JERICO-S3 DELIVERABLE

Joint European Research Infrastructure for Coastal Observatories
Science, Services, Sustainability

DELIVERABLE #, WP# and full title	JERICO-S3 D.2.4 - WP2- "Planned Joint International Activities"
5 Key words	Ocean observing systems, international collaboration, technical synergies
Lead beneficiary	EuroGOOS
Lead Author	Inga Lips
Co-authors	Jay Pearlman, Holger Brix, Laurent Delauney
Contributors	
Final version date/ Submission date (dd.mm.yyyy)	21/03/2024

Nature: **R**

(**R = Report**, P = Prototype, D = Demonstrator, O = Other)

Dissemination level : **PU**

PU = Public, PP = Restricted to other programme participants (including the Commission Services), RE = Restricted to a group specified by the consortium (including the Commission Services), CO = Confidential, only for members of the consortium (including the Commission Services)

GRANT N°: 871153
PROJECT ACRONYME : JERICO-S3
PROJECT NAME : Joint European Research Infrastructure for Coastal Observatories - Science, services, sustainability
COORDINATOR : Laurent DELAUNEY - Ifremer, France - jerico@ifremer.fr

DOCUMENT TECHNICAL DESCRIPTION

Document ID	JERICO-S3-WP2-D2.4-21.03.2024-V1.3

REVISION HISTORY

Revision	Date	Modification	Author
V1.1	17.01.2024	First Draft	Inga Lips
V1.2	07.02.2024	Second Draft	Inga Lips + Co-authors
V1.3	21.03.2024	Final	Inga Lips + Co-authors

APPROVALS

	Name	Organisation	Date	Visa
Coordinator	Delauney Laurent	Ifremer	21.03.2024	X
WP Leaders	Holger Brix	Hereon	21.03.2024	X

Diffusion list

Consortium beneficiaries	Third parties	Associated Partners	other
X	X		

TABLE OF CONTENT

1. EXECUTIVE SUMMARY

Marine Research Infrastructures and observing systems or networks play an important role in improving the understanding of the Ocean's functioning by delivering fit-for-purpose observational data, providing access to observation and experimentation tools, and providing services to a broad range of users. For inter-comparability of observations and interoperability of data, but also for the sustained development and efficient operation of ocean observing systems in Europe and globally, sufficient information and data sharing, collaboration and coordination of actions are needed to avoid duplications and use of available resources efficiently. JERICO has taken steps to foster collaboration with other European marine RIs, as well as with the national RIs and the non-European OOS.

The JERICO S3 task T2.5 aimed to interface with monitoring programmes, non-European Ocean Observing Systems (OOS) and the political realm. In this deliverable, we focus on the interactions with non-European OOS and JERICO to demonstrate the synergies, needs and achievements for continued collaboration around common issues of technological and societal concern. The current actions in this regard have been mainly focussed on the international collaboration options along the Atlantic coast, but also in neighbouring areas in the Black and Mediterranean Seas.

2. INTRODUCTION

JERICO is a European research infrastructure of regional coastal observatories across Europe that covers a wide range of coastal marine environments and aims to support the contribution of coastal marine research in addressing a variety of scientific and societal challenges. The objective of this regional approach is to enable the collection of comparable, long-term and multi-disciplinary (physical, biogeochemical, biological) data and promote collaboration, alignment and harmonisation among the different regions and countries. Overall, this will enhance our understanding of coastal marine systems, support the development of sustainable coastal management (best) practices, and contribute to the European marine research and innovation landscape.

The general objective of the JERICO-S3 WP2 is to foster cooperation and coordination with existing European Research Infrastructures (RIs) at different regional, national and transnational levels, as well as other relevant communities (such as numerical modelling, Earth observation, decision-makers and industry), by integrating knowledge, approaches, methods and activities between JERICO and other Earth science communities and stakeholders. The task T2.5 aims to interface with monitoring programmes, non-European Ocean Observing Systems (OOS) and the political realm. In this deliverable, we focus on the interactions with non-European OOS to enhance interaction between JERICO and non-European ocean observing systems (such as US IOOS, ONC Canada and IMOS in Australia) to facilitate continued collaboration around common issues of technological and societal concern.

There have been interactions with these three OOS over the course of the JERICO S3 project. For example, the JERICO information infrastructure (JERICO-CORE) requirements and design approach came from IMOS, IOOS and ONC interactions. There are also significant areas of common interest. All three programs cited have a social impact and application focus as part of their observing and data mission. Many are similar to European interests. There has been a collaboration already in gliders, HF radar, Argo, etc, which has been productive. There are also regional overlaps as ONC and segments of Europe focus on the Arctic. The work of ONC with indigenous peoples is a model and a place for cross-fertilisation. IMOS work in best practices/observing methods, and motivating their community to use them is a model. One additional common area is quality assessment and assurance. The Quality Assurance/Quality Control of Real-Time Oceanographic Data (QARTOD)[1] work of IOOS for real-time data and the efforts of Alliance for Coastal Technologies (ACT)[2] for instrument performance assessment in the US offer natural areas of collaboration.

[1] https://ioos.noaa.gov/project/qartod/
[2] https://www.act-us.info/

3. MAIN REPORT

3.1. JERICO

JERICO is an integrated pan-European multidisciplinary and multi-platform research infrastructure aiming to seamlessly bridge existing continental, atmospheric and open ocean RIs, thus filling a key gap in the European landscape, as well as reducing overlaps (Fig. 1), increasing efficiency, and enabling and fostering interoperability. JERICO aims to organise, harmonise, and integrate existing coastal observing activities and initiatives in order to address both pre-identified region-specific and pan-European scientific and socio-economic challenges.

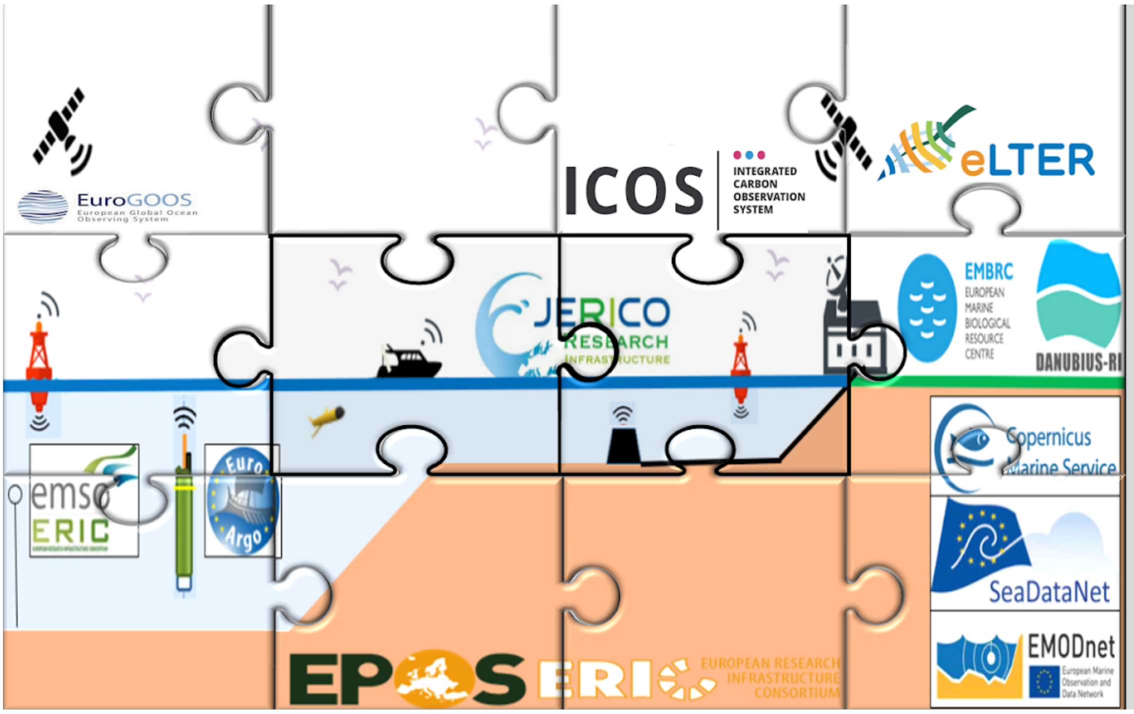

Figure 1. Schematic illustrates how JERICO is a key component of the European marine research landscape.

The Vision of the JERICO is to be the pan-European integrated gateway to long-term scientific and harmonised observations and related services for coastal marine systems.

The JERICO mission is to enable a sound understanding of the responses of coastal marine systems to natural and anthropogenic stressors. To do so, JERICO adopts a systematic approach to monitor, observe, explore and analyse coastal marine systems in order to reach reliable information on their structuration and functioning in the context of global change. Multi-platform marine RIs are an effective and promising strategy for developing an integrated observation system to face the global challenges that affect the Ocean, including the coastal areas. JERICO encompasses the whole range of environmental sciences, technologies and data sciences. It achieves global, regional and local observations through the implementation and harmonisation of a set of complementary platforms and multidisciplinary observation systems. JERICO enables open-access to state-of-the-art and innovative facilities, resources, FAIR data and fit-for-purpose services, fostering international science collaboration.

The components for the JERICO consist of the central hub, the coastal observatory network, i.e. systems which consist of multidisciplinary observational platforms and stations that are available for scientific teams and industry partners to lead research and experiments, as well as the JERICO-CORE. JERICO-CORE is envisioned as the unified central hub of JERICO to discover, access, manage and interact with JERICO resources, including services, datasets, software, best practices, manuals, publications, organisations, projects, observatories, equipment, data servers, e-libraries, support, training, and similar assets as well as Technical and Thematic Expert Centers.

The current JERICO infrastructure is highly complex, with a large variation in types of observing platforms (with varying technological requirements), the extent of national observing capabilities and the national organisation of JERICO infrastructure (number/types of national partners). The most widespread national JERICO infrastructures are fixed platforms (platforms or buoys), high-frequency radars, gliders, ferrybox systems, tide gauge networks, and research vessels. Other platforms included involve drifters (surface/profile), profilers (cable/buoy-based), various autonomous observation systems (ROV, AUV, drones), wave buoy network, weather buoy network, benthic landers, in addition to calibration and test facilities.

JERICO is characterised by multidisciplinary teams, which implies the availability of different resources and interlinkages among different capacities, with the ability to approach research questions from different perspectives. While consisting of the national RIs, finding a balance in addressing the pan-European, regional and national societal needs might often be challenging. The identification of common scientific questions resulted in the elaboration of a common general scientific framework structured in Key Scientific Challenges (KSCs), Specific Scientific Challenges (SSCs), and Research Axes (RAs) (see D1.3 of JERICO DS).

3.2. Non-European Ocean Observing Systems

The current grand challenges, such as climate change and the continuing loss of biodiversity, are global in nature. It is very important to create links with global networks and maintain an active dialogue that will ensure the exchange of information and knowledge and, more importantly, the alignment of strategy and priorities. Many marine observation programs are being implemented worldwide, such as Integrated Ocean Observing System[3] (IOOS) in USA, Integrated Marine Observing System[4] (IMOS) in Australia, and Ocean Networks Canada[5] (ONC). European marine RIs have a direct contribution to global efforts to address the grand challenges through projects and initiatives supporting international collaborative activities. These contribute to the missions of the international global networks (e.g., GOOS, Global Climate Observing System[6] (GCOS)) by promoting harmonisation and standardisation of operations and data, furthering interoperability, and ensuring an open channel for dialogue. Thematic collaboration between European marine RIs and non-European OOS on specific scientific and technological topics is stimulating progress in ocean observation capabilities.

[3] https://ioos.noaa.gov/
[4] https://imos.org.au/
[5] https://www.oceannetworks.ca/
[6] https://gcos.wmo.int/en/home

3.2.1. Integrated Ocean Observing System - IOOS

The Integrated Ocean Observing System (IOOS) is a national-regional partnership to provide data, integrated near real-time and delayed mode information from eleven regions in the US (Fig. 2): Alaska (AOOS), the Caribbean (CARICOOS), Central and Northern California (CeNCOOS), Southern California (SCCOOS), Gulf of Mexico (GCOOS), the Great Lakes (GLOS), the Mid-Atlantic (MARACOOS), the Northeast Atlantic (NERACOOS), the Pacific Northwest (NANOOS), the U.S. Pacific Islands (PacIOOS), and the Southeast Atlantic (SECOORA). The Regional Associations (RAs) guide the development of and stakeholder input to regional observing activities. They are also effective in working with users in ocean data applications.

IOOS' mission is to produce, integrate, and communicate high-quality ocean, coastal and Great Lakes information that meets the Nation's safety, economic, and stewardship needs.

Figure 2. Map of IOOS as a federation of 10 marine and 1 freshwater regional observing systems.

IOOS bridges the gap from the local to the global and creates products and services to address domestic needs and interests all across the country with its 11 RAs and 17 federal agencies. The federal agencies provide active support, funding, guidance, or advice to the program. Additional partners include many organisations, including industry, academia, state, local, and tribal governments, and other federal and non-federal organisations.

The IOOS is governed by the Integrated Coastal and Ocean Observation System Act (ICOOS Act[7]) which authorises the establishment of a National Integrated Ocean Observing System and codifies a governance structure within which the System will operate.

IOOS includes over 600 regional and over 700 national platforms that provide data to the Data Assembly Centres (DACs). The regional associations maintain the regional platforms through

[7] https://cdn.ioos.noaa.gov/media/2017/12/icoos_act.pdf

IOOS has a critical role in implementing operational, sustained programs to observe biology and catalogue biodiversity in all eleven RAs and, therefore, IOOS is leading the development of the Marine Biodiversity Observation Network (MBON), which connects regional networks of scientists, resource managers, and users and integrates data from existing long-term programs to understand human- and climate-induced change and its impacts on marine life. The other important biological data flowing to the IOOS DACs are coming from the multi-agency U.S. Animal Telemetry Network (ATN) and National Harmful Algal Bloom Observing Network (NHABON).

IOOS advances technology through the IOOS Ocean Technology Transition program, which sponsors the transition of emerging marine observing technologies. The IOOS interacts tightly with ACT, which is a partnership of research institutions, resource managers, and private sector companies dedicated to fostering the development and adoption of effective and reliable sensors and platforms for use in coastal, freshwater and ocean environments. As such, ACT ensures a technological watch and is a key interface between technology developers, users, and providers, as well as committed to providing the information required to select the most appropriate tools for studying and monitoring coastal environments. ACT constitutes a key organisation in good practice dissemination and harmonisation within IOOS.

IOOS is also contributing to data management practices through its IOOS Data Management and Cyberinfrastructure (DMAC) subsystem. The DMAC provides a coherent strategy that enables the integration of marine data streams across disciplines, institutions, time scales, and geographic regions is central to the success of IOOS. One of the primary goals of the DMAC Subsystem is to make discovery, access, and understanding of ocean, coastal, and Great Lakes information easy and accessible for the public. Another goal is to have consistent core capability requirements for IOOS Regional Associations and other IOOS grant recipients who are contributing data to the U.S. IOOS.

3.2.2. Integrated Marine Observing System - IMOS

Australia's Integrated Marine Observing System (IMOS) has been operating a wide range of observing equipment throughout Australia's coastal and open ocean since 2006. IMOS is a national collaborative RI, currently supported under the Australian Government's National Collaborative Research Infrastructure Strategy[8] (NCRIS). IMOS is operated by a consortium of institutions (Australian Institute of Marine Science, Bureau of Meteorology, CSIRO, Sydney Institute of Marine Science (encompassing the University of New South Wales, The University of Sydney, Macquarie University and University of Technology Sydney), University of Western Australia, South Australian Research and Development Institute) as an unincorporated joint venture (UJV), with the University of Tasmania as the Lead Agent and the host of the IMOS Office. The IMOS Governing Board, led by an Independent Chair, is responsible for the governance of IMOS under the UJV. IMOS also has the Science and Technology Advisory Committee to advise the IMOS Office on a national observing system's scientific rationale and direction.

[8] https://www.education.gov.au/ncris

IMOS's mission is to provide data to improve decision-making and support marine operations, increase understanding of climate change impacts and resilience, improve understanding of conditions, species and habitats, support research, training and ocean-monitoring innovation, and engage at multiple scales for greatest impact.

IMOS is designed to be a fully integrated national system, with a portfolio of thirteen facilities[9] to undertake systematic and sustained observing of Australia's marine environment across scales (open ocean-continental shelf-coast) and across disciplines (physics, biogeochemistry, and biology and ecosystems). To successfully establish a national collaborative RI in the form of a sustained *in situ* ocean observing system, IMOS engaged the Australian marine and climate research community in a network of science-community-driven Nodes: Bluewater and Climate (open ocean), Queensland's Integrated Marine Observing System, New South Wales Integrated Marine Observing System, South Australia Integrated Marine Observing System, Western Australia Integrated Marine Observing System, Victorian Integrated Marine Observing System, Tasmania, the Northern Territory.

Besides Nodes, there are IMOS Task Teams to bring together people with specific interests and appropriate expertise to tackle issues that cross Node and/or Facility boundaries. The current Task Teams are focused on zooplankton observations and modelling, harmful algal bloom forecasting, and Australia's Ocean assessment.

IMOS observation data are delivered to the Australian Ocean Data Network (AODN) Portal, which provides access to all available Australian marine and climate science data. The IMOS data is open access. A number of data processing and visualisation tools are provided for the users. To increase the interoperability and value of data to society, IMOS sponsors the creation of best practices for both ocean observing and applications. The use of such practices is part of the funding strategy for IMOS projects.

3.2.3. Ocean Networks Canada - ONC

Ocean Networks Canada (ONC) is a non-profit ocean observing facility established in 2007, hosted and owned by the University of Victoria (UVic), and managed and operated by the ONC Society. ONC operates internet-connected ocean observatories that collect Ocean biological, chemical, geological and physical data on the Pacific, Arctic and Atlantic parts of the Ocean (Fig. 3).

[9] https://imos.org.au/facilities

Figure 3. Map of the ONC's infrastructure (ONC ©).

ONC's mission is to launch world-leading, next-generation physical and digital infrastructures, grow data services, and foster partnerships for a bright ocean future and a resilient planet.

ONC governance includes a Board of Directors (oversees the ONC Society), ONC's President and CEO (reports to the Board of Directors), the International Science Advisory Board (provides strategic advice to ONC in the context of international ocean research developments), and the Ocean Observatory Council (includes working groups that represent the interests of major ONC science users). ONC has committed to advancing equity, diversity, and inclusion within ocean science and technology by ensuring that diverse perspectives are represented at all levels of the organisation by partnering with and hiring members of underrepresented groups to the Board of Directors, Advisory Board, and staff at all levels.

ONC maintains a large regional cabled observatory network off Canada's west coast - NEPTUNE (North East Pacific Time-series Undersea Networked Experiments) reaching up to 300 kilometres offshore, to depths of 2,660 metres (Fig. 4), and maintained annually at sea using ships and remotely operated vehicles. Besides large cabled observatories, community observatories are small versions tailored to the needs of coastal and Indigenous communities to conduct year-round continuous monitoring. The other facilities include ferries, gliders, fixed buoys and moorings, and from coastal installations radars, ship traffic sensors, weather stations and onshore cameras. Thousands of seafloor instruments enable multi-disciplinary research within biological, chemical, geological and physical oceanography disciplines. Partnerships with Indigenous communities, coastal communities, citizen scientists and non-governmental organisations expand the spatial and temporal reach of accessible ocean data to support developing and implementing localised ocean protection measures and climate actions.

Figure 4. Map of Ocean Networks Canada observing systems along the Southern coast of British Columbia (ONC ©).

ONC provides scientists, communities and decision-makers access to free, open, continuous, long-time series data in real-time via ONC's data management system. Data from autonomous moorings are available following their recovery from the ocean. In 2021 ONC endorsed a new set of best practices for digital data repositories following the TRUST principles (Transparency, Responsibility, User focus, Sustainability and Technology), providing a common framework to facilitate discussion and implementation of best practices for digital repositories by all stakeholders. ONC has set up the Observatory Digital Operations division to ensure that well-described, quality data continues to flow and is made available to all users in a timely way and through suitable platforms and formats.

ONC has long paid specific attention to biological observations with a focus on benthic ecosystems, both in the coastal areas and deep sea. ONC's coastal zone observing systems and growing network of community-based monitoring programs further support the study of regional- and local-scale ocean processes and changes in ocean health. ONC's extensive network of hydrophones in coastal, deep-sea, and Arctic locations enables to study the movements of marine mammals, discover uses of sound by fishes and invertebrates, investigate the impact of human-induced noise on marine organisms, as well as detect tectonic and geological events.

ONC delivers ocean intelligence for science, society, and industry to advance public and marine safety, scientific research, climate mitigation and coastal resilience, as well as accelerate ocean technology research and development. ONC is running its own technological division, which strongly emphasises the deployment of modular cabled systems allowing for integrated ocean observing. ONC works extensively, in addition to academia, also with industry to assist with designing and testing innovative ocean technology to help expedite entry to the marketplace. ONC's services include earthquake early warning, tsunami and flood risk inundation modelling, and hydrophone calibration. ONC has developed analytics tools that address big data challenges, such as analysing underwater imagery and acoustic data.

3.3. Technological and societal synergies with non-European OOS

Setting up an integrated multi-platform coastal ocean observing system over a large spatial scale (European coastline) constitutes an ambitious task. Major non-European OOS are based on one nation and have been tackled through the developments of their national ocean observing systems over many decades already. The large initiatives such as IOOS, IMOS and ONC have been facing challenges linked with coastal ocean observing along their long coastlines and have gained highly valuable experience regarding these challenges. It is, therefore, essential to develop interactions with them further through continuous exchanges regarding scientific questions *per se*, technological expertise and developments, and interactions with partners, including stakeholders.

The possible synergies identified are:

1. Balance between integration and regionalisation;
2. Biological observations;
3. Operational observations;
4. Technological developments;
5. Interoperable data and information systems
6. Common methods/best practices and standards
7. Interactions with stakeholders;
8. Interactions with external partners.

Integration and regionalisation. Most non-European OOS consist of networks of regional subsystems, which also applies to IOOS, IMOS, and ONC. The rationale for this structuring is either the existence of functional links, e.g., due to boundary currents or the structuration of biological communities (e.g., IMOS), or the result from political considerations (e.g., IOOS). In Europe, the ocean observing network consists of national efforts/systems. As for the European coastal Ocean, regionalisation can constitute a significant benefit by coordinating transnational efforts in observing the different components of functionally connected systems. Regional coordination allows addressing the regional specificities, harmonising observation and sampling strategies, and interaction with a broad range of stakeholders with the same interests and needs. Most importantly, it would allow the establishment of multipurpose/multidisciplinary sites serving the pan-European needs to study grand environmental challenges. Current European regional systems (e.g., EuroGOOS Regional Operational Oceanography Systems, Regional Sea Conventions) have more co-development, harmonisation, and advisory roles than true observation coordination.

Biological observations. Biological observations are needed to understand marine ecosystems' functioning and changes. The observations must be taken across disciplines to fully understand the Ocean's functioning, but Europe lacks, for example, a multi-purpose integrated biological ocean observing system[10]. In IOOS and IMOS, the emphasis is clearly put on the acquisition of automatically and semi-automatically measured data that can be

[10] //www.marineboard.eu/sites/marineboard.eu/files/public/publication/EMB_FSB3_Biological_Ocean_Observation_October2018.pdf

processed and used (e.g., for data assimilation) in near real-time. In the last few decades, novel methodologies have been developed to enable sampling of biological variables simultaneously with physical and chemical variables and to process a much larger number of samples compared to the traditional methods (e.g., microscopy) automated and autonomously. JERICO is inducing a paradigm shift in the frequency of observation of several crucial biological parameters for the understanding of marine coastal ecosystems. With the use of novel technologies in biological ocean observing, large datasets are produced, often suffering from a lack of standards in formats and automated processing, but also of the quality/resolution of the derived information compared to classical (non-operational) biological approaches.

Operational observations for services. One of the major issues of multidisciplinary integrated observing consists of enhancing the harmonisation of observations achieved by different operators at various locations so that they become comparable and readily usable for pan-European and regional oceanographic services and product development. This is particularly important for regions where ocean and coastal currents transverse national boundaries, as these currents directly impact the ocean's physical and biological conditions. A way forward is defining and applying best practices and procedures that allow satisfactory quality standards to be reached. This approach has been, for example, initiated by IOOS. The availability of current best practice recommendations clearly depends on the maturity of the observing technology and the maturity of the practice itself and there are still significant gaps in the coverage, harmonisation and implementation of best practices in some fields, including biogeochemistry (e.g., carbonate system variables, oxygen, nutrients) and biology (e.g. biodiversity assessments).

Technological developments. Major users and applications of ocean observing data require a multidisciplinary integrative approach for observations. Following an integrative approach is also essential for developing trusted products derived from observations when stakeholder expectations are linked to biological/biogeochemical processes since those are most often cued through physical-chemical-biological interactions. Therefore, JERICO has focused on technological foresight through all its projects over the last decade. Even though sensor technologies are advancing fast, their Technological Readiness Levels (TRLs) are hampered by short-term project-based funding schemes. The other significant challenge lies in the nature of the European ocean observation and monitoring initiatives, which are most often limited by disciplinary scope, which in turn results in a lack of platforms encompassing large sets of sensors allowing for integrative multidisciplinary measurements.

Interoperable data and information systems/Common methods and standards. As we move to more complex multi-disciplinary systems and to integration across geospatially diverse observing systems, interoperability across data and information systems will be increasingly important if a broad, even global perspective is needed. Such interoperability is facilitated through the use of common methods, as discussed above. It is desirable that all ocean processes adhere to the same (appropriate) mature practices. Experience shows that this is challenging in the near term because the observation environments can differ, e.g., the Baltic and Mediterranean Seas. A nearer-term solution is to have documented methods in a central registry, such as the Ocean Best Practices System (OBPS) repository so they are open and readily available for comparison not only regional-wise, but also global-wise. The processes in the methods should be transparent to users and provide essential attributes such as uncertainty estimations and recommended data and information formats. JERICO has developed a best practices maturity scale, documented in deliverable D5.2, which identifies the key attributes of mature methods that will support the adoption of such methods for operational observing systems. These can also stimulate and facilitate technological developments so that new technologies can be introduced into observation, data, and information systems.

Interactions with stakeholders. Current European and international initiatives regarding ocean observations (e.g. GOOS, EOOS and EuroGOOS) all stress that observations and derived products should be set up in tight interactions with stakeholders on a fit-for-purpose basis to guarantee their sustainability in the long term. The broad stakeholder community clearly constitutes a key element in enhancing the visibility and sustainability of ocean observing. Ocean observing stakeholders mostly include scientists and users of data, products and services. This last community is especially diverse in the case of the coastal ocean and even more in its littoral component due to the large diversity of uses of ecological services made by humans and resulting socio-economic concerns. The JERICO has created a Jerico User Committee (JUC) to get necessary feedback on the needs and requirements of different stakeholders in order to define the products and services derived from JERICO observations, design the necessary observing network and create transnational collaborations. For European coastal ocean observing as well as for the selected non-European OOS, the common challenge lies in the magnitude of the ocean coastline that needs to be observed and hence the regional specificity in the needs of the broad stakeholder community. IOOS, IMOS, and ONC are all emphasising their interactions with stakeholders to develop a large variety of fit-for-purpose products in close collaboration with local stakeholders.

Interactions with external partners. IOOS and ONC have developed significant interactions with external partners through different pathways: IOOS integrates information originating from different organisations (e.g., the US Geological Survey for river monitoring), and ONC favouring the use of its technology by external users/partners, allowing the widening of the panel of observations achieved at dedicated sites, and enriching the ONC technological expertise. The latter approach is somehow comparable to the Transnational Access in JERICO.

3.4. Joint activities with non-European OOS

To better engage and exchange with the non-European OOS, an information and experience exchange on best practices, innovative monitoring, and technological developments has been established and will be continued via JERICO international activities in the frame of the UN Decade Programme CoastPredict and its activity Global Ocean Experiment, as well as via the Joint Action chaired by JERICO, AA-COASTNET, part of the All-Atlantic Ocean Research Alliance and Innovation Alliance EU project, going beyond OOS and networks described above.

The UN Decade of Ocean Science CoastPredict programme, endorsed in 2022, plans to advance global coastal ocean observing and forecasting to expand the Global Ocean Observing System into the coast. This will be achieved by co-designing integrated systems for real-time responsiveness and long-term projections, tailored to local stakeholder needs. It's focused on creating a digital framework for data sharing and predictive tools to enhance coastal resilience through capacity building and technology transfer. JERICO-CORE (the Virtual Research Environment of the RI) is an endorsed project of the CoastPredict programme, thus substantially expanding JERICO's network of collaborators (and potential collaborators).

AA-COASTNET joint action. The All Atlantic COASTal observing and technology NETwork ("AA-COASTNET)[11] joint action, chaired by JERICO, is part of the All-Atlantic Marine Research Infrastructure Network (AA-MARINET)[12], which provides tools to support a Trans-Atlantic network of RIs initiatives, promoting transnational access and other methods for sharing infrastructures in the Atlantic area. It works as a platform where stakeholders can share information about planned observation activities and available spare capacities, creating a forum where thematic networking and synergies will bring a better articulation of infrastructure-related activities in the Atlantic basin, improving the support of multidisciplinary science to address global societal challenges.

The partners involved in this joint action are key entities in their country for coastal observation and technology. Besides JERICO, which is a system of systems strengthening the European network of coastal observatories dedicated to observing and monitoring the complex marine European coastal seas, the partners involved are (Figure 5):

- in Brazil: the Brazilian Coastal Monitoring System (SiMCosta), the National Buoy Program (PNBoia), and the Best Practices in Ocean Observations (MePrO), which are networks dedicated to meteorological and oceanic measurements (surface biogeochemical sensors, currents, waves), research and prediction;
- in South Africa: Shallow Marine and Coastal Research Infrastructure (SMCRI), based on the South African Environmental Observation Network (SAEON), and the South African Institute for Aquatic Biodiversity (SAIAB);
- in West Africa (Gulf of Guinea): coastal sea surface temperature network PROPAO and regional databank;
- in Cabo Verde: Cabo Verde Ocean Observatory (CVOO), which is collecting data since 2006 with a deep sea mooring, and also the infrastructure Ocean Science Center of Mindelo (OSCM);
- in Argentina: the EMAC low-cost buoys and stations monitoring network.

The AA-COASTNET AANChOR joint action enables the production of a more science-integrative approach to better observe the coastal ecosystem, raising scientific excellence, while considering the regional and local ecosystems.

[11] https://www.aa-mari.net/aa-coastnet/
[12] https://www.aa-mari.net/

Figure 5. The AA-COASTNET joint action partners

AA-COASTNET have organised two workshops to connect communities from the Belém and Galway countries, define the pillars of long-term collaboration, and identify topics of prime interest for coastal observing on both sides of the Atlantic Ocean. The workshop's short- and long-term objectives were to improve the coordination and alignment of programmes/initiatives and projects between South- and North-Atlantic regions, including the European Union (EU) and its Member States. It contributed to creating the right conditions for the development of homogenised and fit-for-purpose (accuracy) monitoring, modelling, planning, management and prediction capacities. As well as to discuss how to increase the competitiveness of the EU's blue economy by developing new technologies to service societal needs and ocean observing value chains. The long-term strategy for the consolidation of education and training networks, including more ocean-engaged citizens and communities, was established.

The communities' main common needs and objectives as outcomes of the AA-COASTNET workshop were:

- Knowledge exchange (training, teaching culture of planning and documenting) (personnel exchange program);
- Best practices;
- Common database (first at the country level);
- Calibration of sensors (labs and knowledge), adapted to the specificity of the country;

- A global metrology network;
- Low-cost sensor technology;
- Financial support for maintenance and expansion;
- Sharing contacts and building a shared space for shared materials (presentations, links to common interest publications and documents).

In order to keep the AA-COASTNET community active and be able to go further in terms of objectives as described in the outcomes of the workshops, two strategies to secure the sustainability of the network are foreseen.

The AA-COASTNET could become one of the UN Decade CoastPredit[13] programme projects (the AA-COASTNET joint action was presented during the last CoastPredict General Assembly in Bologna, 17-19 January 2023, and was well welcomed), as the CoastPredict objectives are well aligned with the AA-COASTNET ones:

- A predicted Global Coastal Ocean;
- A fit-for-purpose oceanographic information infrastructure benefiting stakeholders such as specialised users who interpret, share and sometimes sell information to end users such as businesses, government and individuals;
- An integrated coastal ocean observing and forecasting system adhering to best practices and standards, designed as a global framework and implemented locally;
- Open and free access to coastal information and the growth of ocean literacy;
- Innovative and sustainable applications for coastal solutions/services.

Also, the AA-COASTNET joint project action could fit easily in the 6 focus areas[14] of the CoastPredict program.

In addition, JERICO will apply to the ESFRI Roadmap 2026. The application will mention the AA-COASTNET joint project action as an added value of JERICO being a European scale RI dedicated to coastal ocean observation and then being able to sustain such AA-COASTNET initiative as well as having the possibility to level up AA-COASTNET at the global level with the help of the CoastPredict program.

3.5. Connections with developing oceanographic systems in adjacent regions

Links with developing oceanographic systems in adjacent regions, including the Black Sea and North Africa, have been established and will be strengthened by creating and expanding collaborations with potential partners to share existing and promising technologies, best practices as well as deployment strategies. The expanded collaboration will be based on the experiences with European RIs and the work of JERICO with non-European programs such as IOOS, IMOS, and ONC mentioned in the previous section.

3.4.1. Black Sea

The Black Sea is bordered by six countries (Bulgaria, Georgia, Romania, Russia, Turkey, and Ukraine) and due to the current political tensions the observation coordination and collaboration are limited. From European RIs, two have established their facilities in the Black Sea - EMSO ERIC with 3 sites and Euro-Argo ERIC with active 3 floats (in addition to the

[13] https://www.coastpredict.org/
[14] https://www.coastpredict.org/focus-areas/

active 2 floats from Italy and active 9 floats from Bulgaria). DANUBIUS RI is coordinated by a Romanian institution (the National Institute for Research and Development of Marine Geology and Geoecology – GeoEcoMar) with which JERICO has established contact and a working relationship. JERICO partners are, together with DANUBIUS RI partners, linked in the recent "Land-Sea interface: Let's observe together! (LandSeaLot)" project (EU Programme: HORIZON-CL6-2023-GOVERNANCE-01-11, Grant Agreement 101134575, Co-ordinator: STICHTING DELTARES (NL), 02/2024-01/2028). One of LandSeaLot's Integration Labs is in the Black Sea, focusing on the coastal sediment budget development under combined human/climate pressures and inputs of pollutants from the Danube River to the North-West Black Sea through the delta. With its facilities and established stakeholder communities and in synergy with ongoing projects in the area (H2020 CERTO and H2020 DOORS), DANUBIUS RI, in collaboration with JERICO partners, will support the action to fill observation gaps, thus integrating information from numerical models at the coastal scale and from the catchment *in situ* and remote sensing data.

JERICO has also contacted several other potential partners in the Black Sea region (especially in Bulgaria and Turkiye), but so far, collaboration has not been developed beyond initial contacts.

3.4.2. Africa

Establishing contact with North African partners has been complicated for various reasons, such as lack of dedicated funding, pandemic restrictions and geopolitical issues. An initial contact with the Institut National des Sciences et Technologies de la Mer in Tunisia is being followed up, and an invitation to join the JERICO-S3 final General Assembly has been issued under the premise that this type of collaboration is designed to be established with JERICO's future path to a potential ERIC in mind. JERICO will continue to pursue further potential partners in this region.

4. CONCLUSIONS

In the European marine RI landscape, RIs either exploit a single type of observation platform (e.g., fixed platforms, profiling floats, research vessels, autonomous vehicles) or are thematic in focus, relying on a multi-platform approach. JERICO is an integrated pan-European multidisciplinary and multi-platform RI dedicated to a holistic appraisal of coastal marine system changes. As it aims to organise, harmonise, and integrate existing coastal observing activities and initiatives in Europe in order to address region-specific but also pan-European scientific and socio-economic challenges, its functioning and operation are close to the multi-platform and multi-disciplinary ocean observing systems worldwide. Therefore, it is paramount to build connections and facilitate collaborations regionally and globally.

A list of technological and societal synergies with non-European OOS has been identified since the JERICO-NEXT project. Those synergies form a platform for ongoing and future collaborations, e.g. in the frame of UN Ocean Decade Programs and Activities.