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EfxINNOs

EfxINNOs: Establishing and Operating an Innovative Marine Technology Transfer Network for Enhancing the Transition to a Sustainable Blue Economy in the Black Sea Basin

ΔΗΜΟΚΡΙΤΕΙΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΡΑΚΗΣ
DEMOCRITUS UNIVERSITY OF THRACE

Georgios Sylaios
Professor
Democritus University of Thrace

Tbilisi, 16/4/2026

Setting the Scene

- The catchment Black Sea area exceeds 2 million sq. km
- It covers partially or entirely 23 countries
- Three main River Basins exist: Danube, Dnipro, and the Don – total 350 km^3 annually
- 160 million people live in the Black Sea Basin
- 10 million tourists visit the region annually.

The Black Sea drainage basin

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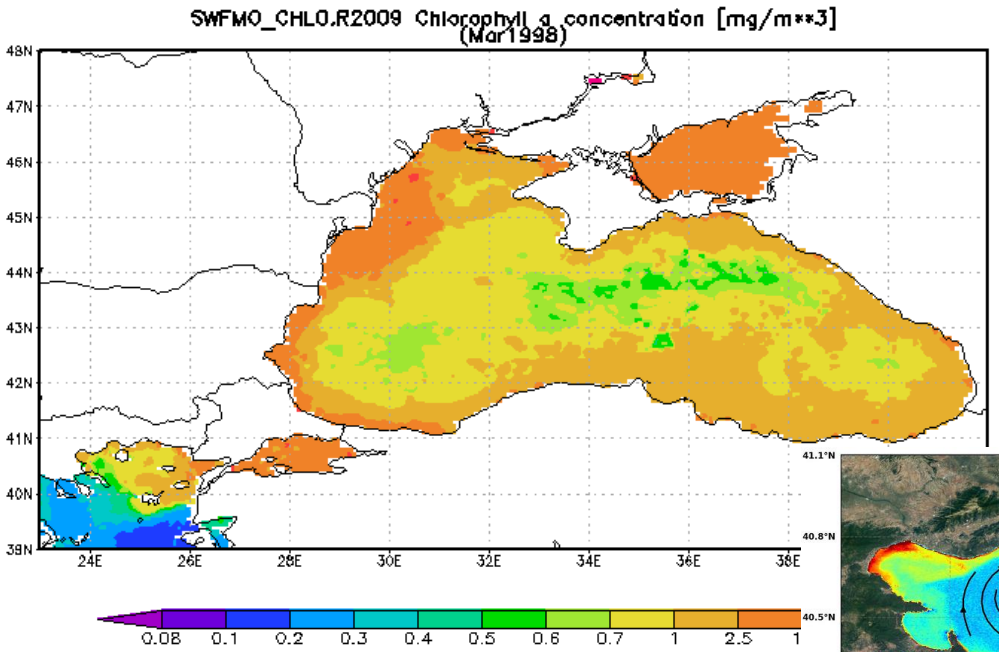
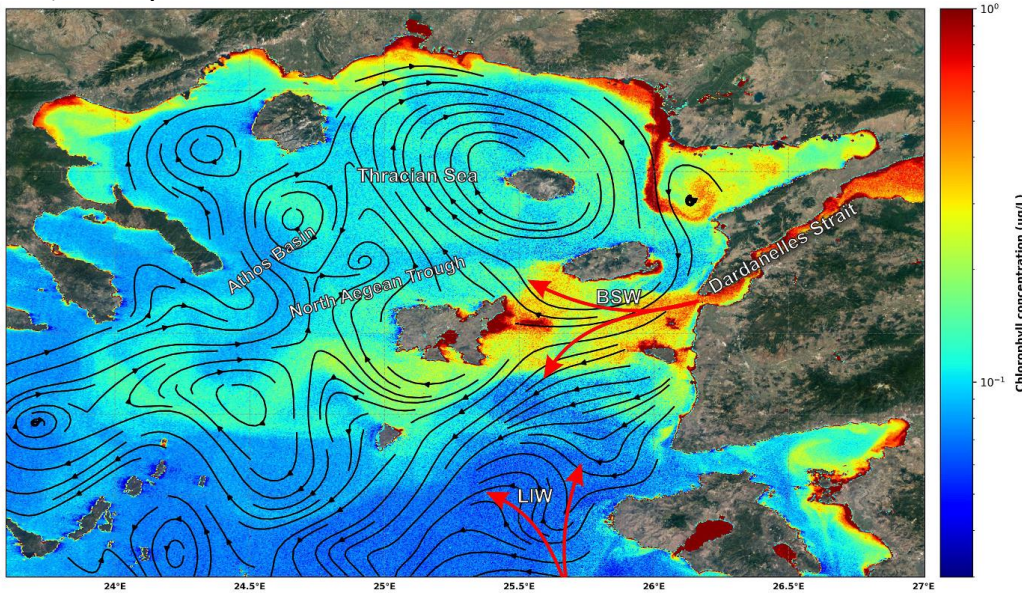
Understanding the Environment



The Black Sea Water exits from the Bosporus Straits, covers the Maramara Sea and spreads over the North Aegean and the Thracian Sea.



In EfxINNOs we focus on seabed ecosystems

Seagrass forms the most vital but highly vulnerable part of the seascape.
Seagrass meadows are the **“lungs” of the coastal ocean**.
They support commercial fisheries and biodiversity, clean the surrounding water, and help **remove the excessive carbon dioxide** from the atmosphere.

The value of sea-bed ecosystems

Seagrass is essential for marine biodiversity and vital for underwater life.

They **absorb the incident wave energy** and protect our coastal zones from erosion, storms and floods.

Through **carbon sequestration**, seagrasses sink and store carbon mitigating CC.

Seagrass meadows are very efficient nitrogen strippers, **removing chemical elements** that cause harmful algal blooms.

They are the oxygen pumps of the ocean:

1 sq.m. of seagrass produces 10 L O_2/day.

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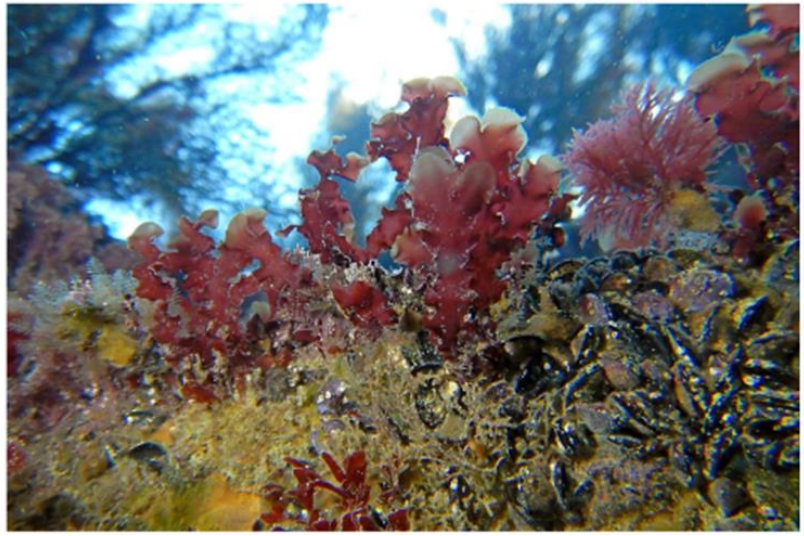
The value of sea-bed ecosystems

Seagrass meadows provide numerous ecosystem services, including **nursery habitats for commercially important marine species** such as bivalves, crustaceans, fish, and sea turtles, thereby enhancing coastal biodiversity.

Zostera Marina

A high bias exists in the assessment of global seagrass coverage, ranging from 17×10^6 to 60×10^6 ha.

This uncertainty highlights the need for further intensive research to map seagrass distribution worldwide and better understand their spatio-temporal changes in relation to human pressures.



Phyllophora Crispa

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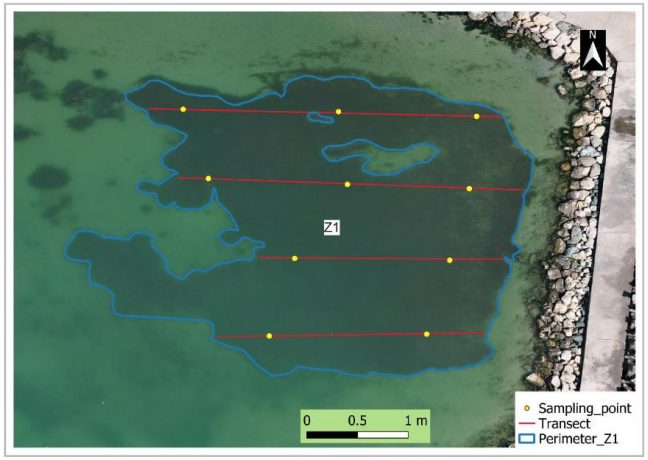
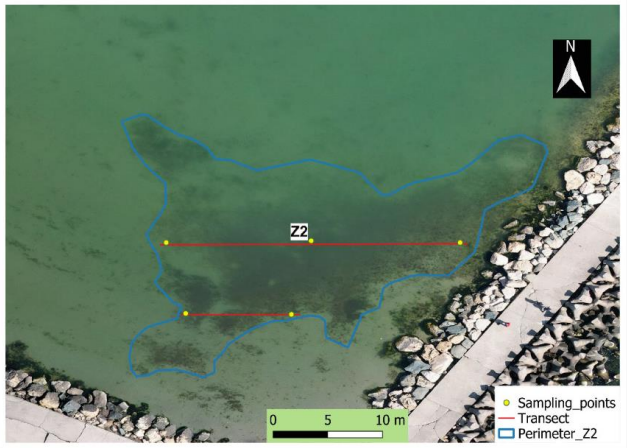
The value of sea-bed ecosystems

Jackson et al. (2015) used a seagrass residency index to calculate the contribution of seagrass habitat provisioning service to the Mediterranean commercial fisheries landings value (CFV) and recreational fisheries value (RFV), **estimating that approximately 4 % of CFV and 6 % of RFV** were directly linked to seagrass, corresponding to approximately EUR 77.7 million (CFV) and EUR 112.6 million (RFV).



(a)



(b)

Seagrass meadows under threat

Seagrass meadows are among the least protected coastal ecosystems. Almost 30% of global seagrass areas have been lost since the late nineteenth century. An estimated 7% of this vital habitat disappears each year.

The main threats to seagrass include **urban, industrial, and agricultural run-off; coastal development; dredging; unregulated fishing and boating activities; and climate change**.

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Seagrass meadows under threat

Approximately 19.1% of the area of monitored meadows has been lost since monitoring began in the 1900s.

However, in many parts of the world, seagrass coverage is not systematically monitored, so the areas most at risk of decline and the management actions needed there are largely unknown.

This lack of data contradicts other valuable coastal habitats, such as coral reefs, which have extensive long-term monitoring programs, and mangrove forests, which can be observed in satellite imagery.

Ulva ulva

Potamogeton pectinatus L.

Black Sea Seagrass communities

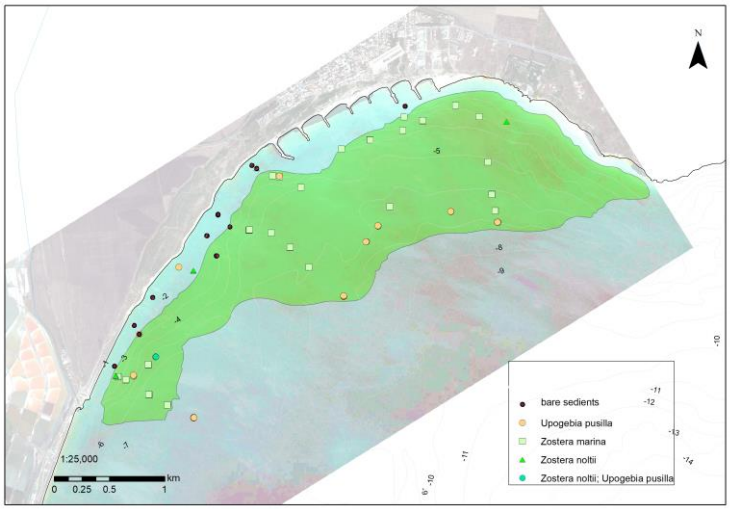
There are six species of seagrasses in the Black Sea: *Zostera marina* (eelgrass), *Z. noltii*, *Potamogeton pectinatus*, *Ruppia maritima*, *R. spiralis* and *Zannichellia major*.

The number of plant species in the Black Sea is **one-fourth** that of the Mediterranean.

Increasing anthropogenic pressure (industry, agriculture, aquaculture and tourism) in BS coastal zones resulted in the decline of seagrasses presence.

Nutrient enrichment and the consequent phytoplankton blooms limit light transparency.

Epiphytes affect seagrasses negatively through shading and hypoxia.



Zostera spp. seagrass meadow in front of Sarafovo, Inner Burgas Bay. Berov D, Klayn S, Deyanova D, Karamfilov V (2022) Current distribution of Zostera seagrass meadows along the Bulgarian Black Sea coast (SW Black Sea, Bulgaria) (2010-2020). Biodiversity Data Journal 10: e78942.

Black Sea Seagrass communities

https://seagrassspotter.org/sighting/7167

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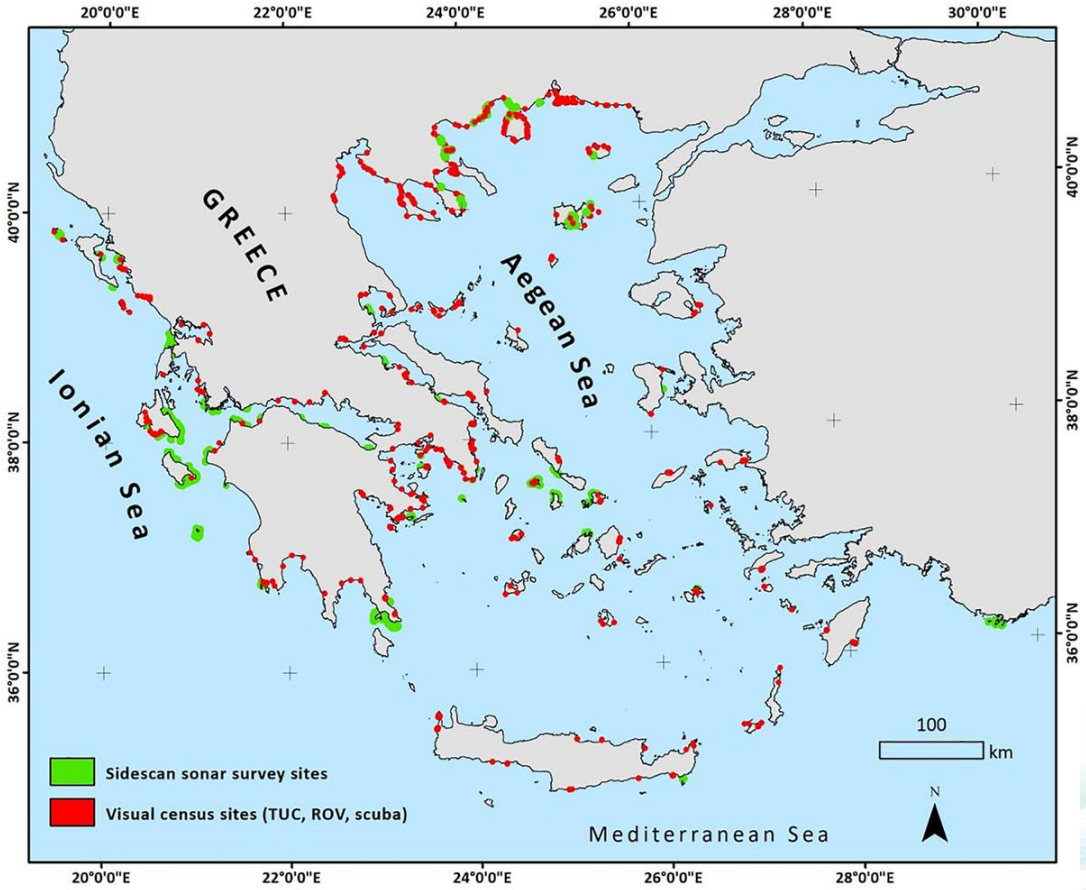
Table 4. The percentage of *Zostera* spp. in total biomass of macrophytes estimated from 1989 to 1991 on Kalanchakskaya shoal, Karkinitsky Bight (according to unpublished data from YugNIRO,1992)

Species	Year		
	1989	1990	1991
Zostera marina	32.1	42.8	55.1
Z. marina f. angustifolia	47.7	41.7	35.8
Z. noltii	20.1	15.5	9.0

Nataliya A. Milchakova, 1999

North Aegean Sea Seagrass communities



Panayotidis, P., et al.,2022. "Seagrass meadows in the Greek Seas: presence, abundance and spatial distribution" Botanica Marina, vol. 65, no. 4, 2022, pp. 289-299.

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«Establishing an Innovative Marine Technology Transfer Network for Enhancing the Transition to a Sustainable Blue Economy in the Black Sea Basin»

EfxINNOs Central Scope

To develop and operate a **novel, cost-effective, technologically advanced, sustainable network of monitoring platforms,** improving existing research infrastructures, serving the joint monitoring requirements of EU Policy Instruments and the Black Sea Integrated Monitoring Assessment Program (BSIMAP), linking the Black Sea and the North Aegean Sea.

Specific Objectives

EfxINNOs will advance knowledge on benthic marine ecosystem functioning, as well as on the impact of human stressors from land-based and maritime activities.

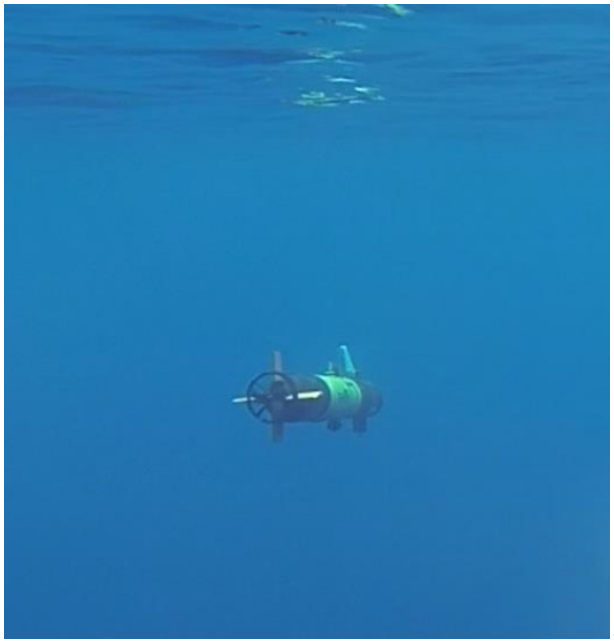
The project will fill the gaps in **data collection, data harmonization and policy implementation** among the BSB and the Med.

The project will develop a consistent approach for the protection and restoration of the Black Sea seabed ecosystems in line to MSFD.

EfxINNOs will produce science-based policy tools to serve the directions set by the Commission on the Protection of the Black Sea Against Pollution.

EfxINNOs - A Sea of Actions

a) Utilize innovative underwater platforms (like the microAUVs) for the mapping of coastal marine environment at selected regions of the BS and the NAS
b) Produce extensive digital seabed habitats maps, emphasizing on marine protected species, like the *Posidonia oceanica* and *Zostera marina* and *Zostera noltii* meadows
c) Collect new data, images and videos never earlier recorded to report on coastal marine biodiversity of the BS and NAS
d) Collect RT data on physicochemical conditions to serve maritime activities
e) Correlate the prevailing environmental seabed conditions with the present health of seabed habitats



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EfxINNOs - A Sea of Actions

f) Assess the ecological significance and delineate ecologically-sensitive regions and prioritize potential marine protected areas

g) Evaluate the existing threats that seabed habitats and benthic biodiversity face

h) Develop policy tools and directions to protect seabed habitats from man-made impacts

i) Link project outputs to EU Environmental Legislation (e.g., MSFD, MSPD, Biodiversity Strategy) with the objectives of SRIA and BSIMAP

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EfxINNOs - A Sea of Actions

j) Communicate results and raise awareness to minimize threats (e.g., marine litter at sea bottom, trawling, pollution, human actions like shipping, cables, etc.)

k) Educate people on the significance of coastal marine biodiversity protection

l) Report results and policy recommendations to the Common Maritime Agenda Steering Group of the BSEC

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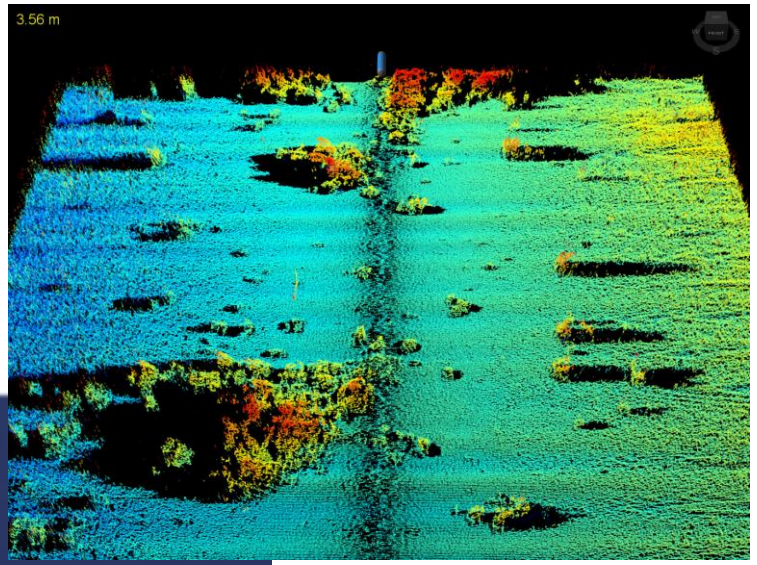
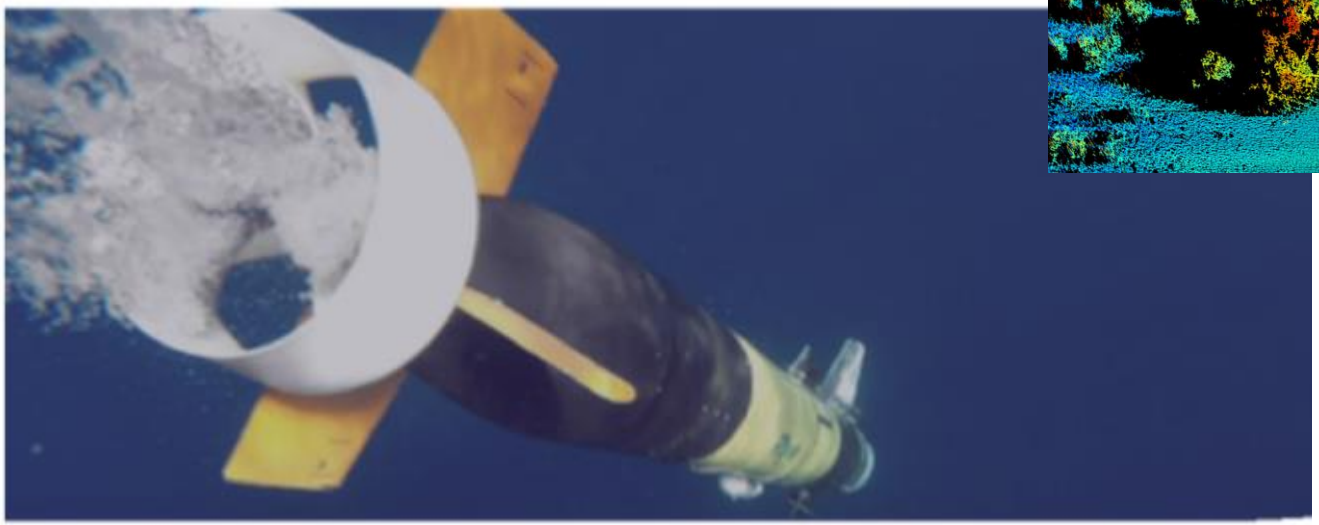
The microAUV

EfxINNOs has purchased and deployed a fleet of versatile microAUVs for the underwater exploration of seagrass meadows.

Max Operational Depth	300 m
Endurance	<10 hours[1]
Length	<0.9 m[1]
Hull Diameter	124 mm
Weight	<9 kg
Max Speed	8 knots
Positioning	GPS, INS, SPARSE-LBL





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The microAUV

Technology platform and data collection

RTSYS NEMOSENS mAUV equipped with:

- **RBRlegato CTD**: salinity and temperature data
- **GoPro Camera**: RGB videos and images
- **StarFish 454 Side Scan Sonar**: acoustic images

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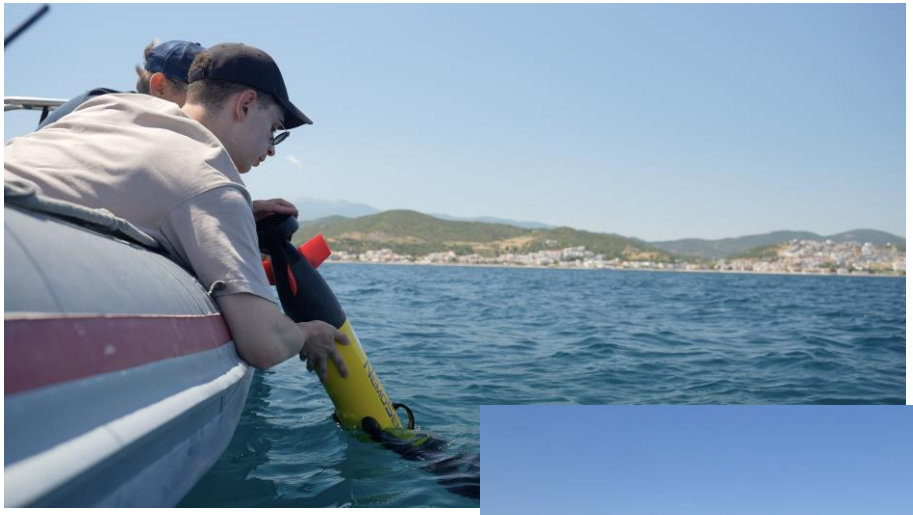
Instrumentation Training Workshops – mAUV (Greece)



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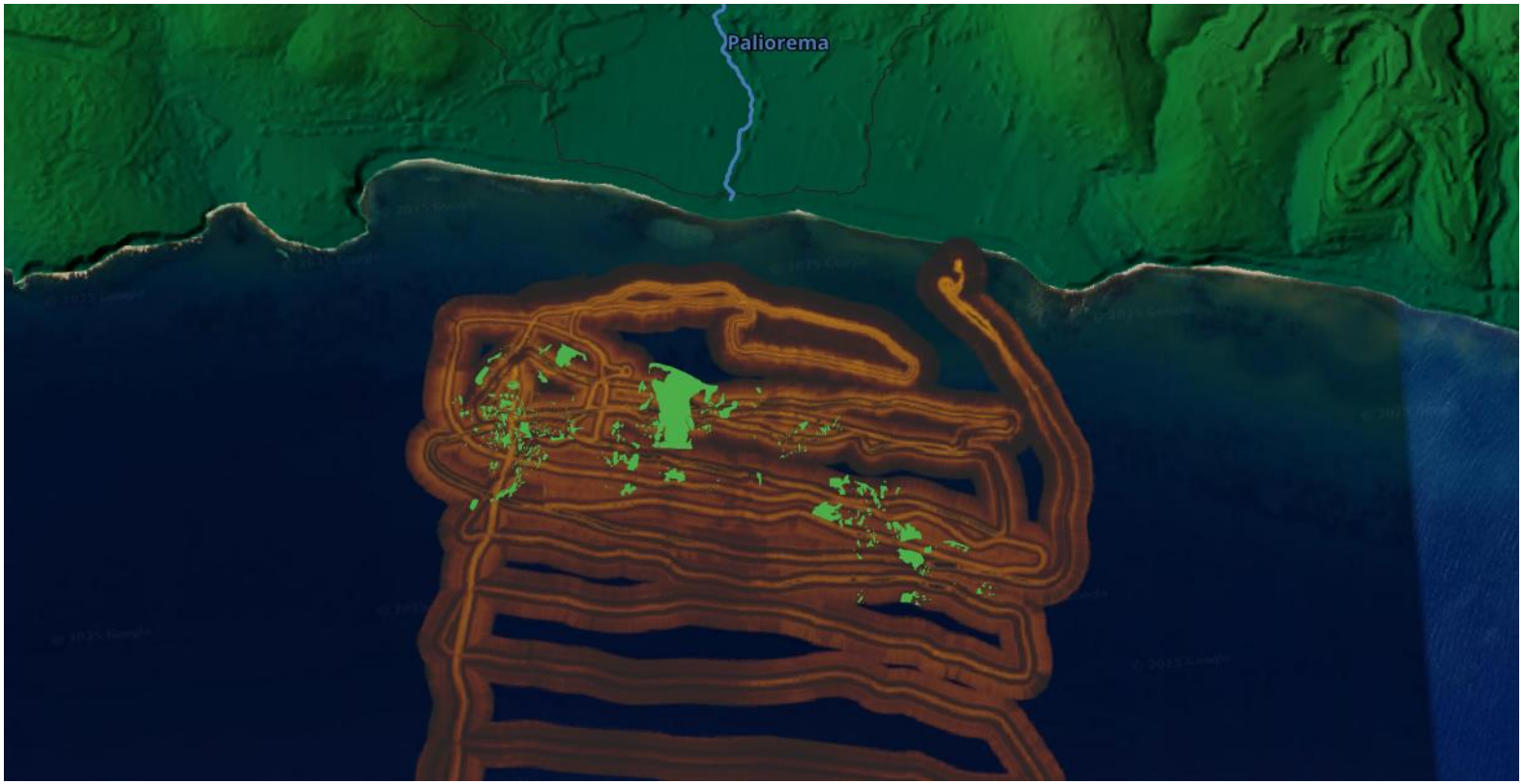
SONARWIZ

Digitizing features



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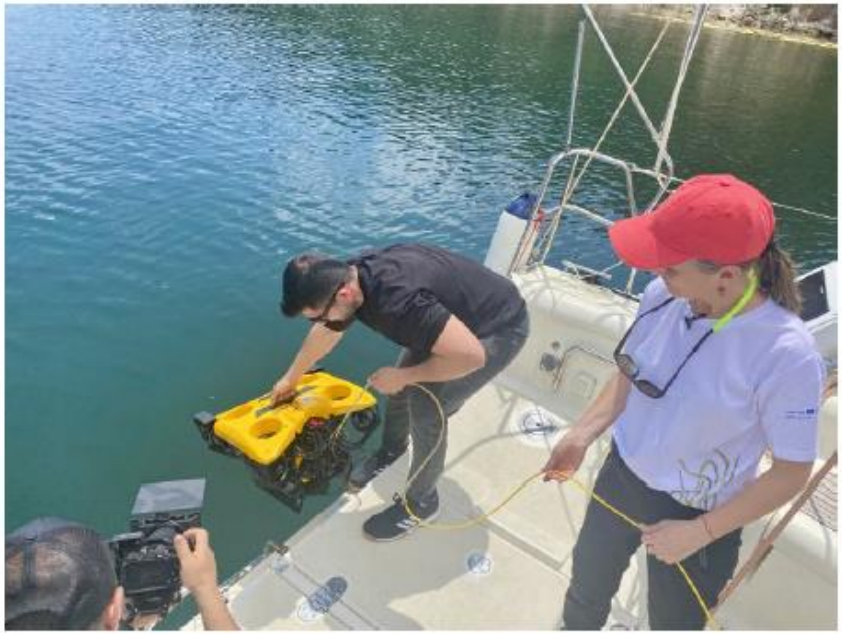
Seagrass Mapping with ROV (Turkey)



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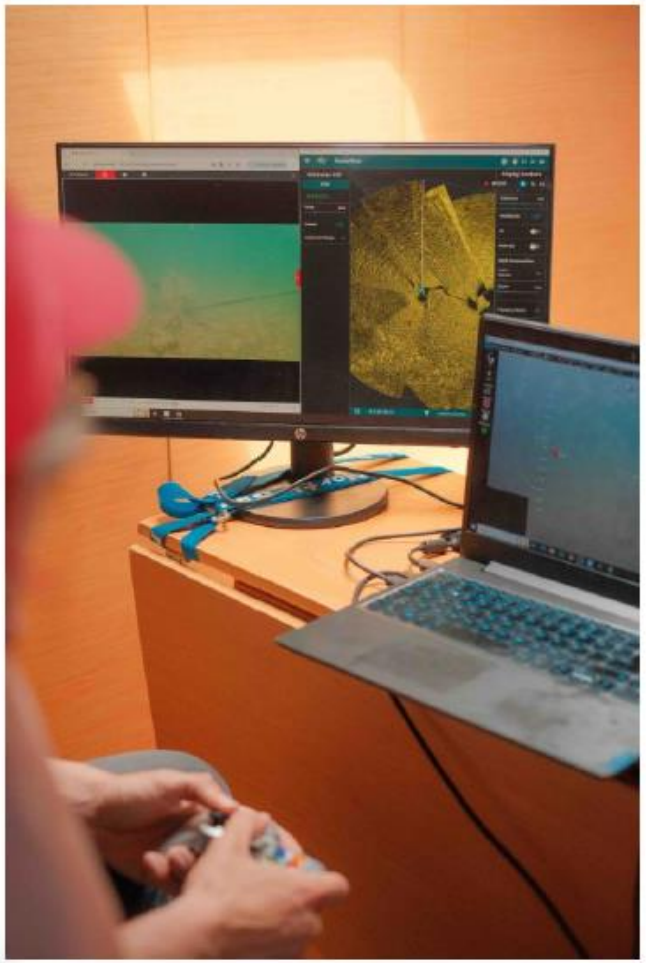

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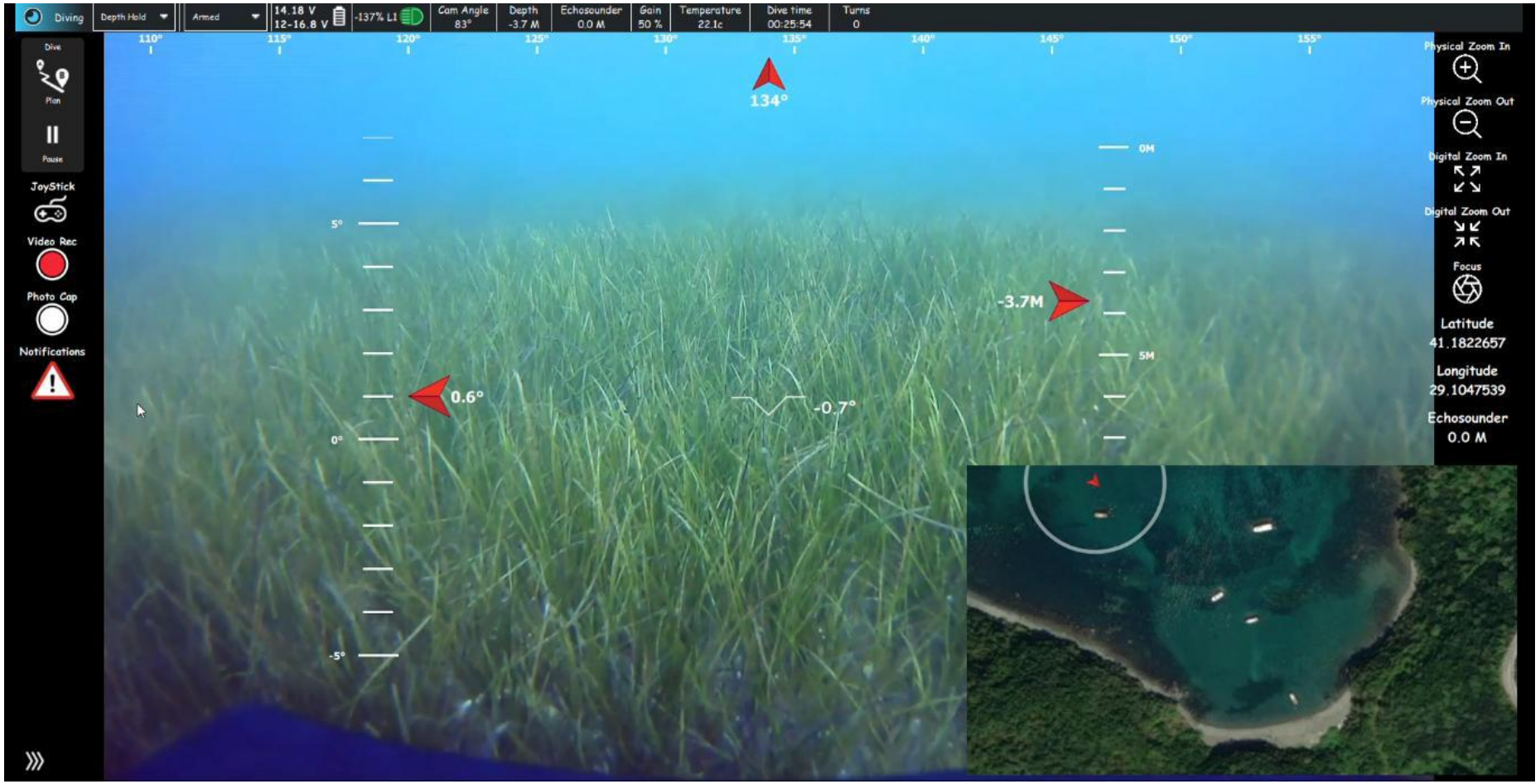
Seagrass Mapping with ROV (Turkey)



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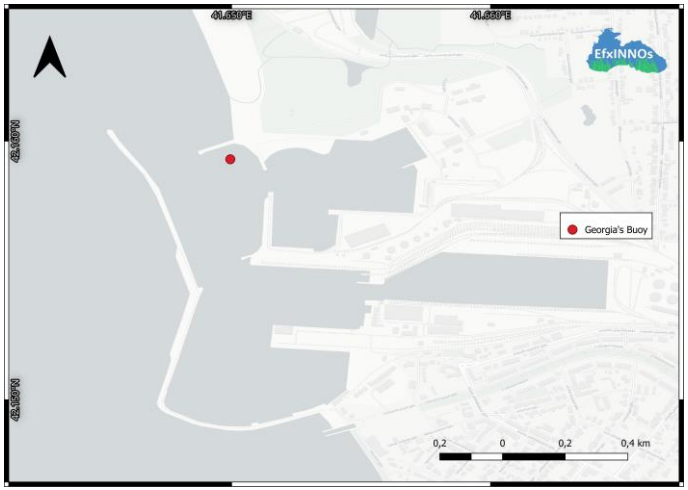
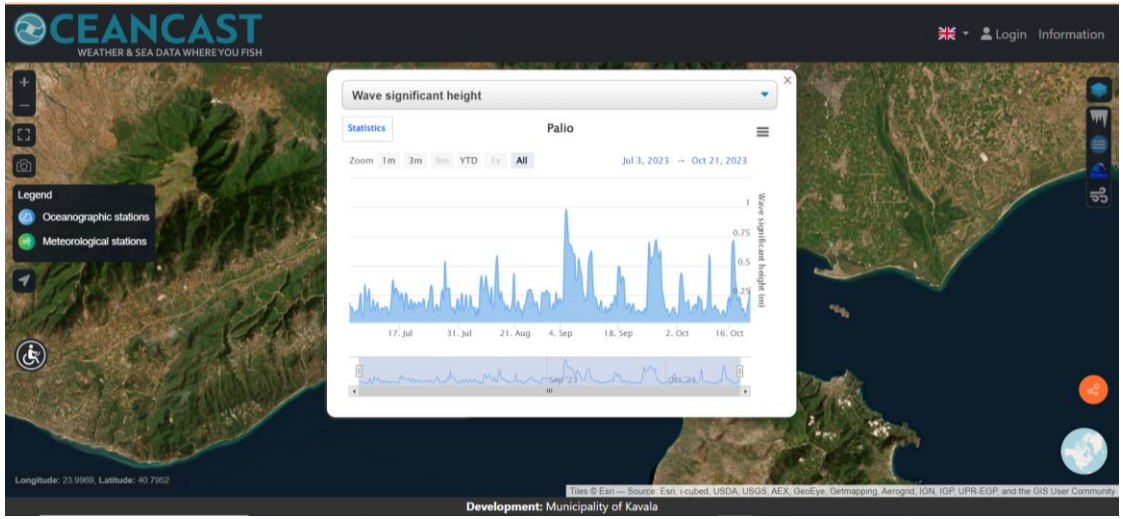
Buoy Tendering, Delivery, and Deployment in Georgia (ISU)

- RT recording of physicochemical parameters from the water surface
- Water quality measurements of sea surface temperature, electrical conductivity, turbidity, and dissolved oxygen
- Buoy deployment at Poti Port
- Platform to collect, process, and visualize data





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https://envrio.org/oceancast/

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The Target Audience

EfxINNOs aims to familiarize the broad BSB public with the conditions prevailing on the seabed, the current status of key benthic habitats and ecosystems, the level of marine litter pollution, and the harm humans exert on these vulnerable ecosystems.

The target audience of EfxINNOs at the first level is the broad public.

At the second level, the target audience is all supranational, national, regional, **and municipal authorities** responsible for the protection of the BSB environment, the establishment of MPAs, and the minimization of human pressures.

Finally, the third-level target audience for EfxINNOs is **marine and maritime users**, namely fishers, aquaculture operators, port authorities, shipping companies, oil and gas operators, touristic agents, etc.

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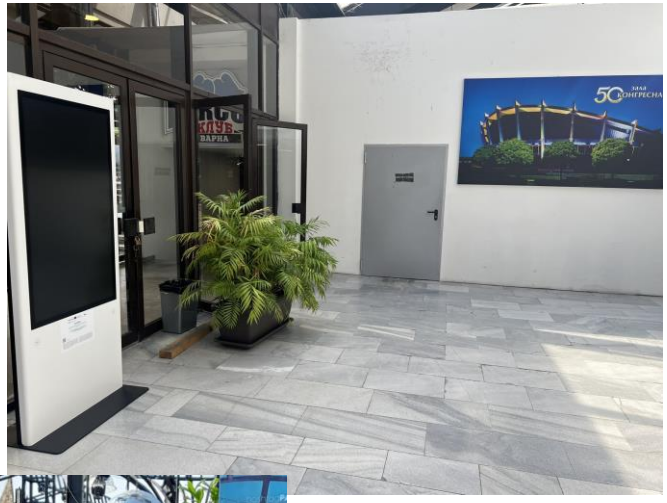
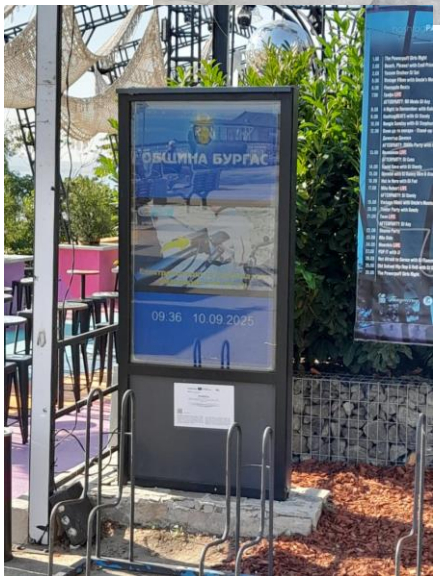
Kiosks installed and Video production in preparation

The four purchased information kiosks have been installed in three locations in Varna, Burgas, and Nessebar, with visualization stickers adhered to them according to the program rules.





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Supporting EU Policies

Descriptor 1: Biodiversity is maintained

Descriptor 2: Non-indigenous Species do not adversely alter the ecosystem

Descriptor 3: The population of commercial fish species is healthy

Descriptor 4: Elements of food webs ensure long-term abundance and reproduction

Descriptor 5: Eutrophication is minimised

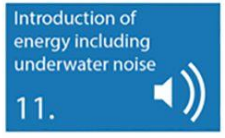
Descriptor 6: The sea floor integrity ensures functioning of the ecosystem

Descriptor 7: Permanent alteration of hydrographical conditions does not adversely affect the ecosystem

Descriptor 8: Concentrations of contaminants are at levels not giving rise to pollution effects.

Descriptor 9: Concentrations of contaminants are at safe levels.

Descriptor 10: Marine litter does not cause harm



Descriptor 11: Energy including Underwater Noise

Black Sea Integrated Monitoring and Assessment Program

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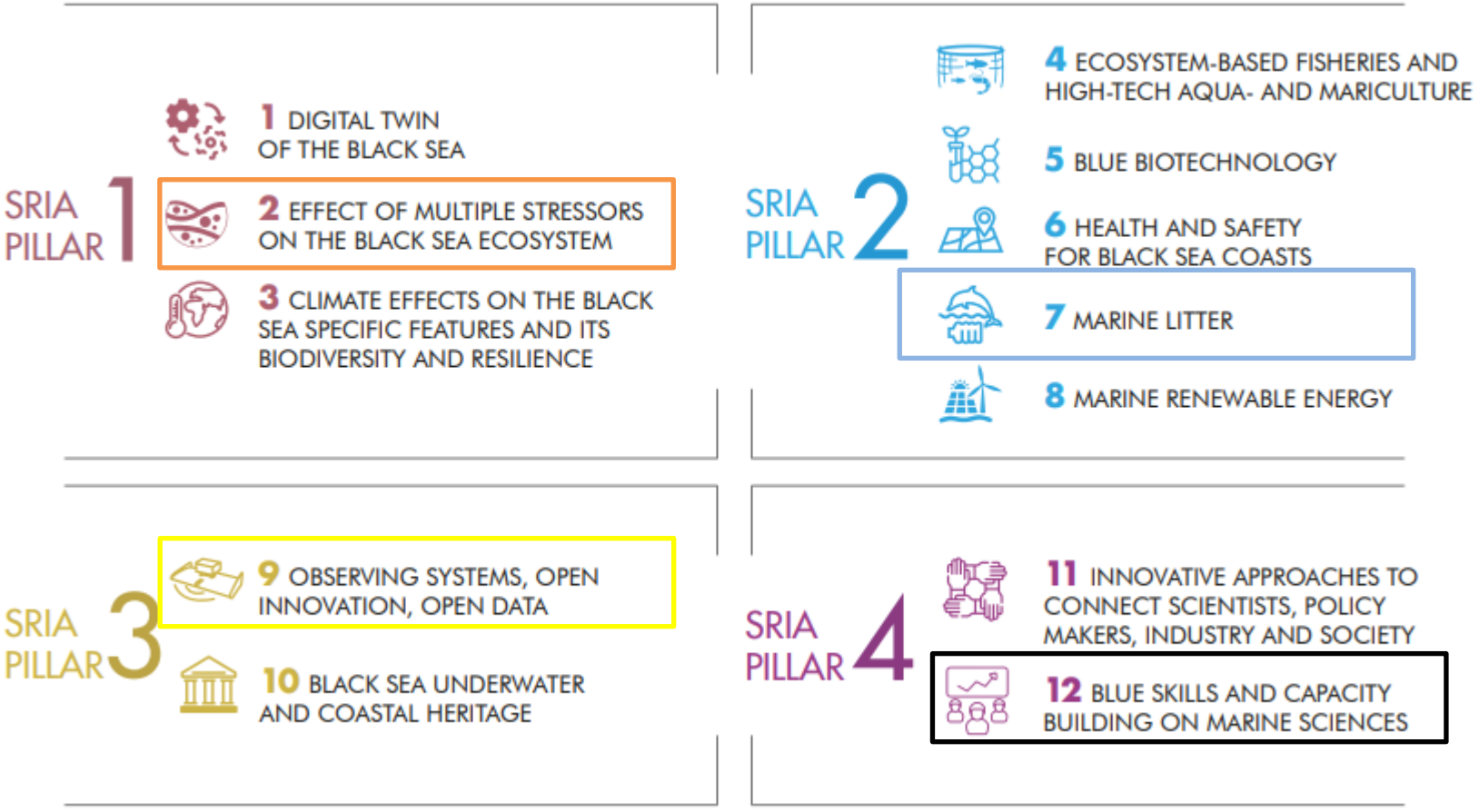
Supporting SRIA Implementation



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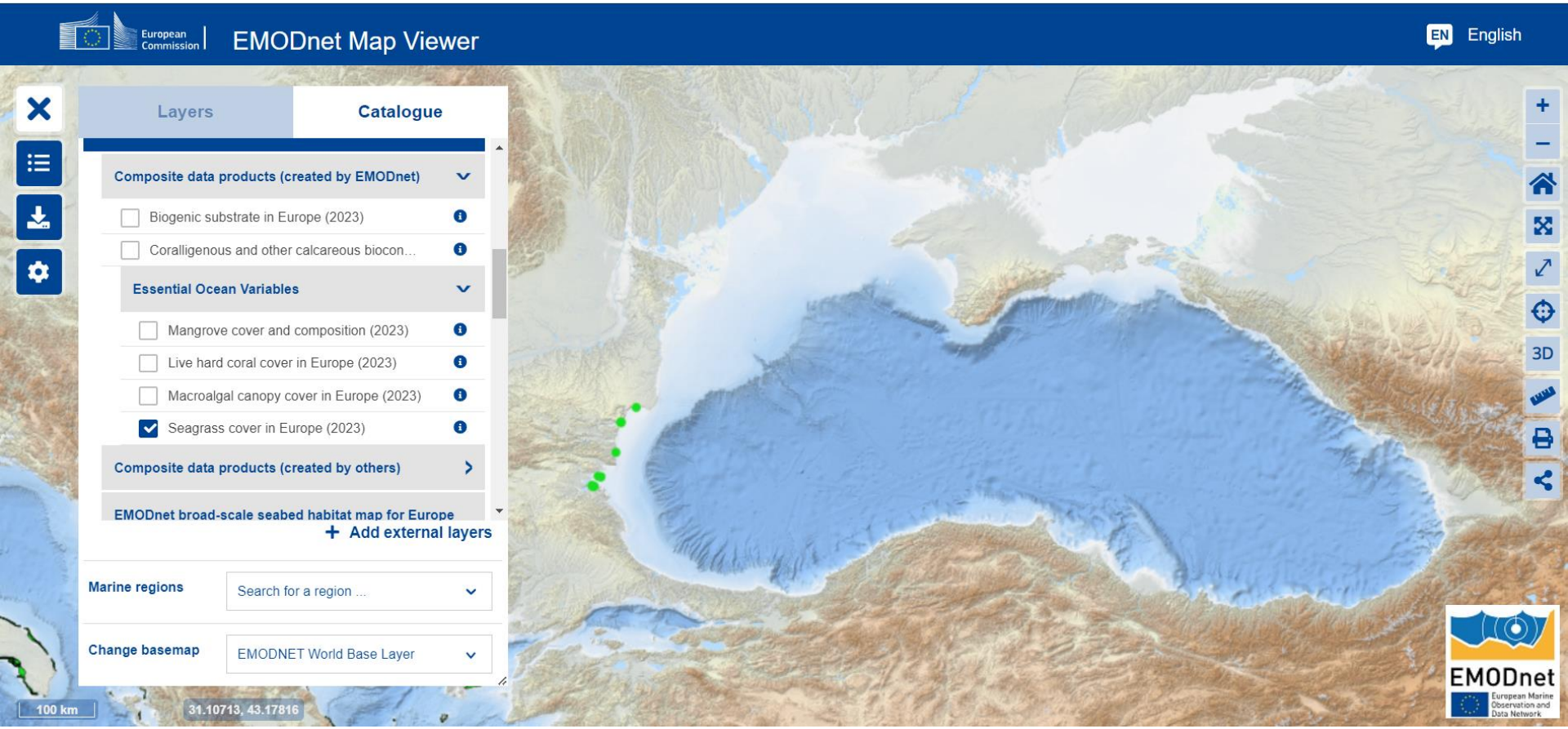
Expand Monitoring Capacities



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Interconnect EfxINNOs to EU Infrastructures

Copernicus Marine Service

dynamic, and directly connected

Copernicus

Implemented by MERCATOR OCEAN INTERNATIONAL

EMODnet

European Marine Observation and Data Network

EfxINNOs databases and ecological indicators

EDITOInfra

European Digital Twin Ocean

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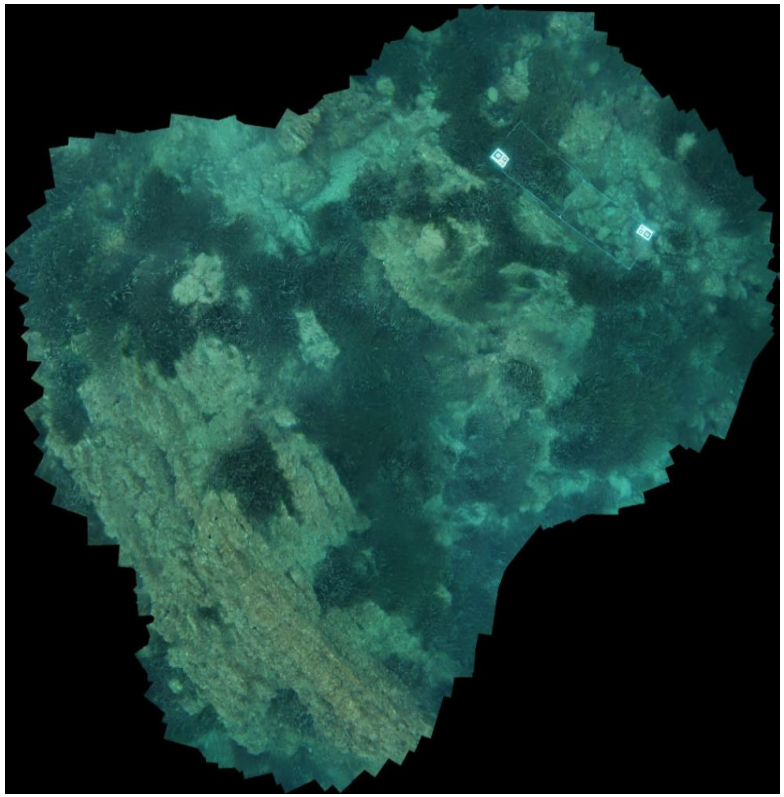
Budget Overview



Interreg Funds	1,479,283.56 Euros
Other public contribution	164,364.84 Euros
Total project budget	1,643,648.40 Euros

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The EfxINNOs Partnership

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The Consortium

1. Democritus University of Thrace – DUTH (EL, Leader)
2. Union of Bulgarian Black Sea Local Authorities - UBBSLA (BG, P1)
3. National Institute for Marine Research and Development “Grigore Antipa” – NIMRD (RO, P2)
4. Ilya State University – ISU (GE, P3)
5. Istanbul University – IU (TR, P4)
6. Technical University of Varna – TUV (BG, P5)

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INCDM

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The EfxINNOs Web Site

About Us

Efxinnos Project

EfxINNOs is a collaborative project aimed at developing a sustainable and advanced marine monitoring network to assess and protect the benthic ecosystems of the Black Sea and North Aegean Sea. Utilizing a combination of mobile and static platforms, including autonomous underwater vehicles (AUVs) and remotely operated vehicles (ROVs), the project will collect and analyze data on marine biodiversity, human impacts, and ecosystem health using machine learning and AI tools. The initiative aligns with EU environmental policies and promotes transnational cooperation to fill gaps in data collection, harmonization, and policy implementation. EfxINNOs will produce science-based recommendations, foster professional development through workshops and training, and raise public awareness about marine pollution, conservation, and the sustainable Blue Economy. The project involves a diverse partnership of research institutions across the Black Sea Basin, aiming to create a lasting network for ecosystem protection and responsible marine resource management.

https://envrio.eu/efxinnos/

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Thank you!