MAIN LINES OF PROGRESS AND ELEVATED TECHNOLOGICAL READINESS IN BRIDGE-BS TECHNOLOGIES

Mustafa YÜCEL, BRIDGE-BS Co-Coordinator

Middle East Technical University

Institute of Marine Sciences

BRIDGE-BS

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

TODAY'S AGENDA

11:00 – 11:20 Introduction and Scope

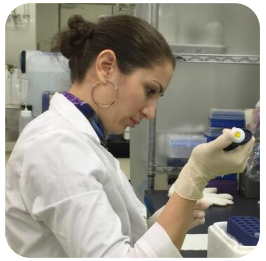
Mustafa Yücel, BRIDGE-BS Co-coordinator, METU

Main Lines of Progress and Elevated Technological Readiness in BRIDGE-BS Technologies

11:20 – 12:10 Demonstrator Cases

Kremena Stefanova, IO-BAS

Case 1:
Rapid Jellyfish Detection



Nina Dzhembekova, IO-BAS

Case 2:
Smart phytoplankton monitoring

Agathe Laes, Ifremer

Case 3:
High-precision pH sensor application in the Black Sea

12:10 – 12:30 Pathways for Upscaling and Acceleration

Matteo Bocci
Stratégies Mer et Littoral

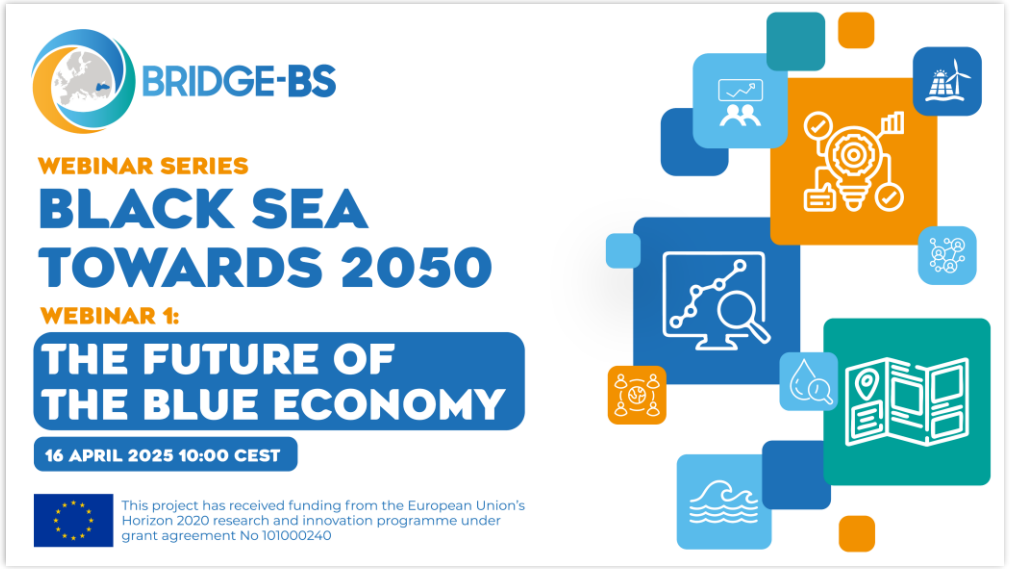
Frederick Herpers
Stratégies Mer et Littoral

Patrizio Mariani
DTU

12:30 – 13:00 Discussion / Q&A

BRIDGE-BS BLACK SEA TOWARDS 2050 WEBINAR SERIES

"Black Sea Towards 2050" Webinar Series builds on the momentum of the BRIDGE-BS project to **co-design a sustainable future** for the region. The series brings together Black Sea and international researchers, policymakers, industry representatives, and the wider public to **explore how BRIDGE-BS research enhances** our understanding of the Black Sea's challenges and emerging opportunities.



WEBINAR 1 — THE FUTURE OF THE BLUE ECONOMY

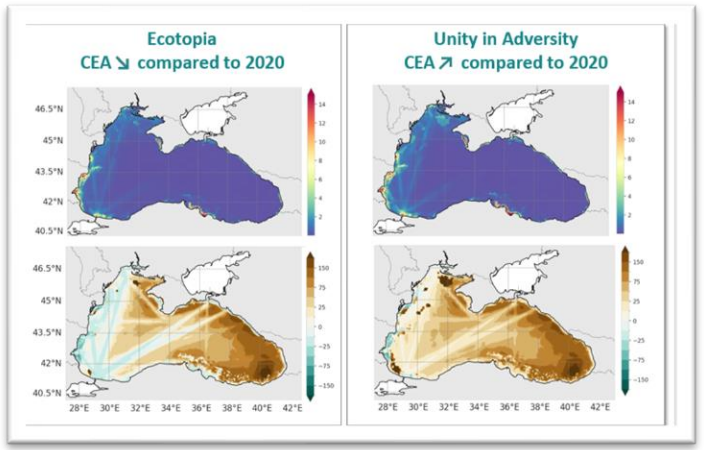
- **100 participants** joined the webinar focused on **multiscale scenarios of BRIDGE-BS** for a sustainable Black Sea blue economy.

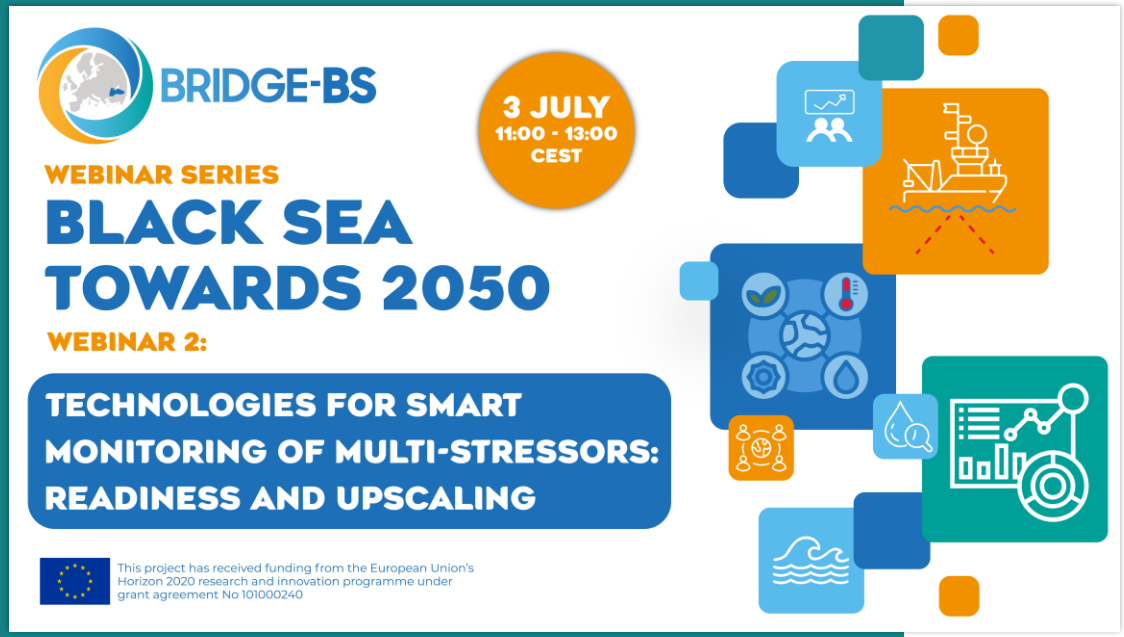
A GLIMPSE INTO BLACK SEA IN 2050

- 4 Prospective scenarios for Black Sea basin level based the level of innovation and governance (Ecotopia, Unity in Adversity, Technocracy for Common good, The Great Decoupling)
- 2050 vision for the Black Sea co-developed with stakeholders, with roadmap of actions
- Co-design of future scenarios capitalizing from Living Labs and prospective scenarios followed by quantitative and spatially-explicit analysis using a Risk Based Cumulative Effect Assessment (CEA) tool.

BOTTOM LINE: WE NEED TO TAKE ACTION NOW!

- Nutrient input from land-based activities need to decrease
- Significant reduction of fishing activities.
- Implementation of MPA network across the basin.
- Social and technological innovation is a must for a more sustainable future





WEBINAR 2

TECHS FOR SMART MONITORING OF MULTI-STRESSORS: READINESS AND UPSCALING

Today, participants will discover:

- Novel sensor-based platforms for monitoring key ocean variables like pCO_2, pH, and H_2S
- Advances in eDNA-based biodiversity monitoring
- Innovative jellyfish detection methods using acoustics and drones
- How these technologies contribute to more accurate ocean models and future forecasting
- The pathways for upscaling and integrating these tools across the Black Sea and beyond

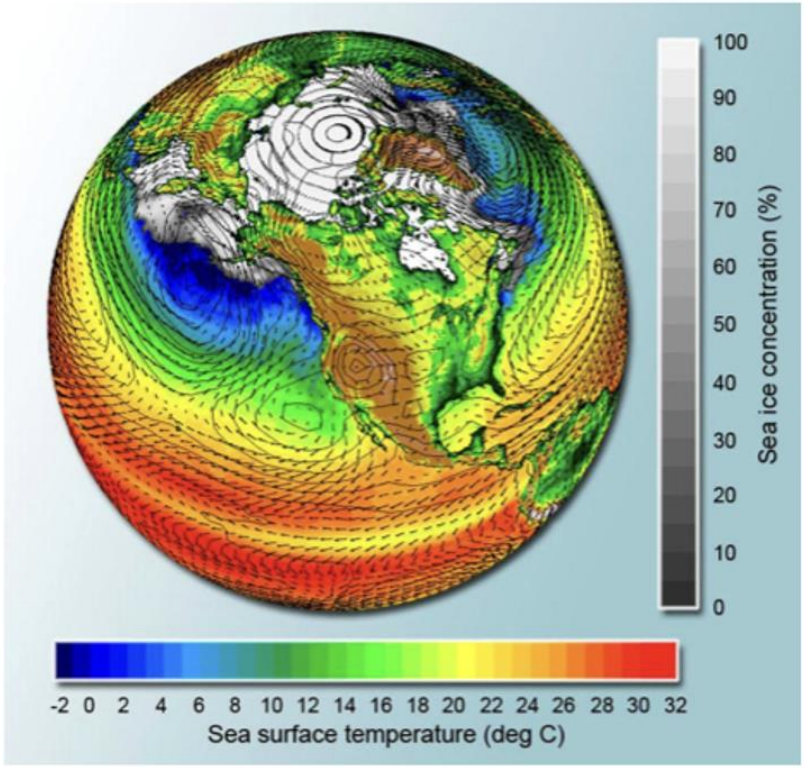
WEBINAR 3

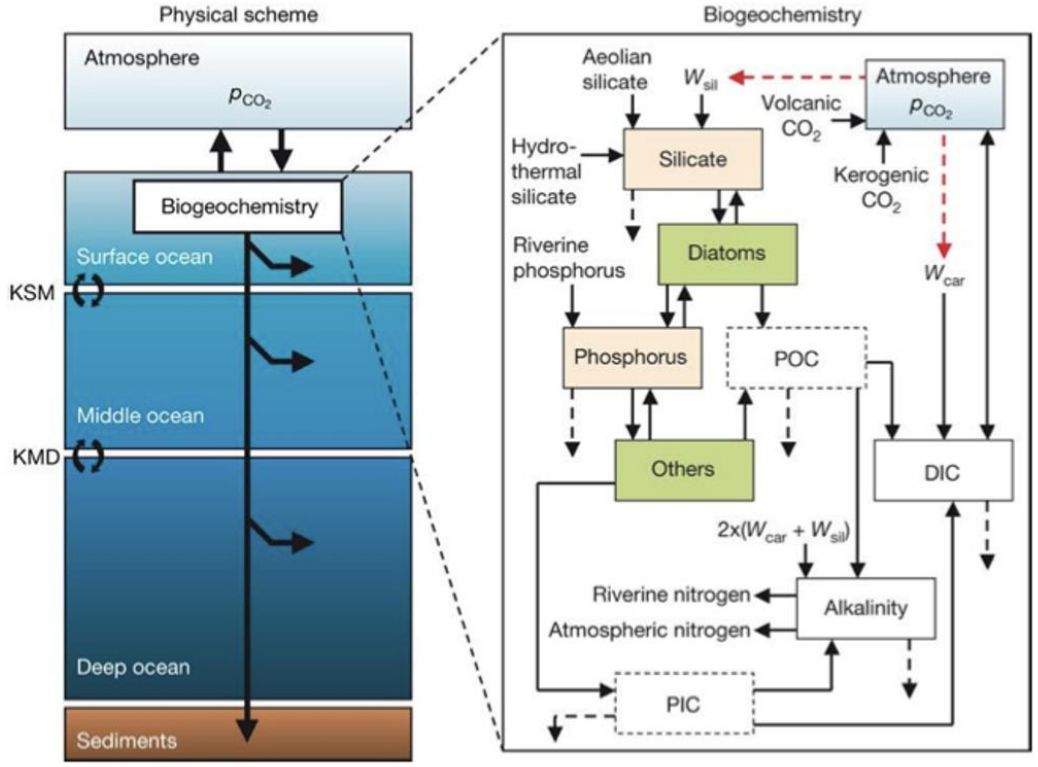
BRIDGE BLACK SEA DEMONSTRATOR

- Upcoming! – **SEPTEMBER 2025**
- The 3rd Webinar will launch **BRIDGE Black Sea Digital Twin Ocean Demonstrator.**
- The BRIDGE Black Sea DTO is a **decision support tool** that utilizes data pools, integrated simulations, resilience assessments, and adaptive management tools to define the ecosystem's state and associated risks.

REGISTER NOW!

WHY IN SITU AND SMART MONITORING OF MULTI-STRESSORS?

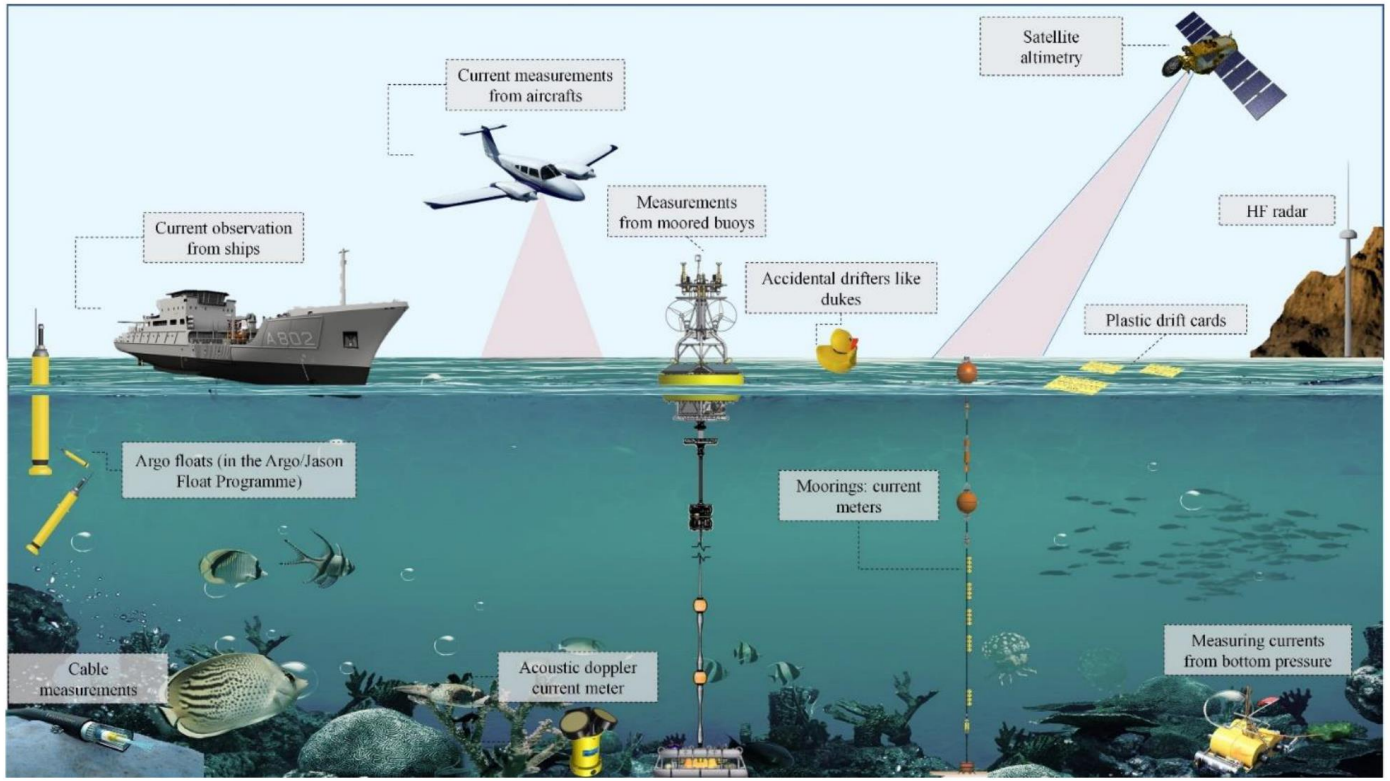




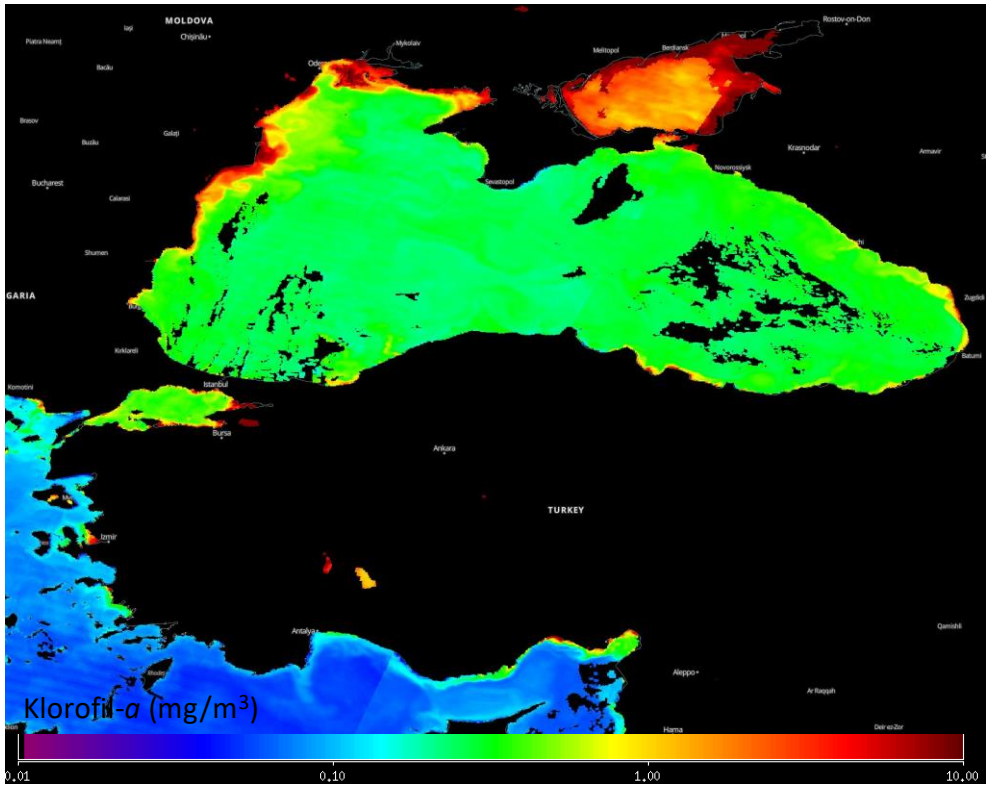
- Seas are often perceived in **2D** because of the **'map representation'**.
- Depth **(the 3rd D)** is often counter-intuitive so often neglected in public and policy opinion.
- Ocean interiors are under-observed due to challenging conditions but they are vital for **element cycles**, represent **a large habitat**, **storage of carbon**, **recycling of pollutants**.

WHY IN SITU AND SMART MONITORING OF MULTI-STRESSORS?

- Great deal of progress in surface ocean monitoring by surface-deployed and remote sensing tools
- Remote sensing can see **top 2m** but average ocean is **3800m deep**
- Black sea is **2200m deep! Need underwater tools capable of withstanding specific Black Sea conditions!**



Amani et al. 2022



This project is co-funded by the European Union

COUSTEAU
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CUSTODIAN OF THE SEA SINCE 1943

ANOXIC LAYER OF THE BLACK SEA

THE DANGER OF ITS RISE

EMBLAS-Plus
Environmental Monitoring in the Black Sea

UNDP

Map of the main currents of the Black Sea

The lowest depths of the oxygen layers (54 m) have been found in **the middle of the western and the eastern cyclonic gyres** in the open sea. The oxygen layer is thicker (160 m) near the coast.

spots of lowest depths of the oxygen layer

87 % of the Black Sea's volume is anoxic,
which means without dissolved oxygen (O_2).

This anoxic zone is impregnated with hydrogen sulphide (H_2S)
which is a highly toxic chemical compound.
It is the largest anoxic water basin in the world

The Black Sea is a closed sea and the vertical currents are weak in its deep part.
The consequence is that the deep waters do not mix with the upper oxygenated waters.
This induces an increasingly large anoxic zone.

Between 1955 and 2017, toxic boundary shoaled from **140 m to 54 m deep*.**
This phenomenon is strengthened by eutrophication and global warming.

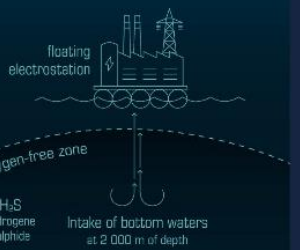
54 m

ANOXIC ZONE
oxygen free layer
contains H_2S

O_2

H_2S

There is ongoing research about the potential use of H_2S to **produce energy.**
This could be an advantageous solution to combat the rise of the anoxic layer.



Consequences of the rise of the anoxic layer :

A compression of almost **40% of the habitable space** for oxygen dependent marine inhabitants (fish, shellfish, dolphins, algae and microorganisms). It threatens biodiversity.

The Black Sea is more vulnerable **to pollution and climate change.**

160 m

Only a few microorganisms can live in the extreme conditions of the anoxic zone.
Among them, the group ***Lokiarchaeota*** were found in the Black Sea.
Discovered in 2015, this group is very interesting because it is a kind of 'missing link' between prokaryotes (organisms which do not have nucleus) and eukaryotes (ones which have nucleus, like animals and plants).

Microscopic observation of microorganisms belonging to the group Lokiarcheaota

2 km : maximum depth

* According to the EMBLAS-II field data (2017). More information at http://emblasproject.org/wp-content/uploads/2019/07/EMBLAS-II_NPMS_JOSS_2017_ScReport_FinDraft2.pdf

WHAT CAN WE DO ABOUT IT?

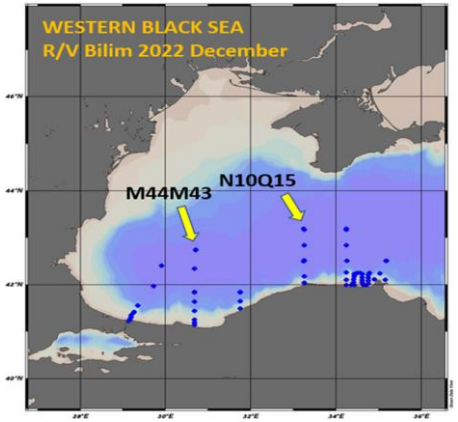
We can all act to make things better!

As a citizen: Reduce your carbon footprint. Use as less energy as possible at home and at work. Prefer the use of public transports or bikes rather than cars when possible.

As a decision maker: Adopt measures and laws to limit air pollution and greenhouse gases. Join international agreements to fight climate change.

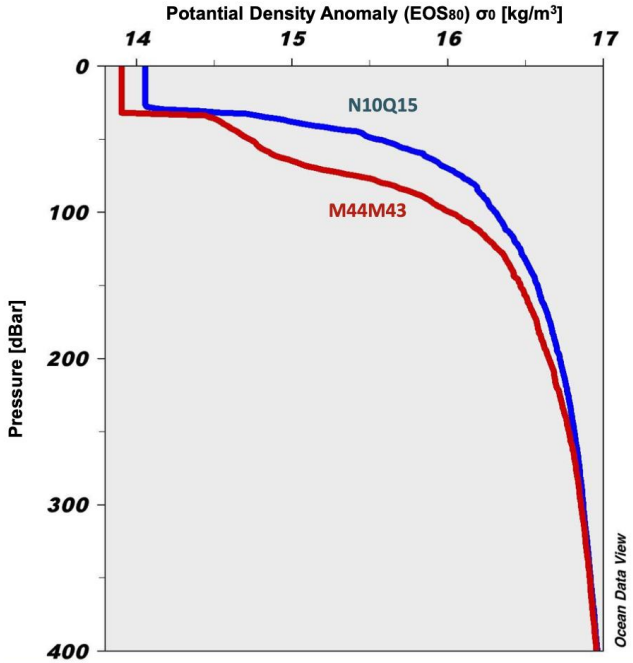
More information at **emblasproject.org**

RECENT STATE: VERTICAL STRUCTURES OF DENSITY AND TEMPERATURE

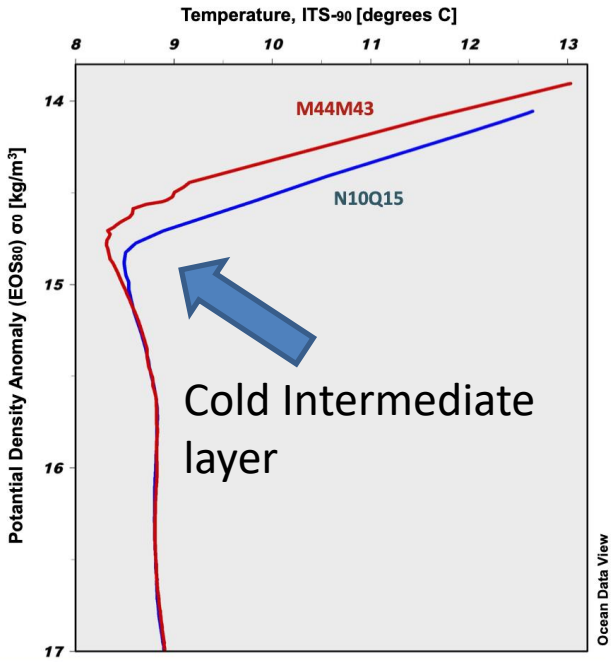


Stations occupied by RV Bilim-2 in the eastern and central part of the Black Sea

Density



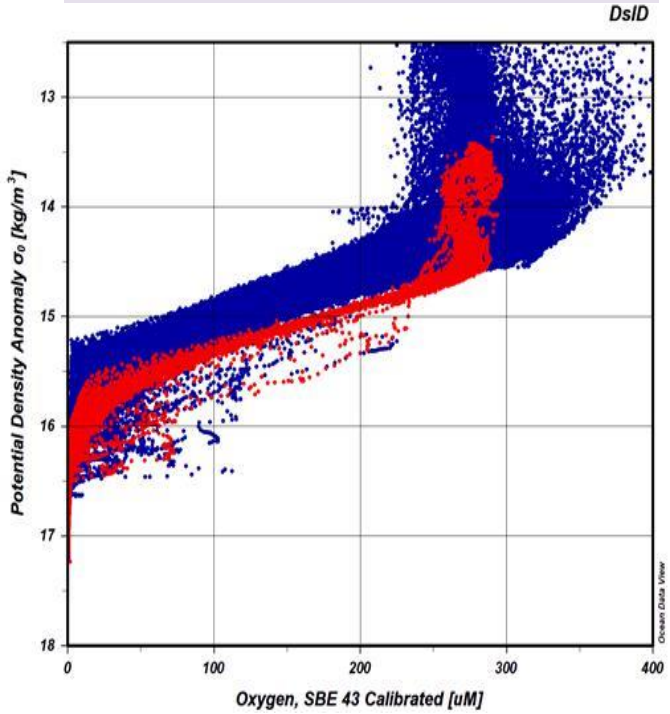
Temperature



The upper layer of the western central station M44M43 was observed thicker and colder while the surface layer was thinner and warmer in the mid-central station N10Q15. Throughout December 2022, the sea surface was transitioning to winter conditions while maintaining above-average sea surface temperatures.

Oxygen

Blue: 1980-2020
Red: 2022-23 BRIDGE-BS



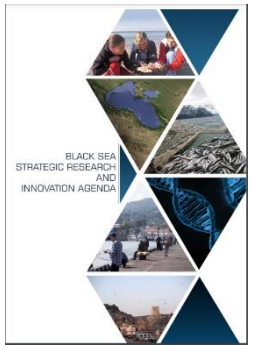
BLACK SEA STRATETIC RESEARCH AND INNOVATION AGENDA (SRIA)

2017 — Blue Growth Initiative

2018 — Burgas Vision Paper

2019 — Common Maritime Agenda

2020 — Black Sea SRIA

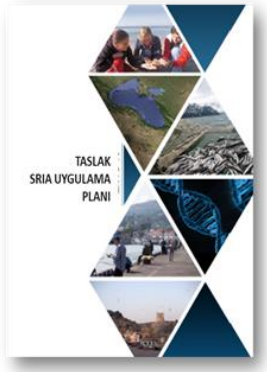


2020 — 1. Round of National Consultations

Black Sea CONNECT Priorities and Activities

European Policies

2020-2022 — Draft Implementation Plan



2023 — National and International Consultations

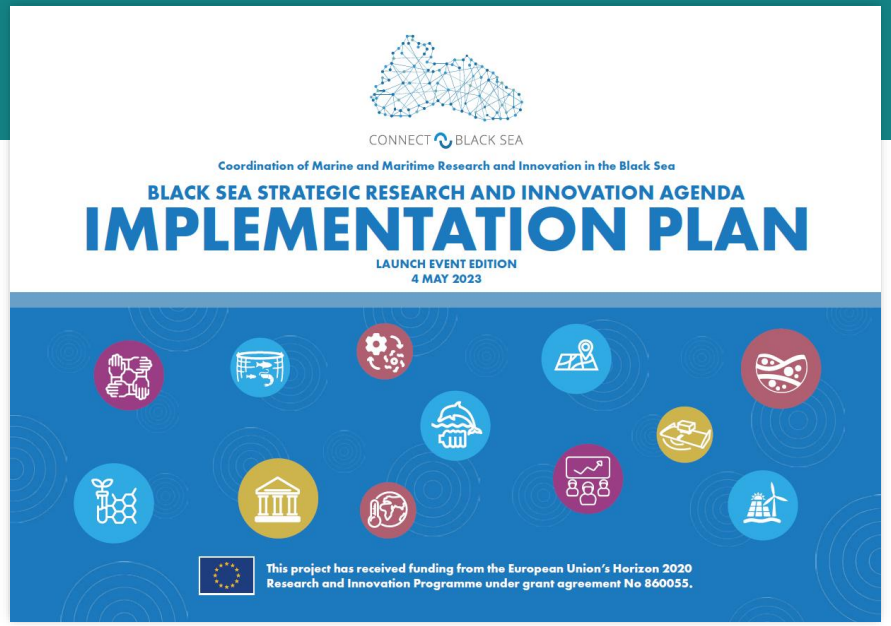
BRIDGE-BS

DOORS BLACK SEA

2023 — Final SRIA and Implementation Plan

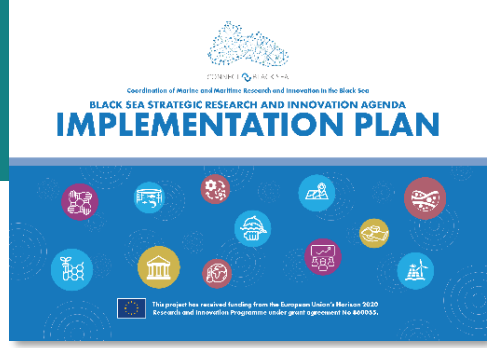
4 May

BLACK SEA SRIA IMPLEMENTATION



- Developed under the **H2020 funded Black Sea CONNECT CSA**, the Implementation Plan of Black Sea SRIA (Strategic Research and Innovation Agenda) offers a common vision for a sustainable, healthy and resilient Black Sea.

THE FOUR PILLARS OF THE BLACK SEA SRIA IMPLEMENTATION PLAN (SRIA IP)



Black Sea SRIA IP translates SRIA Goals into concrete, cutting-edge science and technology actions.

SIRA PILLAR 1

- 1 DIGITAL TWIN OF THE BLACK SEA
- 2 EFFECT OF MULTIPLE STRESSORS ON THE BLACK SEA ECOSYSTEM
- 3 CHANGING BLACK SEA BIODIVERSITY AND ECOSYSTEM RESILIENCE UNDER CLIMATE CHANGE AND MULTISTRESSORS

SIRA PILLAR 2

- 4 ECOSYSTEM-BASED FISHERIES AND HIGH-TECH AQUA AND MARICULTURE
- 5 BLUE BIOTECHNOLOGY
- 6 HEALTH AND SAFETY FOR BLACK SEA COASTS
- 7 MARINE LITTER
- 8 MARINE RENEWABLE ENERGY

SIRA PILLAR 3

- 9 INNOVATIVE OBSERVING SYSTEMS
- 10 BLACK SEA UNDERWATER AND COASTAL HERITAGE

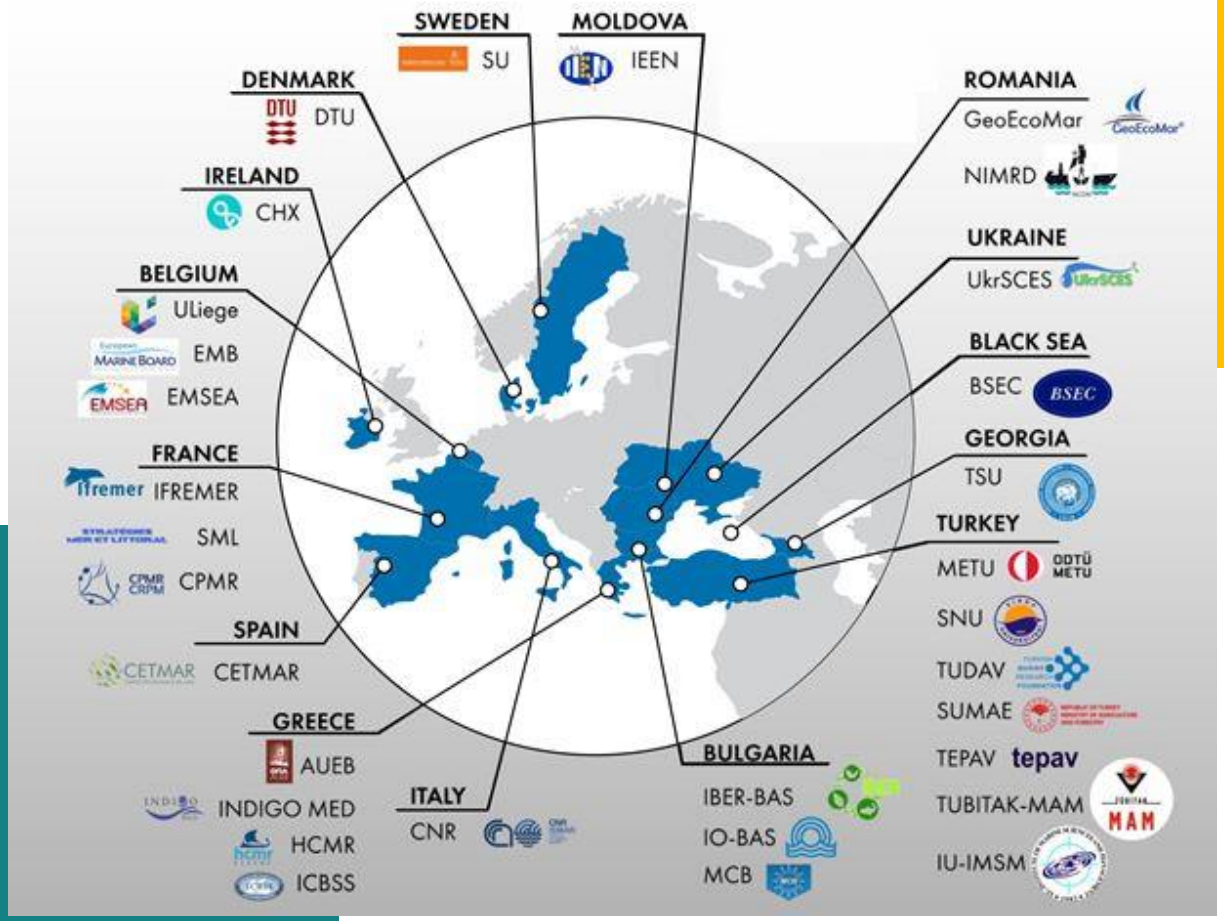
SIRA PILLAR 4

- 11 INNOVATIVE APPROACHES TO CONNECT SCIENTISTS, POLICY MAKERS, INDUSTRY AND SOCIETY
- 12 BLUE SKILLS AND CAPACITY BUILDING ON MARINE SCIENCES

ABOUT THE HORIZON 2020 BRIDGE-BS: ADVANCING BLACK SEA RESEARCH AND INNOVATION TO CO-DEVELOP BLUE GROWTH WITHIN RESILIENT ECOSYSTEMS

BRIDGE-BS

Blue Growth Incubators | Service Dynamics | Empowered Citizens



CALL: H2020-BG-2018-2020 (Blue Growth)
TOPIC: LC-BG-09-2019
TYPE OF ACTION: Research and Innovation Action
PROPOSAL NUMBER: 101000240
PROJECT ACRONYM: BRIDGE-BS
DURATION: 06.2021-12.2025
COORDINATOR: METU IMS (Türkiye)

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

PILOT SITES: KEY ECOSYSTEM SERVICES AND REGIONAL MULTI-STRESSORS

BRIDGE-BS

NORTHWESTERN BLACK SEA (ODESSA BAY)

KEY MULTIPLE STRESSORS

KEY ECOSYSTEM SERVICES

WESTERN BLACK SEA (DANUBE DELTA REGION)

KEY MULTIPLE STRESSORS

KEY ECOSYSTEM SERVICES

WESTERN SHELF (VARNA & BURGAS)

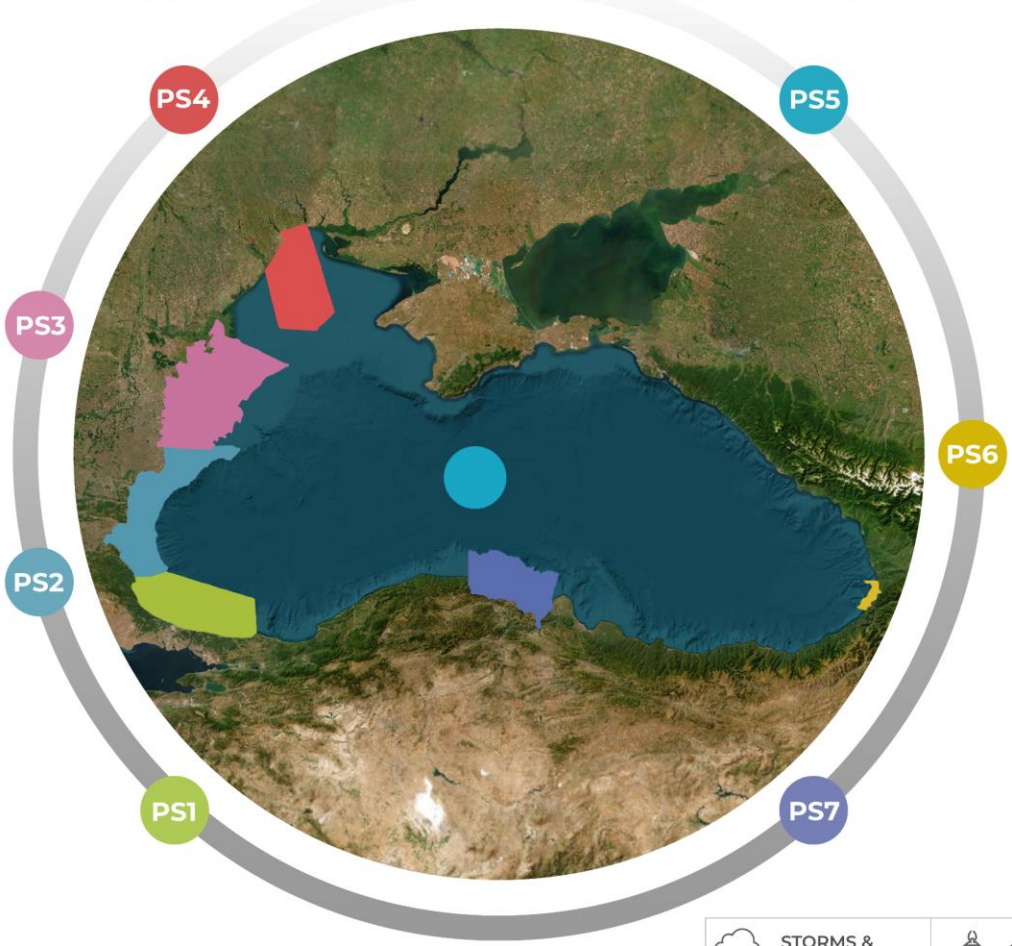
KEY MULTIPLE STRESSORS

KEY ECOSYSTEM SERVICES

İSTANBUL SITE

KEY MULTIPLE STRESSORS

KEY ECOSYSTEM SERVICES



BASIN WIDE

KEY MULTIPLE STRESSORS

KEY ECOSYSTEM SERVICES

EASTERN BLACK SEA (BATUMI SITE)

KEY MULTIPLE STRESSORS

KEY ECOSYSTEM SERVICES

SOUTHWESTERN BLACK SEA (SİNOP SITE)

KEY MULTIPLE STRESSORS

KEY ECOSYSTEM SERVICES

PROVISIONING: FISHERIES & AQUACULTURE

REGULATING & MAINTENANCE

CULTURAL SERVICES: RECREATION & TOURISM

PORTS & SHIPPING

STORMS & FLOODS

OVERFISHING

NUTRIENT LOADS & EUTROPHICATION

ACUTE POLLUTION

CLIMATE CHANGE

ILLEGAL FISHING

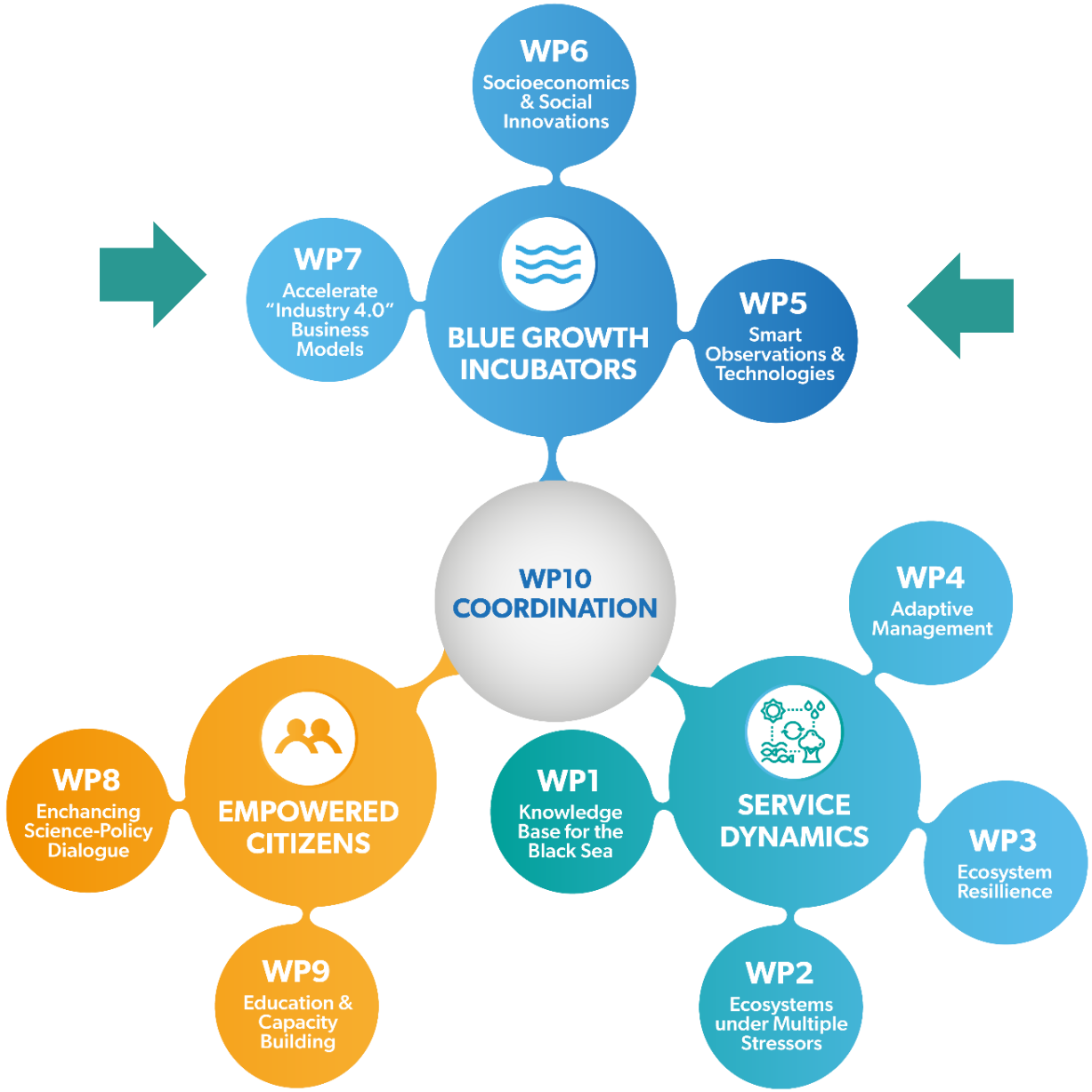
WATER QUALITY DETERIORATION

MILITARY-BASED PRESSURES

INVASIVE SPECIES & HABITAT LOSE

COASTAL EROSION

BRIDGE-BS STRUCTURE

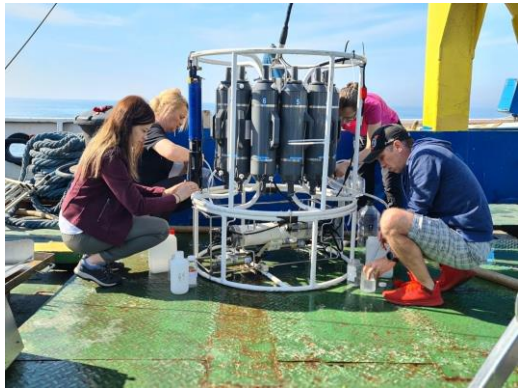


WP5: BRIDGE-BS PARTNERS CO-DEVELOPING SOLUTIONS

Over 100 scientists from 19 partner institutions across 12 countries are involved!

JOINT RESEARCH

BRIDGE-BS brings together **leading institutions** from across the Black Sea region and Europe to conduct **collaborative research** and **share expertise** to tackle the **multi-stressors** of the Black Sea.

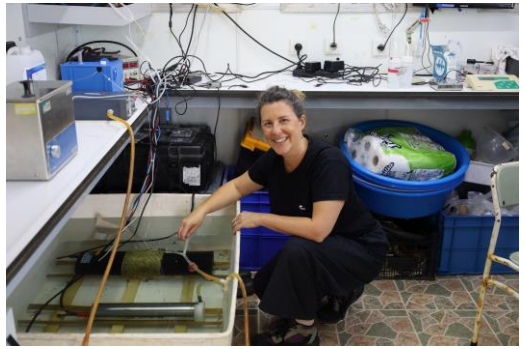


EXPERT COLLABORATION

From **co-designed methodologies** to **joint scientific cruises**, BRIDGE-BS partners work together to **generate knowledge**, **conduct fieldwork**, **harmonize methodologies**, and build long-term **research capacity**.

YOUNG SCIENTISTS ENGAGEMENT

Onboard collaborations among BRIDGE-BS partners strengthen **regional monitoring**, ensure **data comparability**, and promote transboundary **knowledge exchange**, while actively **engaging young scientists** in hands-on research and capacity building.



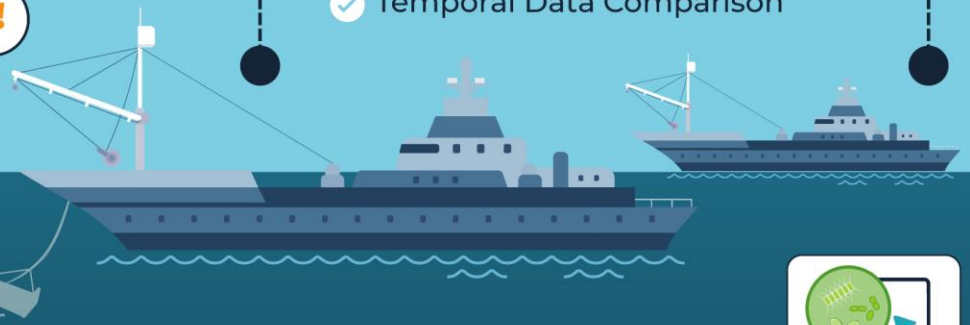
BRIDGE-BS

INNOVATIVE TECHNOLOGIES DRIVING BRIDGE-BS RESEARCH

AMONG THE FIRST IN THE BLACK SEA!

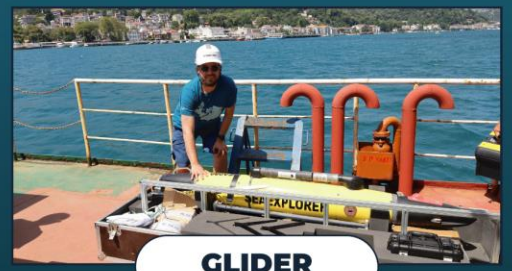
COLLABORATIVE RESEARCH CRUISES

- Harmonization of Methodologies
- Intercomparison of Results
- Temporal Data Comparison



UAVS FOR JELLYFISH MONITORING

SMART MONITORING SYSTEMS



GLIDER

SCANFISH

ENZYMES METAGENOMICS

E-DNA METABARCODING

BENTHIC OBSERVING SYSTEMS

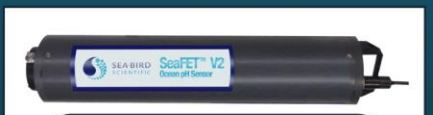
NEW SENSORS AND TOOLS

DIGITAL LIBRARY FOR PHYTOPLANKTON

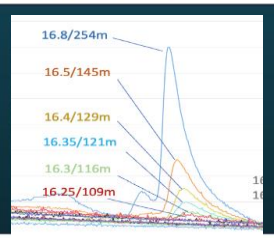
PCO_2 MONITORING

ACOUSTIC JELLYFISH DETECTOR

ACOUSTIC MARINE MAMMAL OBSERVING



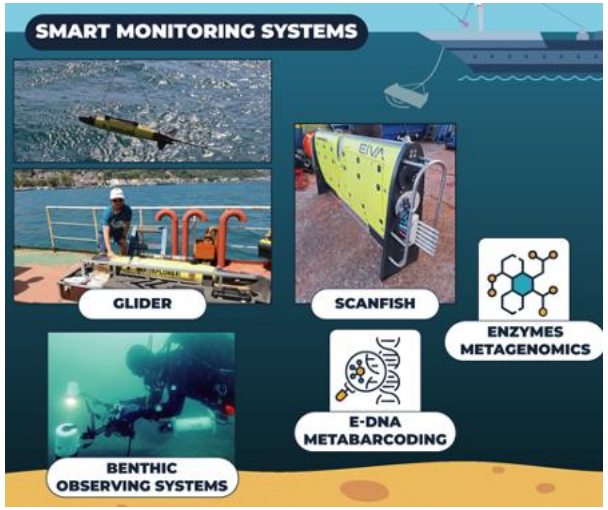
IN-SITU pH SENSOR

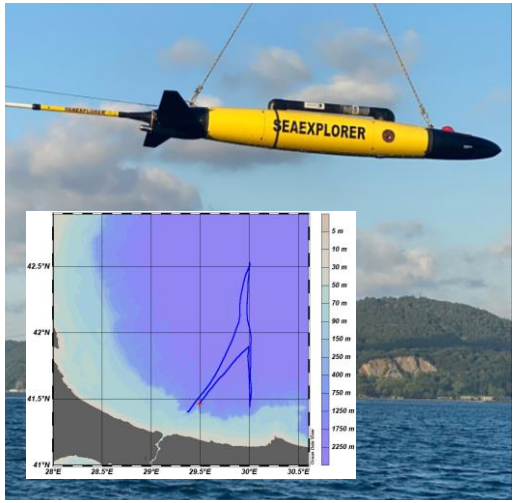


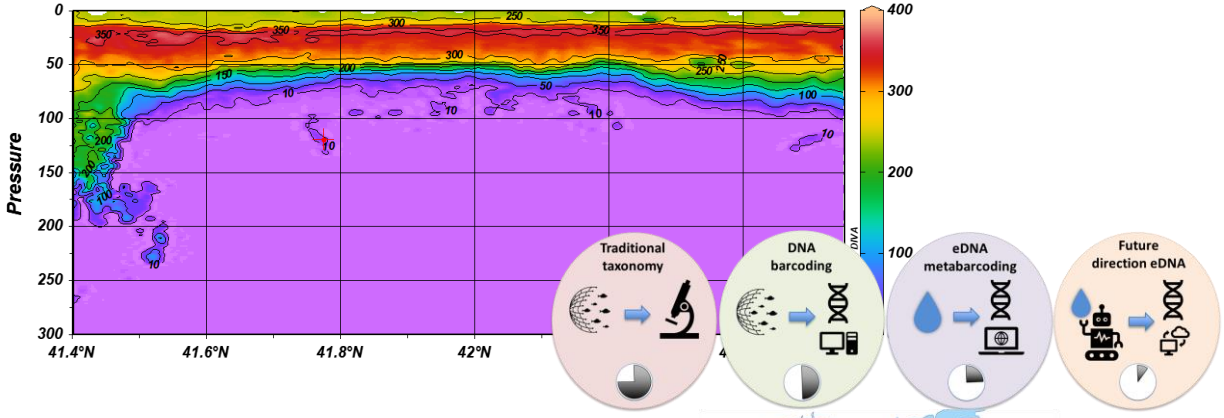
E-CHEM H_2S SENSOR

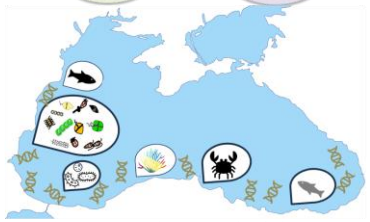
RADIONUCLIDES DETECTOR

SMART MONITORING SYSTEMS: INCREASING LEVEL OF ADOPTION (LOA) IN THE BLACK SEA



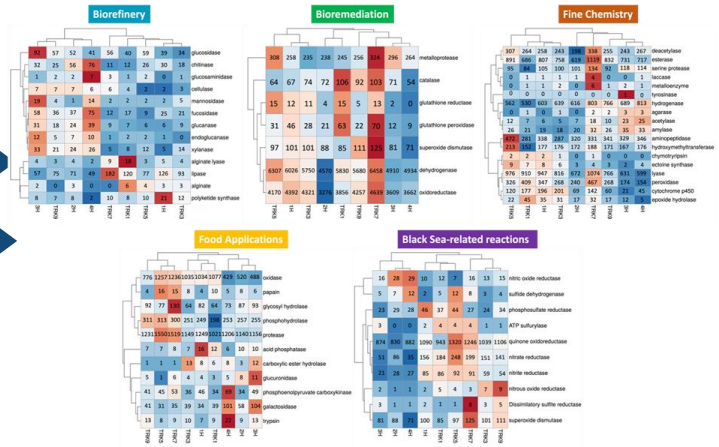




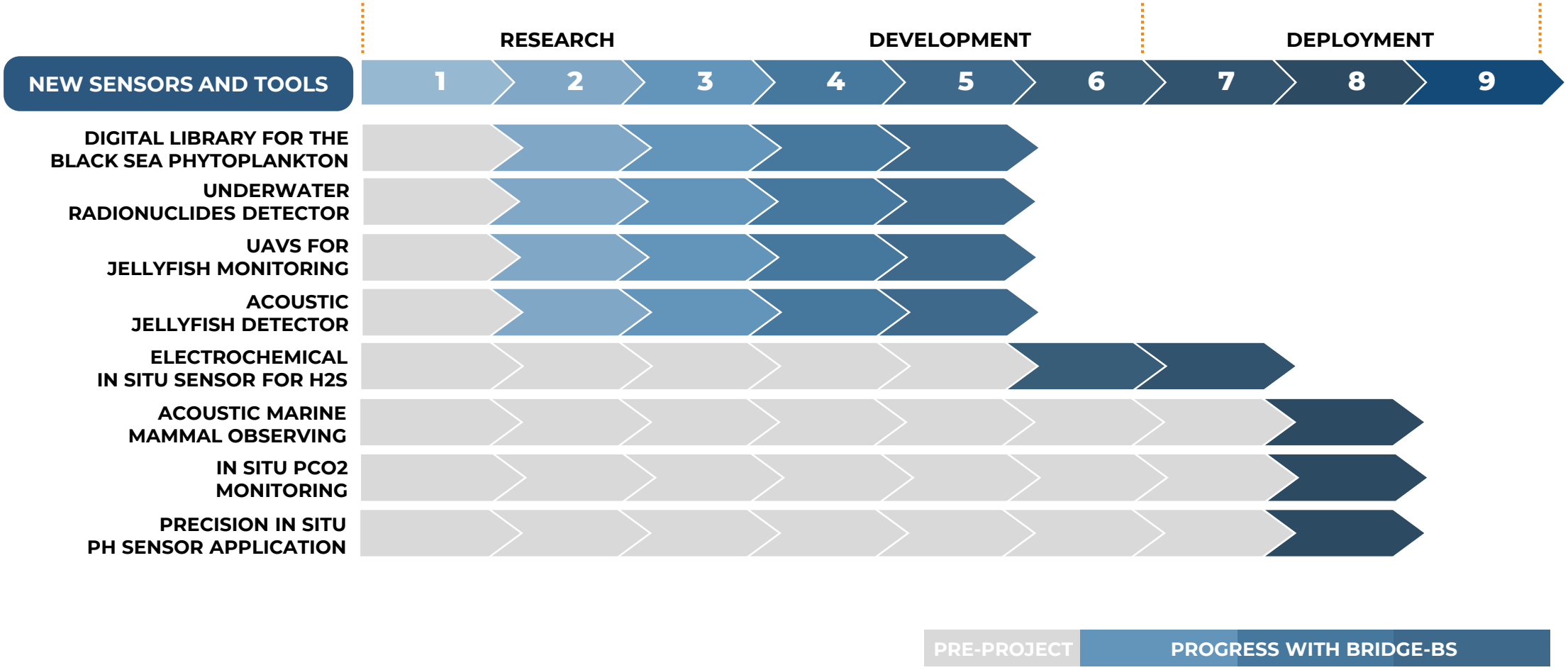

Bridge-BS eDNA applications on the Black Sea

SMART MONITORING SYSTEMS	LOW	MEDIUM	HIGH
E-DNA METABARCODING FOR COST EFFICIENT BIO-MONITORING			
FAST SCREENING OF NOVEL ENZYMES VIA METAGENOMICS			
SMART OCEANOGRAPHIC SURVEYS WITH SCANFISH AND GLIDER			
HIGH-RESOLUTION BENTHIC OBSERVING SYSTEMS			

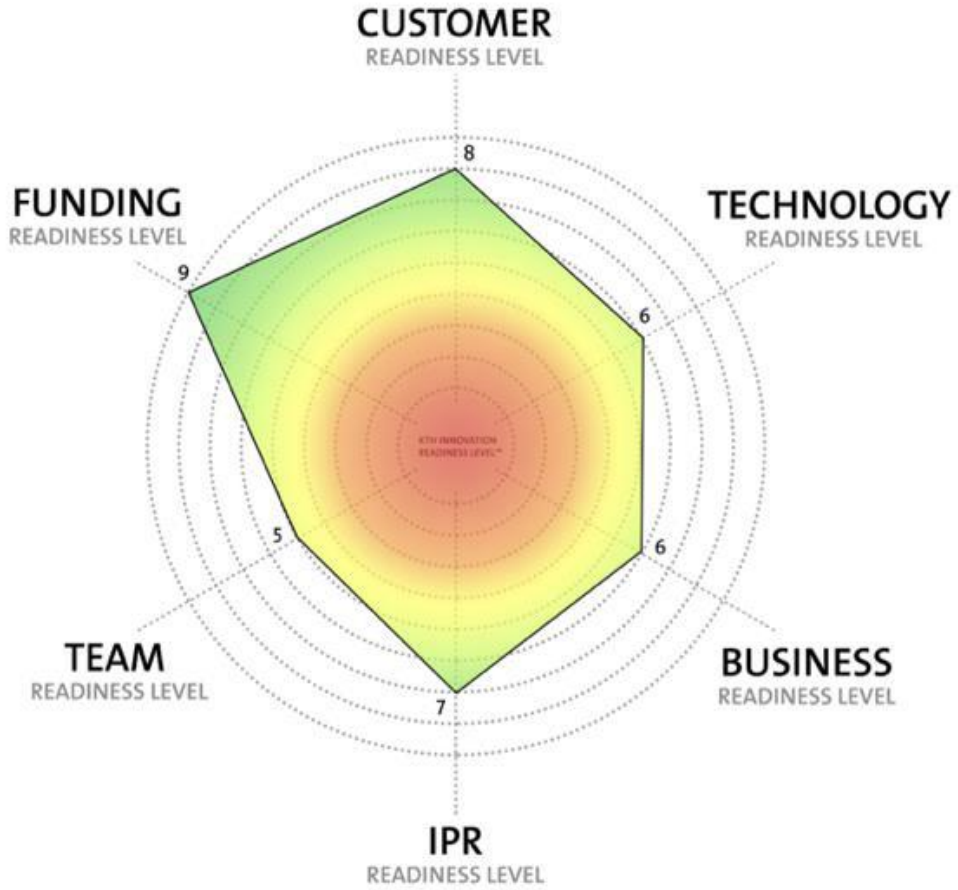
PRE-PROJECT | PROGRESS WITH BRIDGE-BS



NEW SENSORS AND TOOLS: ELEVATING TECHNOLOGICAL READINESS LEVEL (TRL)



FROM PROOF OF IDEAS TO PROOF OF BUSINESSES (BRIDGE-BS WP7)



kthinnovationreadinesslevel.com

How do we translate science into business opportunities?

PROOF OF IDEAS
(methods, technologies, services, models, etc.)

PROOF OF CONCEPTS
(how it works, is it relevant, is it needed, etc.)

PROOF OF BUSINESS
(*how it works, is it relevant, is it needed, etc.)*

BRIDGE-BS WP7: ACCELERATING ‘INDUSTRY 4.0’ BUSINESS MODELS HIGHLIGHTS AND KEY OUTSOMES

WP7 demonstrates an **accelerator platform** to boost **ocean digitalization** and **innovative industry 4.0** business models towards sustainable Blue Growth in the Black Sea.

Two Editions of High Tech Summit for the Black Sea (HTS4BS)

Black Sea Accelerator Trainings

Black Sea Accelerator Programme

- ✓ Supported **19 Business** operating in **12 countries** (received over **50 applications** for both calls)
- ✓ Over **300 attendees** from academia, industry, policy and investors to HTS4BS
- ✓ Investor Engagement
- ✓ Wide range of **TRL solutions**
- ✓ **Strengthen the Black Sea's position** in global blue economy sectors
- ✓ Joint cooperation between H2020 funded **DOORS** project

MAIN LINES OF PROGRESS AND ELEVATED TECHNOLOGICAL READINESS IN BRIDGE-BS TECHNOLOGIES

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BRIDGE-BS

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