



**GRANT N°:** 871153  
**PROJECT ACRONYME :** JERICOS3  
**PROJECT NAME :** Joint European Research Infrastructure for Coastal Observatories - Science, services, sustainability  
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<b>JERICOS3 MILESTONE</b>	
Joint European Research Infrastructure network for Coastal Observatory <b>Science, Services, Sustainability</b>	
<b>MS#, WP# and full title</b>	JERICOS3 MS51 - WP9 - "Chapter 2 of D9.6: Skeleton of national nodes: involved institutions and definition of national representatives"
<b>5 Key words</b>	European Research Infrastructures, EOOS, collaboration, coordination
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<b>Submission date</b>	30/07/2024

→ Please specify the type of milestone:

- Report after a workshop or a meeting (TEMPLATE A)
- Report after a specific action (TEMPLATE B) (test, diagnostic, implementation,...)
- Document (TEMPLATE B) (guidelines,...)
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## Objectives

The objective of this milestone is to provide a first version of Chapter 2 of deliverable D9.6 “Common action plans with other RI initiatives and one with EOOS for the future”. The written content aims at giving an exhaustive overview of the marine Research Infrastructure landscape in Europe, in other words the immediate surroundings of the future JERICO-RI.

## Main report

### **1.1. Marine Research Infrastructures landscape in Europe**

Research Infrastructures (RIs) are large-scale facilities that provide resources and services for the scientific communities to conduct high-level research and foster innovation. There are currently three marine RIs as European Research Infrastructure Consortiums (ERICs)<sup>1</sup>:

1. Euro-Argo<sup>2</sup> - Europe's contribution to the Argo programme observing the oceans;
2. European multidisciplinary seafloor and water column observatory<sup>3</sup> (EMSO);
3. European Marine Biological Research Centre<sup>4</sup> (EMBRC).

Besides, there are also several ERICs with a marine component.

1. European carbon dioxide capture and storage laboratory<sup>5</sup> (ECCSEL);
2. WindScanner<sup>6</sup> - wind energy research network;
3. International centre for advanced studies on river-sea systems<sup>7</sup> (DANUBIUS-RI);
4. Integrated Carbon Observation System<sup>8</sup> (ICOS);
5. Svalbard Integrated Arctic Earth Observing System<sup>9</sup> (SIOS);
6. KM3NeT 2.0<sup>10</sup> - a network of deep-sea neutrino telescopes in the Mediterranean Sea with user ports for Earth and Sea sciences;
7. European Plate Observing System<sup>11</sup> (EPOS);
8. LifeWatch<sup>12</sup> - providing e-science research facilities to scientists investigating biodiversity and ecosystem functions and services.

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<sup>1</sup>[https://research-and-innovation.ec.europa.eu/research-area/environment/oceans-and-seas/marine-research-infrastructures\\_en](https://research-and-innovation.ec.europa.eu/research-area/environment/oceans-and-seas/marine-research-infrastructures_en)

<sup>2</sup> <https://www.euro-argo.eu/>

<sup>3</sup> <https://emso.eu/>

<sup>4</sup> <https://www.embrc.eu/>

<sup>5</sup> <https://www.eccsel.org/>

<sup>6</sup> <https://www.windscanner.eu/>

<sup>7</sup> <https://www.danubius-ri.eu/>

<sup>8</sup> <https://www.icos-cp.eu/>

<sup>9</sup> <https://sios-svalbard.org/>

<sup>10</sup> <https://www.km3net.org/>

<sup>11</sup> <https://www.epos-eu.org/>

<sup>12</sup> <https://www.lifewatch.eu/>

In parallel, since 2010, the EU Framework Programmes for Research and Innovation (FPs) INFRAIA and INFRADEV calls have led to the creation of European marine RI projects such as JERICO RI<sup>13</sup>, Eurofleets+<sup>14</sup>, GROOM RI<sup>15</sup>, and later EUMR2<sup>16</sup>, MINKE<sup>17</sup> and EuroGO-SHIP<sup>18</sup>. The nation's involvement in several ERICs and marine RI projects, together with the evolution of national research infrastructure roadmaps has stimulated the reorganisation and consolidation of national efforts in some countries (e.g., Finland, Italy, France), leading to the creation of a variety of national networks involving national agencies, research centres and universities. The European marine RIs and national networks have become key players in the collection of ocean *in situ* data for research and operational services and should become the backbone of the sustained European Ocean Observing System<sup>19</sup> (EOOS).

In the European marine RI landscape, RIs either exploit a single type of observation platform (e.g., fixed platforms for EMSO ERIC, profiling floats for EURO-ARGO ERIC, research vessels for Eurofleets+ and EuroGO-SHIP, autonomous vehicles for GROOM RI) or are thematic in focus, relying on a multi-platform approach (e.g., ICOS-OTC for assessing CO<sub>2</sub> emissions and JERICO for 'holistic appraisal of coastal marine system changes'). In addition, the MINKE marine RI project is transverse, building an innovative 'ocean data quality' framework based on accuracy and completeness to support the observation of Essential Ocean Variables (EOVs).

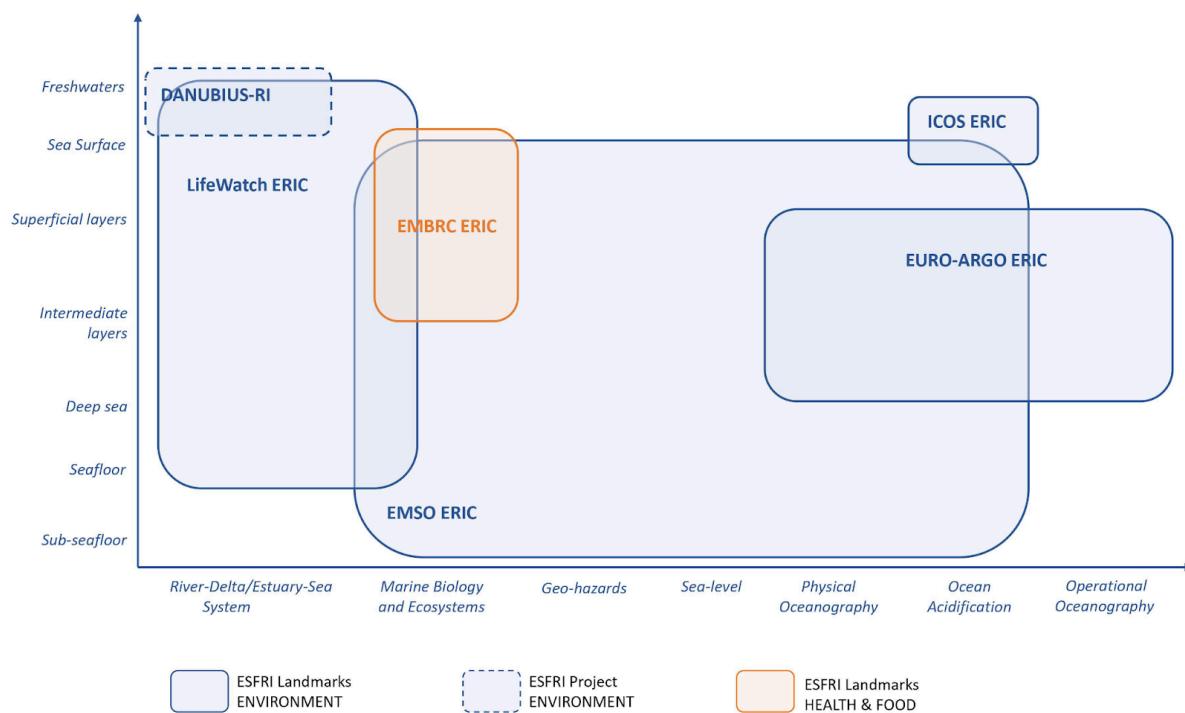


Figure 1. The different domains covered by the European marine RIs versus depth from the seafloor to sea surface and freshwater (Dañobeitia et al., 2023<sup>20</sup>).

<sup>13</sup> <https://www.jerico-ri.eu/>

<sup>14</sup> <https://www.eurofleets.eu/>

<sup>15</sup> <https://www.groom-ri.eu/>

<sup>16</sup> <https://www.eumarinerobots.eu/>

<sup>17</sup> <https://minke.eu/>

<sup>18</sup> <https://eurogo-ship.eu/>

<sup>19</sup> <https://www.eoos-ocean.eu/>

<sup>20</sup> <https://www.frontiersin.org/articles/10.3389/fmars.2023.1047251/full>

The European marine ERICs jointly present a unique force to support the observation, monitoring, and study of marine systems from the land to the open ocean (Fig. 1). Together, with the marine RI projects, they can provide an integrated pan-European multidisciplinary platform, combining *in situ* and remote observations of physical, chemical, and biological parameters with experimental manipulation, to provide the basis for a holistic understanding of European marine systems and support European policies. Marine RIs promote the dissemination and updating of harmonised data standards, and other methods, ontologies and data and other resource catalogues following FAIR (Findable, Accessible, Interoperable, Reusable) principles, facilitating the exchange of data, as well as the development of integrated services. The data, products and services offered by the marine RIs are essential contributions to the European Open Science Cloud<sup>21</sup> (EOSC) initiative. European marine RIs also aim to structure research communities and implement guidelines and best practices laid out in international frameworks of the Intergovernmental Oceanographic Commission<sup>22</sup> (IOC), such as the Global Ocean Observing System<sup>23</sup> (GOOS), Genomics Standards Consortium<sup>24</sup> (GSC), and the European Ocean Biodiversity Information System<sup>25</sup> (EurOBIS), and seek to actively contribute to the United Nations Decade of Ocean Science<sup>26</sup>.

As the coastal ocean is currently a high priority in different EU policies but also of the UN Decade for Sustainable Development, Europe needs dense enough, well-instrumented sites and regions to study, observe and monitor waters of the coastal shelf. A comprehensive analysis of the changes impacting coastal ecosystems requires an integrated basin approach to understand the impact of different drivers and to find measures for coastal preservation, management and planning. Long-term observations are needed to address transversal scientific and societal challenges acting at various spatio-temporal scales and to understand large-scale processes that can significantly impact coastal and littoral areas. This could only be achieved at the pan-European level with close collaboration between different actors. For the sustained development and efficient operation of ocean observing systems in Europe and globally, information and data sharing, and collaboration and coordination of actions are needed to avoid duplications and use available resources efficiently. JERICO, in collaboration with other environmental RIs, has taken steps to foster the collaboration (as is reported in deliverable D2.1), and to effectively support the progress towards implementation of the EOOS. Below are concise descriptions of JERICO and the marine RIs with the closest collaborations that have been established so far with JERICO.

### 3.1.1. JERICO

JERICO is an integrated pan-European multidisciplinary and multi-platform research infrastructure dedicated to a holistic appraisal of coastal marine system changes. The aim is 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. 2), increasing efficiency, and enabling and fostering interoperability. JERICO aims to organise, harmonise, and integrate existing coastal observing

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<sup>21</sup> <https://eosc-portal.eu/>

<sup>22</sup> <https://www.ioc.unesco.org/en>

<sup>23</sup> <https://www.goosoocean.org/>

<sup>24</sup> <https://www.gensc.org/>

<sup>25</sup> <https://www.eurobis.org/>

<sup>26</sup> <https://oceandecade.org/>

activities and initiatives in order to address both pre-identified region-specific and pan-European scientific and socio-economic challenges.

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.

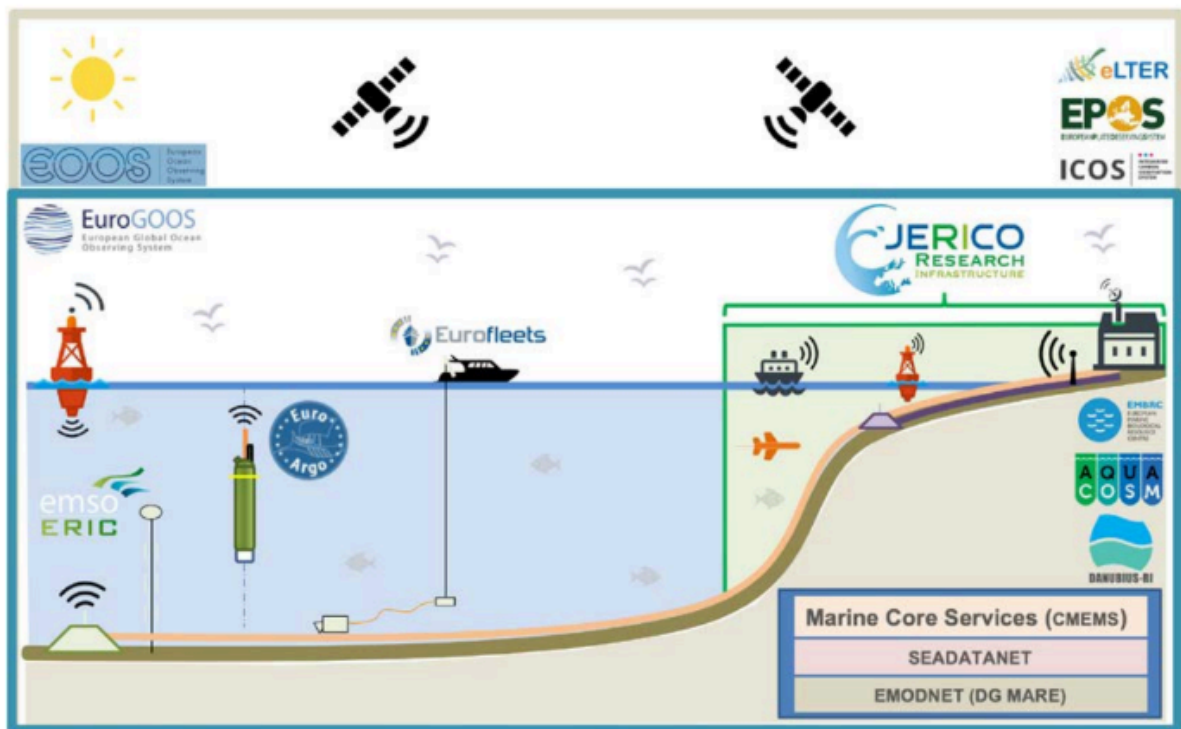


Figure 2. Schematic illustrates how JERICO is a key component of the European marine research landscape.

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 current national JERICO RI infrastructures included are fixed platforms (platforms or buoys), high-frequency radars, gliders, Ferrybox systems, tide gauge networks, and research vessels. Other platforms 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).

### 3.1.2. DANUBIUS RI

The ESFRI Project International Centre for Advanced Studies on River-Sea Systems (DANUBIUS RI) supports interdisciplinary research in river-sea systems (Figure 1). It is the only physical pan-European RI devoted to supporting research on transitional zones between coastal marine and freshwater areas. The development of DANUBIUS RI as a distributed environmental RI builds on existing expertise to support interdisciplinary research on River-Sea Systems, covering whole river basins and the coastal waters that they influence. Addressing the conflicts between sustainable development, environmental change and environmental conservation in River-Sea Systems, DANUBIUS RI's mission is to facilitate and contribute excellent science on the continuum from river source to sea, offer state-of-the-art research infrastructure, and to provide the integrated knowledge required to sustainably manage and protect River-Sea Systems. DANUBIUS RI's goal is to overcome the fragmentation of science, knowledge, data and management approaches in rivers and seas by integrating spatial, temporal, disciplinary and sectoral thinking. It will provide science-based solutions to societal risks arising from global and climate change as well as coincident extreme events. Likewise, it will offer a source-to-sea perspective to resolve the problems of adverse human impacts on water and sediment quality and quantity, hydromorphology, biodiversity and ecosystem functioning.

### 3.1.3. EMSO ERIC

European Multidisciplinary Seafloor and water column Observatory (EMSO ERIC) aims to explore the oceans, better understand phenomena, and explain the critical role of these phenomena in the broader Earth systems. It consists of a system of regional facilities placed at key sites around Europe, from the North East to the Atlantic, through the Mediterranean, to the Black Sea. EMSO Observatories are equipped with multiple sensors, placed along the water column and on the seafloor, constantly measuring different biogeochemical and physical parameters that address natural hazards, climate

change and marine ecosystems. EMSO offers data and services to a large and diverse group of users, from scientists and industries to institutions and policymakers.

#### 3.1.4. ICOS ERIC

Integrated Carbon Observation System (ICOS ERIC) is a distributed RI that facilitates carbon cycle research and provides necessary information on greenhouse gases (GHGs). ICOS conducts long-term observations in the atmosphere, ecosystems, and oceans. It generates high-precision and standardised data to monitor the present state and extrapolate the future behaviour of the global carbon cycle and GHG fluxes to predict environmental changes and mitigate their impacts. ICOS has a cross-domain approach to enable understanding of the carbon cycle and to provide necessary information on the land-ecosystem exchange of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O with the atmosphere. ICOS helps to elaborate an account of the Earth system and its response to climate change and other environmental challenges and advances the fulfilment of the United Nations' Sustainable Development Goals and the European Union's Societal Challenges, especially those concerning climate change. ICOS Ocean Thematic Centre (OTC) currently coordinates 22 ocean stations in seven countries, monitoring carbon uptake and fluxes in the North Atlantic and the Nordic, Baltic and Mediterranean Seas. The measurement methods include sampling from research vessels, moorings, buoys and commercial vessels (so-called Ships of Opportunity - SOOP). They all have been equipped with state-of-the-art carbonate system sensors.

#### 3.1.5. EMBRC ERIC

The European Marine Biological Resource Centre (EMBRC) is Europe's 'research infrastructure' for marine biological resources providing access to marine resources, as well as cutting-edge services and facilities that allow researchers, from both academia and industry, to study the ocean and develop innovative solutions to tackle societal issues. EMBRC gathers more than 70 marine stations and institutes in 9 countries across Europe. By offering a wealth of marine biological laboratories and stations dedicated to the investigation of marine organisms and ecosystems and making their services and resources available to European and international research/innovation communities, EMBRC promotes marine solutions to address societal issues (e.g. global warming, food shortages) and develop novel products (pharmaceuticals, cosmetics, nutraceuticals).

#### 3.1.6. LifeWatch ERIC

The ESFRI Landmark e-Infrastructure for Biodiversity and Ecosystem Research (LifeWatch ERIC) has a cross-domain approach and a focus on the Grand Challenges of preserving biological diversity and protecting ecosystem health. LifeWatch ERIC is an e-Infrastructure that enables knowledge-based solutions to environmental managers by providing access to a multitude of sets of data, services and tools about the role of biodiversity in ecosystem functioning and conservation. LifeWatch ERIC is committed to providing Virtual Research Environments (VREs), virtual labs (vLabs) and Big Data paradigm-based tools to conduct cutting-edge research, but also to boosting technological innovation, continuously improving the performance of VREs, opening up new fields for socio-economic development, establishing synergies with various national and regional stakeholders, and promoting democracy and creativity in science.



### 3.1.7. e-LTER RI

The Integrated European Long-Term Ecosystem, critical zone and socio-ecological system Research Infrastructure (eLTER RI) is a distributed RI to facilitate high-impact research and catalyse new insights about the compounded impacts of climate change, biodiversity loss, soil degradation, pollution, and unsustainable resource use on a range of European socio-ecological systems. eLTER RI aspires to develop the scientific capacity to improve the understanding of terrestrial, freshwater, and transitional water ecosystems. Combined with a socio-ecological approach to studying integrated human-nature systems and commitment to integrating stakeholder knowledge, it provides a solid foundation to inform policy-maker systems to find evidence-based sustainable solutions for addressing current and emerging challenges. eLTER RI provides researchers with access to over 500 sites across Europe and biogeographical regions, establishing and offering harmonised and standardised data, services and training useful to citizens and experts in their joint efforts to find sustainable solutions to the Grand Societal Challenges.

### 3.1.8. GROOM RI

The Gliders for Research, Ocean Observation and Management (GROOM) RI is a distributed European RI harnessing the advantages of Marine Autonomous Systems (MAS). MAS, among which are the underwater gliders, are highly capable platforms that can collect ocean surface and water column measurements at a wide range of spatio-temporal scales and, in recent years, they have become ubiquitous for marine research, Ocean Observing Systems (OOSs) and for industrial applications. GROOM RI integrates national infrastructures for MAS and promotes a collaborative approach of collecting and sharing oceanographic data, and of supporting MAS development and innovation. It provides access to platforms and services to the broadest range of scientific and industrial users, as well as to other marine RIs in the offshore and coastal domains. By maintaining a unique centralised provision of cyber-infrastructure, data and knowledge, it optimises the use of MAS in Europe to study climate and marine environments, and also supports operational services and the blue economy.

### 3.1.9. AQUACOSM

EU network of mesocosm facilities for research on marine and freshwater ecosystems open for global collaboration (AQUACOSM)<sup>27</sup> aims to strengthen the EU network of mesocosm facilities and promote joint research initiatives, capacity building and standardisation with extensive Transnational Access to more than 60 different sites or installations at 28 selected leading and highly complementary European mesocosm facilities. AQUACOSM encompasses a large geographic range from the Arctic to the Mediterranean with unique infrastructures in catchments from mountains to lowlands; rivers, ponds, lakes, estuaries and the sea.

## Conclusion

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<sup>27</sup> <https://www.aquacosm.eu/>



This first section lays the foundation for the description of synergies and other collaborative actions that could be undertaken by JERICO, constituting a sound basis for a common action plan under the framework of EOOS.