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD), EU Biodiversity Strategy, Nature Restoration Regulation, EU DTO, Common Maritime Agenda, National marine monitoring and data strategies



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

D) Cumulative Effects Assessment and Adaptive Management for the Black Sea

Action D.1: Improve the quality of the Cumulative Effects Assessment (CEA) tool

Objective: Address key scientific and technical gaps to expand the tool capabilities and improve its usability for ecosystem-based planning

Relevant KOs	4.2	Other related KOs	
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Description

Building on the experience gained and the challenges encountered during its application within BRIDGE-BS, the CEA tool can be further developed to enhance its accuracy, operational scope, and policy relevance for integrated coastal management and maritime spatial planning in the Black Sea. Advancing its analytical precision and operational scope will require targeted refinement of both its internal architecture and its connection to external analytical models.

Priority areas for improvement include:

- Strengthening the integration of socio-economic dimensions, by linking cumulative pressures to impacts on ecosystem services and incorporating available economic indicators. This will enable more holistic scenario analysis and support planning strategies that integrate ecosystem health with socio-economic development needs.
- Enhancing connectivity with external models, such as pressure and impact models, to ensure consistency in input data and improve the robustness of cumulative impact assessments across spatial and temporal scales.

These developments will contribute to a more regionally adapted and policy-relevant tool capable of supporting transboundary scenario analysis, environmental risk assessment, and informed decision making under conditions of uncertainty.

Suggested approach:	Research project
	<u>Funding to consider:</u> Horizon Europe, national research and innovation programmes

Geographic scope:	Regional	Timeframe:	2026-2029
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Required actors

Research/ Academia	National Policymakers	Other
CNR, METU, IBER-BAS, HCMR, ULiege, SU, BRIDGE-BS	Maritime Spatial Planning practitioners	Other marine researchers/scientists
Pilot Site leaders	Marine Protected Areas managers	

Contribution to BS-SRIA

Pillar 3, Goal 2 – Advancing common approaches to monitoring and assessment

- Support methodological convergence in cumulative effects assessment by refining indicators, data standards, and modelling approaches
- Contribute to more consistent and policy-relevant evaluations across the Black Sea

Policy relevance

Maritime Spatial Planning Directive (MSPD), Blue Economy Strategy, Nature Restoration Regulation (as applicable for spatial planning and impact assessment), EU DTO, 2025 EU Joint Communication on the Strategic Approach to the Black Sea; National blue economy strategies



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action D.2: Support further application of the CEA approach for adaptive and sectoral planning

Objective: Demonstrate the added value of the CEA tool in supporting site-specific decision-making and informing spatial planning processes at different scales.

Relevant KOs	4.3	Other related KOs	1.3
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Description

BRIDGE-BS applied the CEA tool in selected Black Sea settings to explore cumulative pressures and support scenario-based analysis for ecosystem-based management. The results demonstrated its potential to inform adaptive planning in areas facing complex multiple stressors' dynamics, while also revealing key limitations that must be addressed for broader application at national and local levels.

To address technical and data-related gaps and ensure the tool is fit for operational use in national and local planning, targeted improvements are needed in the following areas:

- Completing the implementation of pressure–state relationships, with improved indicator selection and clearer links between pressures and ecosystem components;
- Expanding the spatial resolution and ecological coverage of sensitivity data, especially for species and habitats;
- Filling critical gaps in geospatial data gaps related to human uses and pressures, ensuring balanced sectoral representation and improved consistency across Black Sea countries.
- Improving the integration and management of transboundary datasets, through shared metadata standards, common formats, and better documentation to support transparency and reproducibility.

Once these improvements are in place, pilot studies can be developed in selected national and local contexts to apply the CEA methodology in real-world decision-making. Potential sites include coastal zones under pressure from tourism or shipping, ecologically sensitive areas such as marine protected areas (MPAs), and locations with development potential for aquaculture or marine renewable energy. These applications will demonstrate the tool's value in identifying and prioritising management measures under the Marine Strategy Framework Directive (MSFD), informing National Plans under the Nature Restoration Regulation (NRR), and supporting sustainable blue economy planning in areas affected by multiple environmental and human pressures.

This demonstration will contribute to raise institutional awareness and encourage uptake by highlighting the value of the CEA approach to support more integrated, evidence-based planning at multiple scales.

Suggested approach:	Research project. Pilot project
	<u>Funding to consider:</u> Horizon Europe, national research and innovation programmes

Geographic scope:	Regional, site-specific implementation at national level	Timeframe:	2026-2029
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Required actors

Research/ Academia	National Policymakers	Other
CNR, METU, IBER-BAS, TUBITAK, NIMRD	Local authorities	Blue economy stakeholders
Pilot Site leaders		Marine researchers/ scientists

Contribution to BS-SRIA

Pillar 3, Goal 2 – Advancing common approaches to monitoring and assessment

- Promote the operational use of a harmonised CEA methodology in real-world planning processes
- Supports the translation of science-based assessment tools into actionable inputs for marine and coastal management at national and site-specific level

Policy relevance



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Maritime Spatial Planning Directive (MSPD), Blue Economy Strategy, Nature Restoration Regulation (as applicable for spatial planning and impact assessment), EU DTO, 2025 EU Joint Communication on the Strategic Approach to the Black Sea; National blue economy strategies



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action D.3: Deliver targeted training on ecosystem-based approaches and tools

Objective: Build capacity among policy and decision makers to implement Cumulative Effects Assessment (CEA)-based tools and adaptive management approaches in support of marine policies.

Relevant KOs	4.2, 4.3, 4.4	Other related KOs	1.6
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Description

The CEA framework developed within BRIDGE-BS provides a practical approach to support capacity building for ecosystem-based planning and decision-making in the Black Sea. The CEA-tool, tailored to the region's specific context, together with scenario-based analyses and policy recommendations, can help inform spatial planning, impact assessment, and risk management processes.

Building on these results, targeted training activities are proposed to strengthen institutional capacity and promote the effective use of the tool and its outputs in policy contexts. The training should be adapted to different user profiles, helping participants to understand and apply CEA results effectively in planning and decision-making processes.

- Planners and technical users with a technical background can benefit from guided practical sessions on tool functionality, hypothesis, scenario design, and interpretation of results;
- Policymakers and non-technical users may focus on how CEA outputs can support planning decisions, policy development, and cross-sector dialogue.

To ensure the relevance, training activities should be co-designed with national and regional institutions responsible for implementing the relevant strategies and policy frameworks. Delivery formats may include national workshops, regional exchanges, or dedicated sessions within broader initiatives such as the CMA Stakeholders Conference.

Suggested approach:	Training programmes
	<i>Funding to consider:</i> Horizon Europe, national research and innovation programmes

Geographic scope:	Regional, National	Timeframe:	2026-2028
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Required actors

Research/ Academia CNR, GEOECOMAR, ICBSS, Pilot Site leaders	Regional Organisations BSEC, CPMR Balkan and Black Sea Commission, Common Maritime Agenda National Hubs	National Policymakers Pilot site level environmental managers Ministries/ Agencies in charge of the design and implementation of marine policies and strategies
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Contribution to BS-SRIA*Pillar 4, Goal 3*

- Support evidence-based implementation of environmental regulations and strategies
- Promote adaptive, risk-informed management

Policy relevance

Maritime Spatial Planning Directive (MSPD), Marine Strategy Framework Directive (MSFD), Nature Restoration Regulation (NRR), Sustainable Blue Economy Strategy, Common Maritime Agenda for the Black Sea (CMA) (CMA), 2025 EU Joint Communication on the Strategic Approach to the Black Sea; National blue economy strategies



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

E) Black Sea Digital Twin Ocean demonstrator

Action E.1: Consolidate BRIDGE-BS results into the Black Sea Digital Twin Ocean (BS-DTO) demonstrator and enhance it with new scenarios and functionalities

Objective: Ensure the full technical and functional integration of BRIDGE-BS knowledge outputs into the Black Sea Digital Twin Ocean, enabling its use for scenario-based analysis, environmental status assessment, and informed decision-making at regional and national levels

Relevant KOs	1.3	Other related KOs	2.1-2.4, 3.1-3.5, 4.1-4.3, 5.1
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Description

The BS-DTO from BRIDGE-BS is designed as an interactive, scenario-based environment linking environmental and socio-economic data for advanced scientific developments and evidence-based marine governance. Integration work will complete the interconnection between project outputs, ensuring coherence and functionality both at basin and pilot site scales.

Necessary developments include:

- Integrating modelling outputs from climate, physical, and ecological systems, with the capacity to run on-demand scenarios (e.g. climate change, plastic pollution, fisheries management measures);
- Embedding ecosystem indicators, spatial data layers, and ecosystem service maps, related to the cumulative effects assessment (CEA) tool and its scenario analysis modules (linked to [actions D.1, D.2](#));
- Aligning socio-economic data and indicators from the Blue Economy Observatory for the Black Sea to support cross-sector analysis and sector-specific queries;
- Ensuring compatibility with FAIR data standards and BRIDGE-BS infrastructure components
- Harmonising visualisation, user access, and update protocols across modules.

The consolidated BS-DT demonstrator is expected to offer a complete, functional baseline for testing use cases and showcasing how integrated environmental and socio-economic data can inform governance processes.

Suggested approach:	Shared/ distributed research infrastructures and systems. Applied research project
	<u>Funding to consider:</u> Horizon Europe, EU DTO-related calls, national research and innovation programmes

Geographic scope:	Regional	Timeframe:	2025-2030
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Required actors

Research/ Academia	Regional Organisations	National Policymakers	EU Policymakers	Other
METU, ULiege, IBER-BAS, HCMR, CNR, DTU, SU EU Joint Research Centre (EU JRC)	Common Maritime Agenda National Hubs	Pilot site level environmental managers Ministries/ Agencies in charge of the design and implementation of marine policies and strategies National research authorities Operational Network of Funders	DG ENV, DG MARE, DG DEFIS	Destination Earth Community Mercator Ocean International



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Contribution to BS-SRIA

Pillar 3 – Goal 1

- Development of a fully integrated digital platform bringing together observational data, modelling, and policy-relevant tools
- Support improved decision-making by enabling interactive assessments, cross-sectoral planning, and cumulative pressure analysis at multiple scales

Policy relevance

European Digital Twin Ocean (EU DTO); Maritime Spatial Planning Directive (MSPD), Marine Strategy Framework Directive (MSFD), Nature Restoration Regulation (NRR), Sustainable Blue Economy Strategy, Common Maritime Agenda for the Black Sea (CMA) (CMA), 2025 EU Joint Communication on the Strategic Approach to the Black Sea; Bucharest Convention / BSIMAP



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action E.2: Ensure sustainability and institutional coordination of the BRIDGE-BS Portal as a regional reference platform for marine data

Objective: Promote the effective use, coordinated maintenance, and long-term relevance of the BRIDGE-BS Portal and Database as a jointly managed platform for marine data exchange and policy support in the Black Sea region, ensuring its integration with the BS-DTO in the long-term.

Relevant KOs	1.2	Other related KOs	1.1, 1.4
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Description

The BRIDGE-BS Portal and Database offer a consolidated source of marine data, integrating national and regional datasets under common standards, and including GIS-based mapping services to support data analyses. In the short to mid-term, the portal will continue to operate as an independent platform, while also serving as the core data layer for the BS-DTO. Over time, both systems are expected to converge into a single integrated platform, ensuring continuity, access, interoperability, and sustained relevance for regional policy and governance needs.

Two mutually reinforcing activities are proposed to maintain sustainability and policy relevance beyond the project's lifetime:

- Establishment of a regional coordination mechanism involving BRIDGE-BS partners, the BSC Secretariat, and national monitoring authorities to coordinate protocols for data submission, quality control, metadata, and interface updates, ensuring alignment with EU and regional reporting obligations (e.g. MSFD, Bucharest Convention)
- Promote institutional uptake and stakeholder engagement by implementing targeted actions to raise awareness and secure long-term commitments from national authorities and policy institutions, including a dedicated info-day for competent ministries (e.g. MSFD, MSP units) and BSC representatives, and bilateral meetings to explore integration into national data systems.

Suggested approach:	Bi-/Multilateral interaction with national competent ministries/departments. Awareness raising actions
	<i>Funding to consider:</i> Horizon Europe, EU DTO-related calls, national monitoring and data management programmes

Geographic scope:	Regional, National	Timeframe:	2025-2030
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Required actors

Research/ Academia	Regional Organisations	National Policymakers	EU Policymakers	Other
UkrSCES, NIMRD, METU, TUBITAK, IO-BAS EU JRC	Black Sea Commission Common Maritime Agenda National Hubs	National Monitoring Agencies National research authorities Ministries/ Agencies in charge of the design and implementation of marine policies and strategies Operational Network of Funders	DG RTD, DG MARE, DG ENV, DG ENEST	Mercator Ocean International



Contribution to BS-SRIA*Pillar 3 – Goal 1*

- Promote regional standardisation and institutional alignment, supporting interoperable systems, consistent methodologies and shared data practices
- Ensure the continuity and interoperability of the data infrastructure underlying the BS-DTO

Policy relevance

Marine Strategy Framework Directive (MSFD); Maritime Spatial Planning Directive (MSP); Nature Restoration Regulation (NRR); Mission “Restore our Ocean and Waters” – Black Sea Lighthouse; European Digital Twin Ocean (EU DTO); Common Maritime Agenda for the Black Sea (CMA); 2025 EU Joint Communication on the Strategic Approach to the Black Sea; Bucharest Convention / BSIMAP; National marine monitoring and data strategies



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action E.3: Ensure alignment of the Black Sea Digital Twin (BS-DTO) demonstrator with the European Digital Twin Ocean (EU DTO)

Objective: Ensure the BS-DTO demonstrator becomes a recognised regional component of a pan-European Digital Twin infrastructure

Relevant KOs	1.3	Other related KOs	1.2
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Description

This action supports the technical and strategic alignment between the BS-DTO and EU DTO. Building on the collaboration initiated under BRIDGE-BS, engagement with the EU DTO technical coordinator and other relevant EU actors will be maintained to ensure that the BS-DTO evolves in line with the European standards and infrastructure.

Proposed activities include:

- Participating in EU DTO ecosystem meetings, working groups, and technical workshops
- Aligning metadata standards, service architecture, interface design and user interaction management with EU DTO requirements
- Exploring interoperability with other regional European DTOs, as well as thematic services or applications (e.g. biodiversity, pollution, coastal flooding), to facilitate data sharing and cross-basin scenario applications

By securing early integration and interoperability, the action contributes to positioning the BS-DTO as the Black Sea node of the EU DTO

Suggested approach:	Bi-/ Multilateral interaction with specific actors. Research project. Innovation Actions
	<u>Funding to consider:</u> Horizon Europe, EU DTO-related calls, national research programmes

Geographic scope:	Regional, European Union	Timeframe:	2025-2030
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Required actors

Research/ Academia	EU Policymakers	Other
METU, HCMR, ULiege, IBER-BAS, CNR, DTU EU JRC	DG RTD, DG MARE, DG ENV, DG ENEST,	Mercator Ocean International

Contribution to BS-SRIA

Pillar 3 – Goal 1

- Align the BS-DT with EU-level digital infrastructures to ensure that Black Sea data, models, and services are fully interoperable and meet common technical standards
- Enable the integration of regional monitoring tools into wider digital platforms, improving access to information, supporting cross-basin scenario analysis, and facilitating coordinated policy implementation

Policy relevance

EU Ocean Pact; European Digital Twin Ocean (EU DTO); 2025 EU Joint Communication on the Strategic Approach to the Black Sea



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action E.4: Sustain and expand the strategic communication and visibility of the Black Sea Digital Twin Ocean (BS-DTO) demonstrator

Objective: Maximise the visibility, stakeholder engagement, and policy impact of the BS-DTO demonstrator through coordinated and continuous communication of its progress at national, regional and European levels

Relevant KOs	1.3	Other related KOs	
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Description

A coordinated and well-targeted communication strategy is essential to sustain the visibility and recognition of the BS-DTO demonstrator and show its potential for regional marine governance. Efforts should be aligned across BRIDGE-BS platforms (website, Black Sea HELIX), EU-level channels (EU Mission: Restore our Ocean and Waters), and social media, conveying clear, consistent messages and reaching all key user and target audiences

Proposed measures include:

- Exploring the benefits of joining the ILIAD Digital Twins Marketplace to increase visibility and link the BS-DTO demonstrator to broader DTO initiatives;
- Securing BS-DTO demonstrator presence at key policy and stakeholder events such as European Maritime Day, Digital Ocean Forum, and CMA stakeholder meetings;
- Producing tailored outreach materials for policymakers, funding agencies, and technical stakeholders, highlighting the potential of the BS-DTO demonstrator for knowledge integration and provision of specialised services.

This action will help position the BS-DTO demonstrator as a relevant reference in regional marine governance and strengthen its potential contribution to the European Digital Ocean landscape.

Suggested approach:	Awareness Raising Actions
	<u>Funding to consider:</u> Horizon Europe, EU DTO-related calls, Interreg NEXT Black Sea Basin, National research programmes

Geographic scope:	Regional, European Union, International	Timeframe:	Continuous action
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Required actors

Research/ Academia	Regional Organisations	EU Policymakers	Other
METU, CNR, DTU, SU, HCMR, IO-BAS, IBER-BAS, NIMRD, GEOECOMAR TSU, UkrSCES, AUEB	BSEC, CPMR Balkan and Black Sea Commission	DG RTD, DG MARE, DG ENV, DG ENEST	Mercator Ocean International
MCB, ICBSS, EMB			

Contribution to BS-SRIA

Pillar 3 – Goal 1

- Raise awareness, enhance uptake, and facilitate cross-border knowledge exchange around integrated marine observation and decision-support tools

Policy relevance

Marine Strategy Framework Directive (MSFD); Maritime Spatial Planning Directive (MSP); Nature Restoration Regulation (NRR); Mission “Restore our Ocean and Waters” – Black Sea Lighthouse; European Digital Twin Ocean (EU DTO); Common Maritime Agenda for the Black Sea (CMA); 2025 EU Joint Communication on the Strategic Approach to the Black Sea.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action E.5: Promote early engagement of potential (policy) users to provide feedback and support the development of the Black Sea Digital Twin (BS-DTO) demonstrator

Objective: Support the development, refinement, and policy-relevance of the BS-DTO by engaging target users during the early operational phase, ensuring responsive technical evolution of the system.

Relevant KOs	1.3	Other related KOs	
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Description

Building on living lab approaches already tailored and tested under BRIDGE-BS, this action proposes early engagement with potential users of the BS-DTO demonstrator, combining access to the demonstrator with structured feedback gathering, ensuring that further developments remain aligned with governance needs and operational realities.

Proposed activities include:

- Defining and prioritising end-user groups, followed by targeted outreach to ensure their active participation;
- Organising live demonstrations, guided testing sessions and co-generation of scenarios with policymakers, researchers and sectoral stakeholders;
- Delivering training sessions to equip different end-user groups with the skills to effectively interpret the BS-DTO demonstrator potential;
- Collecting feedback through surveys, interviews, and consultative dialogues;
- Using results to guide technical refinement, improve usability and prioritise specific functionalities.

This approach will strengthen trust, usability, and policy relevance of the BS-DTO demonstrator, resulting in a tool that reflects the governance challenges and knowledge needs of its intended users.

Suggested approach:	Awareness Raising Actions. Training programmes
	<i>Funding to consider:</i> Horizon Europe, EU DTO-related calls, Interreg NEXT Black Sea Basin, National research programmes

Geographic scope:	Regional	Timeframe:	2028-2030
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Required actors

Research/ Academia METU, AUEB, IO-BAS, TSU, IBER-BAS, NIMRD, GEOECOMAR, UkrSCES	Regional Organisations Black Sea Commission Common Maritime Agenda National Hubs	National Policymakers Ministries/ Agencies in charge of the design and implementation of marine policies and strategies Operational Network of Funders
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Contribution to BS-SRIA

Pillar 4 – Goal 3

- Embed user feedback in early operational stages to ensure alignment with governance needs
- Improve the relevance, usability, and endorsement of digital tools for integrated, science-based decision-making.

Policy relevance

Marine Strategy Framework Directive (MSFD); Maritime Spatial Planning Directive (MSP); Nature Restoration Regulation (NRR); Mission “Restore our Ocean and Waters” – Black Sea Lighthouse; European Digital Twin Ocean (EU DTO); Common Maritime Agenda for the Black Sea (CMA); 2025 EU Joint Communication on the Strategic Approach to the Black Sea.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action E.6: Define a portfolio of potential environmental services based on BRIDGE-BS data and tools for potential delivery through the Black Sea Digital Twin (BS-DTO) demonstrator

Objective: Translate the knowledge base generated by BRIDGE-BS into a structured portfolio of potential services to support marine environmental and blue economy policies in the Black Sea, taking into account the identified end-user groups ([action E.5](#)).

Relevant KOs	1.3	Other related KOs	2.1-2.4, 3.1, 4.1-4.3, 5.1-5.5
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Description

Developing a clear **portfolio of possible environmental services** will help to connect BRIDGE-BS data, models and tools to practical policy and management needs. This portfolio should outline a range of potential products and early-warning services that could be delivered through the BS-DTO demonstrator, tailored to specific governance, monitoring, or sectoral contexts (e.g. TRIX-based eutrophication maps¹⁴, hypoxia-depth profiles, SST/pH anomaly detection, early-warning tools for harmful algal blooms).

The focus should be on describing each potential service in detail to enable informed planning, prioritisation and uptake by national or regional authorities, including:

- Brief functional description;
- Data requirements and expected update frequency;
- Technical and human resource needs for delivery;
- Estimated operational and maintenance costs;
- Potential policy and management applications (e.g. MSFD reporting, adaptive management, risk prevention, NRR implementation).

User-specific entry points to the BS-DTO demonstrator should also be defined, to meet the needs of policymakers, monitoring agencies and blue economy sectors.

To ensure the relevance and effectiveness of the proposed services, it is recommended to adopt a co-creation approach, building on the experience and methodologies implemented in BRIDGE-BS through the living labs to engage the relevant stakeholders in shaping the service portfolio.

The portfolio would serve as a strategic planning and dialogue tool to support the identification of services with high policy relevance and realistic implementation potential, and to inform future investment and coordination efforts for their implementation.

Suggested approach:	Coordination and support action. Bi-/ Multilateral interaction with specific actors
	<u>Funding to consider:</u> Horizon Europe, EU DTO-related calls, Interreg NEXT Black Sea Basin, National research programmes

Geographic scope:	Regional, National	Timeframe:	2027-2030
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Required actors

Research/ Academia	Regional Organisations	National Policymakers	Other
METU, CNR, SU, DTU, HCMR, IO-BAS, TSU, IBER-BAS, NIMRD, GEOECOMAR, UkrSCES	BSEC Working Group on Environmental Protection	Ministries/ Agencies in charge of the design and implementation of marine policies and strategies	Mercator Ocean International
EU JRC	Black Sea Commission	Operational Network of Funders	
DELTARES	Common Maritime Agenda National Hubs		

¹⁴ The composite trophic status index (TRIX) provides useful metrics for the assessment of the trophic status of coastal waters. It was originally developed for Italian coastal waters and then applied in many European seas (Adriatic, Tyrrhenian, Baltic, Black and Northern seas) (Pettine M. et al. 2007)



Contribution to BS-SRIA

Pillar 3- Goal 1

- Support the transition from research to operational service design by identifying scalable, policy-relevant applications of environmental data
- Contribute to regional discussions on monitoring system development, early warning capability, and risk-informed decision-making

Policy relevance

Marine Strategy Framework Directive (MSFD); Maritime Spatial Planning Directive (MSP); Nature Restoration Regulation (NRR); Mission “Restore our Ocean and Waters” – Black Sea Lighthouse; European Digital Twin Ocean (EU DTO); Common Maritime Agenda for the Black Sea (CMA); 2025 EU Joint Communication on the Strategic Approach to the Black Sea.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action E.7: Establish long-term management and funding pathways for the potential Black Sea Digital Twin (BS-DTO) demonstrator

Objective: Ensure the continued development, operationalisation, and strategic relevance of the BS-DTO demonstrator through sustainable governance, management, and funding mechanisms.

Relevant KOs	1.3	Other related KOs	1.2
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Description

To position the BS-DTO demonstrator as a potentially sustainable digital infrastructure, clear governance, management, and funding mechanisms should be established to support its technical evolution and long-term service provision.

Proposed steps include:

- Identifying candidate institutions and coordination models for platform maintenance and development
- Exploring project opportunities under Horizon Europe, EU DTO, Interreg NEXT Black Sea and national research programmes to sustain technical progress and interface design
- Engaging with national Horizon Europe contact points and funding agencies to promote BS-DTO priorities in EU work programmes, while liaising with regional and EU-level actors that can provide strategic support to this effort
- Monitoring the EU Ocean Pact implementation and positioning the BS-DTO demonstrator as a key regional contribution.

Suggested approach:	Bi-/ Multilateral engagement with specific actors. Coordination and support action
	<i>Funding to consider:</i> Horizon Europe, EU DTO-related calls, Interreg NEXT Black Sea Basin, National research programmes

Geographic scope:	Regional, European Union	Timeframe:	2028-2030
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Required actors

Research/ Academia	Regional Organisations	National Policymakers	EU Policymakers
METU, ICBSS, EMB, IO-BAS, TSU, IBER-BAS, NIMRD, GEOECOMAR, UkrSCES EU JRC	BSEC, CPRM Balkan and Black Sea Commission Black Sea Commission Common Maritime Agenda National Hubs Interreg NEXT Black Sea Managing Authority/ Joint Secretariat	Ministries/ Agencies in charge of national research programmes Operational Network of Funders Horizon Europe national contact points	DG RTD, DG MARE, DG ENV, DG ENEST

Contribution to BS-SRIA

Pillar 3- Goal 1

- Ensure that smart monitoring tools developed under BRIDGE-BS can continue evolving beyond project timeline, maintaining their relevance, usability, and accessibility for marine policy and decision-making

Policy relevance

Marine Strategy Framework Directive (MSFD); Maritime Spatial Planning Directive (MSP); Nature Restoration Regulation (NRR); Mission “Restore our Ocean and Waters” – Black Sea Lighthouse; European Digital Twin Ocean (EU DTO); Common Maritime Agenda for the Black Sea (CMA); 2025 EU Joint Communication on the Strategic Approach to the Black Sea.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

F) Blue economy potential in the Black Sea region

Action F.1: Consolidate and expand the Black Sea Blue Economy Observatory for the Black Sea (BS-BEO) by addressing data gaps and promoting harmonisation in socio-economic monitoring

Objective: Complete the initial setup of the BS-BEO by filling core data gaps, improving coverage and comparability, and promoting coordination among national monitoring efforts.

Relevant KOs	1.5	Other related KOs	
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Description

BRIDGE-BS has delivered an initial version of the Black Sea Blue Economy Observatory (BS-BEO), an online platform designed to visualize and provide access to a harmonised set of national socio-economic data and information related to blue economy sectors in the region as well as blue scenarios and pathways providing insight and guidance of future potential development. Since the relevance of this tool strongly depends on its ability to deliver complete, accurate, standardised, and up-to-date information, the immediate priority is to secure access to the core datasets required for its effective functioning and relevance to the community.

Proposed activities include:

- Agreeing on basic procedures with national contact points for regular data submission to keep the BS-BEO updated and relevant;
- Securing future availability and open access to necessary datasets through engagement with relevant authorities;
- Promoting a regional dialogue on harmonised indicators and metrics through regional workshops and interaction with the national statistical institutes or agencies;
- Liaising with other regional platforms (e.g. BSEC Virtual Knowledge Centre) to improve its visibility.

Suggested approach:	Bi-/ Multilateral engagement with specific actors. Coordination and support action
	<i>Funding to consider:</i> Interreg NEXT Black Sea Basin, Sustainable Blue Economy Partnership – SBEP, National funding programmes

Geographic scope:	Regional	Timeframe:	2025-2026
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Required actors

Research/ Academia AUEB, ICBSS, other interested national BRIDGE-BS partners	Regional Organisations BSEC Working Group on Statistical Data & Economic Information	National Policymakers National statistical institutes/ agencies Relevant ministries and agencies responsible for blue economy strategies and sectoral policies
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Contribution to BS-SRIA

Pillar 3 – Goal 1

- Strengthen regional capacity to collect, analyse, and use socio-economic data in support of marine and coastal policy
- Contribute to improved alignment between knowledge systems and decision-making processes

Policy relevance

EU Ocean Pact; Sustainable Blue Economy; Common Maritime Agenda for the Black Sea (CMA); 2025 EU Joint Communication on the Strategic Approach to the Black Sea.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action F.2: Unlock the biotechnology value of marine genetic resources in the Black Sea

Objective: Promote the transition of marine biotechnology research outputs into practical applications for further research, industrial development, and environmental policy

Relevant KOs	5.4	Other related KOs	1.2, 5.2, 5.3, 7.1, 7.2, 7.3.
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Description

BRIDGE-BS has generated a metagenomic dataset with high potential for reuse across environmental, industrial, and policy domains. The identification of a novel catalase enzyme offers a proof of concept for the region's biotech potential, but broader valorisation of the dataset is still pending.

To capitalise on this potential, efforts should focus on:

- Launch follow-up research to validate the industrial potential of the catalase enzyme and other promising biomolecules, including testing enzymatic performance and identifying use cases such as bioremediation, green chemistry, or industrial processing.
- Enable broader access to and reuse of the BRIDGE-BS metagenomic dataset by making them available in the BRIDGE-BS database, and facilitating collaboration with external research institutions, biotech companies, and innovation networks.
- Stimulate entrepreneurship and public-private partnerships by engaging innovation agencies, incubators, and investors, leveraging biotech demonstrators and regional innovation events to highlight commercial opportunities (linked to [actions F.3 and F.4](#) below). Any commercial exploitation of these results must consider the Nagoya Protocol requirements and be carried out in compliance with the European and national Access and Benefit-Sharing (ABS) regulations.

Intellectual property rights (IPR) considerations should be integrated into all stages of use and collaboration, ensuring that ownership, usage rights, and potential benefits are clearly defined for any use of the data or resulting products.

Suggested approach:	(Applied) Research projects. Pilot projects. Awareness raising actions
	<u>Funding to consider:</u> Interreg NEXT Black Sea Basin, Sustainable Blue Economy Partnership – SBEP, National funding programmes

Geographic scope:	Regional, National	Timeframe:	2025-2028
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Required actors

Research/ Academia	Regional Organisations	National Policymakers
TUBITAK, METU, IO-BAS, BSEC, SML, DTU, GEOECOMAR	Common Maritime Agenda National Hubs	National innovation/ development agencies Operational Network of Funders

Contribution to BS-SRIA

Pillar 2

- Promote innovation in emerging blue economy sectors.
- Foster science-industry collaboration, stimulate bio-based innovation, and enable new market opportunities aligned with environmental and sustainability goals

Policy relevance

Sustainable Blue Economy, EU Ocean Pact, EU Bioeconomy Strategy, EU Mission: Restore our Ocean and Waters, Nagoya Protocol and ABS regulation, Common Maritime Agenda for the Black Sea (CMA); 2025 EU Joint Communication on the Strategic Approach to the Black Sea



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action F.3: Strengthen the Black Sea blue innovation ecosystem

Objective: Foster the development of a robust regional innovation system by addressing common challenges for blue economy innovators

Relevant KOs	7.1, 7.2	Other related KOs	7.3
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Description

BRIDGE-BS has engaged with innovation agencies from the region. This dialogue should continue beyond the project through targeted activities that tackle the specific challenges faced by early-stage blue economy innovators in the region. These activities should also highlight the added value of coordinated support, contributing to the development of a robust innovation system.

Follow-up actions may include:

- Engaging with relevant actors (e.g. innovation and development agencies, sectoral clusters) to explore tailored funding and support opportunities for innovators. In this regard, contacts established with the national agencies and the [Blueing the Black Sea project](#) during the project later stage should be continued.
- Positioning the Black Sea Accelerator (BSA) as a strategic instrument to address common innovation barriers, such as limited access to seed funding, lack of tailored incubation support, and weak research-to-market links, by:
 - Securing formal support and recognition from key regional actors (e.g. CMA national hubs, BSEC, development agencies) by presenting the BSA as a shared regional asset;
 - Promoting the formal inclusion of the BSA in the respective national blue economy strategies.
 - Showcasing the potential of the BSA as coordination hub linking innovation and development agencies, innovators and sectoral clusters.

Suggested approach:	Bi-/Multilateral interactions with specific actors. Awareness raising actions
	<i>Funding to consider:</i> Blueing the Black Sea project, Black Sea Trade and Development Bank – BSTDB, European Institute for Innovation and Technology – EIT, Sustainable Blue Economy Partnership – SBEP, Interreg NEXT BSB, National innovation programmes

Geographic scope:	Regional, national-level application	Timeframe:	2025 onwards
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Required actors

Research/ Academia	Regional Organisations	National Policymakers	Other
ICBSS, SML, DTU, MCB	BSEC Common Maritime Agenda National Hubs	National and regional development agencies Operational Network of Funders	Black Sea Trade and Development Bank – BSTDB World Bank

Contribution to BS-SRIA*Pillar 2*

- Strengthen blue innovation ecosystems by promoting inclusive and targeted support mechanisms.
- Encourage the uptake of research-based business models through policy–industry dialogue and coordination platforms.

Policy relevance

Sustainable Blue Economy, EU Ocean Pact, EU Bioeconomy Strategy, EU Mission: Restore our Ocean and Waters, Common Maritime Agenda for the Black Sea (CMA); 2025 EU Joint Communication on the Strategic Approach to the Black Sea, National Blue Economy Strategies and Smart Specialisation Strategies (S3).



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action F.4: Consolidate the High-Tech Summit as a sustainable reference forum for Black Sea research and innovation

Objective: Establish a long-term framework to support the continuation of the High Tech Summit for the Black Sea and consolidate its role as a reference forum for regional innovation

Relevant KOs	7.3	Other related KOs	7.1, 7.2
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Description

The High-Tech Summit for the Black Sea (HTS4BS), initiated under BRIDGE-BS, has become a key forum for showcasing emerging technologies, fostering innovation, and connecting stakeholders from across the regional blue economy. To maintain this momentum and strengthen its position as a reference forum, the HTS4BS should be embedded within a permanent regional framework that provides continuity, secures stakeholder commitment, and actively links it with complementary initiatives.

Building on the experience of previous editions, the proposed approach includes:

- Identify and engage a suitable umbrella initiative (e.g. CMA, Operational Network of Funders) with the capacity to promote and coordinate future HTS4BS editions under a long-term view;
- Engage with relevant actors (e.g. BSEC, Mission lighthouses) to maximise visibility by organising the HTS4BS back-to-back with other major regional events, ensuring synergies and stakeholder participation;
- Set up an organising committee with a core group of BRIDGE-BS partners (SML, DTU, METU, ICBSS, CPMR, BSEC, MCB) to ensure continuity, representation, and operational leadership.
- Develop a multi-year vision for the HTS4BS, including frequency (e.g. biennial, with rotating host countries), thematic priorities, and target audiences, aligning with evolving regional and EU innovation agendas. Explore a mixed funding strategy leveraging public programmes and private sponsorship to secure financial sustainability in the long-term;
- Explore the creation of a “Black Sea research and innovation community” or “alliance” (inspired in models such as the All-Atlantic Ocean Research Alliance) to foster collaboration and investment beyond the event itself.

Suggested approach:	Bi-/Multilateral interaction with specific actors. Coordination and support action
	<i>Funding to consider:</i> Sustainable Blue Economy Partnership – SBEP, Interreg NEXT Black Sea Basin, National innovation programmes, Operational Network of Funders

Geographic scope:	Regional	Timeframe:	2025-2026
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Required actors

Research/ Academia	Regional Organisations	National Policymakers
ICBSS, METU, SML, DTU, MCB	BSEC, CPMR Balkan and Black Sea Commission Common Maritime Agenda national hubs	Potential national host organisations Operational Network of Funders

Contribution to BS-SRIA

Pillar 2

- Maintain dialogue and collaboration between science, policy, and industry in the region.
- Facilitate the uptake of innovative solutions
- Strengthen the visibility and integration of Black Sea innovators in European and global frameworks.

Policy relevance

Sustainable Blue Economy, EU Ocean Pact, EU Bioeconomy Strategy, EU Mission: Restore our Ocean and Waters, Common Maritime Agenda for the Black Sea (CMA); 2025 EU Joint Communication on the Strategic Approach to the Black Sea, National Blue Economy Strategies and Smart Specialisation Strategies (S3)



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

G) Promote capacity building, social engagement and participation

Action G.1: Promote the uptake of the BRIDGE-BS MOOC in regional capacity-building and policy processes

Objective: Strengthen awareness and skills on Black Sea ecosystems, sustainability challenges, and blue economy opportunities by integrating the BRIDGE-BS MOOC into ongoing training, education, and stakeholder engagement initiatives across the region.

Relevant KOs	9.1	Other related KOs	
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Description

The BRIDGE-BS Massive Open Online Course (MOOC) offers accessible, multidisciplinary learning on Black Sea environmental issues, science-policy interaction, and sustainable blue economy topics.

To maximise its impact and ensure long-term relevance, this action promotes the adoption of the MOOC into national and regional capacity-building initiatives, awareness campaigns and sectoral training materials by:

- Encouraging and facilitating integration of the MOOC as a preparatory or parallel module, or as a complementary resource in marine science, policy, and blue economy curricula, established training and education programmes, stakeholder workshops and policy dialogue initiatives to strengthen participants' baseline knowledge;
- Translating or subtitling the MOOC into Black Sea national languages to improve accessibility and maximise the audience;

Embedding the MOOC into structured learning environments will contribute to sustained knowledge transfer, foster a shared understanding of the Black Sea challenges and sustainability priorities, and enhance regional capacity to address key regional and EU marine policy frameworks.

Suggested approach:	Bi-/Multilateral interaction with specific actors. Awareness raising activities
	<i>Funding to consider:</i> Rather than seeking dedicated funding, the focus should be on identifying suitable opportunities within ongoing regional and EU initiatives to embed the proposed activities

Geographic scope:	Regional	Timeframe:	2026
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Required actors

Research/ Academia	Regional Organisations	Other
METU, EMSEA, INDIGO MED, TSU, IU, SNU, ICBSS, MCB	BSEC, CPMR Balkan and Black Sea Commission	ECOP Networks, such as the UN Ocean Decade's ECOP Programme
Black Sea Young Ambassadors	Common Maritime Agenda national hubs	Black Sea Literacy Network

Contribution to BS-SRIA

Pillar 4 – Goal 1

- Support stakeholder education and skills development through open, flexible learning
- Reinforce long-term capacity building and science-policy-society interaction around Black Sea sustainability

Policy relevance

EU4Ocean Coalition, EU Mission: Restore our Ocean and Waters, EU Ocean Pact, Common Maritime Agenda for the Black Sea (CMA); 2025 EU Joint Communication on the Strategic Approach to the Black Sea



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action G.2: Consolidate the BRIDGE-BS Winter and Summer Schools as permanent capacity building and networking initiatives

Objective: Promote the continuation of the Black Sea Summer and Winter Schools as sustained initiatives for capacity building, networking, and science-policy interaction for early-career ocean practitioners (ECOPs) and young policy professionals in the region

Relevant KOs	9.2, 8.2	Other related KOs	
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Description

BRIDGE-BS has successfully developed two complementary training formats: the Summer School, providing interdisciplinary training on ecosystem services, blue economy and sustainability challenges in the Black Sea, and the Winter School, focused on enhancing science-policy dialogue and interaction. Both formats have proven effective in strengthening skills, fostering regional networks, and connecting participants with science-policy processes.

Consolidation beyond the project can be achieved by embedding both initiatives within an appropriate regional framework that maintains coordination and secures the necessary funding for future editions. This should include:

- Identifying a suitable host framework (e.g. BSEC, CMA capacity building pillar) to secure continuity, visibility and alignment with regional priorities;
- Adapting coordination procedures, potentially linked to the panel of directors proposed under [action C.6](#) above, to support the partnership and the integration into broader initiatives;
- Aligning content with policy-relevant topics and emerging regional priorities, relying on BRIDGE-BS outputs and partners' expertise;
- Exploring mobility and training schemes (e.g. Marie Skłodowska-Curie programme, Erasmus+) to support regional learning exchanges. This could be linked with [action G.4](#) (below).

Embedding the Summer and Winter Schools within a broader regional cooperation framework will reinforce their long-term relevance, broaden participation, and enhance youth engagement across the Black Sea.

Suggested approach:	Bi-/Multilateral interaction with specific actors. Training programmes
	<i>Funding to consider:</i> Marie Skłodowska-Curie programme, Erasmus+, Institutional funds from the participating organisations. Where available, national mobility and training programmes

Geographic scope:	Regional, national-level applications	Timeframe:	2026 on
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Required actors

Research/ Academia	Regional Organisations	National Policymakers
University of Istanbul, METU, ICBSS, MCB, IO-BAS, IBER-BAS, GEOECOMAR, TSU, Sinop University, UkrSCES	BSEC, CPRM Balkan and Black Sea Commission	Ministries/ Agencies of Science/ Research and Education

Contribution to BS-SRIA

Pillar 4 – Goal 1

- Promote long-term regional initiatives for education and training in marine governance and the blue economy
- Foster science-policy interaction through youth-focused and interdisciplinary training programmes

Policy relevance

EU4Ocean Coalition, EU Mission: Restore our Ocean and Waters, EU Ocean Pact, Common Maritime Agenda for the Black Sea (CMA); 2025 EU Joint Communication on the Strategic Approach to the Black Sea



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action G.3: Promote participatory approaches in coastal and marine governance

Objective: Promote the use of participatory approaches by national and local authorities to enable more inclusive, transparent, and effective governance processes.

Relevant KOs	6.2	Other related KOs	
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Description

BRIDGE-BS offers a full set of methodologies tested and adapted to the Black Sea's specific characteristics, governance needs, and stakeholder context. Promoting participatory approaches in coastal and marine governance requires not only having practical tools available but also implementing effective ways to reach the users who can actually apply them, which can be achieved through:

- Translating guidelines and other support materials (e.g. templates, forms) into Black Sea national languages to improve accessibility and uptake;
- Disseminating methodologies, guidelines, and practical tools through established networks (CMA, BSEC, CPMR, ICBSS) to reach both national and local levels;
- Embedding these methodologies into ongoing and new regional and national projects addressing ecosystem services, multi-stressor management, MSP, blue economy, etc. (e.g. through foreseen workshops);
- Identifying local governance initiatives where these approaches could be promoted and implemented.

Specific pilot applications can provide real-life examples to demonstrate the added value of participatory approaches and facilitate a broader adoption across the region.

Suggested approach:	Awareness raising and targeted dissemination actions. Bi-/Multilateral interaction with specific actors
	<u>Funding to consider:</u> Interreg NEXT Black Sea Basin, National research programmes. Embedding within ongoing and new regional and national projects

Geographic scope:	Regional, national to local level application	Timeframe:	2025-2027
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Required actors

Research/ Academia AUEB, GEOECOMAR, ICBSS Pilot Site leaders,	Regional Organisations BSEC, CPMR Balkan and Black Sea Commission Common Maritime Agenda national hubs	National Policymakers Local authorities
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Contribution to BS-SRIA

Pillar 4 – Goal 3

- Support co-creation, transparency, and long-term stakeholder engagement in policy development and implementation processes

Policy relevance

Sustainable Blue Economy, EU Ocean Pact, EU Bioeconomy Strategy, EU Mission: Restore our Ocean and Waters, Common Maritime Agenda for the Black Sea (CMA); 2025 EU Joint Communication on the Strategic Approach to the Black Sea, National Blue Economy Strategies and Smart Specialisation Strategies (S3)



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action G.4: Consolidate the Black Sea Young Ambassadors programme as a regional framework for sustained youth engagement in Black Sea science, policy, and the blue economy.

Objective: Provide a sustained framework for youth participation, visibility and career development opportunities in the Black Sea.

Relevant KOs	9.3	Other related KOs	9.2, 8.2, 9.4
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Description

The Black Sea Young Ambassadors (BSYA) programme, launched under the Black Sea CONNECT project and continued by BRIDGE-BS, has demonstrated the value of structured youth engagement in the region, providing visibility to early-career professionals, fostering peer networks, and creating entry points into science, policy, and blue economy discussions.

The key challenge ahead is to secure the long-term continuity of the initiative by ensuring it can operate independently of short-term, project-based funding opportunities. To address this, the following measures can be considered:

- Embedding youth participation under the Common Maritime Agenda (CMA) by proposing a dedicated technical group on youth. This could be coordinated through CMA national hubs via a joint concept note to be presented at the CMA Stakeholders Conference;
- Securing mobility support through specific funding instruments to ensure youth participation across the region and beyond;
- Strengthening connections with other ECOP networks (e.g. UN ECOP Network Programme, EMB ECOP Network, Youth4Ocean) to promote exchange, joint actions, and visibility;
- Facilitating BSYAs' participation in expert-led working groups (e.g. CMA technical groups, BSEC initiatives, GFCM Black Sea Working Group, regional MSP groups), supported by mentoring from national experts when possible;
- Linking with the Summer and Winter Schools ([Action G.2](#)) to provide continuity and coherence between training, youth engagement, and career opportunities;

Suggested approach:	Interdisciplinary networks. Dedicated project (Erasmus+ or similar) for the consolidation of the network
	<i>Funding to consider:</i> Marie Skłodowska-Curie programme, Erasmus+, Common Maritime Agenda. Institutional funds from the participating organisations. Where available, national mobility and training programmes

Geographic scope:	Regional	Timeframe:	2026-2028
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Required actors

Research/ Academia	Regional Organisations	National Policymakers	EU Policymakers
METU, EMB, ICBSS, MCB, EMSEA, IO-BAS, IBER-BAS, GEOECOMAR, NIMRD, TSU, UkrSCES	BSEC, CPMR Balkan and Black Sea Commission Common Maritime Agenda national hubs	Ministries of Education	DG REGIO – Youth Unit

Contribution to BS-SRIA

Pillar 4 – Goal 2

- Promote structured youth participation in regional cooperation, enhancing visibility, mobility, and career opportunities for young professionals in Black Sea science, policy, and the blue economy
- Strengthen intergenerational dialogue and links between training, youth engagement, and science-policy processes



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Policy relevance

EU4Ocean Coalition, EU Mission: Restore our Ocean and Waters, EU Ocean Pact, Common Maritime Agenda for the Black Sea (CMA); 2025 EU Joint Communication on the Strategic Approach to the Black Sea



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action G.5: Ensure the continuity and expand the outreach of the Black Sea Literacy Network

Objective: Ensure the long-term operation of the Black Sea Literacy Stakeholder Network as a platform for coordination, resource sharing, and engagement on ocean literacy across the region

Relevant KOs	9.4	Other related KOs	9.3
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Description

The Black Sea Literacy Network (BSLN), established under BRIDGE-BS, has proven effective in connecting educators, NGOs, researchers, youth organisations, and public institutions around ocean literacy and citizen engagement. Ensuring its sustainability requires both maintaining its existing functions and expanding its reach to new audiences and initiatives by:

- Maintaining and expanding the BSLN and its resource repository, hosted by EMSEA within a dedicated Black Sea domain. Activities will include co-development of outreach materials, coordination of joint events, and thematic contributions from BRIDGE-BS partners and future initiatives.
- Expanding the role of the network to mainstream ocean literacy in formal and informal education, through partnerships with ministries of education, science centres, museums, and youth programmes. The BSLN shall provide resources, facilitate collaboration, and promote behavioural change through regional awareness.

To keep the BSLN active and growing, EMSEA will continue engaging with the network through regular webinars, sharing new materials, and connecting members to the wider ocean literacy community. The BSLN will be regularly invited at EMSEA's annual conferences, where BSLN members can exchange ideas and showcase their work. EMSEA will also explore opportunities for joint grant applications to support collaboration and ensure the long-term sustainability of the network.

These efforts will contribute to consolidate the BSLN as a long-term structure supporting education, citizen engagement, and shared ocean stewardship in the Black Sea.

Suggested approach:	Interdisciplinary networks
	<i>Funding to consider:</i> regular activities involving the BSLN will be covered by EMSEA

Geographic scope:	Regional	Timeframe:	Continuous action
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Required actors

Research/ Academia	National Policymakers	Other
EMSEA, Indigo Med, METU, TUDAV, GEOCOMAR, TSU, IO-BAS, NIMRD	National ministers of environment and education	Other youth organisations
Science institutions		Museums
Networks of educators		Environmental NGOs
Black Sea Young Ambassadors		

Contribution to BS-SRIA*Pillar 4 – Goal 2*

- Reinforce access to educational resources and mainstream ocean literacy into formal and informal education
- Promote collaboration among practitioners and engagement of youth and citizens across the Black Sea
- Support public awareness of marine sustainability challenges and shared responsibility for the ocean



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Policy relevance

EU4Ocean Coalition, EU Mission: Restore our Ocean and Waters, EU Ocean Pact, Sustainable Blue Economy Strategy, European Blue Schools Initiative, Common Maritime Agenda for the Black Sea (CMA); 2025 EU Joint Communication on the Strategic Approach to the Black Sea



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

H) Enhance science-based policymaking in the Black Sea region

Action H.1: Translate climate modelling results into policy-relevant knowledge for the Black Sea

Objective: Facilitate the usability and uptake of complex climate modelling outputs by establishing a sustained interface between scientific and policy communities in the Black Sea region

Relevant KOs	2.1	Other related KOs	8.2
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Description

BRIDGE-BS modelling results on climate and multi-stressors interactions provide relevant knowledge on future risks and vulnerabilities in the Black Sea region. To ensure this information is translated into accessible, policy-actionable knowledge, it is recommended the establishment of a Black Sea Regional Climate Expert Group, bringing together expertise in climate modelling, ecosystem assessment, and science-policy engagement, alongside invited experts from regional governance bodies such as the Black Sea Commission and national ministries.

This group would work on:

- Translating modelling outputs into policy-relevant recommendations, aligned with regional and national policy cycles;
- Producing periodic science-based synthesis reports on Black Sea climate risks, vulnerabilities and response pathways, taking the Intergovernmental Panel on Climate Change (IPCC) reports as a reference;
- Facilitating dialogue between scientists and policymakers to ensure the provided knowledge is relevant and usable.

To achieve this, the group should build on the experience gained from BRIDGE-BS on enhanced science-policy dialogue. Liaising with BSEC is also strongly recommended, in connection with its initiative to promote a *Regional Data and Information Hub on Climate Change*, aimed at consolidating projections, expected impacts, detected vulnerabilities and adaptation strategies for the black sea. Connections should also be explored with the forthcoming *Implementation Platform for the EU Mission on Adaptation to Climate Change*, to be launched under a CINEA-funded service contract, which will provide additional channels to link regional knowledge with European adaptation efforts. Exploring recognition within other regional cooperation frameworks, such as BSC and the CMA, will contribute to continuity and policy relevance.

In the longer term, this work could also contribute to global assessment initiatives, by providing IPCC with regional-specific input from the Black Sea.

Suggested approach:	Bi-/Multilateral interaction with specific actors. Interdisciplinary networks
	<u>Funding to consider:</u> COST Actions, European Climate, Infrastructure and Environment Executive Agency (CINEA), Interreg NEXT Black Sea Basin, National research programmes. Embedding within new regional and national projects

Geographic scope:	Regional	Timeframe:	2025-on
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Required actors

Research/ Academia	Regional Organisations	National Policymakers	EU Policymakers
METU, ULiege, IBER-BAS, HCMR, CNR, DTU, ICBSS	BSEC Black Sea Commission, Common Maritime Agenda national hubs	National ministries/ agencies responsible for climate policies Operational Network of Funders	DG CLIMA



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Contribution to BS-SRIA*Pillar 4 – Goal 3*

- Facilitate the application of complex modelling outputs in policy and decision-making contexts
- Enable continuous science–policy exchange, enhance adaptive capacity, and support ecosystem-based responses to climate risks

Policy relevance

EU Mission: Restore our Ocean and Waters, EU Ocean Pact, EU Mission: Adaptation to Climate Change, EU Climate Adaptation Strategy, Marine Strategy Framework Directive (MSFD), Common Maritime Agenda for the Black Sea (CMA), 2025 EU Joint Communication on the Strategic Approach to the Black Sea, national climate adaptation strategies



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action H.2: Streamline environmental status updates for the Black Sea

Objective: Support more responsive environmental governance by ensuring that policy makers have timely access to clear and actionable information on the state of the Black Sea

Relevant KOs	5.1	Other related KOs	3.1, 1.2, 1.3
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Description

Periodic science-based assessment reports are essential to track the environmental status of the Black Sea and inform governance and decision-making processes. While the BSC has the formal mandate for such reporting, its capacity to deliver comprehensive and publicly accessible reports has been constrained in the recent years.

Building on BRIDGE-BS results and the collaboration network established among the project partners, periodic Black Sea environmental status briefs could provide synthetic updates focused on key parameters and indicators of policy relevance (e.g. dissolved oxygen, SST, pH, eDNA, TRIX). Designed as concise communication products, these briefs would offer timely, actionable knowledge to decision makers, complementing longer reporting cycles such as the BSC Status of the Ecosystem reports, and improving the usability of monitoring data.

To maximise their impact, these briefs should be:

- Produced in collaboration with relevant regional actors, ensuring alignment with existing monitoring initiatives, coherence with EU reporting requirements (e.g. MSFD) and compatibility with the BSC mandate;
- Based on data generated by BRIDGE-BS and follow-up projects, as well as other regional monitoring initiatives;
- Disseminated through established platforms (e.g. BSC, CMA, BSEC) to reach both regional and national policy levels and ensure policy uptake;

In the longer term, this approach could help to reactivate and reinforce structured BSC reporting, should regional conditions allow, while filling current gaps in the availability of science-based knowledge for governance.

Suggested approach:	Interdisciplinary networks. Awareness raising actions
	<i>Funding to consider:</i> National Environment Ministries, Instrument for Pre-Accession calls with Ministries as the final beneficiary

Geographic scope:	Regional, national level application	Timeframe:	2026-on
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Required actors

Research/ Academia	Regional Organisations	National Policymakers
METU, IO-BAS, TUBITAK MAM, IBER-BAS, NIMRD, GEOECOMAR, TSU, UkrSCES	Black Sea Commission BSEC Working group on environmental protection	National environment and research ministries Environmental monitoring agencies and MSFD national authorities Operational Network of Funders

Contribution to BS-SRIA

Pillar 4 – Goal 3

- Support the translation of scientific outputs into policy-relevant formats, enhancing the uptake of ecosystem indicators in environmental governance
- Contribute to the alignment of research, monitoring, and reporting practices across countries and institutions



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Policy relevance

Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD), EU Biodiversity Strategy, Nature Restoration Regulation, EU DTO, Common Maritime Agenda, 2025 EU Joint Communication on the Strategic Approach to the Black Sea; Bucharest Convention and Black Sea Integrated Monitoring and Assessment Programme (BSIMAP); National marine monitoring and data strategies



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action H.3: Support the development of National Nature Restoration Plans under the EU Nature Restoration Regulation in Romania and Bulgaria

Objective: Facilitate the use of BRIDGE-BS outputs to improve the knowledge base for setting priorities and targets under the Nature Restoration Regulation (NRR) in Bulgaria and Romania and showcase their potential to support alignment with EU restoration objectives in other Black Sea countries.

Relevant KOs	3.1	Other related KOs	5.1, 1.2, 1.3
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Description

Work in the Western Black Sea (PS2, Bulgaria) produced a set of spatially explicit analyses and indicators that are directly relevant for identifying restoration priorities. These outputs, covering ecosystem condition, stressor impacts, and ecosystem service hotspots, provide a solid evidence base for site selection and prioritisation under the NRR.

Effective uptake requires targeted engagement with national authorities drafting and coordinating NRRs. This can be achieved through technical briefings, joint working sessions, and tailored guidance materials to illustrate how BRIDGE-BS results can inform restoration planning and target setting.

While the initial focus is on Bulgaria, where BRIDGE-BS delivered the most comprehensive set of spatial data and analyses, the same approach can be extended to Romania to address knowledge gaps and promote methodological consistency across both countries

At the wider regional level, these applications can serve as a practical example for other Black Sea countries (Ukraine, Georgia, Türkiye) to advance their commitment to align with the EU water and marine legislation, as reflected in the 2025 EU Joint Communication on the Strategic Approach to the Black Sea.

Suggested approach:	Bi /Multilateral interaction with specific actors
	<u>Funding to consider:</u> Service contracts with the competent national ministries (e.g. through tendering procedures) could provide the most suitable Funding to consider for this action

Geographic scope:	National (BG, RO), potential for regional uptake	Timeframe:	2025-2026 (aligned with NRR planning timeline)
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Required actors

Research/ Academia	Regional Organisations	National Policymakers
IBER-BAS, IO-BAS, NIMRD, GEOECOMAR, ICBSS	BSEC	Ministry of Environment and Water (BG), Ministry of Environment, Water and Forests (RO) Environmental agencies and ministries from GE, UA, TR Operational Network of Funders

Contribution to BS-SRIA

Pillar 4 – Goal 3

- Enable the practical application of BRIDGE-BS scientific results in a specific EU policy process.
- Enhance science-policy integration by incorporating scientific knowledge into decision-making processes for the development of National Nature Restoration Plans.

Policy relevance

Nature Restoration Regulation (NRR), and indirectly other environmental frameworks at EU and regional level

At national level, application of the NRR obligations in Bulgaria and Romania



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action H.4: Facilitate science-policy dialogue and cooperation

Objective: Ensure that research results are effectively integrated into policy decisions by equipping policymakers and scientists with practical skills for communication, cooperation and co-production of knowledge.

Relevant KOs	8.2	Other related KOs	
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Description

BRIDGE-BS experience in enhancing science–policy interaction has been consolidated into a manual that provides flexible guidance to strengthen users’ capacity to work with project knowledge outputs in support of science-based policymaking. Building on this resource, **joint training activities** can be a suitable approach to equip participants with the practical skills needed to overcome communication barriers, strengthen dialogue capacities, and create the conditions for continued cooperation, thus enhancing the application of scientific knowledge in policy and governance processes.

Interactive formats such as role-based exercises, scenario simulations, and case discussions that reflect real policy challenges can help participants explore different perspectives and decision pathways in realistic settings. The programme should engage both early-career and senior professionals from ministries, governmental agencies, universities and research centres, encouraging the exchange of experience and perspectives and fostering mutual learning.

To maximise impact, training should be embedded in existing initiatives such as CMA events or BSEC working group sessions or incorporated into future projects. Follow-up sessions and peer exchanges within these frameworks can help reinforce skills and ensure continuity of dialogue over time.

Together with **Action G.2**, this action strengthens science–policy dialogue by fostering practical and applied cooperation across the region.

Suggested approach:	Training programmes
	<i>Funding to consider:</i> Embedding within new regional and national projects

Geographic scope:	Regional	Timeframe:	2026-on
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Required actors

Research/ Academia	Regional Organisations	National Policymakers
ICBSS, MCB	BSEC, CPMR Balkan and Black Sea Commission Black Sea Commission Common Maritime Agenda national hubs	Ministries and agencies responsible for environment, fisheries, maritime affairs, research, economy, and education

Contribution to BS-SRIA

Pillar 4 – Goal 3

- Strengthen institutional and individual capacity for science-informed policymaking
- Reinforce science–policy interfaces in the region, enhancing trust, communication, and co-production of policy-relevant knowledge

Policy relevance

EU Ocean Pact, EU Mission “Restore our ocean and waters”, Common Maritime Agenda (CMA), 2025 EU Joint Communication on the Strategic Approach to the Black Sea



This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 101000240

Action H.5: Promote foresight approaches in support of strategic dialogue and planning

Objective: Enable exploration of alternative development pathways and trade-offs to improve long-term policy and decision-making

Relevant KOs	1.6	Other related KOs	8.2
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Description

BRIDGE-BS has developed a set of future imaginaries that offer a forward-looking perspective on possible development pathways for the Black Sea Blue Economy. These imaginaries, based on the European Environmental Agency (EEA) “Scenarios for a Sustainable Europe in 2050”, are shaped by different drivers such as environmental pressures, economic transitions, and policy choices, and provide a common frame for discussing uncertainties, trade-offs, and strategic options. Used in dialogue and planning processes, they can stimulate reflection on long-term challenges and opportunities, and support more resilient and evidence-informed decisions.

To encourage uptake, the imaginaries would benefit from being shared and discussed within existing regional dialogue frameworks (e.g. CMA, BSEC, CPMR), as well as in national policy forums. Translation into national languages and open access through relevant portals will further improve accessibility. A dedicated section in the Black Sea Blue Economy Observatory for the Black Sea (BEO-BS) will ensure long-term visibility.

The use of these imaginaries in workshops, foresight exercises, and co-creation processes, adapted where necessary to national contexts, can help to embed them in the policy dialogue, while feedback from these activities can help to refine the narratives.

Suggested approach:	Bi-/ Multilateral interaction with specific actors. Awareness raising activities. Training programmes
	<u>Funding to consider:</u> Embedding within new regional and national projects

Geographic scope:	Regional, national and local level application	Timeframe:	2025-2027
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Required actors

Research/ Academia ICBSS, SML, MCB	Regional Organisations BSEC, CPMR Balkan and Black Sea Commission Black Sea Commission Common Maritime Agenda national hubs	National Policymakers Ministries and agencies responsible for environment, fisheries, maritime affairs, research, economy, and education
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Contribution to BS-SRIA*Pillar 4 – Goal 3*

- Strengthen the science-policy-practice interface by ensuring that forward-looking recommendations are embedded in planning and decision-making cycles.
- Promote regional coherence by aligning implementation efforts across multiple countries through shared cooperation structures.

Policy relevance

EU Ocean Pact, EU Mission “Restore our ocean and waters”, Marine Spatial Planning (MSP) Directive, Integrated Coastal Zone Management (ICZM) strategies, Nature Restoration Regulation (NRR), Marine Strategy Framework Directive (MSFD), EU Sustainable Blue Economy Strategy, Common Maritime Agenda (CMA), 2025 EU Joint Communication on the Strategic Approach to the Black Sea, National Blue Economy strategies



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action H.6: Facilitate the implementation of transformative pathways in national and regional policy frameworks

Objective: Support the uptake and application of BRIDGE-BS transformative pathways by linking them to concrete implementation strategies at national and regional levels.

Relevant KOs	6.3, 4.4	Other related KOs	8.2
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Description

BRIDGE-BS developed transformative pathways and adaptive management recommendations that outline options for sustainable development of the Black Sea Blue Economy. To move from vision to practice, these outputs should be connected to ongoing planning processes and institutional frameworks, ensuring that proposed actions can be realistically taken forward.

Implementation can be facilitated by:

- Developing targeted briefs or technical notes that translate each pathway into concrete steps and identify the responsible authorities, timelines, and resource needs;
- Mapping the entry points in current policy cycles, including revision schedules (e.g. MSFD cycles, national MSP plans, NRR implementation), responsible authorities, and relevant discussion groups, to promote the integration of the proposed actions into existing strategies and action plans.
- Leveraging new project opportunities to support pilot implementation in selected sites or sectors (e.g. aquaculture, tourism, ports) and cross-sectoral integration, to demonstrate feasibility and scalability.
- Engaging with regional cooperation structures (CMA, BSEC, CPMR) to foster consistency throughout the region and mobilise support.

Dissemination and outreach remain important, but the central focus should be on aligning pathways with existing policy obligations and institutional mandates, creating clear entry points for implementation.

Suggested approach:	Bi-/ Multilateral interaction with specific actors. Awareness raising activities
	<u>Funding to consider:</u> Interreg NEXT Black Sea Basin, National funds. Embedding within new regional and national projects

Geographic scope:	Regional, tailored delivery at national level	Timeframe:	2025-2027
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Required actors

Research/ Academia AUEB, GEOECOMAR, ICBSS, MCB Pilot Site leaders	Regional Organisations BSEC, CPMR Balkan and Black Sea Commission Common Maritime Agenda national hubs	National Policymakers Ministries and agencies responsible for environment, fisheries, maritime affairs, research, economy, education
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Contribution to BS-SRIA

Pillar 4 – Goal 3

- Strengthen the link between participatory visions of stakeholders and formal policy by integrating locally co-designed pathways into national and regional planning processes.

Policy relevance

EU Ocean Pact, EU Mission “Restore our ocean and waters”, Marine Spatial Planning (MSP) Directive, Integrated Coastal Zone Management (ICZM) strategies, Nature Restoration Regulation (NRR), Marine Strategy Framework Directive (MSFD), EU Sustainable Blue Economy Strategy, Common Maritime Agenda (CMA), 2025 EU Joint Communication on the Strategic Approach to the Black Sea, National Blue Economy strategies



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Action H.7: Update and promote the Integrated Policy Review to inform national and regional Blue Economy strategies

Objective: Ensure the BRIDGE-BS Integrated Policy Review is updated, expanded to address remaining gaps, and effectively communicated to policymakers to support the alignment of national Blue Economy strategies.

Relevant KOs	8.1	Other related KOs	6.2, 7.2
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Description

The Integrated Policy Review produced under BRIDGE-BS (2023) established a baseline overview of national and regional frameworks across the Blue Economy, highlighting cross-sectoral priorities and existing gaps. While some of these gaps have been totally or partially addressed by the project, others remain and require further attention. Updating this review to identify progress achieved, persisting gaps and emerging needs will ensure it continues to serve as a reference point for national and regional policy dialogue.

To keep its value as a reference document, the review should be:

- Updated to integrate the progress achieved by BRIDGE-BS and other relevant initiatives recently developed in the region;
- Tailored to national contexts by preparing country-specific briefs that highlight specific priorities, challenges and opportunities for action (related to action H.6 above);
- Integrated into regional dialogue frameworks (e.g. CMA, BSEC, PABSEC, CPMR) to facilitate exchange and alignment across countries;
- Maintained as a living document with updates every 3-4 years to track progress, highlight persisting gaps and respond to emerging priorities.

Suggested approach:	Bi/ Multilateral interaction with specific actors – policy dialogue. Awareness raising activities
	<i>Funding to consider:</i> Interreg NEXT Black Sea Basin, European Climate, Infrastructure and Environment Executive Agency (CINEA), Sustainable Blue Economy Partnership (SBEP), National Funding Agencies and Ministries

Geographic scope:	Regional, national-level application	Timeframe:	2026-2027, with follow-up updates every 3–4 years
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Required actors

Research/ Academia	Regional Organisations	National Policymakers
ICBSS, SML, MCB	BSEC, CPMR Balkan and Black Sea Commission Parliamentary Assembly of the BSEC (PABSEC) Common Maritime Agenda national hubs Black Sea Commission	Ministries/ Agencies responsible for environment, fisheries, maritime affairs, research, economy, and education

Contribution to BS-SRIA

Pillar 4 – Goal 3

- Provide a shared policy reference document that supports structured dialogue between national and regional actors on Blue Economy strategies.
- Contribute to long-term alignment of national strategies with regional cooperation frameworks and EU objectives by maintaining the review as a regularly updated resource.

Policy relevance

EU Ocean Pact, EU Mission “Restore our ocean and waters”, Marine Spatial Planning (MSP) Directive, Integrated Coastal Zone Management (ICZM) strategies, Nature Restoration Regulation (NRR), Marine



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Strategy Framework Directive (MSFD), EU Sustainable Blue Economy Strategy, Common Maritime Agenda (CMA), 2025 EU Joint Communication on the Strategic Approach to the Black Sea, National Blue Economy strategies



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

Action H.8: Update research needs for a sustainable management of the Black Sea

Objective: Ensure that emerging research needs identified through BRIDGE-BS are consolidated, updated, and channelled into regional policy dialogue, funding agendas, and future BS-SRIA updates

Relevant KOs	8.3	Other related KOs	1.3, 2.1-2.4, 3.1-3.5, 4.1-4.3, 5.1-5.4, 7.1-7.3
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Description

BRIDGE-BS has identified a number of research needs for the Black Sea, as it is highlighted in the deliverables and reports produced by the project. While these topics are already visible, they need to be consolidated into a coherent set of priorities and linked with ongoing policy agendas and funding processes.

Further expert discussions at regional level could help review the existing findings, identify additional topics, and agree on a shared set of priorities. Particular attention may be given to new methodologies for assessing the effects of multiple stressors, and further development and exploitation of climate and ecosystem services modelling capacities.

By liaising with the Operational Network of Funders, the outcome of this process will directly inform and promote the update of the Black Sea Strategic Research and Innovation Agenda (BS-SRIA) for the Black Sea. This would facilitate recognition and endorsement of the regional research priorities at EU and regional levels, and their translation into future research calls and cooperation initiatives. Building on the progress achieved in BRIDGE-BS and other recent research results, the updated BS-SRIA will ensure coherence and help shape the long-term agenda for the sustainable management of the Black Sea.

Suggested approach:	Bi/ Multilateral interaction with specific actors – policy dialogue. Coordination and support action
	<u>Funding to consider:</u> Operational Network of Funders

Geographic scope:	Regional, national level engagement and EU/ international alignment	Timeframe:	2026-2027
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Required actors

Research/ Academia	Regional Organisations	National Policymakers	EU Policymakers
METU, IBER-BAS, IO-BAS, NIMRD, GEOECOMAR, UkrSCES, TSU, HCMR, CNR, ICBSS, MCB	BSEC, CPMR Balkan and Black Sea Commission Common Maritime Agenda national hubs Black Sea Commission Parliamentary Assembly of the BSEC (PABSEC)	Ministries/ Agencies responsible for environment, fisheries, maritime affairs, research, economy, and education Operational Network of Funders	DG RTD, DG MARE, DG ENV, DG ENEST

Contribution to BS-SRIA*Pillar 4 – Goal 3*

- Facilitate expert coordination to define future research needs and well-informed funding priorities
- Support alignment of future policy frameworks with emerging challenges and knowledge gaps

Policy relevance

This action facilitates that national, regional and EU marine research frameworks keep aligned with evolving research needs in the Black Sea.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

7. Conclusion

The 2030 Blue Roadmap for the Black Sea is intended as a practical reference for policy and decision-makers, the research community, and other interested stakeholders. Its main value lies in **guiding further action to capitalise on the results of BRIDGE-BS, while supporting policy implementation, shaping funding priorities, and encouraging stronger regional cooperation**. It provides a **common framework for designing future initiatives and identifying opportunities for alignment with wider agendas**.

Planning knowledge transfer always requires balancing scientific accuracy with accessibility for non-expert audiences. Maintaining dialogue with policy stakeholders throughout the process has contributed to shaping the message so that the scope of the knowledge generated, and its potential applications can be more easily understood, while preserving technical precision.

The development of the BRIDGE-BS roadmap faced a number of constraints that affected the level of detail achievable in the analysis of the project results and in the description of the proposed actions:

- As the analysis had to be carried out while the research was still ongoing, many results only became available at a late stage, leaving limited information for the analysis and making the process highly dependent on the active involvement of knowledge owners. Some outputs were still not at a stage that allowed them to be considered in detail.
- The number and diversity of results generated by the project, together with the uneven availability of knowledge owners to provide input, made it difficult to address all of them with sufficient detail during the analysis phase.
- The proposed actions provide a fairly complete picture of what needs to be done, though further detail is required before they can be put into practice. To this end, the discussions initiated during the road-mapping process should be carried forward, focusing on the specific topics that structure the proposed actions.

Ensuring that the Roadmap achieves its full potential impact will depend on how it is communicated. Beyond serving as a reference for BRIDGE-BS partners, it should be **disseminated through regional and European fora, with national administrations, and across stakeholder networks, where it can inform dialogue and decision-making**. A **key added value** of the Roadmap lies in **its potential contribution to strategic processes**, particularly the future revision of the Black Sea SRIA, where it can provide a concrete basis for discussion. Events such as the Common Maritime Agenda Stakeholders' Conference, Mission Ocean Lighthouse bootcamps, and the Macro-regional and Sea Basin Strategies Days can help increase visibility and impact by creating opportunities to discuss the actions with the actors capable of taking them forward.

The document is structured in a way that allows specific sections to be extracted and summarised as stand-alone materials for different audiences and policy frameworks, ensuring clear and concise communication of key messages. To facilitate the uptake by national authorities, it is strongly recommended to translate these communication materials into national Black Sea languages.

Making it accessible through digital platforms and linking it to ongoing initiatives is also strongly encouraged to support its uptake, keep the discussion alive and ensure that it remains a dynamic resource.



The Roadmap is therefore not an endpoint, but a foundation for continued dialogue, cooperation, and action in the Black Sea, providing a living framework that partners and stakeholders can build upon to ensure that the knowledge generated by BRIDGE-BS translates into lasting impact.



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GLOSSARY

BRIDGE-BS Partners' Acronyms

NO	CONSORTIUM MEMBERS	COUNTRY
1	METU - Middle East Technical University - Institute of Marine Sciences	TR
2	IO-BAS - Bulgarian Academy of Sciences Institute of Oceanology	BG
3	NIMRD - The National Institute for Marine Research and Development "Grigore Antipa"	RO
4	IBER-BAS - Institute of Biodiversity and Ecosystem Research - Bulgarian Academy of Sciences	BG
5	UkrSCES - Ukrainian scientific Centre of Ecology of Sea	UA
6	TSU - Ivane Javakhishvili Tbilisi State University	GE
7	GeoEcoMar - Institutul National de Cercetare Dezvoltare pentru Geologie si Geoecologie Marina	RO
8	ICBSS - International Center for Black Sea Studies	EL
9	HCMR - Hellenic Centre for Marine Research	EL
10	CNR - Consiglio Nazionale Delle Ricerche	IT
11	ULiege - University of Liège	BE
12	AUEB - Athens University of Economics and Business	EL
13	SU - Stockholm University - Stockholm Resilience Centre	SE
14	CETMAR - Centro Tecnológico del Mar, Fundación	ES
15	INDIGO MED	EL
16	IEEN - Institute of Electronic Engineering and Nanotechnologies	MD
17	DTU - Technical University of Denmark	DK
18	BSEC - Organization of the Black Sea Economic Cooperation	TR
19	SML - Stratégies Mer Et Littoral	FR
20	CPMR - Conference of Peripheral Maritime Regions	FR
21	TUBITAK - The Scientific and Technological Research Council of Turkey	TR
22	MCB - Marine Cluster Bulgaria	BG
23	TEPAV - The Economic Policy Research Foundation of Turkey	TR
24	SUMAE - Ministry of Agriculture and Forestry	TR
25	TUDAV - Turkish Marine Research Foundation	TR
26	IU - Istanbul University	TR
27	EMSEA - European Marine Science Educators Association	BE
28	SNU - Sinop University	TR
29	EMB - European Marine Board Ivzw	BE
30	IFREMER - Institut Français De Recherche pour l'Exploitation de la Mer	FR
31	CHX - Crowdhelix	IE



Other Relevant Acronyms

ACRONYM	TITLE
BSC	Black Sea Commission
Black Sea CONNECT	H2020 funded Coordination and Support Action: “Coordination of Marine and Maritime Research and Innovation in the Black Sea”
BSUN	Black Sea University Network
CMEMS	Copernicus Marine Environment Monitoring Service
Copernicus	The European Earth Observation Programme
DANUBIUS-RI	International Centre for Advanced Studies on River–Sea Systems
DOORS	H2020 funded Research and Innovation Action: “Developing Optimal and Open Research Support”
EC	European Commission
EMODNET	The European Marine Observation and Data Network
EMSEA	European Marine Science Educators Association
EMSO-ERIC	European Multidisciplinary Seafloor and Water Column Observatory - European Research Infrastructure Consortium
ESFRI	European Strategy Forum on Research Infrastructures
EU	European Union
EURO ARGO -ERIC RI	European contribution to the Argo programme
EUROFLEETS	New operational steps towards an alliance of European research fleets
EuroGOOS	European Global Ocean Observing System
FAO	Food and Agriculture Organization
GFCM	General Fisheries Commission for the Mediterranean
GOOS	Global Ocean Observing System
Hydralab	Network of environmental hydraulic institutes in Europe
ICES	International Council for the Exploration of the Sea
ICT	Information and Communication Technologies
ICZM	Integrated Coastal Zone Management
IMO	International Maritime Organization
IOC-UNESCO	Intergovernmental Oceanographic Commission of UNESCO
IODP	International Ocean Discovery Program
JERICO	Joint European Research Infrastructure network for Coastal Observatories
JPI	Joint Programming Initiatives
MEDCOAST	Mediterranean Coastal Foundation
MPA	Marine Protected Area
MSP	Maritime Spatial Planning
NGOs	Non-governmental Organizations
RCG Med&BS	Regional Coordination Group Mediterranean and Black Sea
SeaDataCloud	EU Funded Project - Further developing the pan-European infrastructure for marine and ocean data management
SeaDataNet	EU Funded Project - Pan-European infrastructure for ocean & marine data management
SMEs	Small and Medium-sized Enterprises
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme



Annex I: BRIDGE-BS Knowledge Outputs

8. Annex I: BRIDGE-BS Knowledge Outputs

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9. WP 1 – Knowledge base for the Black Sea

KO_1.1 Identification of information gaps and data readiness

This result provides a systematic assessment of the availability, accessibility, and suitability of data needed to analyse key marine stressors in the Black Sea. It involves the compilation of a detailed inventory of datasets from project partners, EU infrastructures (e.g. SeaDataNet, EMODnet, OBIS), and regional initiatives such as EMBLAS and ANEMONE, with a focus on identifying which datasets are available, to what extent they cover relevant spatial and temporal scales, and whether they were suitable to meet the specific needs of BRIDGE-BS project.

The analysis covered 244 parameters grouped under major stressors defined in the Black Sea SRIA — including warming, deoxygenation, acidification, eutrophication, overfishing, invasive species, and pollution. For each Pilot Site and at the basin-wide level, data were assessed in terms of their completeness, format, origin, accessibility, and consistency with modelling and analysis requirements.

The results show uneven levels of readiness: while data for parameters such as temperature, salinity, and nutrients are generally available and suitable, other types — including those linked to fisheries, litter, socio-economic drivers, or certain pollutants — are limited or fragmented. Some are only accessible through negotiation or held in national repositories with restricted access. The exercise highlighted significant gaps, especially for land- and sea-based activities and biological indicators and helped clarify which datasets require harmonisation or targeted updates to support further analysis.

Responsible partner: NIMRD

Reference project document(s):

D1.1 Report on assessment of data readiness at basin-scale and pilot-site scale

EXPECTED IMPACT

The assessment carried out under BRIDGE-BS enables a more informed and targeted approach to improving the consistency and practical use of data for marine environmental assessments. By identifying where relevant data sets are available, incomplete, or difficult to access, it helps guide future data mobilisation and monitoring efforts, especially regarding to obligations under the MSFD, WFD, and Bucharest Convention.

The readiness scoring also offers a practical tool for planning scientific work beyond BRIDGE-BS, allowing researchers and institutions to gauge where additional efforts — including negotiations for data access, integration of socio-economic information, or new observation campaigns — may be required. It provides a clearer picture of what existing datasets can support ecosystem modelling, scenario development, or cumulative effects assessments, and where limitations may constrain such work.

At the regional level, it helps to identify opportunities for strengthening alignment between national datasets and European data infrastructures, contributing to better integration and interoperability. These steps are essential for improving the consistency of environmental assessments and supporting joint planning across Black Sea countries.



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KO_1.2 Black Sea BRIDGE-BS Portal and Database

The **BRIDGE-BS Portal** is built as a **comprehensive web platform** developed to serve as a central hub for consolidating and making available essential knowledge about the Black Sea ecosystem for public use, providing access to historical and harmonized data and methods. Built on the foundation of the Black Sea Water Quality Database (developed under the EMBLAS project), the BRIDGE-BS Portal is structured to meet the region's specific needs and support long-term monitoring, research and management.

The BRIDGE-BS Portal integrates three core components: a publicly accessible website, an internal repository for project partners, and a **multidisciplinary environmental database**. The database is designed to store and manage physical, chemical, biological, and socio-economic data relevant to the Black Sea, structured according to FAIR principles and international standards, including ISO 19115, SeaDataNet protocols, and WoRMS identifiers for biological records. It accommodates a range of observation types—such as single measurements, profiles, time series, and underway data—ensuring flexibility in data input and use. The web interface supports tailored queries by parameter, location, time period, stressor type, or pilot site, and allows data to be exported in standard formats for further analysis. Access is managed through differentiated user roles: internal users can retrieve full datasets, while external users may access metadata, with plans for expanded openness in the future.

The system has been developed with a modular architecture to allow future expansion, including the integration of additional tools, data sources, and visualisation features. A Web-GIS application enables spatial queries and interactive mapping of observation metadata and is expected to evolve to include additional data layers. Integration with SeaDataNet is underway, ensuring alignment with established European infrastructures and enhancing cross-platform visibility. Regular updates and backups ensure platform stability, while joint maintenance efforts support continued development and responsiveness to emerging needs.

Responsible partner: UkrSCES

Reference project document(s):

- D1.2 Report on the design of the Portal and BSDB (including web-GIS interface), mapping and visualization tools
- D1.3 Report on the database with Guidelines on using the products

EXPECTED IMPACT

The BRIDGE-BS Portal and Database provide a centralised, standards-compliant infrastructure that supports environmental data access and management across the Black Sea region. By consolidating historical datasets, project-generated data, and contributions from previous initiatives, it improves the continuity and comparability of environmental information across spatial and temporal scales.

For policymakers, the portal offers a practical tool to support national and regional reporting obligations under frameworks such as the MSFD, WFD, and the Bucharest Convention, while allowing to explore trends, assess environmental status, and identify pressures in a consistent way, contributing to better-informed management and planning. For researchers, it streamlines access to harmonised datasets that support modelling, assessments, and interdisciplinary analyses.

The platform's alignment with SeaDataNet protocols strengthens interoperability and enhances visibility at the European level. The ongoing integration will also facilitate broader data sharing, reduce duplication, and expand the scope of accessible datasets. As the portal moves toward more open access, it has the potential to broaden its user base and encourage wider collaboration, including with NGOs, educational institutions, and regional stakeholders.

Its flexible design supports long-term sustainability, enabling future updates and extensions to accommodate new tools or connect with platforms such as the Black Sea Digital Twin demonstrator, contributing to a more connected and responsive data landscape in the region, while supporting coordinated environmental action and knowledge-based governance.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

KO_1.3 Black Sea Digital Twin Demonstrator

The BRIDGE-BS Digital Twin of the Black Sea (DT-BS) is a proof-of-concept platform developed to support informed decision-making through integrated data, models, and scenario analysis. As one of the first demonstrators of a Digital Twin Ocean, and the first focused on the Black Sea, it offers a dynamic, virtual representation of the basin, combining environmental observations, numerical models, and stakeholder-defined priorities. The platform allows to simulate interactions between land-based and marine systems, as well as the cumulative impact of multiple stressors – such as eutrophication, deoxygenation, overfishing, and pollution – on ecological functions and services.

The DT-BS integrates observational data with machine learning and advanced modelling tools to assess present ecosystem conditions and explore future scenarios. It integrates a Cumulative Effects Assessment (CEA) tool, which enables users to visualise and compare alternative development or management pathways under different pressure and climate contexts. By coupling ecological, physical, and socio-economic variables, the demonstrator supports cross-sectoral evaluations and spatial planning at both basin and pilot site levels.

Designed as a decision-support environment, the DT-BS reflects a shift from static assessments to interactive, forward-looking tools that respond to the evolving needs of governance and resource management. While still in a demonstrator phase, it establishes the foundation for more refined applications in the future, including potential integration with European Digital Twin Ocean initiatives.

Responsible partner: METU

Reference project document(s):

Black Sea Digital Twin demonstrator [access link](#)

D10.6 Sustainability and Legacy of BRIDGE-BS: Black Sea Helix and Virtual Centre for Science for a Resilient Black Sea

EXPECTED IMPACT

The DT-BS demonstrator is expected to support policy implementation by making complex environmental dynamics and risks more visible, testable, and manageable. It enables policy and decision makers to explore cause-effect relationships, test adaptive responses, and identify trade-offs between conservation and development goals in a structured, transparent environment.

In practical terms, the platform can support the alignment of national and regional strategies with EU priorities, including the Marine Strategy Framework Directive and the European Ocean Pact. By embedding cumulative effects and climate risk into scenario analyses, it enhances the basis for long-term planning and more resilient coastal management. Its use of spatially explicit outputs can contribute to marine spatial planning, impact assessments, and cross-sectoral coordination. Its development also aligns with the broader European Digital Twin of the Ocean (EDITO) initiative, creating an opportunity to position the Black Sea within the EU's most advanced digital and environmental strategies.

At the regional level, the DT-BS can reinforce cooperation under frameworks such as the Bucharest Convention, the Common Maritime Agenda (CMA), and the SRIA, by offering a shared reference for ecosystem-based decision-making. Its open and integrative approach also supports science-policy dialogue and broader stakeholder engagement, providing an entry point for translating research into actionable strategies.

Although still in early stages, the demonstrator sets the direction for the future use of digital twins in the Black Sea, encouraging innovation in environmental governance and laying the groundwork for operational platforms that are scalable, policy-relevant, and responsive to both ecological and socio-economic change.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

KO_1.4 Harmonised methodologies and quality control standards

BRIDGE-BS has compiled and reviewed methodologies used for the acquisition, analysis, and quality control of environmental data across the Black Sea, aiming to improve consistency and comparability in monitoring and assessment practices. The outcome includes Standard Operating Procedures (SOPs) for the collection and analysis of chemical and biological parameters, tailored to regional conditions and aligned with international best practices.

This compilation provides both a comparative overview of the methodologies currently in use by Black Sea countries and a proposed set of harmonised procedures. The development of intercalibration and intercomparison exercises supports the identification of common approaches and discrepancies, particularly in laboratory-based monitoring. These efforts contribute to a shared reference for conducting ecosystem assessments, with the potential to support broader alignment with EU and global standards.

Designed as a practical resource, this result informs the development of joint protocols, supports the training of monitoring personnel, and encourages dialogue among national institutions. Its adoption will be recommended for consideration by the Black Sea Commission (BSC), providing a pathway for institutional uptake and sustained coordination. It also lays a technical foundation to support future integration of data and results into basin-wide tools such as the Black Sea Digital Twin.

Responsible partner: NIMRD, UkrSCES

Reference project document(s):

D1.4 Report of harmonized methodologies and SOP

EXPECTED IMPACT

By fostering consistency in how environmental data are collected, analysed, and validated, this result directly contributes to improve the reliability and comparability of monitoring outputs across the Black Sea. This consistency is essential for producing robust assessments of ecosystem status and trends, and for aligning national monitoring practices with the requirements of regional frameworks such as the Bucharest Convention, as well as EU requirements such as the MSFD. The adoption of harmonised procedures also facilitates the integration of Black Sea data into global platforms, improving interoperability with initiatives including SeaDataNet and EMODnet, and increasing the visibility and usability of regional datasets in wider marine science and policy contexts.

At the regional level, harmonising methodologies and adopting quality control standards support collaboration among national agencies, research institutions, and the BSC by providing a common technical reference for environmental monitoring. This contributes to more coherent implementation of marine policies and strengthens coordination under frameworks such as the Bucharest Convention and the Common Maritime Agenda.

The availability of this result, combined with the engagement of institutions across the region, offers a timely opportunity to build momentum towards the operationalisation of harmonised monitoring. However, sustained progress will require dedicated resources, continued cooperation, and the active involvement of all Black Sea countries.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

KO_1.5 Black Sea Blue Economy Observatory

BRIDGE-BS delivers the first version of the Black Sea Blue Economy Observatory (BS-BEO) for the Black Sea region, an online platform designed to improve access to harmonised socio-economic information related to marine and maritime activities. The platform provides a structured overview of the current state and possible future development pathways for the regional blue economy, aiming to address long-standing gaps in data availability, comparability, and policy relevance.

The BEO offers three core components: a dashboard displaying harmonised indicators across blue economy sectors, governance, education, and environmental performance; country- and region-level profiles of key sectors; and a repository of scenario analyses and policy pathways developed within BRIDGE-BS. Indicators are organised according to the European Commission's classification of blue economy sectors and cover both socioeconomic metrics (e.g. employment, value added) and context-relevant sustainability indicators.

The observatory is intended as a single-entry point to support socioeconomic data accessibility and comparability in the region, allowing users to visualise trends, identify monitoring gaps, and access relevant BRIDGE-BS outputs. While the first version is based on compiled and harmonised public sources, the platform is structured to enable future integration of updated data and new indicators. The infrastructure is designed for long-term usability, providing the means to update, expand, and connect with external data sources as national and regional monitoring capacities evolve.

Responsible partner: AUEB

Reference project document(s):

D1.5 Report on the Blue Economy Observatories

EXPECTED IMPACT

By improving access to structured and harmonised data, the Blue Economy Observatory supports evidence-based policy development, regional coordination, and market transparency in the Black Sea. It responds to a lack of reliable and interoperable socio-economic data on marine-related sectors, offering a practical tool to track trends, monitor the performance of blue economy activities, and assess progress toward sustainability objectives.

The platform draws attention to existing data gaps and inconsistencies, providing a basis for identifying where improvements in monitoring and reporting are most needed. In doing so, it encourages national efforts to enhance data collection, standardisation, and alignment with FAIR principles. Over time, the observatory can serve as a catalyst for strengthening data infrastructures and fostering more coordinated monitoring of blue economy developments.

In addition to informing national strategies, the BS-BEO can support the implementation of regional initiatives such as the Common Maritime Agenda and contribute to aligning policy efforts with EU-level frameworks. Its forward-looking content, including scenarios, pathways, and investment-relevant information, further enhances its value for strategic planning and innovation support. The platform thus lays the groundwork for more transparent, inclusive, and sustainable blue economy governance in the Black Sea.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

KO_1.6 Blue Economy Imaginaries

Four foresight scenarios for the sustainable development of the Blue Economy in the Black Sea by 2050 are provided in a comprehensive report. Developed through an exploratory approach, these scenarios offer contrasting, yet plausible futures shaped by different forms of governance –regional or local– and types of innovation, technological or social. Each scenario reflects a different pathway toward sustainability, illustrating how socio-political choices influence the evolution and impact of maritime sectors and the communities that depend on them.

Rather than predicting outcomes, the scenarios are designed to expand the range of possibilities considered in strategic planning. They provide narrative frameworks that help visualise how different combinations of cooperation, innovation, and policy priorities might unfold over time. While the analysis is conducted at the sea-basin level, it allows stakeholders to reflect on how shared drivers and challenges could affect national and local contexts.

The scenarios are integrated into the Black Sea Blue Economy Observatory (KO_1.5), where they are presented alongside relevant data, indicators, and policy recommendations. This integration facilitates access and supports their use as tools to stimulate dialogue, test assumptions, and identify long-term strategic options for sustainable blue economy development in the Black Sea.

Responsible partner: SML

Reference project document(s):

D1.5 Report on the Blue Economy Observatories

EXPECTED IMPACT

By introducing structured foresight into blue economy planning, these scenarios support a more proactive, inclusive, and long-term approach to decision-making in the Black Sea region by enabling policy makers, industry actors, and civil society to explore uncertainties, examine the consequences of alternative development pathways, and reflect on which futures are most desirable and achievable.

Used as a strategic tool, the scenarios can help to improve the quality of planning processes by identifying emerging risks, revealing opportunities for innovation, and clarifying trade-offs between economic development and environmental protection. They also provide a shared reference point that can foster cross-sectoral dialogue, encourage collaboration among stakeholders, and promote more coherent and widely supported policy responses.

By reflecting the diversity of stakeholder expectations and visions, the scenarios can guide the development of strategies that are not only technically sound but also socially grounded. They offer a flexible framework that can be revisited and adapted as conditions evolve, supporting the alignment of short-term actions with long-term sustainability goals.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

10. WP 2 Ecosystem dynamics under multiple stressors

KO_2.1 Black Sea physical, biogeochemical and ecosystem state under climate and non-climate, stressors including scenarios of changes

BRIDGE-BS delivers an advanced suite of coupled models that simulate the evolution of the Black Sea under the combined influence of climate change and human-induced pressures. These interconnected physical, biogeochemical, and ecosystem models cover the full marine system, from hydrodynamics and thermohaline circulation to nutrient cycles, fish population dynamics, and key ecosystem services.

Results from this modelling framework reconstruct the environmental history of the Black Sea from 1950 to the present, offering a robust baseline to assess long-term trends and current conditions. Future changes up to 2100 are also projected under two contrasting climate scenarios based on the IPCC Sixth Assessment Report: SSP1-2.6 (low emissions) and SSP5-8.5 (high emissions). In addition to climate drivers, the models incorporate regionally relevant non-climate stressors such as nutrient pollution, overfishing, invasive species, and projected blue economy developments.

Simulations indicate significant shifts in physical and ecological conditions, including warming waters, deoxygenation, acidification, disruptions in food web structure, and increased vulnerability to pollution and plastic dispersion. These findings provide a scientific basis for evaluating risks, identifying ecological tipping points, and informing adaptive responses. Outputs are accessible via Zenodo, the BRIDGE-BS database (KO_1.2), and the Digital Twin Demonstrator (KO_1.3), including GIS-based visualisation tools.

Responsible partner: ULiege, METU, IBER-BAS, HCMR, CNR, DTU

Reference project document(s):

- D2.1 Report on forcing and boundary metadata and model description, implementation and first set of simulation results under multiple stressors
- D2.3 Updated simulation results of Black Sea ecosystem state under multiple stressors

EXPECTED IMPACT

The coordinated climate and ecosystem simulations developed in BRIDGE-BS offer a critical knowledge base for anticipating long-term environmental change in the Black Sea and supporting informed, science-based governance. By combining region-specific physical and ecological processes with plausible future scenarios, the modelling framework provides insights into the evolution of key stressors and their implications for marine biodiversity, fisheries, and ecosystem services. High-resolution, downscaled simulations tailored to the Black Sea context enhance the implementation of EU and regional marine strategies, including the Marine Strategy Framework Directive, the Bucharest Convention, the EU Mission “Restore our Ocean and Waters”, and the UN Ocean Decade.

The ability to identify spatial and temporal hotspots of vulnerability strengthens the basis for resilience-based and ecosystem-based management. Outputs from the simulations can inform cumulative effects assessments, cross-sectoral risk evaluations, and strategic scenario planning, particularly when used in combination with other BRIDGE-BS tools such as the Black Sea Digital Twin (KO_1.3) and the Blue Economy Observatory (KO_1.5).

By addressing persistent gaps in regional modelling capacity, this result creates the conditions for a more adaptive and forward-looking marine policy. It provides researchers and decision-makers with the tools to better understand long-term dynamics, assess trade-offs, and develop management strategies that respond to both current pressures and future risks.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

KO_2.2 Simulated distributions of past and projected GES indicators for policy support

This result provides long-term simulations of Good Environmental Status (GES) indicators for the Black Sea, derived from BRIDGE-BS coupled models. The simulations cover both historical reconstructions (1950–present) and future projections under different climate and management scenarios, offering a detailed assessment of how key ecosystem parameters have evolved and may change in the coming decades. The indicators reflect the Marine Strategy Framework Directive (MSFD) descriptors and offer insights into ecosystem functioning, health, and vulnerability.

Model outputs focus on four key domains:

- **Biodiversity, ecosystem structure and function** (Descriptors 1, 2, 4, 6): including plankton functional types, habitat conditions (temperature, oxygen, pH), fish biomass and species distribution, and benthic community dynamics.
- **Commercial fish and shellfish** (Descriptors 3, 4): covering biomass variability, length distribution, and fishing impacts.
- **Eutrophication and water quality** (Descriptor 5): such as nutrient concentrations, chlorophyll-a, light transparency, and dissolved oxygen.
- **Marine litter and noise** (Descriptors 10, 11): simulated through a plastics dispersion model and mussel-based bioaccumulation estimates for microplastics.

These simulations provide high-resolution information on the ecosystem's condition, which would be difficult to obtain through monitoring alone. While model outputs are not directly designed for use by policymakers, they are integrated into the project's broader assessments of ecosystem resilience and management responses, where they inform the evaluation of environmental targets and policy scenarios.

The simulated indicators also offer a way to evaluate the ecosystem's proximity to the defined "safe operational space" (KO_2.4) and can be used to refine or adapt GES thresholds at regional and national levels.

Responsible partner: ULiege, HCMR, METU

Reference project document(s):

D2.2 GES indicators and SGD targets

D2.4 Updated GES indicators and SGD targets simulations results

EXPECTED IMPACT

The simulated GES indicators offer a robust, cost-effective complement to in situ monitoring, enabling more complete and forward-looking environmental assessments in the Black Sea. They can support national and regional authorities in interpreting current ecosystem conditions, refining policy targets, and tracking progress towards environmental objectives under the MSFD and other relevant frameworks.

By delivering projections under multiple climate and management scenarios, this work helps to clarify the long-term consequences of present-day decisions. It supports regional implementation of resilience-based approaches and contributes to international policy processes such as the Bucharest Convention, the EU Mission "Restore our Ocean and Waters", and the UN Ocean Decade.

Beyond direct assessment, the simulations provide inputs to other BRIDGE-BS tools, including resilience diagnostics and adaptive management frameworks. Their application in scenario testing allows for better understanding of how combined pressures—such as climate change, nutrient input, and fisheries—may interact to affect GES indicators. This integrated use strengthens the science-policy interface and facilitates more dynamic and informed marine governance in the Black Sea region.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

KO_2.3 Selected ecosystem services (food provisioning, climate regulation) under interacting multiple stressors

This result presents the projected changes in Black Sea ecosystem services under the interaction of multiple stressors, considering future climate and socio-economic scenarios at both the basin-wide and Pilot-Site scales.

This work builds on the model tools and simulations developed within BRIDGE-BS coupled models, with the aim to provide a detailed assessment of key ecosystem service changes under a set of future climate scenarios and socio-economic scenarios, that include fishing pressure and plastic delivery scenarios, co-designed with WP6 for addressing the impact of these anthropogenic activities on the Black Sea marine environment. Here the full set of modelling tools proposed within BRIDGE-BS is used, these include 3-D coupled hydrodynamic/biogeochemical Low Trophic Level (LTL) models, simulating the variability of physical and biogeochemical environmental conditions, as well as High Trophic Level (HTL) models, describing the dynamics of the most important fish stocks, and habitat suitability models for key species (e.g. mussels, macroalgae) and a plastics dispersion model.

The ecosystem services accounted for in our analysis include: (a) climate regulation services - changes in carbon sequestration, GHGs (CO₂ and N₂O) emissions, (b) Ecosystem regulation- biogeochemical cycling maintenance - ecosystem structure and plankton functional types changes (c) food provisioning - changes in fish biomass and shellfish size, and (d) recreational services - water quality, eutrophication, plastic dispersion (D2.5)

Responsible partner: CNR, METU, Uliege

Reference project document(s):

D2.5 Service dynamics under Blue Growth scenario

EXPECTED IMPACT

The results of KO_2.3 provide critical, science-based evidence for major marine policy frameworks by quantifying how climate change, pollution, fishing pressure, and plastics will reshape key ecosystem services in the Black Sea. Through spatially explicit projections of fish biomass, habitat suitability, carbon sequestration, eutrophication, water quality, and plastic dispersion, these outputs directly support the **MSFD** by informing Good Environmental Status (GES) assessments across multiple descriptors—particularly biodiversity, food webs, commercial fish, eutrophication, and marine litter—and by providing future scenarios that help design and evaluate Programmes of Measures. At the same time, the spatial mapping of ecosystem service shifts, pollution hotspots, and fisheries responses strengthens **ecosystem-based Maritime Spatial Planning (MSP)** by identifying climate-sensitive areas, guiding sustainable allocation of maritime uses, and supporting decisions on aquaculture, fisheries zones, and potential protected or restoration areas. Combined, KO_2.3 results also advance the aims of Mission Ocean, the European Ocean Pact, the Common Maritime Agenda, and the Black Sea SRIA by offering forward-looking evidence for pollution reduction, ecosystem restoration, and resilient blue economy planning.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

KO_2.4 Boundaries for a safe operational space

Definition of boundaries and limits within which the BS ecosystem can function sustainably involves determining specific thresholds and benchmarks for environmental health and economic activities to determine a "safe space" where both the environment and the economy can thrive without causing harm. Determining the **Safe Operational Space** for the Black Sea requires integrating **multiple assessments**, each capturing different dimensions of ecosystem functioning and pressures.

- **GES-based evaluations**, which provide a first set of benchmarks for environmental health. However, several **GES indicators still lack robust, region-specific thresholds**, highlighting the need for additional research to refine these boundaries.
- **Resilience analyses**, which assess the system's capacity to absorb disturbances (e.g., warming, deoxygenation, eutrophication, overfishing) without shifting to degraded states. These analyses contribute to identifying **early-warning indicators** and **buffer zones** that keep the system away from tipping points.
- **Cumulative Effects Assessment (CEA)** for the two future scenarios, quantifying how combined pressures (climate change, fishing, pollution, habitat change, etc.) interact and where synergies or amplifications occur. This helps identify areas or sectors **most at risk of crossing safe limits**.

Responsible partner: METU, CNR, SU, DTU

Reference project document(s):

- D2.2 GES indicators and SGD targets
- D2.4 Updated GES indicators and SGD targets simulations results
- D3.2 Resilience assessment
- D3.3 Report on Future projections of Black Sea resilience and recovery potential

EXPECTED IMPACT

By defining the ecological limits within which the Black Sea can operate sustainably, KO_2.4 delivers actionable knowledge that strengthens the implementation of several key marine policy frameworks. The identification of region-specific thresholds, resilience margins, and pressure interactions directly advances the **Marine Strategy Framework Directive (MSFD)** by helping refine missing or uncertain GES thresholds, clarifying where environmental conditions approach critical tipping points, and supporting more targeted Programmes of Measures. These boundary maps and risk zones also have strong implications for **Maritime Spatial Planning (MSP)**, enabling planners to evaluate whether proposed activities align with the ecosystem's carrying capacity and to integrate climate and pollution vulnerabilities into spatial allocation decisions. In addition, the quantified limits and system-response relationships feed directly into the **Black Sea Digital Twin (DTO)**, providing the environmental constraints, stressor thresholds, and response functions needed for realistic simulations of future management and climate scenarios. Beyond EU directives, these insights contribute to the **Mission Ocean Lighthouses**, the **European Ocean Pact**, and the **Black Sea SRIA**, supporting a transition toward more resilient and precautionary ocean governance by clearly outlining the boundaries within which sustainable blue economy growth can take place.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

11. WP3 Resilience for a healthy Black Sea ecosystem

KO_3.1 Interactions between multiple stressors

This analysis explores how multiple environmental pressures interact to affect ecosystem structure, function, and resilience in the Black Sea. Drawing on long-term time series, model outputs, and statistical analyses, it investigates the combined effects of climate-related drivers (e.g. warming, acidification) and human activities (e.g. overfishing, eutrophication, invasive species) on key ecological indicators. The study highlights how interactions among stressors can produce non-linear outcomes –ranging from synergistic to antagonistic effects– making ecosystem responses difficult to anticipate through single-driver assessments.

The findings point to a decline in resilience during the 1975–2004 period, including evidence of regime shifts followed by partial recovery. These changes appear to be mediated by ecosystem structure and species interactions, underlining the importance of functional diversity and trophic dynamics in shaping system responses. The analysis includes composite indicators derived from the applications of different models, metrics and indices, to provide insight into shifts in ecosystem organisation and recovery potential.

A pilot case study was conducted for the Western Black Sea shelf (Varna and Burgas Bay, BG), where sufficient long-term data enabled demonstration of integrated multiple stressors assessment methods. This includes the mapping of ecosystem service (ES) bundles –coastal-iconic, coastal-regulating, coastal-touristic, and offshore-windy clusters–, which reflect spatial patterns of ecological value and vulnerability. While the basin-wide application of these approaches remains in development, the methods and indicators offer a replicable framework for future site-level assessments across the region.

Responsible partner: IBER-BAS, SU

Reference project document(s):

- D3.1 Report on the interactions between multiple stressors and indicators of resilience
- D3.2 Resilience assessment
- D3.3 Report on Future projections of Black Sea resilience and recovery potential

EXPECTED IMPACT

These results contribute to more integrated ecosystem assessments by revealing how cumulative stressors shape the state and resilience of the Black Sea environment. Indicators generated through this work, including trophic structure metrics, benthic functional indices, and ecosystem service bundles, can support policy instruments such as the MSFD (Descriptors 1 and 5), the Biodiversity Strategy, and the Water Framework Directive. They are also relevant for informing National Plans development under the new EU Nature Restoration Regulation, particularly in relation to benthic biodiversity and coastal ‘blue carbon’ potential.

By identifying causal links, break points, and alternative states in the ecosystem, this analysis offers valuable input for adaptive management and restoration planning. It highlights the need for multiple stressors approaches when setting environmental targets or evaluating progress toward Good Environmental Status. The pilot application in Bulgaria provides a reference for transferring methods to other coastal areas, especially where data availability and modelling capacity allow.

Mapped results, including spatial layers of ecosystem service provision and benthic habitat quality, are available for integration into the BRIDGE-BS Portal (KO_1.2) and the Black Sea Digital Twin (KO_1.3). These outputs offer a practical toolset for monitoring change, assessing management scenarios, and supporting more spatially informed decision-making across marine and coastal policy domains.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

KO_3.2 Socio-ecological factors contributing to ecosystem service resilience

(Pressure-state indicators + Indicators or resilience)

This result examines how interactions between ecological dynamics and human pressures influence the resilience of ecosystem services (ES) in the Black Sea. Applying a socio-ecological systems (SES) perspective, it has been explored how changes in environmental conditions and resource use affect the system's ability to maintain ES delivery under stress. In this context, resilience refers to the ability of ecosystems to absorb disturbances such as climate change, eutrophication, or overexploitation, without shifting into an alternative, potentially less desirable state.

The assessment uses pressure-state indicators, which link environmental pressures (e.g. nutrient inputs, warming, or fishing intensity) with corresponding changes in ecosystem condition, measured through variables like oxygen levels, biomass, or species composition. These indicators help identify where and how stressors are affecting ecosystem functions. Alongside these, composite time-series indices track long-term trends by aggregating multiple variables into single, interpretable metrics. This approach supports the detection of change patterns, early warning signals, and shifts in ecosystem stability.

The findings show that ecosystem resilience depends not only on ecological attributes such as functional diversity or trophic structure, but also on the capacity of human systems to respond and adapt through governance choices, monitoring practices, and socio-economic responses to environmental change. This approach contributes to a more integrated understanding of the thresholds, feedback and capacities that shape sustainability in coastal and marine systems.

Responsible partner: SU

Reference project document(s):

D3.2 Resilience assessment

EXPECTED IMPACT

Understanding how pressure-state interactions influence the resilience of ecosystem services helps policymakers identify where management interventions are most needed and when early signals of degradation may emerge. This knowledge may inform the design of early warning systems by highlighting which variables are most sensitive to cumulative stress and where potential tipping points may lie.

The indicators and composite indices developed in this work support risk-based monitoring and scenario analysis to inform national and regional strategies. This is particularly relevant for implementing adaptive management under frameworks such as the MSFD, the Biodiversity Strategy, and forthcoming Nature Restoration Plans. By clarifying how ecological and social factors interact to shape resilience, this result provides a strong basis for designing management strategies to maintain the long-term functionality of Black Sea ecosystems under increasing environmental and anthropogenic pressures.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

KO_3.3 Resilience landscape for the Black Sea

(Ecosystem limits to stress + Resilience landscape)

An integrated assessment of the Black Sea ecosystem's ability to absorb and recover from multiple stressors is provided, using the concept of a resilience landscape to illustrate how close the system is to potential tipping points where key functions and services could be lost. It offers a system-level perspective on how far current ecosystem conditions are from these potential tipping points, beyond which key functions and services could be lost. The analysis combines indicators of ecosystem resilience and stress limits, integrating long-term observations, pressure-state relationships, and model outputs, where available.

The resilience landscape is built using quantitative indicators derived from time series data and ecological assessments. These indicators reflect the stability and recovery capacity of critical ecosystem components under cumulative stress. The result identifies which ecological functions are more vulnerable and which remain robust, explaining the ecosystem's capacity to maintain essential service provision under changing environmental and human pressures.

Where applicable, model scenarios are used to project future conditions, and confidence ranges are provided to account for uncertainty and temporal variability. Rather than defining a fixed threshold, the landscape approach presents resilience as a dynamic property shaped by interacting pressures, natural variability, and system structure. This framework is designed to support strategic reflection on safe operational conditions for the Black Sea and inform ecosystem-based management decisions.

Responsible partner: SU

Reference project document(s):

D3.2 Resilience assessment

D3.3 Report on Future projections of Black Sea resilience and recovery potential

EXPECTED IMPACT

The resilience landscape improves understanding of the Black Sea's stability under multiple pressures and clarifies the risks associated with crossing ecological thresholds. It helps to identify which ecosystem components are closest to critical limits and what conditions support their continued functioning. This knowledge is essential for designing precautionary and adaptive management strategies that ensure the sustainable delivery of ecosystem services over time.

By offering a spatially and functionally differentiated view of resilience, the assessment provides a practical tool for integrating resilience thinking into marine policy and planning. It can support the application of the Marine Strategy Framework Directive, the EU Biodiversity Strategy, and the development of National Restoration Plans by informing where and how to prioritise interventions to reduce risk and maintain ecological integrity in a changing environment.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

KO_3.4 Methods and tools to assess ecosystem service resilience in data poor systems

A set of complementary methods adapted to data-poor conditions are combined to address the challenge of assessing ecosystem service (ES) resilience in regions with limited quantitative data. These methods include network analysis, Bayesian approaches, causal loop diagrams, and stakeholder interviews, allowing for system-level insights even in the absence of long-term monitoring.

A Qualitative Comparative Analysis (QCA) was also applied across selected pilot sites to identify which combinations of socio-ecological factors are associated with greater or weaker adaptive capacity. By integrating both expert knowledge and context-specific qualitative data, these tools help reveal how resilience is shaped under different local conditions.

This approach is particularly relevant in the Black Sea context, where many ecosystem services such as small-scale fisheries, cultural values, or coastal regulation play a central role in community wellbeing but remain underrepresented in standard monitoring frameworks. The use of participatory and interpretive tools provides an alternative means to assess system dynamics and guide resilience-oriented planning where conventional indicators are lacking or unavailable.

Responsible partner: SU

Reference project document(s):

D3.2 Resilience assessment

EXPECTED IMPACT

This result expands the range of tools available for assessing ecosystem service resilience in regions with limited data availability, improving the capacity to identify risks and design adaptive responses even in the absence of long-term quantitative records. This is particularly relevant for coastal areas where local knowledge is strong, but monitoring systems are weak or fragmented.

By offering methods that integrate expert judgement and stakeholder perspectives with structured system analysis, the tools support more inclusive and context-sensitive approaches to ecosystem management. They can inform preliminary risk assessments, prioritisation of monitoring investments, and the design of locally adapted restoration or conservation actions.

The flexibility of these tools makes them suitable for replication across other under-monitored sites in the Black Sea, supporting broader policy objectives such as the MSFD, Biodiversity Strategy, and Nature Restoration Regulation by improving diagnostic capacity and enabling more equitable access to resilience assessment frameworks.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

KO_3.5 Future projections of ecosystem resilience and recovery potential

This result explores how Black Sea ecosystems may respond to future environmental stressors and management actions, drawing on climate projections for both mid-century (2040) and end-of-century (2100) horizons. It uses scenario-based analysis to assess the resilience and recovery potential of key ecosystem components under different climate trajectories and socio-economic assumptions.

The assessment considers how quickly and to what extent ecosystems may rebound from disturbances such as warming, acidification, or cumulative human activities, and under which conditions recovery becomes uncertain or unachievable. It also identifies ecological baselines that may no longer be attainable, helping define realistic expectations for ecosystem restoration in a changing climate.

Scenario outputs include projected shifts in resilience indicators, recovery pathways under alternative management strategies, and indicative timeframes for ecological rebound or continued degradation. These projections help anticipate future pressures on ecosystem services and inform the adaptive capacity of marine management strategies.

Responsible partner: SU

Reference project document(s):

D3.3 Report on Future projections of Black Sea resilience and recovery potential

EXPECTED IMPACT

By projecting how resilience and recovery potential may evolve under future environmental and socio-economic conditions, this work contributes to more forward-looking, adaptive marine policy. It enables decision-makers to identify critical thresholds, assess recovery feasibility, and plan management actions in light of anticipated ecosystem trajectories rather than historical baselines.

These findings are particularly relevant for the implementation of long-term policy frameworks such as the Marine Strategy Framework Directive, the Biodiversity Strategy, and National Restoration Plans, especially for defining realistic restoration targets and identifying areas where precautionary action is most urgent. The projections also support the integration of climate risk into marine spatial planning, resilience-based governance, and monitoring strategies aligned with the EU's Mission "Restore our Ocean and Waters" and the objectives of the UN Ocean Decade.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

12. WP 4 Adaptive management

KO_4.1 Integrated machine learning/ artificial intelligence-based risk assessment framework

BRIDGE-BS delivers prototype modelling frameworks that analyse the relationships between physical, chemical, and biological variables in the Black Sea ecosystem, supporting risk assessment, vulnerability analysis, and decision-making. Two approaches have been explored: Bayesian Networks (BNs) and Artificial Neural Networks (ANNs).

BNs are applied at the pilot site scale using available time-series data, particularly focused on sprat biomass and landings. These models incorporate inputs such as phytoplankton functional types, zooplankton, salinity, and temperature, to generate probabilistic forecasts of biological responses. Their strength lies in their interpretability and capacity to reveal causal relationships among variables.

ANNs are trained at the basin scale using a hybrid approach that combines simulated and observed data. This integration improves the models' ability to capture complex, non-linear interactions while maintaining predictive accuracy. Two ANN prototypes have been developed to test predictive capabilities under different configurations, with further refinements underway. Planned enhancements include incorporating full spatial time series, which would improve the models' capacity to detect spatial patterns and identify early warning signals for extreme events or regime shifts.

Together, these tools provide complementary perspectives: BNs offer local, transparent diagnostics for decision-making, while ANNs enable the identification of high-dimensional interactions across broader spatial and temporal scales.

Responsible partner: DTU

Reference project document(s):

- D4.1 Report on the Prototype supervised BN ANN frameworks
- D4.3 Report on the future vulnerabilities and pressure-impact linkage chains

EXPECTED IMPACT

These prototype models enhance the ability of scientists and policymakers to anticipate ecosystem responses and make informed, adaptive decisions. Their application can support the development of early warning systems for events such as marine heatwaves, harmful algal blooms, regime shifts, or fishery collapses by identifying key drivers, detecting trends, and forecasting ecological thresholds.

By linking environmental pressures with biological responses, the models contribute to the design of adaptive management strategies aligned with resilience-based governance. They can guide scenario testing, stressor-response analysis, and monitoring prioritisation under frameworks such as the MSFD and the EU Biodiversity Strategy.

In addition, these tools offer a foundation for collaborative science-policy engagement, by simplifying complex environmental data into interpretable outputs. Over time, the models may inform sustainable transition pathways by helping identify future vulnerabilities, forecast ecosystem recovery potential, and evaluate the effectiveness of policy measures under different environmental scenarios.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

KO_4.2 Cumulative effects assessment (CEA) tool

A geospatially explicit Cumulative Effects Assessment (CEA) tool has been developed to support risk-based, science-informed marine planning and management in the Black Sea. The tool enables users to evaluate the collective impacts of multiple human activities and environmental pressures on ecosystem components and services, providing a structured approach to understanding and managing cumulative risks. Built within a broader Risk-Based Assessment (RBA) framework, the CEA methodology identifies pressure-receptor relationships and quantifies spatially explicit driver-pressure-impact chains across the sea basin and at pilot site scales. It incorporates diverse data sources and modelling techniques to assess the exposure and vulnerability of key ecosystem services under current conditions and projected future scenarios.

Designed as a web-based decision support tool, it allows custom user-defined assessments. Case studies have been pre-configured for three pilot sites and the entire Black Sea, including harmonised datasets and preloaded scenario settings. This enables non-expert users – particularly policy stakeholders – to explore cumulative effects under different management pathways with minimal technical input.

By integrating spatial analysis, risk mapping, and scenario testing, the CEA tool helps identify ecological hotspots, key pressure combinations, and areas where trade-offs between blue economy activities and environmental integrity are most critical. The platform's modularity also supports future integration with the Black Sea Digital Twin (KO_1.3), enabling dynamic, real-time updates and broader system modelling capabilities.

Responsible partner: CNR

Reference project document(s):

D4.2 Geospatial CEA tool: explanatory assessment of cumulative impacts.

EXPECTED IMPACT

The CEA tool provides policymakers, planners, and environmental managers with a practical instrument to assess and anticipate the cumulative impact of marine and land-based activities, enhancing the effectiveness and coherence of marine spatial planning and environmental regulation. Its spatially explicit, scenario-based outputs strengthen the science-policy interface by translating complex interactions into actionable information.

This result contributes to:

- **Evidence-based decision-making** under frameworks such as the MSFD, the Bucharest Convention, and the Common Maritime Agenda;
- **Improved cross-sectoral planning**, by revealing the interactions between pressures, receptors, and ecosystem service delivery;
- **Early identification of risk hotspots**, informing prioritisation of management interventions and investment;
- **Scenario building and forward-looking planning**, including the evaluation of new or intensified uses of marine space and climate-related stressors.

In the longer term, integrating the CEA tool with the Black Sea Digital Twin and refining sensitivity and vulnerability indicators will further enhance its value for adaptive marine governance. Its continued development may also offer opportunity to incorporating socio-economic modelling and improving the coverage and quality of transboundary datasets, supporting a more holistic understanding of cumulative risks in the Black Sea region.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

KO_4.3 CEA-based risk assessment and scenario analysis

A cumulative effects assessment (CEA) framework was applied to identify and quantify key anthropogenic and climate-related risks to the Black Sea marine environment. The analysis integrates spatially explicit data with scenario-based projections to evaluate current conditions and explore future risks across three pilot sites: Bosphorus area, Varna and Burgas Bay, and the Danube Delta, as well as at the basin scale. Development scenarios are projected to 2050 and used to assess the effectiveness of potential management responses.

The assessment is structured around several key components. First, context definition was undertaken for each site and at regional level, incorporating stakeholder input and socio-economic scenario elements to identify relevant policy objectives, ecosystem services, and pressures. Second, CEA index score maps and heatmaps were built to visualise the spatial distribution and intensity of risks, highlighting critical pressure-receptor interactions. Third, difference maps and scenario comparison plots revealed how different management strategies influence projected risk levels. Finally, the analysis links spatial risk patterns to core ecosystem services and MSFD Good Environmental Status (GES) descriptors, supporting the identification of areas most in need of intervention.

Sectoral narratives are integrated into the scenario framing, grounding the analysis in realistic development pathways. These narratives connect land- and sea-based drivers with ecological risks and help articulate what adaptive measures might look like under different socio-economic trajectories.

Responsible partner: CNR

Reference project document(s):

D4.4 Report on the Geospatial CEA

EXPECTED IMPACT

The integration of cumulative effects analysis with future scenarios provides decision-makers with a powerful tool to prioritise management interventions based on risk intensity, spatial extent, and relevance to policy objectives. By identifying how risks vary across different areas and comparing the implications of alternative management pathways, this work supports the implementation of adaptive, ecosystem-based marine planning.

These outputs can be directly applied to strategic processes such as Marine Spatial Planning (MSP), MSFD implementation, and the development of National Plans under the new Nature Restoration Regulation. They also help identify where key ecosystem services are under pressure and which policy levers are most likely to reduce cumulative risk (e.g. reducing land-based inputs, adjusting fishing practices, or expanding marine protected areas).

Beyond immediate applications, it creates the conditions for a more operational CEA integration into tools like the Black Sea Digital Twin (KO_1.3), fostering cross-sectoral dialogue and contributing to a more resilient and sustainable future for the Black Sea.



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KO_4.4 Recommendations for adaptive management, planning and policy implementation

A consolidated set of recommendations for adaptive management is delivered to support sustainable Blue Economy development in the Black Sea. These recommendations address both local and regional scales, and are tailored to area-specific conditions, ecosystem-based priorities, and Blue Economy sectoral needs. They are based on the integration of findings from across the project (models, decision support tools (DSTs), and stakeholder engagement activities) and reflect both current risks and future scenarios.

The recommendations are structured along three complementary categories:

- **Area-based**, addressing site-specific actions for the Black Sea basin and pilot sites;
- **Ecosystem-based**, focusing on the protection and sustainable use of core ecosystem services;
- **Sector-based**, targeting relevant Blue Economy activities within and across pilot sites.

There are aimed to improve the coherence, responsiveness, and long-term vision of marine and coastal management practices, particularly where current approaches lack the flexibility or scope to address complex multiple stressors dynamics.

The recommendations were developed through a four-phase process: assessing current conditions, identifying key risks and gaps, formulating targeted proposals, and synthesising results into a practical, policy-oriented format.

Responsible partner: GEOECOMAR

Reference project document(s):

D4.5 Report based on DST guidelines and recommendations for adaptive management

EXPECTED IMPACT

These recommendations provide a science-based foundation for more strategic, adaptive, and inclusive marine governance in the Black Sea. By aligning environmental protection with socio-economic development goals, they support the integration of risk management into core policy frameworks such as the Marine Strategy Framework Directive (MSFD), the Common Fisheries Policy (CFP), the European Ocean Pact, and SDG14, among others.

Their structured design enhances coherence between national and regional planning processes, while strengthening links between ecosystem service protection and Blue Economy innovation. The recommendations offer a practical reference for the implementation of marine spatial planning (MSP), integrated coastal zone management (ICZM), and forthcoming National Restoration Plans, helping decision-makers prioritise actions based on risks, pressures, and long-term sustainability goals.

The result promotes more forward-looking and flexible management approaches, better suited to addressing uncertainty, climate change, and cumulative impacts. It also fosters collaboration between science and policy communities, encourages the uptake of decision-support tools, and contributes to capacity building among future marine managers—supporting the transition to a more resilient, knowledge-driven management culture in the region.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

13.WP 5 – Smart observations and technologies for tackling multiple stressors, boosting innovation and supporting monitoring.

KO_5.1 Improved knowledge and understanding on the state of ecosystem health and ecosystem processes and interactions in the Black Sea

This result advances multidisciplinary understanding of ecosystem health, stressor interactions, and environmental processes in the Black Sea. It is based on extensive oceanographic data collected across four pilot sites and at basin-wide scale, which have been analysed to assess the cumulative impacts of pressures such as warming, deoxygenation, eutrophication, and pollution on key ecosystem services, particularly those related to provisioning and regulation functions.

More than 400 sampling stations were surveyed through a combination of multidisciplinary research cruises, fixed monitoring stations, targeted field sampling, and contributions from national monitoring programmes, producing over 400,000 validated physical, chemical, and biological records. These include indicators such as temperature, salinity, nutrient concentrations, oxygen levels, and biodiversity components (phytoplankton, zooplankton, benthos), as well as data from environmental DNA (eDNA).

The resulting datasets have been used to generate 3D spatial maps of key ecosystem variables, supporting habitat modelling. They also inform scenario analysis (KO_4.2, KO_4.3) at both local and regional scales, as well as ecosystem service bundle assessment (KO_3.1) and resilience analyses (KO_3.2, KO_3.3). Together, these contributions support a system-level understanding of ecosystem structure and food web dynamics under multiple stressors conditions. These data also feed into the BRIDGE-BS environmental models (KO_2.1), enhancing their precision and predictive capacity.

The resulting datasets and analyses are made accessible through the BRIDGE-BS portal (KO_1.2), which provides visualisations of trends in oxygen, nutrients, and other key environmental parameters. This knowledge provides a basis for future early warning and improved decision-support systems.

Responsible partner: METU, IBER-BAS, GEOECOMAR

Reference project document(s):

- D5.1 First report of field research activities conducted until M12
- D5.2 Report of integrated field datasets and process observations

EXPECTED IMPACT

Improved knowledge on the cumulative impacts of multiple stressors strengthens the evidence base for assessing the current condition of the Black Sea ecosystem and supports more informed, science-based policy development. By addressing key knowledge gaps and enhancing understanding of how cumulative pressures affect biodiversity, water quality, and ecosystem functions, it contributes directly to the implementation of the Marine Strategy Framework Directive (MSFD), the EU Mission “Restore our Ocean and Waters”, and related national marine strategies.

The improved resolution and consistency of physical, chemical, and biological datasets enable more accurate model predictions and long-term scenario analysis, supporting adaptive management, enhanced monitoring strategies, and better-targeted interventions at national and regional levels.

Beyond policy alignment, this work also creates the conditions for improved regional cooperation by providing a shared empirical foundation for joint observation efforts. Its integration into the BRIDGE-BS portal increases data accessibility and transparency, while supporting the development of open, interoperable systems for future marine data sharing. In the long term, this will help reduce costs, foster trust among regional actors, and accelerate the transition to integrated ecosystem-based management across the basin.



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KO_5.2 Next generation innovative tools for biodiversity monitoring

This result introduces environmental DNA (eDNA) metabarcoding as an advanced, non-invasive method for biodiversity monitoring in the Black Sea. Unlike conventional trawl surveys, which mainly capture commercial species, eDNA enables the detection of a broader array of aquatic organisms—including migratory, invasive, and rare species—by identifying genetic material shed into the water. This approach significantly expands the scope and efficiency of biodiversity assessments while reducing environmental disturbance and resource intensity.

Pilot studies along the Bulgarian coast (PS2) showed that eDNA could detect up to four times more species than traditional trawling methods, revealing organisms not captured by nets and providing insights into seasonal dynamics, habitat use, and community turnover. The campaigns enabled direct comparison with conventional surveys and demonstrated the method's added value and operational feasibility. In doing so, the work identified key technical and infrastructural needs such as the development of more complete regional reference genomic databases, which remains a limiting factor for broader application. These findings support the potential of eDNA as a scalable and sensitive tool for tracking biodiversity changes, assessing ecosystem responses, and guiding marine conservation.

Although eDNA does not currently provide reliable estimates of population size, maturity, or biomass, its integration with conventional surveys offers a more holistic monitoring framework. This approach is particularly valuable for early detection of invasive species and tracking climate-driven shifts in species distribution. The method's effectiveness, however, depends on the availability of robust genetic reference databases, which remain a limiting factor in the Black Sea context.

As high-throughput sequencing technologies advance and region-specific reference libraries are improved, eDNA metabarcoding stands to become a central component of marine monitoring strategies. Its adoption supports more inclusive, cost-effective, and adaptive biodiversity assessments, with direct implications for fisheries management, regulatory frameworks, and marine policy. In this way, BRIDGE-BS contributes to filling key knowledge and technology gaps, enabling better-informed, science-based decisions for marine resource protection and sustainable use in the region

Responsible partner: IO-BAS

Reference project document(s):

D5.3 Report on assessment of conventional and e-DNA based biodiversity methods and observations

EXPECTED IMPACT

The adoption of eDNA metabarcoding offers the opportunity for a transformative step forward in biodiversity monitoring and marine ecosystem assessment in the Black Sea. By enabling the detection of a wider range of species with greater sensitivity and efficiency, this approach enhances the evidence base for policy development and supports the implementation of key frameworks such as the Marine Strategy Framework Directive (MSFD), the EU Biodiversity Strategy, and the forthcoming Nature Restoration Regulation.

Its integration into national and regional monitoring programmes can improve the spatial and temporal resolution of assessments while reducing dependence on resource-intensive and environmentally disruptive survey methods. In the longer term, this approach contributes to more adaptive, inclusive, and cost-effective monitoring strategies, which is especially relevant in a region where monitoring budgets and capacities vary significantly between countries. As sequencing technologies become more affordable and reference databases more complete, the method's operational value will grow.

Furthermore, BRIDGE-BS has helped identify both the potential and limitations of eDNA applications in the Black Sea context. Field campaigns, comparison with conventional methods, and the identification of key technical challenges highlight strategic areas future investment priorities. This work also supports the design of fit-for-purpose monitoring frameworks by determining where eDNA application can be most effectively applied, e.g. biodiversity baselines, enabling early detection of invasive species, and providing complementary data for stock assessments. These contributions facilitate the integration of eDNA



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approaches into coordinated regional strategies and upcoming policy instruments, ensuring that biodiversity monitoring in the Black Sea is based on up-to-date scientific and technological approaches.



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KO_5.3 Integrated method for monitoring phytoplankton biodiversity and harmful algal bloom species

An integrated method combining light microscopy and DNA metabarcoding has been developed to improve phytoplankton biodiversity monitoring and the detection of harmful algal bloom (HAB) species in the Black Sea. A year-long study in Varna Bay, BG allowed for direct comparison of both approaches across different environmental conditions.

DNA metabarcoding detected up to 1.4 times more species and 1.3 times more genera than traditional microscopy, with 24 out of 38 potentially toxic species found exclusively through molecular analysis. This includes cryptic, small-sized, or morphologically variable species that are often missed in conventional monitoring. The method provides enhanced insight into species turnover, seasonal dynamics, and community structure, particularly for genera such as *Azadinium*, *Karenia*, *Pseudo-nitzschia*, and *Vulcanodinium rugosum*.

Microscopy remains essential for providing abundance estimates and assessing bloom intensity, as DNA reads cannot yet reliably quantify cell concentrations. However, their combined application significantly improves taxonomic resolution and monitoring accuracy. While molecular workflows require further standardisation and better genomic reference databases, the study demonstrates that the integrated approach compensates for the limitations of each method.

By combining morphological and molecular tools, the monitoring of phytoplankton biodiversity and harmful taxa becomes more sensitive, comprehensive, and adaptable. The approach addresses long-standing taxonomic challenges and enhances the capacity to detect changes in community composition under stressors such as eutrophication and climate variability.

Responsible partner: IO-BAS

Reference project document(s):

D5.3 Report on assessment of conventional and e-DNA based biodiversity methods and observations

EXPECTED IMPACT

Improved detection of HAB and cryptic phytoplankton species provides the basis for developing early warning systems and more robust biodiversity assessments in the Black Sea. The integrated method strengthens national and regional capacities to monitor ecological shifts driven by eutrophication, temperature anomalies, and nutrient dynamics, supporting the implementation of the MSFD, WFD, and broader marine environmental policies.

By enhancing sensitivity to changes in species composition and improving taxonomic accuracy, the approach allows earlier detection of ecological risks, including the emergence or expansion of toxic algae. This facilitates timely management responses, particularly in sensitive coastal zones, and improves understanding of how phytoplankton communities respond to climate-driven and anthropogenic pressures.

The study also identifies key technical challenges such as the need for region-specific genomic reference libraries and harmonised protocols, highlighting strategic priorities for investment and capacity building. Lessons from comparison of methods and workflow integration provide a useful operational model for scaling up the use of molecular tools in regional monitoring frameworks.

Adopting this dual-method approach contributes to a more comprehensive understanding of phytoplankton dynamics in the Black Sea. It supports a transition to monitoring systems that are more inclusive, accurate, and responsive to environmental change, contributing to the resilience and sustainable use of marine ecosystems.



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KO_5.4 Black Sea microbial biotechnology demonstrator

Marine microbial communities in the Black Sea represent an underexplored reservoir of enzymes with potential industrial applications. Through environmental DNA (eDNA) analysis of sediment samples collected in the south-western Black Sea, BRIDGE-BS has identified 59 enzyme types or groups of interest, covering applications in biorefinery, bioremediation, food processing, fine chemistry, and processes specific to the region (e.g. sulphide oxidation, denitrification, and anammox). These enzymes were detected across multiple sampling stations, and heatmaps were generated to visualise their spatial distribution, offering an initial mapping of the region's enzymatic richness.

From this initial screening, a large database has been compiled, containing thousands of enzyme candidates. This constitutes a valuable platform for both scientific exploration and industrial innovation. As a proof of concept, one promising enzyme (a novel catalase, H2C) was successfully isolated and characterised. This catalase functions optimally under cold, alkaline, and saline conditions, making it particularly suited for industrial processes in sectors such as cleaning agents, food preservation, and pharmaceuticals.

The demonstrator presents a replicable methodological framework, combining eDNA-based detection with laboratory testing to confirm the function and properties of selected enzymes. This combined method links DNA-based detection with functional screening, illustrating a practical pathway from field sampling to industrial application.

The resulting datasets are integrated into the BRIDGE-BS Database (KO_1.2), ensuring accessibility for researchers and stakeholders.

Responsible partner: TUBITAK

Reference project document(s):

D5.4 Black Sea microbial biotech potential demonstrator assessment

EXPECTED IMPACT

This biotechnology demonstrator unlocks new opportunities for blue biotechnology in the Black Sea by providing the first structured overview of microbial enzymatic potential in the region. It generates a foundational dataset for future research and innovation, offering thousands of enzyme candidates linked to industrially relevant processes. By identifying and validating a novel catalase enzyme adapted to specific conditions, it demonstrates how marine genetic resources can support the development of more sustainable, low-impact biotechnological applications.

The methodological process, from eDNA screening and enzyme filtering to structural modelling, expression, and laboratory testing, offers a reference model for future bioprospecting efforts and enables more targeted exploration of marine microbial diversity. This approach can be replicated in other areas of the Black Sea, supporting the development of a transnational knowledge base and promoting cooperation among scientific and industrial actors.

In practical terms, this result helps to identify strategic priorities for investment, such as the development of dedicated genomic libraries, improved sampling strategies, and the creation of collaborative platforms for screening and characterising marine bioresources. These are essential for positioning the Black Sea region within broader EU and international initiatives in blue biotechnology and marine genetic resources.

While the sector is still in early stages, this work contributes to create enabling conditions for future development, demonstrating the scientific relevance, technological feasibility, and economic potential of valorising microbial biodiversity in the Black Sea. It also supports the implementation of sustainable bioeconomy strategies by aligning marine biodiversity knowledge with innovation-driven, low-impact industrial solutions.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

KO_5.5 Sensor systems for a multiple stressors early warning system in the Black Sea

A suite of advanced marine sensor systems has been developed, adapted, and integrated to improve the monitoring of multiple stressors in the Black Sea. These systems are tailored to the region's unique environmental conditions and contribute to the transition from intermittent, low-resolution data collection to continuous, real-time observations that can better inform management and early warning responses.

Key innovations include upgraded in situ sensors for pH and pCO₂, enabling more accurate tracking of acidification processes, and enhanced electrochemical sensors for real-time chemical analyses. A flow cytometer was adapted for phytoplankton monitoring, allowing more detailed analysis of bloom dynamics and ecosystem shifts.

To support biological monitoring, a combined jellyfish observation and acoustic detection system was developed, offering early alerts for bloom events. Passive acoustic monitoring for marine mammals was also upgraded, improving detection capacity for biodiversity assessments. Additionally, a novel underwater radionuclide sensor was implemented to monitor radioactive contamination risks.

Each of these technologies has advanced along the Technology Readiness Level (TRL) scale, providing not only improved hardware, but also pathways for its integration into broader environmental assessment frameworks. These developments enable continuous, in situ measurements of key stressors generating high-resolution data directly relevant for use within the BS-DT (KO_1.3).

Responsible partner: TUBITAK, METU, GEOECOMAR

Reference project document(s):

D5.5 BRIDGE-BS technology advance report, featuring the full analyses of new potential monitoring technologies for Black Sea and, multiple stressors early warning system demonstrator in support of sectors and ecosystem services

EXPECTED IMPACT

Improved environmental sensor technologies developed under BRIDGE-BS significantly enhance the region's capacity to generate high-frequency, spatially resolved environmental data, supporting MSFD descriptors such as D5 (eutrophication) and D7 (hydrographic conditions), among others. In practical terms, this enables more responsive risk management, e.g. issuing hypoxia or jellyfish alerts within hours rather than days, reducing potential environmental and economic damage.

Real-time data also enhance transparency and public engagement, especially when integrated into open platforms or citizen science tools. Furthermore, these sensors fill key observational gaps not addressed by satellite data, improving data assimilation in ecosystem models (KO_2.1) and the BS-DT (KO_1.3).

From a policy perspective, these tools strengthen national and regional monitoring frameworks, enable cost-effective expansion of observation capacity, and provide a stronger evidence base for adaptive management. They also open new opportunities for Blue Economy innovation by supporting the development of data-driven services, such as environmental forecasting, marine safety solutions, or ecosystem-based planning platforms, while fostering collaboration between marine scientists, technology developers, and coastal industries.



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14. WP 6 – Socioeconomics and social innovations

KO_6.1 Valuation of ecosystem services

An ecosystem services (ES) valuation exercise was conducted at three BRIDGE-BS pilot sites – Bosphorus area (TK), Danube Delta (RO), and Batumi (GE) – to better understand how local communities perceive the benefits provided by marine ecosystems and how much they are willing to pay (WTP) for their protection. The assessment focused on three categories of ES: wild capture fisheries (provisioning), tourism (cultural), and lifecycle maintenance and habitat protection (regulating).

Public preferences were collected through an online survey designed to explore how people value different marine protection options. Participants were asked to choose between alternative future scenarios for managing coastal areas, each with different environmental and access conditions, and to indicate how much they would be willing to pay each year to support their preferred option.

The analysis explored how people value different marine protection measures and their associated benefits, such as improved fish stocks, greater biodiversity, clearer water, and stronger coastal protection, considering how activities like fishing, anchoring, and recreation might be managed within protected areas. Surveys were conducted in Türkiye, Georgia, and Romania. Participants were asked to choose among a range of hypothetical protection scenarios and to indicate which ones they would support, as well as how much they would be willing to pay yearly for their implementation. Results showed positive willingness to pay in all three countries, with the highest values reported in Türkiye, followed by Georgia and Romania. Respondents tended to favour stricter protection options, particularly those limiting anchoring and amateur fishing, reflecting strong public concern for the long-term health of marine ecosystems.

By translating ecological benefits into economic terms, the study provides a replicable framework for integrating societal values into marine management. It also serves as a decision-support tool to inform cost–benefit assessments, improve communication with stakeholders, and shape policies aligned with both ecological priorities and public preferences.

Responsible partner: AUEB

Reference project document(s):

D6.2 Valuation of ecosystem services

EXPECTED IMPACT

Understanding the public's willingness to pay (WTP) for healthier marine environments facilitates the design of policy measures that are not only environmentally effective but also socially acceptable. By revealing the economic value that citizens give to marine ecosystem services such as fisheries, coastal tourism, and habitat maintenance, and how they perceive the benefits of marine protection, the study offers relevant information design management strategies adapted to local preferences and needs. Quantifying WTP for different scenarios offers a robust evidence base for introducing targeted measures such as marine fees, restrictions on damaging activities, or protected areas.

Results are presented disaggregated by income level, education, age, and occupation, revealing patterns across social groups that should be considered when designing communication and compensation measures. The analysis also reveals significant differences between sites, highlighting the need for locally tailored interventions instead of uniform, one-size-fits-all approaches.

These findings contribute to improve the alignment between environmental policy and public expectations in the Black Sea region, supporting more equitable and legitimate marine governance, where protection efforts are not perceived as constraints, but as shared commitments to long-term well-being.

Moreover, the methodology applied, combining economic valuation with participatory surveys, can be replicated across other coastal contexts, helping to build a broader understanding of societal support for marine ecosystem protection.



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KO_6.2 2050 Stakeholders' vision and blue economy transformative pathways for the Blue Economy

A transformative pathway refers to a trajectory of change that leads to a fundamental and significant shift in a system, process, or situation moving away from current unsustainable practices towards a desirable and sustainable future. This approach challenges the status quo and fosters outcomes that are more resilient, equitable, and environmentally sound.

At pilot site level, transformative pathways were co-designed with local stakeholders through a participatory approach. Key ecosystem services and blue economy sectors were identified, and a shared 2050 vision was developed around them. To support this vision, stakeholders outlined the intermediary steps (milestones) required in each blue economy sector to reach the sustainability goals for their coastal regions by 2050. These milestones are accompanied by a set of targeted actions, including management measures, technological innovations, and social changes needed to reach them.

Together, these actions form a roadmap for the sustainable development of the blue economy in each of the study areas (pilot site), grounded in the principle of maintaining or achieving good environmental status of marine and coastal ecosystems. It consists of a portfolio of short, mid and long terms actions combining technological, social, institutional innovations, necessary to transform blue sectors towards sustainability, in order to reach to future envisioned by stakeholders (2050 stakeholder vision).

Transformative pathways include the following key elements:

- social, technological and institutional innovations, management measures to be taken and best practices to be implemented,
- Barriers to be addressed and enablers to be capitalized on when implementing the pathways
- Organisations that are expected to lead the implementation of specific actions within the pathways

Responsible partner: AUEB

Reference project document(s):

D6.3 Transformative pathways for Blue Growth

EXPECTED IMPACT

By articulating shared long-term visions and locally grounded transition pathways, this work enhances the strategic orientation of blue economy development across the Black Sea region. It empowers stakeholders to define realistic and desirable futures, aligning sustainability objectives with context-specific priorities and capacities. The participatory process strengthens stakeholder ownership, improving the social legitimacy and feasibility of proposed actions.

These portfolios of short-, mid- and long-term actions provide practical guidance for integrating sustainability into blue economy strategies, supporting marine spatial planning, investment prioritisation, and adaptive governance. By combining ecosystem protection goals with economic and social dimensions, the pathways promote a more balanced and forward-looking approach to marine and coastal management. They also help identify key enablers in terms of innovation, financing, and institutional reforms, and structural barriers that should be addressed to achieve long-term resilience.

These results can inform policy at both national and regional levels, contributing to the implementation of mission-driven strategies and reinforcing alignment with long-term goals under the EU Mission Ocean, the European Ocean Pact, the Common Maritime Agenda, and other relevant frameworks.



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KO_6.3 Stakeholders engagement for developing Blue Economy sustainable development strategies

Strengthening stakeholder engagement is critical for shaping inclusive and context-sensitive pathways toward sustainable Blue Economy development. The document provides a comprehensive set of guidelines and practical recommendations for implementing participatory co-design processes that foster local ownership, improve legitimacy, and support transformative change in marine and coastal governance.

Building on co-design activities and living lab experiences across Black Sea pilot sites, these guidelines identify effective approaches and tools to engage diverse stakeholder groups, including local communities and small-scale fishers, youth, public authorities, scientists, and private actors, in decision making processes. Participation is framed around key participation principles such as transparency, inclusiveness, long-term engagement, and responsiveness to local conditions and needs.

Guidelines include:

- Recommendations to engage stakeholders to drive transformative change;
- Procedures to implement sustainability living labs, including how to tailor them to different local contexts;
- Identification of the appropriate tool for each purpose, matched to objectives such as planning, knowledge sharing, conflict resolution, or capacity building;
- Local stakeholders' feedback on the co-design process, including factors for success, barriers encountered and areas for improvement;
- Tips and common pitfalls to avoid when implementing participatory processes.

These guidelines address the dynamic and evolving nature of participation, highlighting the need to adapt engagement formats over time and foster shared learning, particularly in areas where institutional trust may be low or stakeholder groups are underrepresented. They consolidate validated approaches and field-based insights into a transferable framework that can inform future initiatives in the Black Sea and other regional seas.

Responsible partner: AUEB

Reference project document(s):

D6.4 Living Lab Report

EXPECTED IMPACT

The adoption of these participatory guidelines can lead to more inclusive and effective marine governance in the Black Sea region. Incorporating local knowledge and stakeholder priorities into policy development, authorities are better equipped to design strategies that reflect local realities and generate stronger public support. This contributes to more socially accepted, resilient, and actionable Blue Economy policies.

Engagement processes based in co-design and living lab approaches not only improve mutual understanding and trust among actors but also reduce the likelihood of conflicts by fostering a sense of shared ownership over marine and coastal initiatives. These participatory dynamics are particularly relevant in contexts with complex governance structures or competing sectoral interests.

The practical tools, typologies, and lessons presented in the guidelines enhance the capacity of local institutions, facilitators, and marine practitioners to manage participatory processes effectively, including how to identify appropriate entry points, manage stakeholder diversity, and tailor engagement strategies to different governance settings. This supports a culture of participation and collaborative problem-solving at multiple levels.

Beyond immediate application in the Black Sea, the guidelines offer a replicable model that can be transferred and adapted to other coastal regions facing similar challenges, contributing to mainstreaming inclusive and participatory approaches in marine policy, in line with global ocean governance targets and sustainability commitments.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

15. WP 7 – Accelerating ‘Industry 4.0’ business models

KO_7.1 Business acceleration platform on Black Sea Blue Economy

The Black Sea Accelerator (BSA), developed under BRIDGE-BS in collaboration with the DOORS project, is designed to foster innovation and sustainability in the region’s blue economy. This initiative provides tailored support to early-stage entrepreneurs and research-based solutions that address key challenges in sectors such as coastal tourism, fisheries, marine biotechnology, renewable energy, and sustainable shipping. By offering mentoring, service acquisition, access to finance, and networking opportunities, the BSA helps promising ideas progress through proof-of-concept to proof-of-business stages.

Two accelerator calls were launched to attract innovative proposals across the Black Sea region. Applications were evaluated based on their environmental relevance, technological feasibility, and scalability, and selected candidates received support through structured programmes involving expert mentoring, targeted training, and investor matchmaking.

Special emphasis was placed on aligning business development with sustainability principles, promoting solutions that reduce environmental impacts, foster circularity, and support the ecological resilience of Black Sea ecosystems. The BSA also contributes to the development of a supportive innovation infrastructure by facilitating cross-sectoral collaboration, enhancing innovation readiness, and stimulating entrepreneurship in less mature or emerging sectors.

The accelerator is embedded in a wider innovation landscape, closely linked to Living Labs (KO_6.3) and the High-Tech Summits (KO_7.3) to ensure alignment with regional priorities and policy agendas.

Responsible partner: SML, BSEC, DTU

Reference project document(s):

D7.1 Guidelines for the accelerator platform implementation

D7.3 Report on BRIDGE-BS business initiatives: activities and impacts

EXPECTED IMPACT

The BSA contributes to strengthen the innovation capacity of the Black Sea blue economy by boosting the development and uptake of sustainable, market-ready technologies and services. It supports job creation, fosters green business models, and promotes improved environmental performance across traditional and emerging maritime sectors.

By integrating regional actors, from academia and start-ups to public institutions and investors, this initiative encourages collaboration and knowledge exchange, helping to connect innovation supply and demand. Supported businesses are expected to contribute to a more efficient use of marine resources, low-emission practices, and the restoration of marine and coastal ecosystems.

In addition, the BSA addresses persistent barriers to innovation in the region, such as limited access to finance, weak internationalisation, and insufficient support services for early-stage enterprises. By offering tailored mentoring, matchmaking, and investor readiness support, it helps participating companies to address these constraints and scale up their solutions.

The initiative also promotes alignment between technological innovation and regional sustainability priorities, facilitating the development of solutions that respond to context-specific needs and policy priorities, such as marine pollution mitigation, smart aquaculture, or port decarbonisation.

By embedding the accelerator in a broader regional innovation support structure (coordinated with other related actions, and in dialogue with policy stakeholders), the program fosters institutional learning and cross-sector synergies, contributing. This contributes to building a more resilient, interconnected innovation environment in the Black Sea and strengthens the capacity of public institutions to engage with private-sector actors on sustainability challenges.



This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 101000240

KO_7.2 Business models and initiatives around BRIDGE-BS

A comprehensive review of existing and emerging business models across key Blue Economy sectors in the Black Sea was conducted to assess innovation potential, environmental performance, and investment readiness. The analysis covers both well-established and emerging sectors, including ocean observation and monitoring, fisheries and aquaculture, ports and logistics, marine tourism, blue biotechnology, sustainable marine energy, and nature-based solutions. The analysis explores how these sectors are positioned in terms of market dynamics, regulatory context, innovation uptake, and integration of sustainability principles.

By identifying promising practices and persistent barriers, the report offers targeted insights into how innovation can be accelerated. Challenges such as fragmented funding landscapes, limited access to risk capital, and insufficient coordination between research and industry are highlighted, alongside sector-specific constraints (e.g., regulatory gaps in aquaculture or low digitalisation in ports). At the same time, high-potential opportunities are documented, including the integration of digital tools for environmental monitoring, circular economy applications in tourism and fisheries, and the commercialisation of marine genetic resources.

The work provides a strategic basis for public authorities, funding bodies, and innovation actors to design interventions that unlock private investment and accelerate the uptake of sustainable business models. It supports ongoing dialogue between policy and industry and connects with other BRIDGE-BS initiatives, including the Blue Economy Accelerator (KO_7.1) and Living Labs (KO_6.3), to align financial support mechanisms with real-world needs.

Responsible partner: SML, DTU

Reference project document(s):

D7.2 Collection of business models around BRIDGE-BS

EXPECTED IMPACT

This report provides strategic guidance for policy alignment and funding coordination, helping to direct investments toward high-potential sectors of the Black Sea Blue Economy. By identifying strategic areas where public support can have the highest leverage effect in enabling new business models and attracting private capital, it helps to define national and regional investment priorities in alignment with the Common Maritime Agenda's objectives on competitiveness and investment.

The analysis assesses sectoral innovation capacity and market readiness, revealing where efforts are most needed to unlock transition pathways, from concept-stage ideas to commercially viable products and services. It also identifies persisting barriers that need to be addressed to shift from a fragmented landscape towards a more coherent innovation ecosystem.

To ensure continuity beyond the lifetime of BRIDGE-BS, the report recommends institutionalising the Black Sea Accelerator as a long-term structure to bridge funding gaps, align support services to technology readiness levels, and reinforce collaboration between national and regional innovation systems. Strengthening links among accelerators, funding instruments, and policy frameworks will help consolidate local innovation capacity and maximise the impact of public and private investments.

Coordinating these elements supports the development of a more resilient, innovation-driven Blue Economy in the Black Sea, better positioned to compete globally while addressing regional socio-economic and environmental priorities.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

KO_7.3 High Tech Summit for the Black Sea (HTS4BS)

The High Tech Summit for the Black Sea (HTS4BS) has been set up as a research-based innovation forum focused on digitalisation, marine technologies, and Industry 4.0 applications in the Blue Economy. Designed as a strategic interface between science, policy, and industry, it brings together innovators, entrepreneurs, investors, researchers, public authorities, and civil society from the Black Sea region and beyond. It aims to accelerate the uptake of sustainable, digital, and circular economy solutions by fostering collaboration and showcasing real-world innovation.

Two editions of the HTS4BS were organised under BRIDGE-BS, in Varna (2022) and in Sofia (2024) respectively, attracting over 300 participants across both events. Sessions were structured to promote exchange between early-stage ventures, support providers, and funding actors, while offering visibility to emerging solutions tailored to regional challenges.

Both events included thematic panels on renewable marine energy, sustainable aquaculture, blue biotechnology, digital and green port systems, yachting, circular economy, maritime security, and environmental monitoring. Key highlights included the promotion of the Black Sea Accelerator (KO_7.1), with selected participants presenting business ideas developed through the programme. Pitching sessions allowed these initiatives to connect with investors and mentors, creating a platform for market entry and scaling.

Beyond its role as a showcase for regional innovation and blue economy solutions, the HTS4BS is evolving into a central gathering point for shaping the regional innovation agenda and building long-term collaboration mechanisms, including links to Living Labs (KO_6.2), regional clusters, and national innovation frameworks.

Responsible partner: SML, BSEC, DTU

Reference project document(s):

D7.3 Report on BRIDGE-BS business initiatives: activities and impacts

EXPECTED IMPACT

The HTS4BS plays an enabling role for shaping a forward-looking innovation landscape in the region, as it supports the emergence of a more dynamic and connected blue economy by fostering collaboration between academia, business, and policy, therefore helping to close the gap between technological development and market application.

By showcasing concrete digital solutions, business innovations, and research results from the Black Sea region, the event illustrates how innovation can be applied to address challenges such as marine pollution, inefficient resource use, and the impacts of climate change. It contributes to translating project outcomes into practical, policy-relevant discussions among entrepreneurs, researchers and decision-makers, supporting the implementation of the Common Maritime Agenda for the Black Sea, particularly its goals on innovation, investment alignment, and regional cooperation.

The HTS4BS facilitates early exchanges on regulatory frameworks and innovation support needs, providing policymakers with first-hand insights on emerging technologies and business models. This facilitates the design of more responsive governance tools, such as public-private partnerships and targeted funding instruments.

In the longer term, establishing the HTS4BS as a regular regional event can enhance continuity and visibility for blue innovation. It strengthens alignment with broader EU and international strategies, including the EU Ocean Mission, the European Ocean Pact, and the Sustainable Blue Economy Partnership.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

KO_7.4 Black Sea roadmap for “Industry 4.0” acceleration

Through extensive research, four rounds of Living Labs, two editions of the High-Tech Summit for the Black Sea, the Black Sea Accelerator, and many more, BRIDGE-BS has identified critical gaps in funding, market access, and technical expertise. Building on these insights, BRIDGE-BS has outlined a roadmap with concrete recommendations to address these gaps and advance a sustainable and innovative Blue Economy in the Black Sea.

Infographics on the Black Sea Roadmap for Industry 4.0 Acceleration aims to define the main challenges for Blue Economy to flourish in the Black Sea and potential solutions driven as a result of BRIDGE-BS activities such as Black Sea Accelerator, living labs, flagship events such as High-Tech Summit for the Black Sea. It is developed in cooperation with outputs of WP5, WP6, and WP8.

Responsible partner: SML, DTU, METU

Reference project document(s):

D7.4 Infographics on the Black Sea roadmap for Industry 4.0 acceleration

EXPECTED IMPACT

The roadmap builds on evidence generated through BRIDGE-BS Living Labs, the High-Tech Summit, and the Black Sea Accelerator to provide a coherent set of recommendations that empower start-ups, entrepreneurs, and maritime sectors to integrate advanced tools such as automation, AI, sensors, and digital twins. The Roadmap for Industry 4.0 has potential to accelerate the digital and technological transformation of the Black Sea Blue Economy by identifying clear pathways for the uptake of Industry 4.0 solutions, reducing fragmentation, and strengthening regional innovation ecosystems. By outlining actionable measures for improving funding access, enhancing investment readiness, stimulating cross-border collaboration, and supporting SME innovation, it will help bridge existing gaps in technology adoption, market access, and digital capacity.

In alignment with major European initiatives and strategies—including **Mission Ocean**, the **EU Ocean Pact** the **European Blue Economy Strategy**, the forthcoming **Ocean Act** and regional policy frameworks - **Common Maritime Agenda for the Black Sea**, **EU Strategic approach to the Black Sea Region** and investment instruments such as **BlueInvest**—the roadmap positions the Black Sea region to better integrate into the broader EU innovation and sustainability landscape. By offering a strategic direction for policy harmonisation, responsible innovation, digitalisation, and sustainable blue growth, it strengthens the region’s ability to contribute to EU-wide climate neutrality goals and to the transition towards a resilient, carbon-neutral, and innovation-driven maritime economy.



This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 101000240

16. WP8 Science-based policy making for Blue Growth

KO_8.1 Integrated policy review and dialogue in the Black Sea

The report provides a comprehensive review of national policies and regional frameworks for the Blue Economy in the Black Sea both at sector-level, focusing on established and emerging Blue Economy sectors and cross-sectorial, focusing on three overarching priorities, i.e. multiple stressors, innovation and capacity building.

It serves as a basis for targeted and result-oriented science-policy dialogue and knowledge transfer, tailor-made to respond to actual needs and priorities.

Desk research and consultations with key national and regional stakeholders were implemented, with the aim to assess the current state-of-play of the Blue Economy sectors and identify actual needs and bottlenecks for the successful development of a sustainable blue economy in the Black Sea.

Responsible partners: ICBSS, CETMAR

Reference project document(s):

D8.1 Integrated Policy Review and Dialogue in the Black Sea

EXPECTED IMPACT

The document reviews both challenges and opportunities in the established and emerging Blue Economy sectors in the Black Sea, suggesting measures to address them sustainably and result oriented. These recommendations could provide an entry point for policy makers to help guide their decision-making process, and prioritise their efforts accordingly, to achieve the desired outcomes.

Given that certain gaps and challenges remain or require additional consideration, the document could support a collaborative dialogue process, with involved stakeholders other than the policy makers, such as funding agencies, business, researchers and academia, and the general public.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

KO_8.2 Guiding Manual for enhanced science-policy synergy

A flexible tool to strengthen users' capacity to utilize the knowledge generated by BRIDGE-BS to support future science-based policymaking. The manual provides guidelines to support the use of knowledge outputs developed under BRIDGE-BS, in the different administrative, economic, environmental and social contexts of the policy and decision-making processes.

Responsible partners: ICBSS, CETMAR, CPMR

Reference project document(s):

D8.2 Guiding Manual for policy makers and knowledge transfer activities in the Black Sea

EXPECTED IMPACT

The manual includes tools and processes to enable and strengthen effective science-policy interface. It provides guidelines to support two-way communication, help make scientific knowledge available and relevant, and clarify policy needs for the research community.

Science-based policies require ongoing monitoring, evaluation of outcomes and adaptation where necessary. By strengthening the science-policy interface, policy makers can understand challenges, consider different perspectives to make informed decisions and create resilient strategies that align with the public interest.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

KO_8.3 BRIDGE-BS International Policy Brief: Reinforcing the implementation of marine EU and international policies in the Black Sea Region

The BRIDGE-BS International Policy Brief summarises key knowledge generated by the project and provides recommendations for its implementation in support of marine policies in the Black Sea. Rather than providing full account of scientific results, it is aimed at highlighting relevant findings for governance and regional cooperation. The document draws on the project work on environmental stressors, ecosystem resilience, future scenarios and progress in monitoring and modelling, with a focus on how this knowledge and tools can reinforce current policy agendas to address pressing challenges in the region.

Recommendations presented cover both policy and research needs, including measures to improve monitoring and reporting, strengthen ecosystem-based management, enhance data availability and use, and consolidate regional cooperation mechanisms. It also points out areas where investment in innovation and capacity building are required.

Responsible partners: EMB

Reference project document(s):

D8.3 BRIDGE-BS International Policy Brief

EXPECTED IMPACT

The Policy Brief is expected to contribute to the uptake of scientific knowledge in policy processes and reinforce the implementation of marine and environmental commitments in the Black Sea. By presenting an overview of the project results an accessible way, it enables decision makers to connect research outputs with their immediate responsibilities in planning, monitoring, and cooperation. The recommendations help to clarify where coordinated action is needed.

In the short term, the Policy Brief provides administrations and regional organisations with targeted advice that can be applied in national strategies and regional dialogue. It provides guidance on how knowledge from BRIDGE-BS relates to their ongoing work and priorities. In the medium term, it encourages improved alignment across countries through harmonised monitoring, more consistent approaches to planning, and stronger science–policy dialogue. Over the longer term, it is expected to contribute to the development of more resilient management practices, better aligned national and regional strategies, and steady progress toward biodiversity, climate, and sustainability goals.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

KO_8.4 2030 Blue Roadmap for the Black Sea

The BRIDGE-BS Roadmap is a strategic document designed to ensure the long-term visibility, uptake, and impact of the scientific and innovation results generated by the project. It consolidates a wide range of Knowledge Outputs (KOs) into a coherent set of actions that respond directly to the priorities of the Black Sea Strategic Research and Innovation Agenda (BS-SRIA). By linking research findings with policy frameworks at both regional and EU level, the Roadmap provides a practical guide to how BRIDGE-BS knowledge can be applied beyond the lifetime of the project.

The Roadmap is structured around the four SRIA pillars, addressing ecosystem research, blue economy innovation, support systems and infrastructures, and the policy and society dimensions. It shows how project results contribute to advancing regional cooperation, strengthening monitoring and observation capacities, fostering innovation in existing and emerging sectors, and enhancing science–policy dialogue. The proposed actions represent opportunities for collaboration and reference points for future initiatives.

Beyond highlighting BRIDGE-BS contributions, the document translates scientific results into policy-targeted actions that can inform decision-making processes and support policy implementation under different frameworks. It also underscores opportunities for innovation and entrepreneurship, helping to create enabling conditions to unlock the potential of the sustainable blue economy in the Black Sea.

Responsible partners: CETMAR

Reference project document(s):

D8.4 Black Sea Blue Roadmap: a BRIDGE to the future

EXPECTED IMPACT

The 2030 Blue Roadmap for the Black Sea is expected to enhance the long-term impact of BRIDGE-BS by enabling the systematic uptake of its scientific outputs into regional and European marine governance. By translating complex research findings into concrete, actionable steps, the Roadmap strengthens evidence-based policymaking and supports the implementation of key regional and EU frameworks, including the Black Sea SRIA, the Marine Strategy Framework Directive, the Maritime Spatial Planning Directive, the Nature Restoration Regulation, the EU Mission “Restore our Ocean and Waters”, the EU Ocean Pact, and the 2025 EU Strategic Approach to the Black Sea.

The Roadmap also provides a foundation for guiding future research and investment priorities by identifying gaps, opportunities, and areas where further development is required. This supports funders, national authorities, and regional organisations in shaping future agendas and ensuring alignment with emerging scientific knowledge. By proposing a structured action plan, it is expected to contribute to strengthening regional capacity through better knowledge transfer, structured science–policy dialogue, and more coordinated planning processes. Overall, the Roadmap is expected to facilitate the translation of BRIDGE-BS knowledge into practice, support more coherent and adaptive marine governance, and promote long-term resilience and sustainability in the Black Sea region.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

17. WP 9 Education and capacity building

KO_9.1 Science-Technology-Policy English language MOOC on Blue Economy

An open-access Massive Open Online Course (MOOC) has been developed to enhance awareness and understanding of the Blue Economy in the Black Sea, connecting scientific research, technological development, and policy relevance. Structured around BRIDGE-BS's three thematic nodes, Service Dynamics, Blue Growth Incubators and Empowered Citizens, the course integrates key knowledge outputs from the project and demonstrates their practical relevance in policy and innovation contexts.

The MOOC offers thematic modules covering ecosystem health and multi-stressor analysis, monitoring tools, biodiversity and ecosystem services, participatory governance, and business innovation. Each module draws directly on results from BRIDGE-BS, combining with field experience from pilot sites and living labs.

The course is hosted on METU's Open Course Ware platform and is freely accessible. It has been designed to be accessible to a wide audience, including early-career ocean professionals, local decision-makers, and practitioners without a technical background, offering an entry point into the Black Sea blue economy and promoting knowledge uptake across science, technology, and policy communities. By offering structured content in an accessible format, the MOOC helps to make BRIDGE-BS outputs usable beyond the project timeline and facilitates knowledge transfer across sectors.

Responsible partner: METU

Reference project document(s):

Access links: <https://bridgeblacksea.org/index.php/bridge-black-sea-mooc/>

<https://ocw.metu.edu.tr/course/view.php?id=365>

EXPECTED IMPACT

The MOOC helps build a common understanding of sustainable blue economy principles across different stakeholder groups, supporting efforts to connect scientific and technological knowledge with policy discussions and capacity-building activities. It contributes to strengthening the capacity of early-career professionals and other stakeholders to engage with sustainability challenges in the marine domain. By presenting knowledge developed through BRIDGE-BS, the course equips participants with a practical understanding of key scientific and technological approaches relevant to marine ecosystem protection and sustainable Blue Economy development.

The course also enables regional institutions to incorporate relevant training materials into their own capacity-building efforts. The topics covered contribute to building competencies to respond to requirements under policy frameworks such as the European Ocean Pact, the Marine Strategy Framework Directive or the Common Maritime Agenda for the Black Sea.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

KO_9.2 Summer School programme

The BRIDGE-BS Summer School is an intensive, multidisciplinary three-day training programme tailored for Early-Career Ocean Professionals (ECOPs) from Black Sea countries. It aims to enhance their understanding of the Blue Economy and strengthen their ability to address marine sustainability challenges through a science-policy-business perspective.

Thematic coverage includes ecosystem resilience, fisheries and aquaculture, marine renewable energy, blue biotechnology, and sustainable tourism. The proposed curriculum combines expert-led sessions with interactive workshops, providing both conceptual knowledge and applied learning opportunities. Through team-based activities and peer collaboration, participants explored practical challenges and developed context-specific solutions, including a hackathon-style activity held in the second edition.

Expert engagement is a key component, with sessions delivered by professionals from Black Sea and EU institutions, who encouraged interdisciplinary dialogue and introduced participants to context-specific practices and research priorities across the Black Sea region. The second edition placed stronger emphasis on the business perspective, particularly in the context of blue biotechnology, highlighting how sustainable solutions can align with economic viability and market potential.

The proposed format, combining expert-led sessions, collaborative discussions, and hands-on solution development, is replicable and adaptable to diverse regional or thematic contexts. It is particularly well-suited for early-career professionals involved in marine science, policy, and innovation.

Responsible partner: University of Istanbul

Reference project document(s):

- D9.1 First report on Good Practices on Training & Learning Exchange Program
- D9.2 Midterm report on Good Practices on Training & Learning Exchange Program
- D9.3 Final report on Good Practices on Training & Learning Exchange Program

EXPECTED IMPACT

The Summer School contributes to building a new generation of professionals equipped with the interdisciplinary knowledge and collaborative mindset needed to engage in the sustainable transformation of the Black Sea Blue Economy. By integrating scientific, policy, and innovation perspectives, the format encourages participants to reflect on the governance and funding conditions that influence marine sustainability efforts.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

KO_9.3 Black Sea Young Ambassadors programme

The Black Sea Young Ambassadors (BSYA) Programme supports a new generation of early-career ocean professionals (ECOPs) from Black Sea countries in actively promoting a sustainable, resilient, and healthy marine environment. Initiated under the Black Sea CONNECT project in 2020 and further expanded by BRIDGE-BS, the programme fosters youth leadership and regional cooperation around the shared vision of the Black Sea Strategic Research and Innovation Agenda (SRIA).

Ambassadors are selected from diverse fields across research, policy, civil society, and industry. Through dedicated training on the sustainable blue economy, science-policy communication, and stakeholder engagement, they gain the skills and knowledge to act as effective science-informed change agents. Mentorship by senior experts from BRIDGE-BS prepares them to take on future leadership roles in marine science and policy, while participation in Summer Schools, scientific expeditions, and joint PhD programmes deepens their research engagement and regional integration.

The programme places a strong emphasis on visibility and outreach. Ambassadors actively contribute to international forums (e.g. the SRIA Implementation Plan launch at the European Parliament), national blue economy dialogues, and local outreach activities, including biodiversity activities for schoolchildren. Through their initiatives, young ambassadors contribute to raise awareness of marine challenges and foster youth involvement and dialogue across science, policy, and society in the Black Sea.

Responsible partner: METU

Reference project document(s):

- D9.5 Young Ambassadors Reports
- D9.1 First report on Good Practices on Training & Learning Exchange Program
- D9.2 Midterm report on Good Practices on Training & Learning Exchange Program
- D9.3 Final report on Good Practices on Training & Learning Exchange Program

EXPECTED IMPACT

The programme supports active engagement of early-career professionals in marine sustainability and regional cooperation across the Black Sea. By providing targeted training, mentoring, and opportunities to engage directly with policy and stakeholder processes, it helps participants to develop the necessary knowledge and practical understanding to engage in marine and coastal policy discussions in the region.

As ambassadors take part in policy-related events, stakeholder meetings, and public engagement activities, they are able to provide new perspectives to existing processes and to improve communication between scientific, policy, and community actors. Their involvement promotes more inclusive and forward-looking approaches to marine decision-making, while their outreach efforts, especially at the local level, contribute to raise awareness of Black Sea issues among broader audiences.

The networks and relationships built through the programme also foster long-term collaboration across sectors and countries, helping to strengthen a sense of regional ownership and shared responsibility for the Black Sea, while enhancing participants' professional development and fostering future career prospects.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000240

KO_9.4 Black Sea Literacy Network

The Black Sea Literacy Network (BSLN), launched under BRIDGE-BS, is a regional platform that brings together marine scientists, educators, policymakers, industry actors, and community leaders to foster ocean literacy and promote shared responsibility for the protection and sustainable management of the Black Sea. By strengthening connections across countries and sectors, the network supports a culture of stewardship grounded in science, education, and civic engagement.

The BSLN facilitates the co-development and dissemination of educational materials and hosts a public directory of literacy initiatives, enabling the exchange of tools, experiences, and strategies across the region. Activities carried out within the network have engaged diverse audiences, including teachers, schoolchildren, and university students, through hands-on science, art, and outreach initiatives designed to cultivate an early appreciation for the Black Sea's uniqueness and challenges.

By bridging the gap between science, policy, and society, the BSLN serves not only as an awareness-raising platform but also as a strategic enabler of inclusive and informed marine policymaking. For decision-makers, it provides both a knowledge resource and a collaboration hub to strengthen science-policy-society dialogue and promote more responsive ocean governance in the Black Sea region.

Responsible partner: EMSEA

Reference project document(s):

D9.4 Mapping Past and Ongoing Ocean Literacy Initiatives in the Black Sea & Developing the Black Sea Literacy Network

EXPECTED IMPACT

The BSLN strengthens regional capacity for ocean literacy by building an active, interconnected community of educators, scientists, policymakers, and civil society actors, enhancing public understanding of marine ecosystems and promoting early engagement with the Black Sea's environmental challenges. Hands-on initiatives for students and teachers have fostered cross-generational awareness, encouraging young people to develop a personal connection with the sea and a sense of responsibility for its future.

Positioned at the interface between science, policy, and society, the BSLN acts not only as an awareness-raising platform but also as a strategic enabler of more inclusive, informed, and responsive policymaking in the region. More specifically, ocean-literate decision-makers are empowered to integrate scientific knowledge into policy processes, improving the quality, responsiveness, and legitimacy of marine governance at national and regional levels.

By promoting shared ownership and collaborative learning across countries and sectors, the BSLN contributes to a more informed and engaged society better positioned to support marine conservation goals. It contributes to building the foundations for a resilient and sustainability-oriented Black Sea community.



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