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**DELIVERABLE TITLE:**

# JERICO-S3 D3.1: Initial analysis and summary of region-specific and region-wide monitoring strategies, and regional sustainability plans

DELIVERABLE NUMBER: **D3.1**

WORK PACKAGE N° and NAME: WP3 Integrated Regional Sites

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## JERICO-S3 DELIVERABLE

Joint European Research Infrastructure network for Coastal Observatory
**Science, Services, Sustainability**

| | |
|---|---|
| **DELIVERABLE n° WP and full title** | JERICO-S3 D3.1: "Initial analysis and summary of region-specific and region-wide monitoring strategies, and regional sustainability plans" |
| **Description** | This document presents the results of an initial self-evaluation of the scientific of the regionally organized coastal research community. |
| **Lead beneficiary** | IRB |
| **Lead Authors** | M. Pfannkuchen, A. King |
| **Co-Authors** | A. Rubio, H. Wehde, F. Brunetti, J. Vitorino, E. Bréviѐre, B. Karlson, A. Grémare |
| **Submitted by** | M. Pfannkuchen |

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# 1 EXECUTIVE SUMMARY

Within Jerico-S3 the following integrated regional sites (IRS) are formed to showcase and to further develop regional and pan-European integration of coastal observation systems:

- **Northern Adriatic Sea**
- **Iberian Atlantic Margin**
- **Bay of Biscay**
- **Kattegat-Skagerrak-Eastern North Sea**
- **Norwegian Sea**

For each IRS this document gathers information about:

- **the involved scientific partner institution**
- **the main scientific challenges**
- **the observational strategies**
- **the regional organization**
- **the financial sustainability plan**
- **the plans for future development**

This initial assessment demonstrates substantial pan-European interoperability and substantial scientific and observational capacities for coastal observations. Coastal observational strategies are mainly driven by national and regional scientific key challenges and by the national commitments to monitoring programs in the frame of the MSFD and similar directives. Strategic and financial sustainability is demonstrated for the reported observational infrastructure and capacities in all IRS. This sustainability is currently based on financial and strategic commitment at institutional and to a lesser extent at national level.

# 2 INTRODUCTION

Key common scientific challenges within JERICO-S3:
JERICO-RI will address a large diversity of scientific, environmental and societal issues. From a wide catalog of regional scientific questions (presented during the first JERICO-S3 All Region Workshop), a list of specific scientific challenges and three Key Scientific Challenges (KSC) were obtained, as a base for a common science strategy for the observing, monitoring and research in European coastal marine ecosystems. These three KSCs are:

- KSC#1: Assessing and predicting the changes of coastal marine systems under the combined influence of global and local drivers,
- KSC#2: Assessing the impact of extreme events on those changes,
- KSC#3: Unravelling the impacts of natural and anthropogenic changes.

The Key scientific challenges are further detailed by the following list of Specific Scientific challenges, related to each of the three KSC:

- Land-Ocean continuum: impacts of land-based discharges and exchange with the open sea (KSC#1)
- Sea-atmosphere interference: quantification of inputs (KSC#1)
- Connectivity and transport pathways of water masses and materials (KSC#1)
- Biodiversity trends (KSC#1)
- Ecosystem biogeochemical processes and interactions (KSC#1)
- Carbon budget and carbonate system (KSC#1)
- Impact of rare and extreme events (KSC#2)
- Long term observations to resolve climate change impacts (KSC#3)
- Observations to resolve anthropogenic disturbances (KSC#3)
- Interoperable and integrated long term data sets (KSC#3)

These scientific challenges are further explained in the Deliverable 1.1 of JERICO-S3 WP1.

The JERICO-S3 community has formed **Integrated Regional Sites (IRS)** for regions that are characterized by a history of transnational collaboration on regionally integrated coastal observing systems. During the JERICO-S3 project the IRS plan to develop:
- Strong transnational and regional collaborations between research institutions that maintain integrated and interoperable research programs on coastal observations
- Common and interoperable datasets on coastal observations
- Regional governing structures of collaborative observation systems
- Pan-European integration and interoperability of their coastal observing systems.

Those Integrated Regional Sites serve as proof of concept for **regional integration and collaboration** as well as **integrated and interoperable coastal observing systems**. They further serve as model systems for **pan-European integration** of observation systems towards a transnational governance at EU level.
The chosen Integrated Regional Sites are at different levels of regional integration and the process of further regional homogenization and integration of coastal observatories will be developed and monitored through this project and will deliver important experience for the establishment of a pan-European integrated coastal observation system of regional systems as is recommended by the EU.

Within Workpackage 3, JERICO-S3 catalogues and advanced regional organization, integration and interoperability with a particular focus on regional sustainability of the coastal observation systems.

The following figure illustrates the pan-European system of regional systems the JERICO-S3 community aims for, answering the recommendations of the EU DG-Environment.

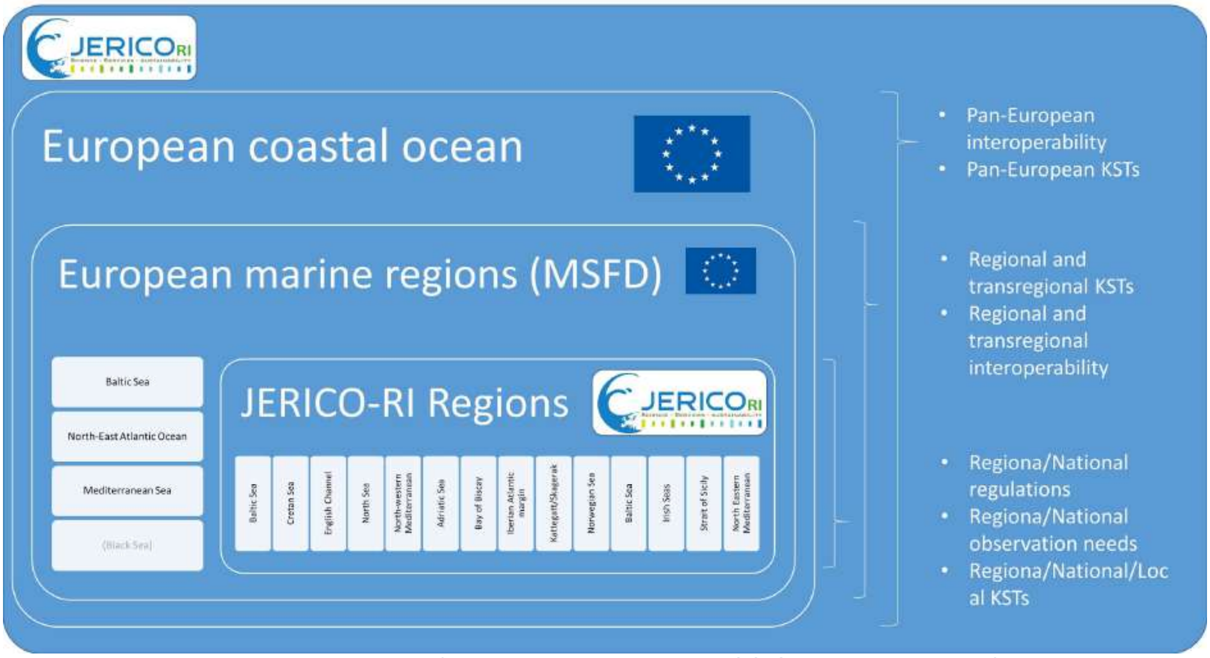



*Figure 1, the pan-European system of regional systems the JERICO-S3 community aims for*

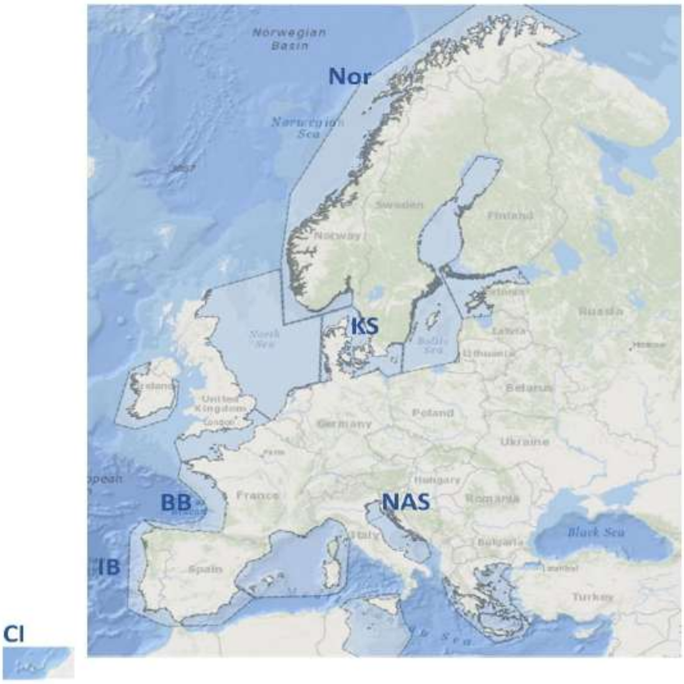
This initial assessment will focus on the existing observation structures and organizational structures that are currently included in the JERICO-S3 community. However, there is considerable capacity for coastal observations (e.g. long term monitoring programs in the frame of the Marine Strategy Framework Directive, MSFD, and long term research programs of individual research infrastructures) currently not yet tightly integrated in the JERICO-S3 community that albeit being of operational monitoring character, delivers valuable observation data for the European coastal marine ecosystem and its scientific exploration. This document as well as the progress within WP3 includes information and outreach about and towards coastal observation capacity currently outside the JERICO-S3 community sensu stricto to further the development of a comprehensive, integrated and regionally adapted joint European coastal observation system.

This document presents the results of an initial self-evaluation of the scientific of the regionally organized coastal research community. It serves as a starting point and guide for the regional consolidation of coastal observation systems and their integration with pilot super sites into a pan-European system of coastal observation systems.

Regional and pan European integration of coastal observation systems is a prerequisite to answer to these challenges. This integration and consolidation is also a prerequisite knowledge based management of coastal ecosystems and for European excellence in coastal marine science.

# 3 MAIN REPORT

The following figure shows the location and geographic extent of the JERICO-S3 Integrated Regional Sites:




**Integrated Regional Sites**

| Abbreviation | Region name |
|---|---|
| Nor | Norwegian Sea |
| KS | Kattegat-Skagerrak E-N Sea |
| BB | Bay of Biscay |
| IB | Iberian Atlantic Margin (+ Canary Islands (CI)) |
| NAS | Northern Adriatic Sea |

## 3.1 Initial assessment of the JERICO-S3 Integrated Regional Sites

The following chapters show information for the 5 JERICO-S3 integrated regional sites on

- the involved scientific partner institution
- the main scientific challenges
- the observational strategies
- the regional organization
- the financial sustainability plan
- the plans for future development.

The information is based on data gathered by the scientists collaborating in WP3, the scientists that lead the development of the JERICO-S3 IRSes and in close collaboration with scientists that are responsible for topical (e.g. physics, biology and chemistry) development within the regions.

The coastal observation infrastructure mentioned in the following chapters is catalogued and georeferenced in the SEXTANT catalogue (https://sextant.ifremer.fr).

### 3.1.1 Northern Adriatic Sea

The following Figure 2 shows the position and extent of the Northern Adriatic IRS (NA-IRS), the location of the fixed mooring platform, the regular sampling stations as well as the observatories (Bari-Dubrovnik glider transect and E2M3A offshore buoy) that contribute to the characterization of the entire Adriatic basin.

*Figure 2 Northern Adriatic IRS*

The ADRIATIC SEA is a semi enclosed basin of the Mediterranean Sea with a general cyclonic circulation. Several rivers (including the river Po as the largest freshwater input into the Mediterranean) discharge dissolved and particulate materials and contaminants. The interactions between river water masses and the general circulation significantly influence the biomass and biodiversity of plankton of the whole basin. The basin is characterized by a shallow bathymetry in the north and central part, while a 1200 m deep pit is located in the south. The northern basin is eutrophic with anoxic/hypoxic events and formation of mucilaginous aggregates detrimental for fishing activities and tourism. The southern basin is mainly oligotrophic, partly influenced by riverine waters. During winters, heat losses and strong evaporation induce dense water formation both in the north and in the south basin mixing physical and chemical seawater properties and governing the primary production in the euphotic zone. The Adriatic is generally characterized by steep spatio-temporal ecological gradients. The dense water masses are exported to the rest of the Eastern Mediterranean basin and become the main component of the Eastern Mediterranean Deep Water. The southern basin receives high salinity water masses that play an important role in the convection processes.

The Northern Adriatic Sea is the northernmost part of the Adriatic Sea and of the entire Mediterranean. It is a shallow marine coastal area with water depths below 100 m and for the most part even below 50 m. It receives freshwater inputs from several rivers most noteworthy the river Po. Circulation pattern result in very long water retention times. Cold and strong winds (Bora) mix the entire water column and results in winter water temperatures below 10°C. The semi-enclosed character of the region renders it particularly sensitive to climatological changes and anthropogenic pressures. At the same time the area is characterized by extremely steep ecological spatio-temporal gradients. It is also the most productive area of the Mediterranean Sea.

#### 3.1.1.1 Scientific partner institutions within the Northern Adriatic IRS:

**Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS), Trieste, Italy**

ISTITUTO NAZIONALE DI OCEANOGRAFIA E DI GEOFISICA SPERIMENTALE

OGS (www.inogs.it) is an Italian public research institution that operates and develops its own mission in the basic and applied research fields of Oceanography (under the Physical, Chemical and Biological aspects), Geophysics, Marine Geology, Experimental and Explorative Geophysics.

The OGS Department of Oceanography carries out scientific research and technological development activities with a multidisciplinary approach. Areas of interest include: experimental and theoretical oceanography, both physical and biological, biogeochemistry, marine ecology and modeling of marine systems.

The department employs more than 60 people including researchers, technologists, technicians and administrative staff.

The skills cover six thematic areas:

- Physical Oceanography (Experimental, Autonomous Systems, Coastal).
- Marine Biogeochemistry.
- Marine Biology.
- Marine System Modeling.
- Technological development.
- Data archiving and their integration.

The main research areas cover: The Mediterranean Sea and in particular the Adriatic Sea, the Cretan Sea and the Sicily Channel. In recent years the research has been extended to the Arctic Sea and the Southern Ocean.

Two major facilities are located in the department: the Marine Metrology and Calibration Unit (CMTO) and the National Oceanographic Data Center (NODC).

The CMTO provides the scientific and technical infrastructure necessary for guaranteeing high-quality observations of the marine environment. The NODC is part of the International Oceanographic Data Exchange (IODE) system of the UNESCO's Intergovernmental Oceanographic Commission (IOC).

**Consiglio Nazionale delle Ricerce (CNR), Italy**

The National Research Council (CNR) is the largest public research institution in Italy, performing multidisciplinary activities. Its mission is to carry out, promote, spread, transfer and improve research activities in the main sectors of knowledge growth and of its applications for scientific, technological, economic and social development.

CNR is composed of several Research Units managing in situ and remote observing systems, such as fixed platforms and moorings, HF radars, a glider and an observational system based on fishing vessels.

The groups mainly involved in the research activity in the Adriatic are based in Trieste, Venice and Bologna with an expertise in physical, chemical and biological oceanography, marine geology and marine system modelling.

**Ruder Boscovic Institute (RBI), Zagreb, Croatia, Center for marine Research (CIM), Rovinj, Croatia**

http://www.irb.hr

The Ruđer Bošković Institute is regarded as Croatia's leading scientific institute in natural and biomedical sciences as well as marine and environmental research. Its central campus is located in Zagreb. The IRBs Center for Marine Research is located in Rovinj and is dedicated to an ecosystem approach towards marine research in the Adriatic Sea. The Center for Marine Research (CMR) Rovinj is an interdisciplinary center, whose activities are focused on basic and applied oceanographic research, including the following areas:

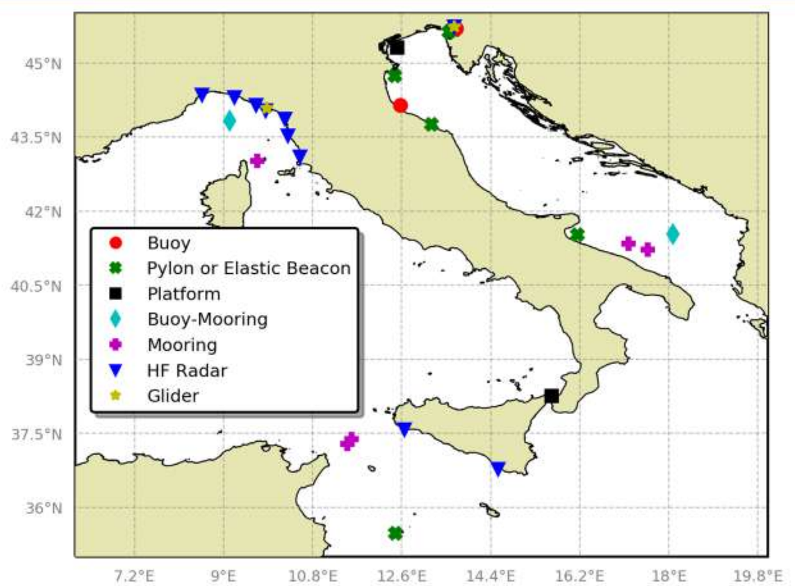
- Processes and dynamics within and between trophic levels (primary and secondary production, cycle of basic and biogenic elements);
- Investigation of water mass dynamics;

- Flora, fauna and animal communities (taxonomy, ecology and organism communities in natural and polluted areas);
- Ecological, physiological and genetic research on marine organisms and the impacts of pollution; monitoring of pollution and marine water quality; investigation of eutrophication.

## Italy : Network of Observing Systems

| | | | | |
|---|---|---|---|---|
| | **Infrastructure:** | **Consiglio Nazionale delle Ricerche** | **Istituto Nazionale di Oceanografia e Geofisica Sperimentale - OGS** | **National integration:** |
| | **Legal Status:** | **Consiglio Nazionale delle Ricerche** | **National Research Center** | **The current Italian JERICO configuration includes infrastructures from the two main marine institutes, CNR and OGS. Consolidation at national level and coordination of a nationally unified system for the monitoring of the coastal ocean are ongoing efforts** |
| | **Coordination:** | **CNR** | **OGS** | |
| | **Accredited by a national roadmap:** | **In progress** | **In progress** | |
| | **Data management plan:** | **In progress** | ✓ | |
| | **Yearly number of publications:** | | | |

**Geographical extend:**
- **East Mediterranean Sea**
- **Tyrrhenian Sea**
- **Sicily Channel**
- **Adriatic Sea**



# Croatia: Network of Observing systems

| | | | | | |
|---|---|---|---|---|---|
| | Infrastructure: | Ruder Boskovic Institute, Center for Marine Research, Rovinj | Research infrastructures outside the JERICO-S3 community<br>Institute for Oceanography and fisheries, Split | Research infrastructures outside the JERICO-S3 community<br>University of Dubrovnik, Institute for Marine and Coastal Research, Dubrovnik | National integration: |
| | Legal Status: | Part of Public Institutes/consortium | Part of Public Institutes/consortium | Part of Public Institutes/consortium | • Further development of regional and Pan-European integration<br>• Definition within the national roadmap<br>• Improved integration of national RI<br>• Organizational consolidation<br>• Involvement of further research institutes to complete the observational portfolio for the eastern Adriatic<br>• Improved data flow towards European data repositories with a special focus on data integration and biological datasets |
| | Coordination | RBI | IOR | UniDU | |
| | Accredited by a national roadmap: | X | X | X | |
| | Data management plan: | ✓ | ✓ | ✓ | |
| | Yearly number of publications: | 1299 | 125 | 219 | |

| | |
|---|---|
| **Geographical Extend:eastern Adriatic Sea** |  |

### 3.1.1.2 Main scientific and societal challenges

***Specific regional scientific topics and objectives*.**

- Understand the impact of global climate change on wind regimes and river discharges and cascading effects on the deep water formation and the general circulation.
- Assess how the horizontal and vertical drivers affect the source and sink of $CO_2$, particles, nutrients and litter dispersal.
- Understand ecosystem functions along steep ecological gradients.
- Monitor the biodiversity changes, especially due to the decrease of the phosphorus loads, overfishing, anthropogenic modifications and climate change.
- Coordinate operational oceanography aiming at integrating synoptic and multidisciplinary regional observations, and synergy of in situ infrastructures and remote sensing systems
- Understand the effects of extreme events to minimize coastal risks, to develop an alert network and improve the forecast systems.
- Understand the impact of the sea level rise on the coast and on the delicate lagoon environment characteristic of the northern Adriatic basin.

### 3.1.1.3 Observational strategy

The observational strategy adopted aims at consolidating, organizing and harmonizing the coastal observational activities already present in JERICO-S3, promoting initiatives to standardize and qualify the acquisition process starting from sensors (for example, collaborations on the intercalibration of biological sensors as already done in the past), up to aspects related to the accessibility of data from a FAIR perspective.
The objectives are to ensure the best spatio-temporal coverage for the variables of interest, filling the gaps also through the involvement of infrastructures not part of JERICO-S3 and to extend the area of interest of the IRS to the whole Adriatic Sea, considering the importance it has for the whole Mediterranean basin.

Given the close interaction between the northern Adriatic Sea and the entire Adriatic Sea the northern Adriatic IRS observational strategy clearly identifies the need to extend the coastal observatory to the entire Adriatic Sea.
Currently the observational strategy includes fixed observatories (e.g. buoys and fixed installations), automated mobile observatories and to a large extent vessel based regular sampling sites.
To this purpose, the observational strategy adopted foresees that, in addition to the fixed observational sites indicated in the following table, a continuous activity is carried out with autonomous systems such as gliders and floats, in order to ensure a more homogeneous distribution of the data collected. At the moment a transect on the Bari - Dubrovnik route is carried out through an OGS glider, several times a year.

*Table 1 coastal observations infrastructures currently active in the IRS Northern Adriatic Sea*

| COUNTRY | INSTITUTE | NAME | TYPE | PARAMETER | START_DATE |
|---|---|---|---|---|---|
| ITALY | CNR | Acqua Alta Oceanographic Tower | Fixed platform | Air Pressure,Air T°,Biological (fish by underwater cam),Chl-A (Fluorescence),Currents (surface),Currents (water column),Density,Depth (water pressure),Dissolved O2,pH,Phytoplankton,Salinity/ Conductivity,Sea level,Turbidity,Water T°,Waves,Wind speed/dir | 01/01/2009 |
| ITALY | CNR | Meteoceanographic site S1-GB | Fixed platform | Wind speed/dir,Air T°,Air Pressure,Air Humidity,Water T°,Dissolved O2,Salinity/ Conductivity,Turbidity,Chl-A (Fluorescence),CDOM,Current Profiles | 29/03/2004 |
| ITALY | CNR | PALOMA | Fixed platform | Wind speed/dir,Air T°,Water T°,Salinity/ Conductivity,Dissolved O2,Depth (water pressure),Density,Water pCO2 | 2012 |
| ITALY | OGS | MAMB | Fixed platform | Air T°,Air Pressure,Wind speed/dir,Water T°,Salinity/ Conductivity,Depth (water pressure),Dissolved O2,pH,pCO2,Chl-A (Fluorescence),Turbidity,PAR | 1998 |
| ITALY | OGS | C1 | Manual sampling | Nutrients, Phytoplankton, Microzooplankton, Mesozooplankton | 1998 |
| ITALY | OGS | GoT-HF Radar | HF Radar | Currents (surface),Waves | 2014 |
| ITALY | OGS | MAMBO_2 | Fixed platform | Air T°,Air Pressure,Wind speed/dir,Water T°,Salinity/ Conductivity,Depth (water pressure),Dissolved O2,pH,Chl-A (Fluorescence),Turbidity,Currents (water column) | 22/01/2003 |
| ITALY | OGS | MAMBO_3 | Fixed platform | Air T°,Air Pressure,Wind speed/dir,Water T°,Salinity/ Conductivity,Depth (water pressure),Dissolved O2,pH,Chl-A (Fluorescence),Turbidity,Currents (water column) | 09/03/2004 |
| ITALY | OGS | MAMBO_4 | Fixed platform | Air T°,Air Pressure,Wind speed/dir,Water T°,Depth (water pressure),Currents (water | 31/01/2007 |

| | | | | | |
|---|---|---|---|---|---|
| | | | | column) | |
| ITALY | OGS | DWRG1 | Fixed platform | Waves | 03/05/2004 |
| ITALY | OGS | DWRG2 | Fixed platform | Waves | 03/05/2004 |
| ITALY | OGS | DWRG3 | Fixed platform | Waves | 14/12/2006 |
| ITALY | OGS | Isonzo River | Fixed platform | Currents (water column) | 18/02/2004 |
| ITALY | OGS | Tagliamento River | Fixed platform | Currents (water column) | 18/02/2004 |
| CROATIA | IRB | RV001 | Fixed platform | Water T°,Salinity/ Conductivity | 2016 |
| CROATIA | IRB | SJ107 | Manual sampling | Air T°,Biological (other),Chl-A (Fluorescence),Density,Depth (water pressure),Dissolved O2,Phytoplankton,Salinity/Conductivity,Sea state,Wind speed/dir,Turbidity | 1972 |
| CROATIA | IRB | SJ105 | Manual sampling | Air T°,Biological (other),Chl-A (Fluorescence),Density,Depth (water pressure),Dissolved O2,Phytoplankton,Salinity/Conductivity,Sea state,Wind speed/dir,Turbidity | 1972 |
| CROATIA | IRB | SJ103 | Manual sampling | Air T°,Biological (other),Chl-A (Fluorescence),Density,Depth (water pressure),Dissolved O2,Phytoplankton,Salinity/Conductivity,Sea state,Wind speed/dir,Turbidity | 1972 |
| CROATIA | IRB | SJ101 | Manual sampling | Air T°,Biological (other),Chl-A (Fluorescence),Density,Depth (water pressure),Dissolved O2,Phytoplankton,Salinity/Conductivity,Sea state,Wind speed/dir,Turbidity | 1972 |
| CROATIA | IRB | SJ108 | Manual sampling | Air T°,Biological (other),Chl-A (Fluorescence),Density,Depth (water pressure),Dissolved O2,Phytoplankton,Salinity/Conductivity,Sea state,Wind speed/dir,Turbidity | 1972 |

#### 3.1.1.4 Regional organization

The **three JERICO-S3 partner organizations OGS, CNR in Italy and IRB in Croatia** are currently operating separate monitoring programs. Those monitoring programs however are the remnants of a transnational and multi-institutional collaborative program in the region that set up a regionally integrated marine coastal observation program for the northern Adriatic Sea, extending into the middle and southern Adriatic.

A **current MOU exists between the OGS and CNR** for scientific collaboration and a **MOU between OGS and IRB** for scientific collaboration in the investigation of the northern Adriatic Sea.

Numerous common publications on the ecosystem of the northern Adriatic Sea integrate datasets from the Croatian and the Italian part of the Oceanographic infrastructure and observation programs in the northern Adriatic Sea. Collaboration between the JERICO-S3 partners currently is based on rather **informal collaboration** at the level of individual researchers, research groups and institutions.

However currently there is **no formal common governing structure** for the region, nor a formal structure that forms a common transnational and regional program for coastal observations and research in the region.

Partnership agreements on specific projects have been signed by these three institutes with other research institutes which are not partners of JERICO-S3 but which operate in the same area of interest. For example, OGS works closely with the National Institute of Biology of Slovenia on the sharing of current data produced by HF-Radar for the Gulf of Trieste.

For Croatia, the IRB is involved in the following list of RIs and data aggregators:
EUROGOOS, SeaDataNetCroatia.

On the Italian side, with reference to the Adriatic Sea, OGS is directly involved in the following infrastructures:
EUROGOOS, SeaDataNet, EuroArgo, EMSO, Copernicus CMEMS, ICOS, e-LTER, EMBRC, LifeWatch;

The JERICO-S3 project is funded by the European Commission’s H2020 Framework Programme under grant agreement No. 871153. Project coordinator: Ifremer, France.

while CNR is involved in the following infrastructures:
EUROGOOS, SeaDataNet, Copernicus, ICOS, e-LTER, DANUBIUS, EMBRC, DISSCO, LifeWatch.

#### 3.1.1.5 Additional existing observational capacity

Within the IRS geographical extent extensive monitoring in the frame of the MSFD is ongoing. Physical (salinity, temp, ocean currents, waves, sea level, transmission, turbidity,…), chemical (nutrients, $CO_2$, pH, oxygen…) and biological parameters (chlorophyll, biodiversity, phytoplankton, bacterioplankton,..), benthos (biodiversity, macrophytes, habitat integrity, …). Parameters are measured throughout the water column and on the seafloor.

The national monitoring programs in Italy and Croatia include several additional research or monitoring organizations and a wide range of additional observational capacity. The integration of all existing observational capacity would generate an observational infrastructure that could cover the entire Adriatic Sea with adequate spatio-temporal coverage and resolution as well as with an adequate range of methods and parameters.

### 3.1.1.6 Financial sustainability plan

The following table summarizes **current operation expenses** for the JERICO-S3 partners observation programs in the region. The cost estimations are based on a self-evaluation exercise in the year 2020.

*Table 2, Initial cost estimation Northern Adriatic Sea*

| JERICO Application costs northern Adriatic | | ANNUAL OPERATIONAL COSTS (eg. for 2019) | | | | |
|---|---|---|---|---|---|---|
| **Member State** | **Institution(s)** | **General RI maintenance 1** | **Personnel 2** | **Ships/Vessels3** | **Data related4** | **Building Running Costs5** |
| **Croatia** | IRB | € 120,000 | € 360,000 | € 160,000 | € 20,000 | € 85,000 |
| **Italy** | CNR | € 360,000 | € 95,000 | € 20,000 | € 10,000 | € 15,000 |
| | OGS | € 70,000 | € 320,000 | € 27,500 | € 16,000 | € 108,125 |
| **total** | | **€ 550,000** | **€ 775,000** | **€ 207,500** | **€ 46,000** | **€ 208,125** |

**In Croatia: National monitoring programs** in the frame of the **EU habitat directive and the EU marine strategy framework directive are funded and maintained by national monitoring programs**. Additionally the Croatian regional observation program receives funding from **national and EU research projects**.
**In Italy**, there is currently no nationally funded marine monitoring program. The NA-IRS observatory sites in charge of OGS and CNR are financed by funds from the institutions themselves; national and European projects such as: JERICO - S3, SHAREMED; by funds from regional agencies, such as the Gulf of Trieste Weather-Marine Monitoring Network, which is partly supported by the Civil Protection of the Friuli-Venezia Giulia Region.
Float and gliders activities in the NA-IRS area of interest are partially supported by the Argo-Italy infrastructure, while the Southern Adriatic Interdisciplinary Laboratory for Oceanographic Research (SAILOR) E2-M3A buoy which is a deep observatory operating in the South Adriatic is part of the EMSO infrastructure.

### 3.1.1.7 Plans for the future development during JERICO-S3

The Northern Adriatic is a particular transnational area due to its morphology, the present physical forcing pressures, the marked seasonal and interannual variability, the biogeochemical characteristics and the anthropogenic impacts.
On one hand, this makes it an exceptional case study, where many processes can be investigated on a limited area and provide answers to processes that occur on a larger scale; on the other hand, the issues that characterize the area present significant challenges in terms

of prevention and sustainable development as well as requirements for transnational coordination.
The observational platforms operating in the area, while already playing an essential role in the characterization of physical, biological and biogeochemical processes, currently do not have a sufficient degree of synergy that allows them to respond structurally to the challenges mentioned above. It is therefore necessary to maximize the existing monitoring capabilities by expanding the range of variables to be observed and in perspective by extending the spatio-temporal coverage to fill the current gaps.
It is therefore planned to harmonize and integrate the currently operational coastal infrastructure of the partners involved in the NA-IRS, acting in close collaboration with the other IRS and PSS present in JERICO-S3. This means assessing the different practices and procedures used by the individual partners in the various aspects of the data acquisition chain: evaluation of the parameters under investigation, harmonization of the sampling strategy, standardization of the instrumentation used with respective sensor calibration, data quality control and construction of a homogeneous database for dissemination.
The objective is to achieve a coordinated and homogeneous processing of data and products from which it will be possible to have:
- an overview of the observational network addressing the scientific and societal challenges peculiar to the area,
- a first investigative tool available to the scientific community and users,
- an exhaustive evaluation of the aspects that will have to be developed, both in terms of parameters to be acquired and space-time coverage.
It has been seen that the new scientific challenges have been increasingly directed in recent years towards biological processes that affect the carbon cycle and consequently the pH and CO2 concentration, the availability of nutrients, potential pollutants such as hydrocarbon spills and last but not least microplastics.
The next step will be to focus on the needs and expansive capabilities of the project partners and secondly to promote the involvement of other scientific institutions operating in the area, in the common interest of making the NA-IRS a regional reference site for the countries bordering the Adriatic Sea.

Through the activities planned within WP3 of JERICO-S3 the research infrastructures involved in the IRS alongside with national authorities will meet and further develop

- **the common observational strategy**
- **the integration of observational infrastructure**
- **the integration of data**

At national level the research infrastructures will meet with national authorities to further develop the

- **formal organization**
- **funding structure**

of **national (possibly organized at regional level) research infrastructures for coastal observations.**

Future development will also involve **further mapping and involvement** of coastal observation infrastructure and expertise in the region but currently not yet involved in JERICO-S3 activities.

## 3.1.2 Iberian Atlantic Margin

The **IBERIAN ATLANTIC MARGIN (IAM) IRS** extends along the continental margins of Portugal and Spain from the Alboran Sea, in the Mediterranean, up to the NW Spanish margin and including the Canary Islands archipelago. The geographical area covered by this IRS brings it in direct contact two continental margins (European and NW African margins) and two marine areas (NE Atlantic and Mediterranean). This is an area marked by major interactions and adjustment processes that influence a large part of the European margin and NE Atlantic, such as the forcing of the Iberian Poleward Slope Current (IPC) or the formation and spreading of Mediterranean Water (MW). The area is well exposed to the seasonal evolution and energetic manifestations of the NE Atlantic atmospheric conditions and includes the rather important area of seasonal upwelling of the European margin - the W margins of Portugal and Spain - part of the large Canary Upwelling System. The continental margin is relatively narrow and indented by numerous submarine canyons. This allows coastal influences (e.g. river plumes, nearshore sediments) to spread to the upper slope and nearby oceanic region and also that oceanic influences impact even the inshore part of the coastal ocean environment. With a high density of coastal populations and area of confluence of main navigation routes the IAM hosts important economic activity in the sectors of navigation, ports, fisheries, aquaculture, offshore energy and tourism (e.g. nautical activities and sports).

The following Figure 3 shows the location and extent of the IRS Iberian Atlantic Margin.

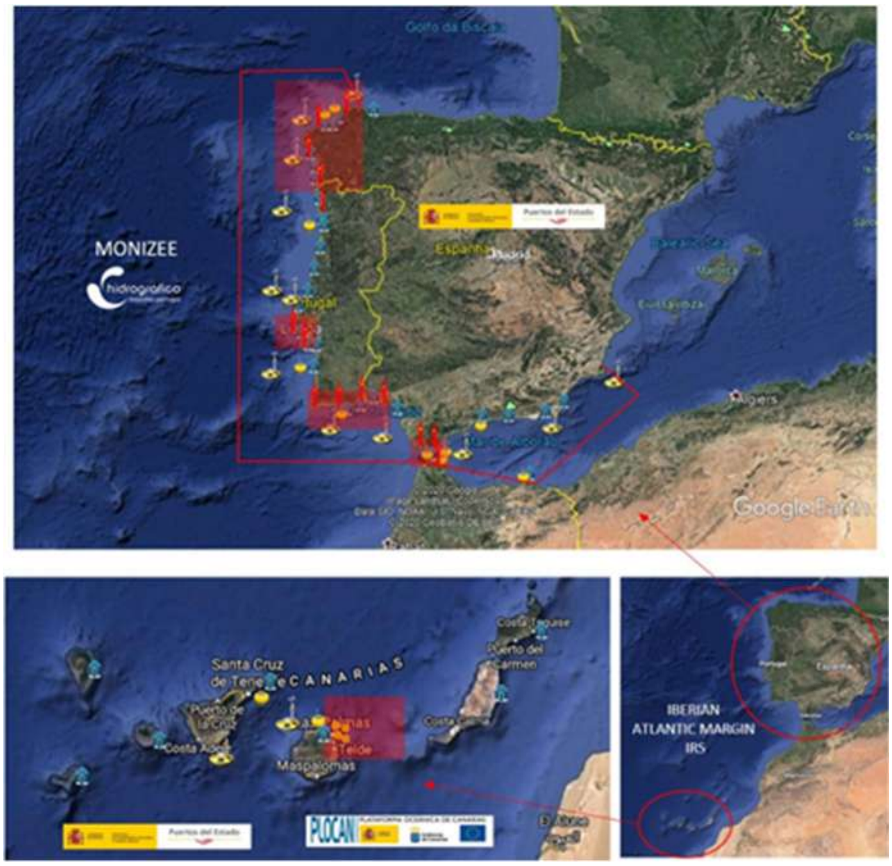


*Figure 3 The location and extent of the IRS Iberian Atlantic Margin*

### 3.1.2.1 Scientific partner institutions

**Instituto Hidrográfico** (IH) is a research institute of the Portuguese Navy, recognized as a State Laboratory and with strategic orientations defined by the Ministry of Defense in articulation with the Ministry of Science and Technology and the Ministry of the Sea. IH is an institute with administrative and financial autonomy and employs 360 permanent staff and 14 contracted elements. IH develops activities in the areas of Hydrography/Cartography (with national responsibilities in the bathymetric surveys and publication of bathymetric charts), Physical Oceanography (with national responsibilities in the publication of tidal tables and in contributing to the Portuguese implementation of MSFD), Marine Chemistry and Pollution (with national responsibilities as expert entity for oil characterization during oil spill accidents and recently as Designated Laboratory, in Portugal, in the field of Inorganic Chemistry), Marine Geology and Safety of Navigation (with national responsibilities in dissemination of Navigation Aids). IH operates an ocean observing infrastructure for the Portuguese waters (MONIZEE system) which is integrated with operational forecasting capacities. The main research areas developed in the last few years cover the dynamics of the Portuguese shelf and slope waters and of the insular waters (Madeira and Azores Archipelagos) and the related impacts on sedimentary dynamics and on contaminant transport as well as the development of support products based on real-time monitoring and operational forecasting. IH is a member of ICES, IHO, IMO, EuroGOOS, GLOSS, Inspire-pt, EMODNET among others.

The **MONIZEE** infrastructure installed and operated by Instituto Hidrográfico is seen as the key monitoring infrastructure for the coastal ocean waters offshore the Portuguese mainland. The infrastructure integrates **networks of coastal tidal gauges, wave buoys, multiparametric buoys and HF radar stations and covers the complete shelf and slope waters offshore continental Portugal**, from the southern coast (Gulf of Cadiz area) to western coast (up to the border with NW Spain). MONIZEE then provides unique data to support studies of the main physical, chemical, sedimentary and biological conditions affecting this coastal ocean area, namely to characterize the shelf and slope dynamics (with emphasis to coastal upwelling and poleward slope currents), to study biological connectivity and contaminant dispersion over vast regions along the European margin, to infer the impacts of wave conditions on coastal environments and of river outputs on the shelf domain or to understand the interaction between deep ocean circulation and the eastern boundary layer in the North Atlantic. **MONIZEE data products** are being used by a broad range of national and international members of the scientific community.

The coastal ocean area offshore the Portuguese mainland is directly exposed to the energetic conditions of the **North Atlantic ocean**. These conditions affect in different ways the coastal populations which economy is, in turn, strongly dependent on activities related to the coastal ocean environment. Pressures over this coastal ocean area are related to the intense maritime traffic between Northern Europe, Mediterranean, Africa and American coasts or the presence of large urban concentrations near the coast. The **MONIZEE** infrastructure was implemented to provide support to different groups of users and stakeholders through a **permanent monitoring of the environmental conditions** that affect this coastal ocean domain linked to numerical modelling and operational forecasting products. The **infrastructure data and derived products are presently being used by national agencies, port authorities, city halls, surfers, fishermen communities, aquacultures, among others**. The data collected by the MONIZEE infrastructure is also one of the contributions of Instituto Hidrografico to the national implementation of **MSFD** as explicitly stated in the law that transcribes this directive to the Portuguese framework.

**Puertos del Estado** (PdE) is a government agency belonging to the Ministry of Public Works that is responsible for implementing the government's port policy, for the coordination and efficiency control of the state-owned Spanish Port System (46 ports managed by 28 Port Authorities). It employs more than 143 multidisciplinary skilled people, with a turnover in 215 of roughly 34 million euros. By means of the own-managed **operational oceanographic system** (**PORTUS**), the Physical Environment Area provides to the port system, the society and other stakeholder institutions with met-ocean data (observations, forecasts and derived products) essential for reducing costs, increasing efficiency and sustainability, and ensuring safety in routine port operations. PdE operates several observing networks: open ocean and coastal moorings, tide gauges and coastal HF radar. It is a member of EuroGOOS, MERCATOR Ocean International, leader of the CMEMS In-Situ TAC for the IBI region (and IBIROOS) and it is involved in the CMEMS IBI Marine Forecasting Center (MFC). PdE participates with many national and international organizations in different projects and initiatives such as EuroSea. PdE experts lead or participate in different working groups and task teams of EuroGOOS, and are as well involved in MONGOOS, the EOOS (European Ocean Observing System) Operations Committee, GLOSS, E-SURFMAR (buoys network) and the HF-Radar Global Network.

The **PORTUS** system compiles a significant component of the infrastructure for met-ocean information along the Spanish coast (mainland, Balearic and Canary Islands). It is based on a multifaceted database and user-friendly visualization tool (https://portus.puertos.es) that allows **access to observations, forecasts and a diverse range of derived products and services**. **Near-real time and historical data from different observing platforms contribute to the system: 15 deep water buoys, 12 coastal buoys, 41 tide gauges and 3 HF radar systems**. These main networks are complemented with models at different spatial scales (regional, coastal and local models) that feed operational forecasts of waves, sea level and circulation. **Coastal and harbor domain models are nested in the regional CMEMS models**, with up to 60 models running operationally around the Spanish coast. An additional downstream service developed for the harbors and named CMA (Cuadro de Mando Ambiental), integrates in-situ and models data to provide additional products of interest for the harbors and coastal management. Data are also distributed through PdE OpenDap, and available via international data programs such as CMEMS In-Situ TAC, GLOSS, etc. **PORTUS** data are used by scientists for a large range of marine research fields.

**Oceanic Platform of the Canary Islands**

The Oceanic Platform of the Canary Islands (**PLOCAN**) is a Research Infrastructure (RI) labeled by the ICTS (Unique Scientific and Technological Infrastructure) Spanish National Roadmap, co-funded by the Ministry of Science, Innovation and Universities of the Spanish government and the Canary Islands government and by the European Regional Development Fund (ERDF) under the

Operational Programme of the Canary Islands. Funding for CAPEX and OPEX over 2007-2021, amount to 21,9M€ and 24,6M€ respectively.

**PLOCAN is a multipurpose technical-scientific service infrastructure that provides support for research, technological development and innovation in the marine and maritime sectors, available to public and private users**. PLOCAN offers both onshore and offshore experimental facilities and laboratories, operational throughout the whole year thanks to the Canary Islands excellent climatic conditions. PLOCAN also brings a broad experience in large national and EU marine/maritime projects.

**Facilities:** An ocean observatory for the continuous and real-time monitoring in fields such as the study of global change and ocean acidification, water-column and deep-sea ecosystems, ocean biogeochemistry and geophysics. It consists of several permanent and mobile systems that interoperate to offer environmental impact monitoring, instrument testing, calibration and validation from shallow waters to the deep seabed.

**A test bed for the research, demonstration and operation of marine technologies**, especially those related to marine renewable energy. PLOCAN provides secure underwater electric infrastructure to evacuate the generated energy to the power grid connection, and a control centre for data analysis.

**A base for underwater vehicles**: gliders, ROVs and AUVs, a dedicated control room to track the UUVs real-time and laboratories and warehouses to support the missions´ needs.

#### 3.1.2.2 Main scientific and societal challenges

***Specific regional scientific topics and objectives***.

- Improve the present understanding on transboundary processes and connectivity, by bringing insight on the key processes which control along-margin transport and across-margin transport.
- Evaluate the biological connectivity within the region and between adjacent regions, through the transport, migration, colonization and invasion of various organisms.
- Assess the dispersion of chemical contaminants
- Study the coastal ocean impacts from remote areas, such as the far impacts of local seasonal upwelling, high turbidity flushing events, vertical mixing and continental dust inputs;
- Evaluate the impacts of extreme weather events and coastal erosion processes on the ecosystems, on coastal ocean conditions and their impacts on coastal communities
- Assess the coastal ocean response and vulnerability to long term variability associated with the North Atlantic atmospheric regimes

The abovementioned marine coastal observation infrastructures and programs currently answer to the regions needs for **port security, marine traffic safety and oceanographic forecasting.**

### 3.1.2.3 Observational strategy

The following table lists the coastal observations infrastructures currently active in the IRS Iberian Atlantic Margin.

*Table 3, coastal observations infrastructures currently active in the IRS Iberian Atlantic Margin*

| COUNTRY | INSTITUTE | NATIONALRI | NAME | TYPE | PARAMETER | START_DATE |
|---|---|---|---|---|---|---|
| PORTUGAL | IH | MONIZEE | RAIA Multiparametric Buoy | Fixed platform | Waves,Water T° (near surface + low cost sensors),Currents (water column),Air Pressure,Wind speed/dir,Air T°,Relative Humidity,Chl-A (Fluorescence),Dissolved O2,Underwater Noise (by Sept 2020) | 23/05/2010 |
| PORTUGAL | IH | MONIZEE | MONICAN1 (deep) Multiparametric Buoy | Fixed platform | Waves,Water T° (near surface + water column),Currents (water column),Air Pressure,Wind speed/dir,Air T°,Relative Humidity,Chl-A (Fluorescence),Dissolved O2 | 24/04/2009 |
| PORTUGAL | IH | MONIZEE | MONICAN2 (coastal) Multiparametric Buoy | Fixed platform | Waves,Water T° (near surface + low cost sensors),Currents (water column),Air Pressure,Wind speed/dir,Air T°,Relative Humidity,Chl-A (Fluorescence),Dissolved O2,Underwater Noise (by Sept 2020),Turbidity | 22/03/2010 |
| PORTUGAL | IH | MONIZEE | SINES Multiparametric Buoy | Fixed platform | Waves,Water Tº (near surface + low cost sensors),Currents (water column),Air Pressure,Wind speed/dir,Air T°,Relative Humidity,Underwater Noise | 29/04/2020 |
| PORTUGAL | IH | MONIZEE | FARO Multiparametric Buoy | Fixed platform | Waves,Water T° (near surface + low cost sensors),Currents (water column),Air Pressure,Wind speed/dir,Air T°,Relative Humidity,Chl-A (Fluorescence),Dissolved O2,Underwater Noise (by Sept 2020) | 09/06/2014 |
| PORTUGAL | IH | MONIZEE | LEIXOES Wave Buoy | Fixed platform | Waves,Water T° (near surface) | 28/07/1993 |
| PORTUGAL | IH | MONIZEE | SINES Wave Buoy | Fixed platform | Waves,Water T° (near surface) | 09/02/1980 |
| PORTUGAL | IH | MONIZEE | FARO Wave Buoy | Fixed platform | Waves,Water T° (near surface) | 16/09/1986 |
| PORTUGAL | IH | MONIZEE | Vila Real S. Antonio HF radar Station | HF Radar | Currents (surface),Waves | 21/11/2012 |
| PORTUGAL | IH | MONIZEE | Alfanzina HF Radar Station | HF Radar | Currents (surface),Waves | 29/09/2014 |
| PORTUGAL | IH | MONIZEE | S. Vicente HF radar Station | HF Radar | Currents (surface),Waves | 15/02/2016 |
| PORTUGAL | IH | MONIZEE | Espichel HF radar Station | HF Radar | Currents (surface),Waves | 04/04/2012 |
| PORTUGAL | IH | MONIZEE | S. Juliao HF radar Station | HF Radar | Currents (surface),Waves | 04/04/2012 |
| PORTUGAL | IH | MONIZEE | Viana do Castelo Tide Gauge | Fixed platform | Sea level | 31/12/1977 |
| PORTUGAL | IH | MONIZEE | Leixoes Tide Gauge | Fixed platform | Sea level | 01/01/1956 |
| PORTUGAL | IH | MONIZEE | Aveiro Molhe Central Tide Gauge | Fixed platform | Sea level | 03/11/1975 |
| PORTUGAL | IH | MONIZEE | Figueira da Foz Cais Comercial Tide Gauge | Fixed Platform | Sea level | 15/09/1977 |
| PORTUGAL | IH | MONIZEE | Nazaré Tide Gauge | Fixed platform | Sea level | 21/06/1983 |

| | | | | | | |
|---|---|---|---|---|---|---|
| PORTUGAL | IH | MONIZEE | Peniche Tide Gauge | Fixed platform | Sea level | 20/10/1957 |
| PORTUGAL | IH | MONIZEE | Lisboa Alcantara Tide Gauge | Fixed platform | Sea level | 01/01/1972 |
| PORTUGAL | IH | MONIZEE | Sesimbra Tide Gauge | Fixed platform | Sea level | 01/08/1974 |
| PORTUGAL | IH | MONIZEE | Setubal Troia Tide Gauge | Fixed platform | Sea level | 30/03/1976 |
| PORTUGAL | IH | MONIZEE | Sines Posto 3 Tide Gauge | Fixed platform | Sea level | 09/05/1977 |
| PORTUGAL | IH | MONIZEE | Barra Faro-Olhao Tide Gauge | Fixed platform | Sea level | 17/10/1978 |
| PORTUGAL | IH | MONIZEE | Vila Real S. Antonio Tide Gauge | Fixed platform | Sea level | 10/01/2014 |
| SPAIN | PDE | NO | Antena Faro de Cabo Silleiro | HF Radar | Currents (surface),... | 14/07/2005 |
| SPAIN | PDE | NO | Antena Faro de Finisterre | HF Radar | Currents (surface) | 12/07/2005 |
| SPAIN | PDE | NO | Antena Mazagón | HF Radar | Currents (surface) | 02/04/2013 |
| SPAIN | PDE | NO | Antena Faro de Punta Carnero | HF Radar | Currents (surface) | 20/06/2011 |
| SPAIN | PDE | NO | Antena Puerto de Ceuta | HF Radar | Currents (surface) | 01/05/2011 |
| SPAIN | PDE | NO | Antena Tarifa | HF Radar | Currents (surface) | 01/01/2013 |
| SPAIN | PDE | NO | 1300130 (Gran Canaria buoy) | Fixed platform | Waves,Air Pressure,Wind speed/dir,Air T°,Water T°,Salinity/ Conductivity,Currents (surface) | 20/06/1997 |
| SPAIN | PDE | NO | 1300131 (Tenerife buoy) | Fixed platform | Waves,Air Pressure,Wind speed/dir,Air T°,Water T°,Salinity/ Conductivity,Currents (surface) | 01/04/1998 |
| SPAIN | PDE | NO | 6101404 (Algeciras coast buoy) | Fixed platform | Waves,Air Pressure,Wind speed/dir,Air T°,Water T° | 21/04/2009 |
| SPAIN | PDE | NO | 6200024 (Bilbao buoy) | Fixed platform | Waves,Air Pressure,Wind speed/dir,Air T°,Water T°,Salinity/ Conductivity,Currents (surface) | 07/11/1990 |
| SPAIN | PDE | NO | 6200025 (Cabo de Penas buoy) | Fixed platform | Waves,Air Pressure,Wind speed/dir,Air T°,Water T°,Salinity/ Conductivity,Currents (surface) | 09/06/1997 |
| SPAIN | PDE | NO | 6200082 (Estaca de Bares buoy) | Fixed platform | Waves,Air Pressure,Wind speed/dir,Air T°,Water T°,Salinity/ Conductivity,Currents (surface) | 19/07/1996 |
| SPAIN | PDE | NO | 6200083 (Villano-Sisargas buoy) | Fixed platform | Waves,Air Pressure,Wind speed/dir,Air T°,Water T°,Salinity/ Conductivity,Currents (surface) | 12/05/1998 |
| SPAIN | PDE | NO | 6200084 (Silleiro buoy) | Fixed platform | Waves,Air Pressure,Wind speed/dir,Air T°,Water T°,Salinity/ Conductivity,Currents (surface) | 06/07/1998 |
| SPAIN | PDE | NO | 6200085 (Golfo de Cadiz buoy) | Fixed platform | Waves,Air Pressure,Wind speed/dir,Air T°,Water T°,Salinity/ Conductivity,Currents (water column) | 27/08/1996 |
| SPAIN | PDE | NO | 6201065 (Langosteira coast buoy) | Fixed platform | Waves,Air Pressure,Wind speed/dir,Air T°,Water T° | 22/05/2013 |
| SPAIN | PDE | NO | Bilbao-coast-buoy | Fixed platform | Waves,Water T° | 26/02/2004 |
| SPAIN | PDE | NO | Ceuta-coast-buoy | Fixed platform | Waves,Water T° | 12/01/1985 |
| SPAIN | PDE | NO | Gijon-coast-buoy | Fixed platform | Waves,Water T° | 02/02/2001 |
| SPAIN | PDE | NO | LasPalmas-coast-buoy | Fixed platform | Waves,Water T° | 05/02/1992 |
| SPAIN | PDE | NO | Tarifa-coast-buoy | Fixed platform | Waves,Water T° | 21/04/2009 |

| | | | | | | |
|---|---|---|---|---|---|---|
| SPAIN | PDE | NO | Tenerife-coast-buoy | Fixed platform | Waves,Water T° | 21/05/2009 |
| SPAIN | PDE | NO | Algeciras tide gauge | Fixed platform | Sea level,Waves,Air Pressure,Wind speed/dir | 22/07/2009 |
| SPAIN | PDE | NO | Almería tide gauge | Fixed platform | Sea level,Waves,Air Pressure,Wind speed/dir | 01/07/2006 |
| SPAIN | PDE | NO | Arrecife tide gauge | Fixed platform | Sea level,Waves,Air Pressure,Wind speed/dir | 07/03/2008 |
| SPAIN | PDE | NO | Bonanza tide gauge | Fixed platform | Sea level,Waves,Air Pressure,Wind speed/dir | 01/07/1992 |
| SPAIN | PDE | NO | Coruña tide gauge | Fixed platform | Sea level,Waves | 01/07/1992 |
| SPAIN | PDE | NO | Ferrol1 tide gauge | Fixed platform | Sea level,Waves,Air Pressure,Wind speed/dir | 22/12/2006 |
| SPAIN | PDE | NO | Ferrol2 tide gauge | Fixed platform | Sea level,Waves | 25/10/2006 |
| SPAIN | PDE | NO | Fuerteventura tide gauge | Fixed platform | Sea level,Waves,Air Pressure,Wind speed/dir | 01/01/2004 |
| SPAIN | PDE | NO | Gomera tide gauge | Fixed platform | Sea level,Waves | 22/11/2006 |
| SPAIN | PDE | NO | Hierro tide gauge | Fixed platform | Sea level,Waves | 01/05/2004 |
| SPAIN | PDE | NO | Huelva tide gauge | Fixed platform | Sea level,Waves,Air Pressure,Wind speed/dir | 13/09/1996 |
| SPAIN | PDE | NO | La Palma tide gauge | Fixed platform | Sea level,Waves | 14/11/2006 |
| SPAIN | PDE | NO | Langosteira tide gauge | Fixed platform | Sea level,Waves | 12/11/2012 |
| SPAIN | PDE | NO | Las Palmas tide gauge | Fixed platform | Sea level,Waves,Air Pressure,Wind speed/dir | 01/07/1992 |
| SPAIN | PDE | NO | Málaga tide gauge | Fixed platform | Sea level,Waves,Air Pressure | 01/07/1992 |
| SPAIN | PDE | NO | Marín tide gauge | Fixed platform | Sea level,Waves,Air Pressure,Wind speed/dir | 22/12/2009 |
| SPAIN | PDE | NO | Motril tide gauge | Fixed platform | Sea level,Waves,Air Pressure,Wind speed/dir | 01/01/2005 |
| SPAIN | PDE | NO | Sevilla2 tide gauge | Fixed platform | Sea level,Waves,Air Pressure,Wind speed/dir | 15/11/2011 |
| SPAIN | PDE | NO | Tarifa tide gauge | Fixed platform | Sea level,Waves,Air Pressure,Wind speed/dir | 22/07/2009 |
| SPAIN | PDE | NO | Tenerife tide gauge | Fixed platform | Sea level,Waves | 01/07/1992 |
| SPAIN | PDE | NO | Vigo tide gauge | Fixed platform | Sea level,Waves,Air Pressure,Wind speed/dir | 01/11/1992 |
| SPAIN | PDE | NO | Vilagarcía tide gauge | Fixed platform | Sea level,Waves | 18/04/1997 |
| SPAIN | PLOCAN | NO | PLOCAN_HFR | HF Radar | Currents (surface),... | 2020-01-24T00:00:00Z |
| SPAIN | PLOCAN | NO | PLOCAN_TestSite_Stations | Manual sampling | Chl-A (Fluorescence),Dissolved O2,pH,Salinity/ Conductivity,Turbidity,Water T° | 11/05/2011 |
| SPAIN | PLOCAN | NO | PLOCAN_ADCP | Coastal profiler | Currents (water column) | |
| SPAIN | PLOCAN | NO | Taliarte- 705 | Fixed platform | Dissolved O2,Surface Salinity/ conductivity,Turbidity,Surface temperature | 2018-12-20T11:30:00Z |

| | | | | | | |
|---|---|---|---|---|---|---|
| SPAIN | PLOCAN | NO | Taliarte-501 | Fixed platform | airTemperature at sea level,Relative Humidity at sea level,air Pressure at sea level,Wind direction,Wind speed,PAR | 2017-12-19T19:15:00 Z |
| SPAIN | PDE | NO | 1300130 (Gran Canaria buoy) | Fixed platform | Waves,Air Pressure,Wind speed/dir,Air T°,Water T°,Salinity/ Conductivity,Currents (surface) | 20/06/1997 |
| SPAIN | PDE | NO | 1300131 (Tenerife buoy) | Fixed platform | Waves,Air Pressure,Wind speed/dir,Air T°,Water T°,Salinity/ Conductivity,Currents (surface) | 01/04/1998 |
| SPAIN | PDE | NO | Tenerife-coast-buoy | Fixed platform | Waves,Water T° | 21/05/2009 |
| SPAIN | PDE | NO | Arrecife tide gauge | Fixed platform | Sea level,Waves,Air Pressure,Wind speed/dir | 07/03/2008 |
| SPAIN | PDE | NO | Fuerteventura tide gauge | Fixed platform | Sea level,Waves,Air Pressure,Wind speed/dir | 01/01/2004 |
| SPAIN | PDE | NO | Gomera tide gauge | Fixed platform | Sea level,Waves | 22/11/2006 |
| SPAIN | PDE | NO | Hierro tide gauge | Fixed platform | Sea level,Waves | 01/05/2004 |
| SPAIN | PDE | NO | La Palma tide gauge | Fixed platform | Sea level,Waves | 14/11/2006 |
| SPAIN | PDE | NO | Las Palmas tide gauge | Fixed platform | Sea level,Waves,Air Pressure,Wind speed/dir | 01/07/1992 |
| SPAIN | PDE | NO | Tenerife tide gauge | Fixed platform | Sea level,Waves | 01/07/1992 |

### 3.1.2.4 Regional organization

**The different institutions that contribute to the IRS are organized through different mechanisms**. A **frame arrangement** was signed in 2015 between Instituto Hidrográfico (IH) and PLOCAN for collaboration in different areas. Partners Agreements have been signed between Instituto Hidrográfico and Puertos del Estado in the framework of specific projects, namely project aimed to install new components of the monitoring systems operated by each of these institutions (e.g TRADE, TRADE II projects under INTERREG programs).

**PLOCAN and Puertos del Estado** have a broad collaboration in different areas of intervention. The two institutions have signed a **collaboration protocol** (EMSO España JRU) for open-ocean observation to coordinate Spain's contribution to EMSO ERIC, for which PLOCAN is the Spanish delegate to the Ministry of Science and Innovation. PLOCAN also delivers its HF Radar data to Copernicus through Puertos del Estado data services. The head of the physical oceanography area in PdE, Enrique Álvarez Fanjul is member of the Scientific Committee of PLOCAN.

The partners contributing to the IAM IRS are also contributing to the national implementations of European directives - such as the **MSFD, the WFD and the INSPIRE** directive - and to regional conventions (**OSPAR**). They are also involved and contributing to several European and international initiatives such as to EuroGOOS, ICES, CMEMS, MERCATOR Ocean International, GLOSS, E-SurfMar, Global HF-radar network, IHO, IMO, Inspire-pt, EMODNET. In particular PdE is the leader of the CMEMS In-Situ TAC for the IBI region and in this quality it is the integrator of real time data collected both by IH MONIZEE system or by PLOCAN systems.

Some of the partners also contribute to networks such as the **Tsunami Warning System for NE Atlantic and Mediterranean** (**NEAMTWS**) or the **Global Telecommunication System (GTS)** that feeds operational weather systems around the world.

The 3 partners of IAM IRS all promote the dissemination of data, data products and complementary information (such as numerical modelling products and operational forecasts) through their institutional websites. In the case of IH besides the dissemination through the institutional web site (www.hidrografico.pt ) a new capacity for data access was developed and implemented during 2020, the hidrografico+ portal (https://geomar.hidrografico.pt/ ).

Data from PdE observing platforms are integrated in near-real time at PdE PORTUS visualization tool: (http://www.puertos.es/en-us/oceanografia/Pages/portus.aspx), with automatic quality control procedures applied to the main physical variables. The system provides access to near-real time data but also to operational forecasts (waves, sea level and circulation), historical data and derived products and reports. Additionally, near-real time data are also available in the CMA (Cuadro de Mando Ambiental):https://cma.puertos.es/#/, a service specifically developed for coastal and port activities, as well as through Puertos del Estado mobile application, **iMar**, freely downloadable from the Spanish Apple App Store and Google Play Store. Data are also accessible through:

- Global Telecommunication System (GTS) (some of the buoys)
- Copernicus Marine Environment Monitoring Service In Situ TAC (http://www.marineinsitu.eu/, https://marine.copernicus.eu/)
- EMODnet portal: http://www.emodnet-physics.eu
- GLOSS (Global Sea Level Observing System) Data Portals) (tide gauges):https://www.psmsl.org/, http://www.ioc-sealevelmonitoring.org/, https://www.sonel.org/
- PdE OpenDap: http://opendap.puertos.es/thredds/catalog.html
- National Tsunami Warning System (Instituto Geográfico Nacional) (tide gauges)

The 3 institutions are in close interaction with different institutions involved in Marine Science and Technology at national level, maintaining a permanent dialogue with institutions or research groups that are involved in coastal ocean observation. **A strong interaction with these non-JS3 actors will be developed as part of the work to be conducted by the IAM-IRS between 2020 and 2024**

#### 3.1.2.5 Financial sustainability plan

The **MONIZEE** infrastructure is being supported mainly from a combination of IH own budget and contributions from national and European projects. The operation of the MONIZEE has a typical annual cost of 1.5 million euros although in some years and depending on specific requirements for systems replacements the cost may rise to 2.5 million euros. A very limited financial contribution is provided by private entities (port operators) and for specific observing platforms (wave buoys). The maintenance, calibration, and operation of the MONIZEE fixed platforms at sea (multiparametric buoys and wave buoys) and tide gauges stations along the coast is assured by Instituto Hidrografico. The maintenance of HF radar stations is assured by IH together with the system manufacturer (Qualitas) through a maintenance contract.

Puertos del Estado **PORTUS system** is mainly supported by the Spanish Port System, with contributions from national and European research projects for research and development. PdE investments in the coastal observing infrastructures in **PORTUS** can range from 1 to 10 million Euros, and annual maintenance & operations costs amount up to 2,6 million Euros. Maintenance and operations are subcontracted for 2 years, with possibility of annual extensions up to a maximum of 5 years. All the networks are running and operational through different contracts, with a budget available and approved by PdE president for at least the next 5 years.

**PLOCAN** sustainability has been based on a formal commitment to fund its activities and facilities from 2007 to 2021 as part of the ICTS creation and consolidation framework. Continuity relies on the decision of both regional and central governments to maintain this commitment over the next decade. A strategic plan is currently being developed for this purpose. The coastal and open-ocean observation infrastructure also relies on the commitment of partner organization, in particular for marine operations, involving small but also medium-large research vessels, managed by IEO and CSIC. Currently, with respect to coastal observation, Plocan has invested an overall amount of approximately 1,8M€, which imply annual operational costs (specialized personnel, maintenance of facilities, consumables, etc.) of around 500k€. PLOCAN plans to financially maintain these infrastructures so that these contribute to the European research infrastructure JERICO-RI.

#### 3.1.2.6 Plans for the future development during JERICO-S3

The work to be developed in the framework of WP3 by the 3 partners presently involved in the Iberian Atlantic Margin IRS is expected to lead to a strong articulation and a broad development of the observing capacities installed in the regional area, reinforcing the ability of the observing infrastructure to answer to the main scientific and societal questions that arise in the Iberian Atlantic Margin regional domain.

The work can be structured in 3 phases:

**Phase 1**, to be developed essentially from M1 to M24, will aim to promote the articulation and harmonization of the capacities from each partner that are presently contributing to JERICO-RI. This involves the identification of the different procedures used by each partner (for example in the operation of observing systems, in sensor calibration, in the data quality control or data dissemination) and the evaluation of common practices and needs for improvement.

**Phase 2** that will be mainly developed from M10 to M24, will focus on the potential for development and expansion of the capacities that each one of these 3 partners can bring to observation in the IRS. This phase will explore in particular the potential for inclusion of new biogeochemical and biological observations, namely by evaluating the potential for insertion of new sensors or other observing systems in the already existing infrastructure or by exploring the potential for incorporating new observations collected for example during regular monitoring programs conducted by the partners (e.g. nutrients and contaminants sampling programs conducted by IH).

**Phase 3** will be developed from M12-M48 and is aimed to promote a broad interaction with the other institutions at national levels, conducting a broad publicizing about JERICO-RI importance to answer to science requests at national and regional levels, identifying other actors involved in the coastal ocean observations and searching for their potential engagement, and exploring complementarities, namely with other RIs operating in the inland waters domain, in the open ocean domain or in the atmospheric and space domains. Initially planned to start in the first months of the project this phase was largely delayed due to the Covid crisis which jeopardize the agendas of meetings and events that were planned in Portugal and Spain and that were intended to be used by the partners to develop initial actions of publicity and contacts in interaction with the national communities.

Through the activities planned within WP3 of JERICO-S3 the research infrastructures involved in the IRS alongside with national authorities will meet and further develop

- **the common observational strategy**
- **the integration of observational infrastructure**
- **the integration of data**

At national level the research infrastructures will meet with national authorities to further develop the

- **formal organization**
- **funding structure**

of **national (possibly organized at regional level) research infrastructures for coastal observations.**

Future development will also involve **further mapping and involvement** of coastal observation infrastructure and expertise in the region but currently not yet involved in JERICO-S3 activities.

### 3.1.3 Bay of Biscay

The **BAY OF BISCAY** is a complex region characterized by irregular bathy-topographical features (e.g. submarine canyons, changing coast orientation and continental shelf width) and subjected to strong physical forcing at different spatio-temporal scales. Along the slope, the main feature of the circulation is the seasonal Iberian Poleward Current (IPC), which is intensified mostly in winter months and promotes trans-boundary interactions along the Atlantic margin of Europe. At local scales, other processes, like the wind-induced intensification of the current or the development and advection of mesoscale eddies, are key in the modulation of the exchanges between the coastal system and the open ocean. The area is affected by the runoff and sediment load of large rivers, and by the occurrence of extreme events (e.g. storm surges, floods, harmful algal blooms). Increasing human activities, such as fisheries, recreation, industry, offshore aquaculture and platforms, give a rise to local environmental challenges (e.g. plastic pollution, poor water quality, biodiversity loss). Figure 4 shows the IRS Bay of Biscay with currently catalogued observation infrastructures.

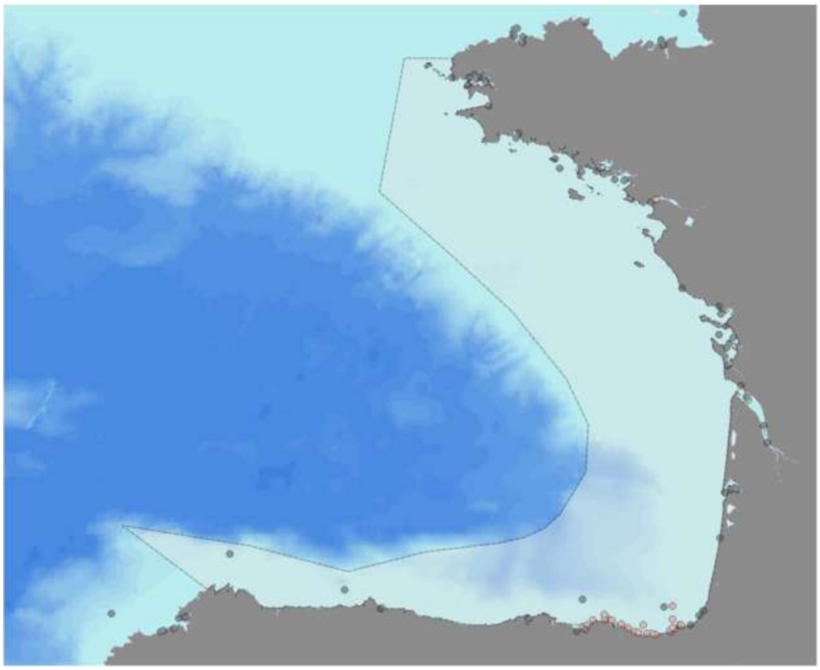


*Figure 4 The Bay of Biscay IRS with currently catalogued observation infrastructures (grey and rose points).*

#### 3.1.3.1 Scientific partner institutions

The Bay of Biscay IRS is currently composed of three partners CNRS, IFREMER (France) and AZTI (Spain).

The involved **CNRS** units are the Joint Research unit "Environnements et Paléoenvironnements OCéaniques et Continentaux" (**EPOC**), and the Joint Service Unit "« Pluridisciplinarité au service de l'Observation et de la Recherche en Environnement et Astronomie » (**POREA**). They are both led by CNRS and the **University of Bordeaux**.

The **EPOC** laboratory is a research unit gathering ca. 75 permanent researchers and 60 technical staff. Its main research areas refer to: (1) environmental chemistry and ecotoxicology, (2) coastal oceanography (physical and biological), and (3) marine geosciences. The laboratory is structured through 7 research teams and 8 technical platforms. EPOC is part of the COTE Laboratory of Excellence (LABEX) and of the Bordeaux Initiative of Excellence (IDEX). Its involvement in JERICO-S3 mainly refers to coastal oceanography, and more particularly to research activities aiming at understanding the complex links between benthic biodiversity and biogeochemical functioning in highly dynamic ecosystems.
**EPOC** is involved in coastal ocean observing through its participation in the "**Observatoire Aquitain des Sciences de l'Univers" (OASU)**. OASU is under the joint authority of CNRS, University of Bordeaux, University of La Rochelle and INRAE. OASU is responsible for the delivery of (physical, biogeochemical, biological, contaminant) observing data in the Bay of Biscay and its catchment basin. Data acquisition is mainly achieved within the framework of the French national infrastructure "**Infrastructure de recherche LIttorale et COtière"(ILICO),** which is grouping 9 elementary national observation networks. Data acquisition in the bay of Biscay benefits from theses synergies and results in spatiotemporally structured and standardized data sets including temperature, salinity, pH, nutrients and oxygen contents (**SOMLIT, MAGEST**), phytoplankton (**PHYTOBS**), and macrobenthos (**BENTHOBS**). Data sets are used for the monitoring of coastal areas in the framework of European directives (**WFD, MSFD**).
Within JERICO-S3, EPOC and POREA both actively participate in the technical development and testing of an innovative interdisciplinary platform dedicated to the assessments of compartments and processes taking place at the seafloor: the "Autonomous Coastal Observing Benthic Station" (**ACOBS**).

**Ifremer**, the French Research Institute for the Exploitation of the Sea, is an industrial and commercial public company. It operates under the joint auspices of the National Ministry of Education, Research and Technology, the Ministry of Agriculture and Fisheries and the Ministry of Equipment, Transport and Housing. Ifremer contributes, through studies and expert assessments, to knowledge about the ocean and its resources, monitoring of marine and coastal zones and the sustainable development of maritime activities. Here, Ifremer is involved through three research units:

- the **Laboratory for Ocean Physics and Satellite remote sensing (LOPS)** aiming to observe and investigate oceanic motions, their connection with the atmosphere, sea floor and the littorals, and their influence on life in the ocean.
- The **Technological Research and Development (RDT)** research unit contributing to the technological developments required for the exploration and sustainable exploitation of the oceans as well as environment monitoring from the coast to the depths.
- the **LITTORAL research units** dedicated to the observation, study and assessment of coastal ecosystems using the monitoring networks deployed across the country that it operates or oversees.

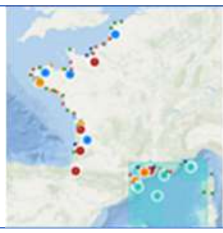
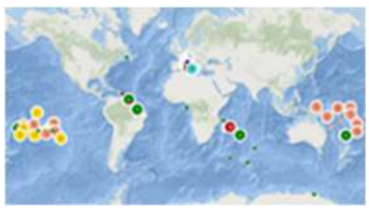
Those units are driving and operating several coastal observing systems in the Bay of Biscay. Those observing networks are part of the national infrastructure **ILICO**. In the framework of the IRS in the Bay of Biscay, automated moored buoys from the **COAST-HF network** and manual sampling of the phytoplankton from the **PHYTOBS and REPHY networks** will be considered.

**AZTI** (www.azti.es) is a research center that specializes in the food and maritime fishing value chain that carries out strategic and applied research to generate new knowledge. This private foundation is a member of **Basque Research and Technology Alliance (BRTA),** an alliance formed by 4 collaborative research centers and 12 technology centers with the aim of developing advanced technological solutions for the Basque companies. It is accredited as a Sectoral Technology Centre by the Basque Government and as a Technology Centre by the Spanish Ministry of Economy. The AZTI team works to contribute to the great challenges facing humanity. Our objectives and fields of application are aligned with the following **Sustainable Development Goals (SDG)** adopted by the UN: climate action (SDG 13), life below water (SDG 14), good health and well-being (SDG 3), responsible consumption and production (SDG 12) and zero hunger (SDG 2).

With almost 40 years of experience, the organization has developed an important **network of collaborating centers** both at national and international level, promoting more than 4.000 projects with industries and public institutions, including 549 projects running at present, reaching a turnover in 2019 of 20 M€. As a research and innovation center AZTI's main activity is focused on its Applied Research projects, New products and services, Scientific advice and Business revitalization and addressed to private companies, scientific organizations, professional associations as well as local, national and international administrations. AZTI provides scientific knowledge on the functioning of coastal systems in order to attain a sustainable management of their goods and services. We investigate to achieve a sustainable fishing activity by an economically competitive fleet, with responsible fishing practices. Within the area of Marine Technologies, through the Operational Oceanography, we carry out systematic description and prediction of sea behavior. Thanks to real-time monitoring and measuring systems of marine processes supplemented with numerical applications, we can forecast sea behavior. Moreover, we have experience in assessing the anthropogenic impact on the marine environment and mitigating the impact of accidental events such as oil spills. AZTI also provides technical support for the operation of EuskOOS (www.euskoos.eus) EuskOOS is the Basque coastal operational oceanography system operated by Euskalmet along with the expert advice of AZTI. This system envisages three purposes: (i) providing an accurate description of current sea conditions along the Basque coastline;(ii) offering ongoing forecasts of future sea conditions; and (iii) supplying ocean-meteorological products to Be coasasqutal users.

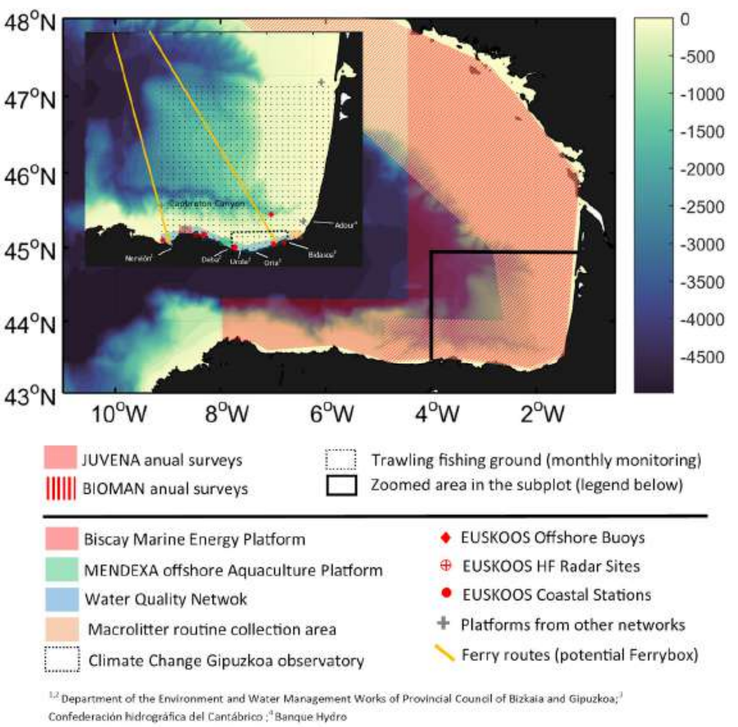
**National and regional Research Infrastructures:**

**Two main research infrastructures are already implemented in the Bay of Biscay**. **The French one (ILICO) is national whereas the Spanish one (EuskOOS) is regional**. The following tables summarize the main characteristics of these two infrastructures.

| France : National Research Infrastructure | | | |
|---|---|---|---|
| | **Infrastructure:** | **ILICO**<br>**Created in 2016** | **Main expected benefits for the IRS strategy:** |
| | **Legal Status:** | **Project or (Research Infrastructure)** | ● **To consolidate articulation between Coastal National Research Infrastructure, Jerico partners and other infrastructures at Pan European and national level, both strategically and scientifically.**<br>● **To strengthen coastal process understanding thank to enlarged the climatic and anthropogenic gradients or recorded parameters**<br>● **To build a European level, a comprehensive view of users and stakeholders and of the products and services they need**<br>● **To foster technological innovation and best practices exchanges**<br>● **To complete European vision of coastal challenges thanks to the integration of ultramarine questions and sites** |
| | **Coordination** | **IFREMER-CNRS** | |
| | **Accredited by a national roadmap:** | ✓ | |
| | **Data management plan:** | ✓ | |
| | **Yearly number of publication:** | **Approx. 90** | |
| **Geographical extend:** | |  |  |

## Spain: Regional infrastructure

| | | | |
|---|---|---|---|
| | 1 Infrastructure: | EuskOOS | Main challenges for the IRS strategy |
| | Legal Status: | Private regional infrastructure | • Work towards a coordinated system for the monitoring and forecast of the coastal ocean in a transnational area.<br>• Improve and enable the access to the existing infrastructures, services and data.<br>• Establish a roadmap for the future integrated observation of the coastal area and contribute to the strategy at European level. |
| | Coordination | AZTI | |
| | Accredited by a national roadmap: | - | |
| | Data management plan: | - | |
| | Yearly number of publication: | 5 | |
| **Geographical Extend:**<br>**SE Bay Biscay** | | | |




**Additional potential main actors in the area:**

In order to gather observations allowing for reaching an integrated understanding of the structuration and functioning of Bay of Biscay ecosystems, it is necessary to develop interactions with actors providing relevant data but not currently involved in the above described partnership. A clear objective of the Bay of Biscay IRS is therefore to identify these actors and to develop these partnerships. Lists of currently identified French and Spanish potential actors are given below.

**France:**

- Long-Term Socio-economic and Ecosystem Research Platforms (Zones Atelier Loire et Brest-Iroise)
- Office Français de la Biodiversité (French Office for Biodiversity)
- Universities (La Rochelle, Pau et Pays de l'Adour, Angers, Nantes, Bretagne-Sud, Bretagne Occidentale)
- Agences de l'Eau (Adour-Garonne, Loire-Bretagne)
- Groupements d'Intérêt Public (Loire-Estuaire, Littoral)

**Spain : Institute /organization (framework)**

- Research institutions & technological centers working in Ocean observation (Instituto Español de Oceanografía, CSIC, EHU - Euskal Herria Unibersitatea, IHC, INTECMAR, Puertos del Estado, which is a JERICO-S3 partner in the IRS - Atlantic Iberian Margin but not in the IRS - Bay of Biscay)
- Other integrated observatories (RAIA OBSERVATORY, Climate Change Gipuzkoa Observatory...)

#### 3.1.3.2 Main scientific and societal challenges

***Initial evaluation of challenges and objectives***

Lists of currently foreseen scientific challenges/objectives and expected impact are given below. It should be pointed out that these lists are likely to evolve together with the enlargement of the set of involved scientific actors (see above) and stakeholders.

***Specific regional scientific topics and objectives.***

- Study the impact of global change on coastal marine habitats, biodiversity, ecosystem functioning and water quality.
- Monitor and assess the impact of human activities.
- Resolve the impact of large rivers on the coastal ocean structure and functioning, and unravel the effects in relation to climate change.
- Study the impact of climate change (sea level rise and extreme events) on the shore-line (hydro sedimentary transport) to better assess and minimize coastal risks.
- Survey the origins and transport of marine litter, plastic pollution and invasive species.
- Advance integration of multisource data and circulation model simulations to develop new approaches for surface and subsurface
- Coastal current retrieval and thereby improve the use of data from coastal observatories to biogeochemical and environmental issues.

**Impact and societal challenges**

- Biodiversity conservation, integrated ecosystem management, conservation of key habitats in the life cycle of harvested species (e.g. the common sole), application for the sustainable management of commercial species (fisheries and aquaculture)
- Water quality assessment, preservation of major economic activities (tourism, aquaculture)
- Marine Safety: SAR operation, navigation etc.
- Physical coastal Hazards, optimizing the management of induced impacts (coastline preservation, flooding risks)
- Marine litter: reduce impacts, improve continuous monitoring for evaluation of the mitigation/prevention strategies, reduce costs of mitigation strategies (active fishing for litter, on-beach litter collection

**Action plan:**

As previously stated, for this area the elaboration of an action plan in accordance to the list of challenges and scientific objectives is immensely important. To this effect it is necessary to enable the establishment of effective links with the main actors in the coastal ocean observations. In a second step we will need to engage the main stakeholders in the area and make the most of the limited resources for workshop organization to ensure involvement of stakeholders in the co-design of the IRSes strategy.

To this end we plan to organize two workshops during 2021. A first Workshop#1 during the first semester (most probably virtual) where we will try to engage the main actors of the coastal ocean observation. Then, a second Workshop#2 during the second semester will be devoted to reach the main stakeholders (list to be defined in collaboration with WP9 and with the bases set in Workshop#1) and to establish a more detailed list of observational requirements linked to different sectors in the area.

As for the French partnership, additional interactions will be developed with the "Europe" *ad hoc* Committee of the "Comité d'Action Scientifique Transverse" (CAST) of the ILICO National Research Infrastructure. It is currently foreseen that these interactions will especially deal with the integration of the observations largely independently generated by elementary national observation networks.

#### 3.1.3.3 Observational strategy

The following table lists the long-term coastal observations currently active in the Bay of Biscay. A distinction is made between: (1) Observational efforts within National/Regional Infrastructures undertaken by JERICO partners, (2) Observational efforts within National/Regional Infrastructures not undertaken by JERICO partners and (3) Other observational efforts (to be extended after interactions with potential actors, in this specific case PDE is a JERICO-S3 partner working in the Iberian Atlantic Margin IRS, see Table 4)

*Table 4 coastal observations infrastructures currently active in the IRS Bay of Biscay*

| **Observational effort within National/Regional Infrastructures undertaken by JERICO partners** | | | | | | |
|---|---|---|---|---|---|---|
| **COUNTRY** | **INSTITUTE** | **NATIONAL /REGIONAL RI** | **NAME** | **TYPE** | **PARAMETER** | **START_DATE** |
| FRANCE | IFREMER-CNRS | ILICO | Gironde | Manual sampling | Turbidity | 2014 |
| FRANCE | IFREMER-CNRS | ILICO | Loire | Manual sampling | Turbidity | 2014 |
| FRANCE | IFREMER-CNRS | ILICO | Arcachon - Bouée 13 | Manual sampling | Phytoplankton,Biological (other) | 1999 |
| FRANCE | IFREMER-CNRS | ILICO | Teychan bis | Manual sampling | Phytoplankton,Biological (other) | 1987 |
| FRANCE | IFREMER-CNRS | ILICO | Bouée 13 | Fixed platform | Chl-*a* (Fluorescence),Water T°,Turbidity,Salinity/ Conductivity,Dissolved O2,pH, Chemical (other elements) | 2007 |
| FRANCE | IFREMER-CNRS | ILICO | MOLIT | Fixed platform | Chl-*a* (Fluorescence), Water T°,Turbidity,Salinity/ Conductivity,Dissolved O2, | 2008 |
| FRANCE | IFREMER-CNRS | ILICO | SMART | Fixed platform | Chl-*a* (Fluorescence),Water T°,Turbidity,Salinity/ Conductivity,Dissolved O2, | 2016 |
| FRANCE | IFREMER-CNRS | ILICO | MAREL-Iroise | Fixed platform | Chl-*a* (Fluorescence),Water T°,Turbidity,Salinity/ Conductivity,Dissolved O2,pH, pCO2Chemical (other elements) | 2000 |
| FRANCE | IFREMER-CNRS | ILICO | Comprian | Manual sampling | Chl-*a* (Fluorescence),Water T°,Turbidity,Salinity/ Conductivity,Dissolved O2,pH,Chemical (other elements) | 2007 |
| FRANCE | IFREMER-CNRS | ILICO | Eyrac | Manual sampling | Chl-*a* (Fluorescence),Water T°,Turbidity,Salinity/ Conductivity,Dissolved O2,pH,Chemical (other elements) | 1996 |

| | | | | | | |
|---|---|---|---|---|---|---|
| FRANCE | IFREMER-CNRS | ILICO | pk 30 | Manual sampling | Chl-*a* (Fluorescence),Water T°,Turbidity,Salinity/ Conductivity,Dissolved O2,pH,Chemical (other elements) | 1984 |
| FRANCE | IFREMER-CNRS | ILICO | pk 52 | Manual sampling | Chl-*a* (Fluorescence),Water T°,Turbidity,Salinity/ Conductivity,Dissolved O2,pH,Chemical (other elements) | 1978 |
| FRANCE | IFREMER-CNRS | ILICO | pk 86 | Manual sampling | Chl-*a* (Fluorescence),Water T°,Turbidity,Salinity/ Conductivity,Dissolved O2,pH,Chemical (other elements) | 1997 |
| FRANCE | IFREMER-CNRS | ILICO | Portzic | Manual sampling | Chl-*a* (Fluorescence),Water T°,Turbidity,Salinity/ Conductivity,Dissolved O2,pH,Chemical (other elements) | 1998 |
| FRANCE | IFREMER-CNRS | ILICO | Camaret | Manual sampling | Abundance of macrobenthos,Sediment granulometry,Organic matter in sediment,Temperature,Salinity | 2003 |
| FRANCE | IFREMER-CNRS | ILICO | Rade de Brest | Manual sampling | Abundance of macrobenthos,Sediment granulometry,Organic matter in sediment,Temperature,Salinity | 2003 |
| FRANCE | IFREMER-CNRS | ILICO | Belle Ile | Manual sampling | Abundance of macrobenthos,Sediment granulometry,Organic matter in sediment,Temperature,Salinity | 2003 |
| FRANCE | IFREMER-CNRS | ILICO | Gironde PK86 | Manual sampling | Abundance of macrobenthos,Sediment granulometry,Organic matter in sediment,Temperature,Salinity | 2007 |
| FRANCE | IFREMER-CNRS | ILICO | Comprian | Manual sampling | Abundance of macrobenthos,Sediment granulometry,Organic matter in sediment,Temperature,Salinity | 2007 |
| FRANCE | IFREMER-CNRS | ILICO | Côte Basque | Manual sampling | Abundance of macrobenthos,Sediment granulometry,Organic matter in sediment,Temperature,Salinity | 2007 |
| FRANCE | IFREMER-CNRS | NO | Labo métro Ifremer Brest | Fixed platform | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| SPAIN | AZTI | NO | Matxitxako | HF Radar | Currents (surface) | 01/01/2009 |
| SPAIN | AZTI | NO | Higer | HF Radar | Currents (surface) | 01/01/2009 |
| SPAIN | AZTI | NO | Donostia Buoy | Fixed platform | Air Pressure,Air T°,Currents (surface),Currents (water column),Salinity/ Conductivity,Water T°,Waves,Wind speed/dir | 01/01/2007 |
| SPAIN | AZTI | NO | Pasaia Station | Fixed platform | Air Pressure,Air T°,Waves,Wind speed/dir,Sea level | 01/01/2001 |
| SPAIN | AZTI | NO | Bilbao Station | Fixed platform | Air Pressure,Air T°,Waves,Wind speed/dir | 01/01/2003 |
| SPAIN | AZTI | NO | L-A10 | Manual sampling | Biological (benthic),Chl-*a* (Fluorescence),Dissolved O2,pH,Phytoplankton,Salinity/ Conductivity,Turbidity,Water T° | 1997 |
| SPAIN | AZTI | NO | L-B10 | Manual sampling | Biological (benthic),Chl-*a* (Fluorescence),Dissolved O2,pH,Phytoplankton,Salinity/ Conductivity,Turbidity,Water T° | 1995 |
| SPAIN | AZTI | NO | L-B20 | Manual sampling | Biological (benthic),Chl-*a* (Fluorescence),Dissolved O2,pH,Phytoplankton,Salinity/ Conductivity,Turbidity,Water T° | 1995 |
| SPAIN | AZTI | NO | L-BI10 | Manual sampling | Biological (benthic),Chl-*a* (Fluorescence),Dissolved O2,pH,Phytoplankton,Salinity/ Conductivity,Turbidity,Water T° | 1995 |
| SPAIN | AZTI | NO | L-D10 | Manual sampling | Biological (benthic),Chl-*a* (Fluorescence),Dissolved O2,pH,Phytoplankton,Salinity/ Conductivity,Turbidity,Water T° | 1995 |
| SPAIN | AZTI | NO | L-L10 | Manual sampling | Biological (benthic),Chl-*a* (Fluorescence),Dissolved O2,pH,Phytoplankton,Salinity/ Conductivity,Turbidity,Water T° | 1995 |
| SPAIN | AZTI | NO | L-L20 | Manual sampling | Biological (benthic),Chl-*a* (Fluorescence),Dissolved O2,pH,Phytoplankton,Salinity/ Conductivity,Turbidity,Water T° | 2002 |

| | | | | | | |
|---|---|---|---|---|---|---|
| SPAIN | AZTI | NO | L-N10 | Manual sampling | Biological (benthic),Chl-*a* (Fluorescence),Dissolved O2,pH,Phytoplankton,Salinity/ Conductivity,Turbidity,Water T° | 1995 |
| SPAIN | AZTI | NO | L-N20 | Manual sampling | Biological (benthic),Chl-*a* (Fluorescence),Dissolved O2,pH,Phytoplankton,Salinity/ Conductivity,Turbidity,Water T° | 1995 |
| SPAIN | AZTI | NO | L-O10 | Manual sampling | Biological (benthic),Chl-*a* (Fluorescence),Dissolved O2,pH,Phytoplankton,Salinity/ Conductivity,Turbidity,Water T° | 1995 |
| SPAIN | AZTI | NO | L-O20 | Manual sampling | Biological (benthic),Chl-*a* (Fluorescence),Dissolved O2,pH,Phytoplankton,Salinity/ Conductivity,Turbidity,Water T° | 2002 |
| SPAIN | AZTI | NO | L-OI10 | Manual sampling | Biological (benthic),Chl-*a* (Fluorescence),Dissolved O2,pH,Phytoplankton,Salinity/ Conductivity,Turbidity,Water T° | 1995 |
| SPAIN | AZTI | NO | L-OI20 - D0 | Manual sampling | Biological (benthic),Chl-*a* (Fluorescence),Dissolved O2,pH,Phytoplankton,Salinity/ Conductivity,Turbidity,Water T° | 1986 |
| SPAIN | AZTI | NO | L-OK10 | Manual sampling | Biological (benthic),Chl-*a* (Fluorescence),Dissolved O2,pH,Phytoplankton,Salinity/ Conductivity,Turbidity,Water T° | 1995 |
| SPAIN | AZTI | NO | L-RF10 - D2 | Manual sampling | Biological (benthic),Chl-*a* (Fluorescence),Dissolved O2,pH,Phytoplankton,Salinity/ Conductivity,Turbidity,Water T° | 1986 |
| SPAIN | AZTI | NO | L-RF20 | Manual sampling | Biological (benthic),Chl-*a* (Fluorescence),Dissolved O2,pH,Phytoplankton,Salinity/ Conductivity,Turbidity,Water T° | 2006 |
| SPAIN | AZTI | NO | L-RF30 | Manual sampling | Biological (benthic),Chl-*a* (Fluorescence),Dissolved O2,pH,Phytoplankton,Salinity/ Conductivity,Turbidity,Water T° | 2006 |
| SPAIN | AZTI | NO | L-U10 | Manual sampling | Biological (benthic),Chl-*a* (Fluorescence),Dissolved O2,pH,Phytoplankton,Salinity/ Conductivity,Turbidity,Water T° | 1995 |

| | | | | | | |
|---|---|---|---|---|---|---|
| SPAIN | AZTI | NO | L-UR20 | Manual sampling | Biological (benthic),Chl-*a* (Fluorescence),Dissolved O2,pH,Phytoplankton,Salinity/ Conductivity,Turbidity,Water T° | 1995 |
| SPAIN | AZTI | NO | D1 | Manual sampling | Chl-*a* (Fluorescence),Dissolved O2,pH,Salinity/ Conductivity,Turbidity,Water T° | 1986 |
| SPAIN | AZTI | NO | D3 | Manual sampling | Chl-*a* (Fluorescence),Dissolved O2,pH,Salinity/ Conductivity,Turbidity,Water T° | 1986 |
| **Observational effort within National/Regional Infrastructures not undertaken by JERICO partners** | | | | | | |
| FRANCE | IFREMER-CNRS | ILICO | Concarneau large | Manual sampling | Phytoplankton,Biological (other) | 1992 |
| FRANCE | IFREMER-CNRS | ILICO | Men er Roué - Quiberon | Manual sampling | Phytoplankton,Biological (other) | 1987 |
| FRANCE | IFREMER-CNRS | ILICO | Ouest Loscolo | Manual sampling | Phytoplankton,Biological (other) | 1987 |
| FRANCE | IFREMER-CNRS | ILICO | Le Cornard - Pertuis Breton | Manual sampling | Phytoplankton,Biological (other) | 1987 |
| FRANCE | IFREMER-CNRS | ILICO | Auger | Manual sampling | Phytoplankton,Biological (other) | 1988 |
| | | | | | | |
| FRANCE | IFREMER-CNRS | ILICO | La Rochelle - Antioche | Manual sampling | Phytoplankton,Biological (other) | 2011 |
| FRANCE | IFREMER-CNRS | ILICO | Antioche | Manual sampling | Chl-*a* (Fluorescence),Water T°,Turbidity,Salinity/ Conductivity,Dissolved O2,pH,Chemical (other elements) | 2011 |
| FRANCE | IFREMER-CNRS | ILICO | ARCACHON-EYRAC | Fixed platform | Sea level | 01/06/2000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| FRANCE | IFREMER-CNRS | ILICO | BOUCAU-BAYONNE | Fixed platform | Sea level | |
| FRANCE | IFREMER-CNRS | ILICO | BOUCAU-BAYONNE | Fixed platform | Sea level | |
| FRANCE | IFREMER-CNRS | ILICO | BREST | Fixed platform | Sea level | |
| FRANCE | IFREMER-CNRS | ILICO | CONCARNEAU | Fixed platform | Sea level | |
| FRANCE | IFREMER-CNRS | ILICO | ILE D'AIX | Fixed platform | Sea level | 22/03/2011 |
| FRANCE | IFREMER-CNRS | ILICO | LA ROCHELLE | Fixed platform | Sea level | |
| FRANCE | IFREMER-CNRS | ILICO | L'AIGUILLON SUR MER | Fixed platform | Sea level | 20/06/2014 |
| FRANCE | IFREMER-CNRS | ILICO | LE_CONQUET | Fixed platform | Sea level | |
| FRANCE | IFREMER-CNRS | ILICO | LE_CROUESTY | Fixed platform | Sea level | |

| | | | | | | |
|---|---|---|---|---|---|---|
| FRANCE | IFREMER-CNRS | ILICO | LES_SABLES_D_OLONNE | Fixed platform | Sea level | |
| FRANCE | IFREMER-CNRS | ILICO | MIMIZAN | Fixed platform | Sea level | |
| FRANCE | IFREMER-CNRS | ILICO | PORT TUDY | Fixed platform | Sea level | |
| FRANCE | IFREMER-CNRS | ILICO | ROYAN | Fixed platform | Sea level | |
| FRANCE | IFREMER-CNRS | ILICO | SAINT JEAN-DE-LUZ | Fixed platform | Sea level | |
| FRANCE | IFREMER-CNRS | ILICO | SAINT-NAZAIRE | Fixed platform | Sea level | |
| FRANCE | IFREMER-CNRS | ILICO | Boyardville | Manual sampling | Abundance of macrobenthos,Sediment granulometry,Organic matter in sediment,Temperature,Salinity | 2007 |
| FRANCE | IFREMER-CNRS (ILICO) | ILICO | Arcay | Manual sampling | Abundance of macrobenthos,Sediment granulometry,Organic matter in sediment,Temperature,Salinity | 2007 |
| **Other observational effort (to be extended after interactions with potential actors, in this specific case PDE is a JERICO-s3 partner working in the Ibserian Atlantic Margin IRS)** | | | | | | |
| SPAIN | PDE | NO | 6200024 (Bilbao buoy) | Fixed platform | Waves,Air Pressure,Wind speed/dir,Air T°,Water T°,Salinity/ Conductivity,Currents (surface) | 07/11/1990 |
| SPAIN | PDE | NO | 6200025 (Cabo de Penas buoy) | Fixed platform | Waves,Air Pressure,Wind speed/dir,Air T°,Water T°,Salinity/ Conductivity,Currents (surface) | 09/06/1997 |
| SPAIN | PDE | NO | 6200082 (Estaca de Bares buoy) | Fixed platform | Waves,Air Pressure,Wind speed/dir,Air T°,Water T°,Salinity/ Conductivity,Currents (surface) | 19/07/1996 |

| | | | | | | |
|---|---|---|---|---|---|---|
| SPAIN | PDE | NO | 6200083 (Villano-Sisargas buoy) | Fixed platform | Waves,Air Pressure,Wind speed/dir,Air T°,Water T°,Salinity/ Conductivity,Currents (surface) | 12/05/1998 |
| SPAIN | PDE | NO | 6201065 (Langosteira coast buoy) | Fixed platform | Waves,Air Pressure,Wind speed/dir,Air T°,Water T° | 22/05/2013 |
| SPAIN | PDE | NO | Bilbao-coast-buoy | Fixed platform | Waves,Water T° | 26/02/2004 |
| SPAIN | PDE | NO | Gijon-coast-buoy | Fixed platform | Waves,Water T° | 02/02/2001 |
| SPAIN | PDE | NO | Bilbao tide gauge | Fixed platform | Sea level,Waves | 02/07/1992 |
| SPAIN | PDE | NO | Coruña tide gauge | Fixed platform | Sea level,Waves | 01/07/1992 |
| SPAIN | PDE | NO | Ferrol1 tide gauge | Fixed platform | Sea level,Waves,Air Pressure,Wind speed/dir | 22/12/2006 |
| SPAIN | PDE | NO | Ferrol2 tide gauge | Fixed platform | Sea level,Waves | 25/10/2006 |
| SPAIN | PDE | NO | Gijón tide gauge | Fixed platform | Sea level,Waves,Air Pressure,Wind speed/dir | 29/06/1995 |
| SPAIN | PDE | NO | Langosteira tide gauge | Fixed platform | Sea level,Waves | 12/11/2012 |
| SPAIN | PDE | NO | Santander tide gauge | Fixed platform | Sea level,Waves | 01/07/1992 |

#### 3.1.3.4 Regional organization

In addition to the individual partners and actors detailed before, there are several national, inter-institutional and trans-border organizations that also can contribute to the IRS strategy.

The French seashore and coastal observing systems are organized through a national research infrastructure. The research infrastructure **ILICO (Infrastructure de Recherche Littorale et Côtière)** was established in 2016 with the support of the Ministry of Higher Education, Research and Innovation. ILICO is a notable example of national infrastructure and inter-institutional efforts to observe and understand coastal and ocean environments and ecosystems as a whole. ILICO brings together observation mechanisms involving the collection of samples and the deployment of various measuring instruments. Long-term monitoring allows for the understanding and prediction of large-scale coastal processes and phenomena which can impact coastal and littoral zones (for example quantifying the impact of specific extreme or intermittent events such as tsunamis or cyclones).

This research infrastructure aims to:

- Ensure that observations in littoral and coastal environments respond to issues in society and associated scientific questions,
- Gather and coordinate a multidisciplinary network of observatories for littoral and coastal environments,
- Guarantee the interoperability and quality of observations conducted under different observation systems.

**ILICO** brings together physical, biogeochemical and biological observation networks (known as elementary networks). In 2020 there are 9 of these:

1. Coastlines and coastal morphological dynamics (DYNALIT)
2. Seawater level (SONEL)
3. Mediterranean Ocean Observing System for the Environment (MOOSE)
4. Physicochemical developments in coastal waters (SOMLIT)
5. Developments in tropical coral ecosystems (CORAIL)
6. Insular Pacific Coastal Waters Network (REEFTEMPS)
7. High-frequency physical and chemical parameters (COAST HF)
8. Microphytoplankton (PHYTOBS)
9. Observation of benthic macrofauna (BENTHOBS) recently launched and currently under development for its full implementation within ILICO.

ILICO is jointly coordinated by CNRS and Ifremer, other bodies involved in its governance are the network of marine universities, IRD, Shom, IGN, CEREMA, and BRGM.

The data collected through ILICO networks will be integrated in a dedicated ocean database portal called ODATIS.

In Northern Spain, there is no organization federating coastal observations at Regional level. However, from 2019, a **Spanish Committee on Ocean Observations** (**CEOO**), led by IEO, is gathering all the institutions that are contributing to this marine observation. CEOO is constituted as a national interlocutor to bring out synergies, optimize resources, identify needs and promote the sustainability of the marine observation system in Spain, paying special attention to its role in the management of services and resources provided by the seas and as a support tool for research. The CEOO comprises a working group to coordinate monitoring actions (with the aim to agree and report on the minimum protocols that must be followed and the optimal observation points, and take the first steps towards organization and future optimization of resources) and a working group for the analysis of the costs of ocean observing systems (which includes as first step the completion of an inventory of existing systems).

In addition, in the Bay of Biscay, two organizations host cross-boundary collaborations:

First, the **Ireland-Biscay-Iberia Regional Operational Oceanographic System** (**IBI-ROOS**), Regional organization integrated in EuroGOOS. IBI-ROOS aims to set up an operational oceanography organisation operated by participating partners from the 5 countries bordering the Iberia-Biscay Ireland Regional maritime area (France, Ireland, Portugal, Spain and UK), collaborating to develop and implement ocean observing systems for the IBI-ROOS area, with delivery of real time operational data products and services. Partners of IBI-ROOS are linked through a MoU and a Data Exchange Agreement.

The goals of IBI-ROOS are:
To develop and implement online operational marine data and information services.

- Give a reliable description of the actual marine condition of the IBI area, including physical and ecosystem variables.
- Provide analysis, forecasts, and model based products describing the marine conditions.
- Establish a marine database from which time-series and statistical analyses can be obtained, including trends and changes in the marine environment, and the economic, environmental, and social impacts.
- Collaborate with national and multinational agencies in the IBI area to maximise the efficiency of the ocean observing system, and to maximise the value of the information products.

Then, at a more local scale around the cross-border area, an organization called "**Basque Coast Scientific Interest Grouping**" is gathering stakeholders and Research centers from the French and Spanish coast in the south-eastern Bay of Biscay. The Basque Coast Scientific Interest Grouping is a flexible, cross-border partnership tool, created in 2013, bringing together the following local authorities and scientific bodies of the Basque coast:

- The Basque Country Conurbation Community (FR)
- The Department of Pyrénées Atlantiques (FR)
- Gipuzkoa Provincial Council (ES)
- The Bureau of Geological and Mining Research (BRGM) (FR)
- The University of Pau and the Pays de l'Adour (UPPA) (FR)
- Rivages Pro Tech, SUEZ Water France's coastal R&D centre (FR)
- The Casagec Ingénierie design and R&D department (FR)
- The AZTI Foundation (ES)

The members of the organization work collectively to build and implement research activities that match the needs of Basque coastal communities in terms of coastal management with the proposals of the scientific community. The collaborations are aimed at developing new research on the Basque coast, with the aim of improving scientific knowledge on the one hand, and providing support for operational decision-making on the other.

Finally it is worth noting that in 2020, the University of Pau et des Pays de l'Adour, through its SIAME laboratory, the Spanish AZTI technology center and the Rivages Pro Tech (RPT) technical and scientific expertise center of the Suez group have joined forces in a joint laboratory (LabCom) motivated by a strong complementarity of their respective expertise. The **KOSTA RISK LabCom** is a joint cross-border research laboratory project applied to the observation and modelling of coastal risks. The purpose of this laboratory is to bring together researchers from the three organizations to implement scientific and technological cooperation in the fields of numerical modelling, physical measurement systems and advanced data analysis, for the development of tools to help manage and mitigate coastal risks. The LabCom team is made up of 5 teacher-researchers, 11 partner researchers (6 for RPT and 5 for AZTI), and may occasionally rely on the technical staff of the partners.

One of LabComs working axes is the development of coastal risk monitoring and observation systems. This axis aims to develop, improve and perpetuate innovative observation and monitoring systems dedicated to measuring meteorological-ocean hazards, as well as the response of coastal systems to these hazards. The results of this work will make it possible to set up and maintain measurement systems adapted to the specific conditions of climatic hazards in terms of frequency and intensity. They will thus make it possible to build lasting databases over the long term, essential for the study of extreme and rare episodes.

In addition to these existing initiatives, it is worth mentioning here the need of a close collaboration with partners within JERICO-S3, namely those involved in the IRS Atlantic Margin and the PSS-English Channel. We foresee a very sound interaction in the framework of the observational strategy and also on the scientific approach to common issues/processes like the shelf/slope dynamics. The collaboration with Atlantic Margin IRS - Puertos del Estado partner, responsible also for several observational efforts in the Cantabrian margin is key. We believe that the CEOO can be a good framework for this, since PdE (with observing infrastructure in the north coast of Spain, inside the BoB) is also part of this Comitée. Similarly for the northern limit, the interaction with the PSS-English Channel will also be significant since it is in the French Brittany where the most dense and exhaustive observations are performed (Bay of Brest/Iroise Sea).

#### 3.1.3.5 Financial sustainability plan

*Table 5 Initial Cost estimation Bay of Biscay*

| JERICO-RI Application costs | ANNUAL OPERATIONAL COSTS (eg. for 2019) |
| --- | --- |

| Member State | Institution(s) | General RI maintenance 1 | Personnel 2 | Ships/Vessels 3 | Data related 4 | Building Running Costs 5 |
|---|---|---|---|---|---|---|
| **Spain** | EuskOOS | € 20,000 | € 120,000 | € 20,000 | € 35,000 | |
| **France** | ILICO | € 830,000 | € 1 700,000 | | € 60,000 | € 340,000 |
| | **Total** | € 850,000 | € 1 820,000 | € 20,000 | € 95,000 | € 340,000 |

The financial sustainability of all above listed current French observations is insured since they are achieved within the ILICO infrastructure. The inclusion of complementary observations not achieved within such a framework would clearly require to secure operating funding.

#### 3.1.3.6 Plans for the future development during JERICO-S3

Through the activities planned within WP3 of JERICO-S3 the research infrastructures involved in the IRS alongside with national authorities will meet and further develop

- **the common observational strategy**
- **the integration of observational infrastructure**
- **the integration of data**

At national level the research infrastructures will meet with national authorities to further develop the

- **formal organization**
- **funding structure**

of **national (possibly organized at regional level) research infrastructures for coastal observations.**

Future development will also involve **further mapping and involvement** of coastal observation infrastructure and expertise in the region but currently not yet involved in JERICO-S3 activities.

### 3.1.4 Kattegat-Skagerrak-Eastern North Sea

The KATTEGAT-SKAGERRAK - EASTERN NORTH SEA is a dynamic transition area with outflow of brackish surface water from the Baltic Sea and currents originating in the North Sea. The outflow of brackish water results in strong stratification in the Kattegat and the Skagerrak. Local circulation in Skagerrak is in favor of pollutant accumulation. Some parts of the area are affected by eutrophication due to high nutrient input from rivers and from the Baltic Sea. Symptoms of eutrophication include harmful algal blooms and low oxygen concentrations in deep water occasionally causing mortalities of benthic organisms. Climate change is likely to affect the region in several ways; changes in temperature may affect winds and stratification and the biogeography of many organisms. Changed precipitation is likely to affect riverine input of nutrients and dissolved organic matter, and changes in the ocean carbonate system potentially lead to ocean acidification. The presence of steep gradients in water quality parameters along the Kattegat-Skagerrak represents a unique opportunity to investigate spatial range of marine contaminants in relation to physical descriptors. Litter may be the most visible environmental problem in the eye of the public.

#### 3.1.4.1 Scientific partner institutions

The **Swedish Meteorological and Hydrological Institute (SMHI)** is an expert agency under the Ministry of the Environment and Energy in Sweden. Through unique expertise in meteorology, hydrology, oceanography and climatology, SMHI contributes towards greater public welfare, increased safety and a sustainable society.

The **Institute of Marine Research (IMR)** in Norway is one of the biggest marine research institutes in Europe. Its main activities are research, advisory work and monitoring. Through it, the IMR seeks to help society to continue exploiting the valuable assets in the sea sustainably.

The **Norwegian Institute for Water Research (NIVA)** is Norway's leading institute for fundamental and applied research on marine and freshwaters. Its research comprises a wide array of environmental, climatic and resource-related fields. NIVA combines research, monitoring, evaluation, problem-solving and advisory services at international, national and local levels.

The **Danish Meteorological Institute (DMI)** serves society with meteorological knowledge and data within the Kingdom of Denmark, the Faroe Islands and Greenland with surrounding waters and airspace. The tasks cover weather, climate and sea.

The **Helmholtz- Zentrum Geesthacht (HZG)** is part of the Helmholtz Association, Germany's largest scientific organization. HZG makes substantial contributions to the clarification of major and pressing issues that focus on key scientific, economic and social issues.

As the Helmholtz Centre for Polar and Marine Research, the Alfred Wegener Institute (AWI) is primarily active in the cold and temperate regions of the world. Working together with numerous national and international partners, it is actively involved in unravelling the complex processes at work in the "Earth System".

### 3.1.4.2 Main scientific and societal challenges

***Specific regional scientific topics and objectives.***

- Investigate the impact of eutrophication and land-sea interactions on marine ecosystem services, biodiversity, and eutrophication.
- Assess the advection of harmful algae, oil, litter and microplastics
- Advance the monitoring of the biogeography and biodiversity of phyto- and zooplankton and develop early detection and warnings of Harmful Algal Blooms
- Improve the understanding on the climate change and climate variability effects on carbonate system and spatial-temporal dynamics of phytoplankton and higher trophic levels
- Evaluate the dispersal and ecosystem effects of contaminants
- Phytoplankton diversity and abundance - Implementing automated imaging in flow systems in stationary ocean observatories and in ferrybox systems on research and merchant vessels
- Combining observations and modelling
- Higher trophic dynamics: Implementing in-situ imaging and automated object analysis systems in stationary ocean observatories (e.g. Underwater observatory North Sea, HZG/AWI)
- Carbonate system
    - Harmonization between different underway carbonate measuring sensors
    - Harmonization with Surface Ocean Carbon Atlas data
    - Observations at the Baltic Sea-North Sea transition zone

### 3.1.4.3 Observational strategy

The general strategy is to build upon **existing long term monitoring programs**. JERICO-S3 activities add **near real time data from ferrybox systems**, instrumented oceanographic buoys etc. By combining data from the participating JERICO-S3 partners with modeling of ocean currents, stratification, etc. and remote sensing of ocean colour, sea surface temperature etc. useful products for the society are produced (see also Figure 5).

**JERICO-S3 contribution**

The following partners are involved in the JERICO-S3 work in the Kattegat-Skagerrak - Eastern North Sea IRS: **SMHI (Sweden), NIVA and IMR (Norway), AWI and HZG (Germany) and DMI (Denmark)**. Collaboration is partly organized through **NOOS**. It should be noted that most of the observations of the marine environment are funded nationally. There are also many **regional monitoring programs with funding at the regional level**.

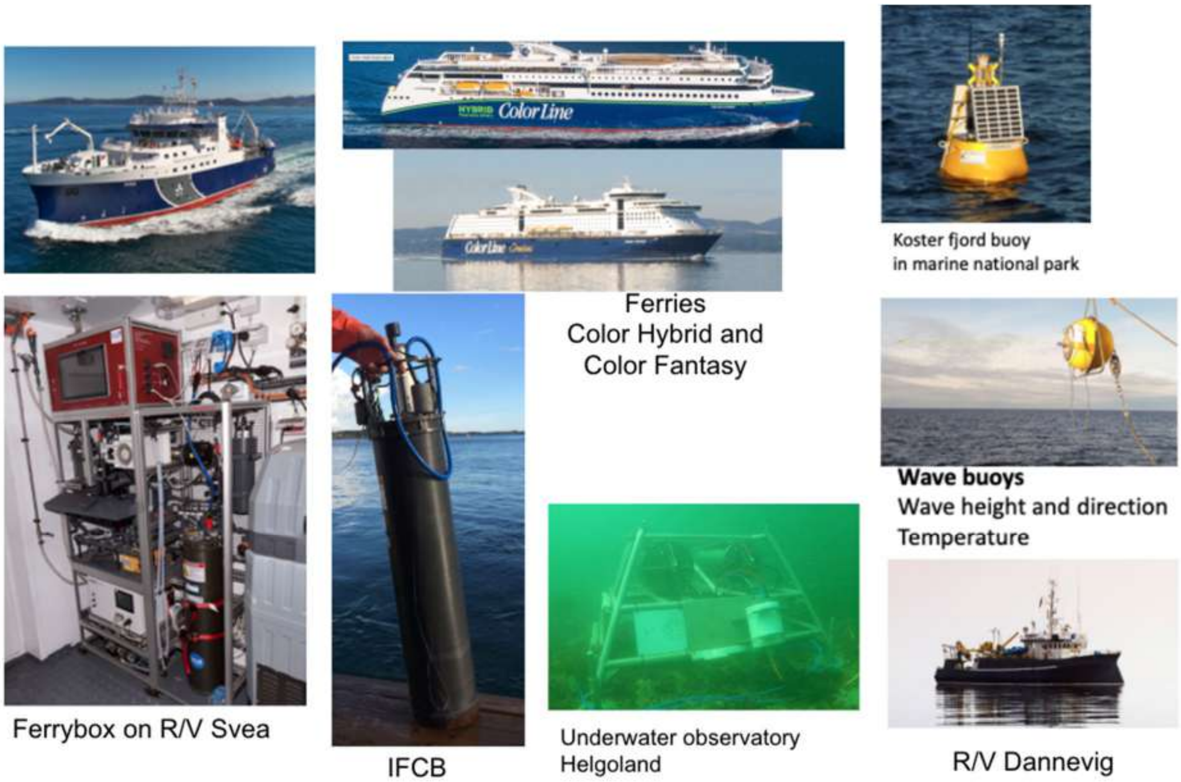



*Figure 5, Selected JERICO-S3 observation platforms in the Kattegat-Skagerrak-Eastern North Sea.*

The following Table 6 lists currently active coastal observation systems in the Kattegat-Skagerrak Eastern North Sea Integrated Regional Site.

*Table 6, JERICO-S3 activities in the Kattegat-Skagerrak-Eastern North Sea.*

| OBSERVATION SYSTEMS & PLATFORMS IN THE REGION | OPERATIONAL READINESS LEVEL (1 TO 9) | DESCRIPTION |
|---|---|---|
| R/V Svea, monthly cruises, includes ferrybox, sampling at stations etc. SMHI | 5-9 | Novel equipment for automated observations to be implemented in observing programs, e.g. Imaging FlowCytobot and carbonate system sensors |
| Flødevigen ocean observatory, IMR | 9 | High frequency water sampling and novel sensors, e.g. Imaging FlowCytobot |
| G.M. Dannevig, monthly research cruises between Norway and Denmark, IMR | 9 | Operational cruises with sampling of physical and lower trophic levels on specific sites repeated monthly, twelve months a year |

| | | |
|---|---|---|
| FerryBox on ferry Color Fantasy, Oslo-Kiel, NIVA | 3-9 | Novel sensors, e.g. Imaging FlowCytobot and carbonate system sensors |
| FerryBox on ferry Color Hybrid, Strömstad-Sandefjord NIVA | 3 | Novel sensors, e.g. Imaging FlowCytobot and carbonate system sensors; installed and operational by mid-2021 |
| FerryBox HZG | 7-9 | High frequency sampling and novel sensors, e.g. Hydro-FIA for pH and TA |
| Coastal oceanographic buoys Kosterfjorden and Kristineberg SMHI + Univ. of Gothenburg | 7 | Cooperation with the University of Gothenburg through EMBRC |
| Off shore oceanographic buoy, SMHI | 9 | At present only temperature and wave parameters are measured |
| Helgoland underwater observatory (with CPICS imaging system, HZG) in 10 m water depth, AWI | 9 | At present, most oceanographic parameters are fully operational and higher tropic levels are pre-analyzed. Ocenographic data are transferred to Pangaea |
| Helgoland underwater observatory in 25 m water depth, AWI | 2 | The deep observatory will be deployed in October 2020. |

There are several non-JERICO monitoring activities in the KASKEN IRS. In tables x and y some examples are listed. Most of these activities have a low temporal and spatial resolution. Monthly sampling of the pelagic environment does not resolve the natural variability.

Table 7Table 7 shows ongoing, non-JERICO monitoring in the Kattegat-Skagerrak-Eastern North Sea IRS. These activities are funded long term nationally or by regions within countries.

*Table 7, Ongoing, non-JERICO monitoring in the Kattegat-Skagerrak-Eastern North Sea IRS. These activities are funded long term nationally or by regions within countries.*

| Country | Type of programme | Main parameters | Data available at |
|---|---|---|---|
| Sweden | National marine monitoring programme | Physical, chemical and plankton | Swedish NODC at SMHI |
| Sweden | Fisheries and hydrography | Fish, hydrography | Swedish database and ICES |
| Sweden | Regional monitoring programmes | Physical, chemical and plankton | Swedish NODC at SMHI |
| Sweden | National and regional monitoring programmes | Contaminants in marine organisms | Swedish National History Museum? |

| | | | |
|---|---|---|---|
| Sweden | National and regional monitoring programmes | Benthic organisms | Swedish NODC at SMHI |
| Sweden | National and regional monitoring programmes | Marine mammals | Swedish NODC at SMHI |
| Sweden | Automated observations from buoys | Physical, chemical, bio-optical, | Swedish NODC at SMHI |
| Sweden | Ferrybox systems | Physical, chemical, bio-optical, | Swedish NODC at SMHI |
| Sweden | River flow | Physical | SMHI |
| Sweden | River input of nutrients etc. | Chemical | Swedish Agricultural University |
| Norway | FerryBox systems | Physical, chemical, biological, bio-optical | NIVA |
| Norway | Regional monitoring programme | Physical, biological, and chemical (water column) | Norwegian Environment Agency |
| Norway | Regional monitoring programme | Benthic fauna/flora (hard bottom/soft bottom) | Norwegian Environment Agency |
| Norway | River monitoring programme | Physical and chemical | Norwegian Environment Agency |

Table 8Table 8 shows major monitoring programs of phytoplankton in the Kattegat-Skagerrak, the eastern North Sea in year 2020.

*Table 8, Major monitoring programs of phytoplankton in the Kattegat-Skagerrak, the eastern North Sea in year 2020.*

| Country | Name | Sampling frequency and part of plankton community | Number of sampling locations | Time from sampling to available result |
|---|---|---|---|---|
| Sweden | Swedish National Food Agency monitoring program HA and biotoxins | Weekly, only phycotoxin producing taxa | 4 | ~2-3 days |
| Sweden | Swedish National Marine Monitoring program | Monthly (24 per year at one station), all phytoplankton including phototrophic picoplankton | 4 | Up to 12 months, quick results within two weeks (AlgaWare bulletin |
| Sweden | SMHI/NIVA ferrybox plankton monitoring | Every two weeks, all phytoplankton excluding phototrophic picoplankton | 2 | ~1 week |
| Sweden | Monitoring program of the County Administration Board of Västra Götaland | 5 per year (May-September) all phytoplankton including phototrophic picoplankton | 4 | Up to 6 weeks, net sample results within one week |
| Sweden | Monitoring program of the Water Quality Association of the Bohus Coast | Monthly, all phytoplankton excluding phototrophic picoplankton | 6 | Up to 6 weeks, net sample results within one week |
| Sweden | Monitoring program of the Halland coast | Monthly, all phytoplankton excluding phototrophic picoplankton | 2 | Up to 6 weeks, net sample results within one week |

| | | | | |
|---|---|---|---|---|
| Sweden | Monitoring program of North Western Skåne | Monthly, all phytoplankton excluding phototrophic picoplankton | 1 | Up to 4 weeks, net sample results within one week |
| Norway | Norwegian food safety monitoring program HA and biotoxins | Weekly March to October,<br>Harmful algae and biotoxins in blue mussels. | ~35 (whole Norwegia n coast) | ~1-3 days |
| Norway | National marine monitoring program - ØkoKyst (WFD) | Monthly February to October<br>all phytoplankton excluding phototrophic picoplankton | ~20 (whole Norwegia n coast) | 1-12 months, reported annually |
| Norway | IMR Monitoring program for environment and plankton. | Monthly, all phytoplankton excluding phototrophic picoplankton | ~15 (whole Norwegia n coast) | 1-12 months, |
| Norway | Regional monitoring programs (fjord systems) | Monthly February to October, all phytoplankton excluding phototrophic picoplankton | ~20 (whole Norwegia n coast) | 1-12 months, reported annually |
| Denmark | Danish National Marine Monitoring Program (NOVANA) | 20 per year, all phytoplankton and microzooplankton including picoplankton | 16 (in addition 10 stations in the coastal North Sea are sampled twice a year) | Up to 1-2 months |
| Denmark | A mandatory Monitoring program conducted by the Danish Mussel industry/-growers | Weekly sampling in active production areas.<br>Toxic and potentially toxic phytoplankton | The number varies between years but covers > 20 productio n areas | ~2-3 days |

| | | | | |
|---|---|---|---|---|
| Germany | Water Body Monitoring System Lower Saxony: Monitoring Network for Coastal and Transitional Waters | Weekly, fortnightly, monthly (March – September) phytoplankton | 5 | Up to one year |
| Germany | AWI Helgoland Roads time series | Daily on working days, all phytoplankton, excluding picoplankton | 1 | Daily |
| Germany | AWI Sylt Roads time series | Weekly, all phytoplankton, excluding picoplankton | 1 | Daily |

#### 3.1.4.4 Regional organization

At present observations in the region are organized mainly by country. In each country different national institutes and agencies organize the work. There is also substantial activity at the regional level within countries, eg. at the county administration board level. In Germany the different member states sometimes work separately.

**ICES working groups** are important for cooperation and sharing information, e.g. the Working Group on Harmful Algal Bloom Dynamics for cooperation regarding harmful algal bloom events. This is just one example of ongoing cooperation through ICES.

**NOOS (part of the IOC Global Ocean Observing System - GOOS)** is important for operational oceanography. It is at present mainly focused on physical parameters. There is ongoing cooperation between the KASKEN IRS partners through NOOS.

The **Nordic Marine Phytoplankton group (NOMP)** organizes yearly meetings and shares information on phytoplankton in general and harmful algae in particular. Species lists with information on cell volumes, carbon content, trophic type and harmfulness are maintained. A joint database with information and images of phytoplankton is maintained http://nordicmicroalgae.org. Several of the partners use the Plankton Toolbox open source software for quantitative phytoplankton analysis http://nordicmicroalgae.org/tools Automated observations of phytoplankton and microzooplankton are developed in cooperation between Nordic partners. Tools include the Imaging FlowCytobot and the FlowCam.

Often cooperation is organized via: 1) cooperative work that are not necessarily linked by MoUs, but more by "informal" agreements - sampling for each other, helping to collect/check infrastructure when needed, sharing data when requested or something of interest comes up; 2) The data flow mostly is organized via NOOS, but overall, there is no strict centralized/organized data handling or data portals except for fragmented data streams.

### 3.1.4.5 Integration efforts

In Table 9 ongoing and needed integration efforts in the KASKEN area are listed.

*Table 9, Ongoing and needed integration efforts in the KASKEN area*

| **Variables** | **Activities** | **Improvement needed** | **Additional comments** |
|---|---|---|---|
| Phytoplankton diversity, abundance and biomass | Coordination of species lists, cell volume and carbon content<br><br>Yearly meetings of Nordic Marine Phytoplankton group<br><br>Web site: http://nordicmicroalgae.org<br><br>Free software: Plankton Toolbox http://nordicmicroalgae.org/tools | Image libraries for training of machine learning algorithms for automated phytoplankton analysis using in situ imaging flow cytometry are needed<br><br>Metabarcoding of phytoplankton - standardisation of methods and improvement of reference libraries | A Nordic collaboration on automated plankton observations has started<br><br>Standardisation of methods for metabarcoding are in development |
| Zooplankton | ? | ? | ? |
| Carbonate system | Intercalibration of $pCO_2$, pH, total alkalinity and DIC | ,yes | A workshop was arranged in JERICO. Workshops need to be yearly |
| Litter | - | yes | Some litter sampling is ongoing as part of fish trawl sampling |
| Microplastics | - | yes | Sampling and analysis are partly experimental |
| Oil | Satellite remote sensing and observations from airplanes | no | |

| | | | |
|---|---|---|---|
| Inorganic nutrients | Intercalibration through QUASIMEME | no | |
| Chlorophyll | Intercalibration through QUASIMEME | no | |
| Ocean colour chlorophyll | Some work through ESA | yes | It is much needed to improve the use of in situ chlorophyll and microscope based phytoplankton biomass observations to improve ocean colour chlorophyll algorithms |
| HF radar - Ocean currents and waves | ? | ? | |
| Salinity and temperature | ? | ? | |
| Sea level/tide gauges | ? | ? | |

#### 3.1.4.6 Financial sustainability plan

In Sweden **SMHI has long term funding for the monthly cruises with R/V Svea and for operating the ferrybox system on the ship**. The **coastal buoys along the Swedish Skagerrak coast** are operated by SMHI and the University of Gothenburg with a **long term commitment**. SMHI also has a **long term commitment for sustained observations of the carbonate system in the sea through ICOS**. Additional support from the Swedish Reserach Council - Research Infrastructure is applied for. This includes the European Marine Biological Resource Center, https://www.embrc.eu.

**In Norway NIVA and IMR have funding from the Research Council of Norway 2018-2023 for FerryBox observations across Norway incl. KASKEN, and after 2023 it is expected that the operation is self-sufficient (NorSOOP).** The main players for funding sustainability for NIVA+IMR in KASKEN are likely the Ministry of Trade, Industry, and Fisheries and the Ministry of Climate and Environment. But also some small support by the Oslofjord research councils and the Norwegian Environment Agency (who are under the Ministry of Climate and Environment). IMR and NIVA (and other Norwegian partners are applying for long-term infrastructure funding from the Research Council of Norway to organize and build coastal observations across Norway incl. KASKEN in the Norwegian node of JERICO-RI that will be called COASTWATCH. Another upcoming activity is AlgeStatus with information about harmful algae.

#### 3.1.4.7 Plans for the future development during JERICO-S3

There are five main focus areas in the KASKEN IRS for JERICO-S3 in years 2021-2023:

- **Sharing data in near real time**
- **Defining a prototype harmful algae early warning system for the area**
- **Improving automated plankton observations**
- **Improving carbonate system observations**
- **Improving observations of contaminants**

Through the activities planned within WP3 of JERICO-S3 the research infrastructures involved in the IRS alongside with national authorities will meet and further develop

- **the common observational strategy**
- **the integration of observational infrastructure**
- **the integration of data**

At national level the research infrastructures will meet with national authorities to further develop the

- **formal organization**
- **funding structure**

of **national (possibly organized at regional level) research infrastructures for coastal observations.**

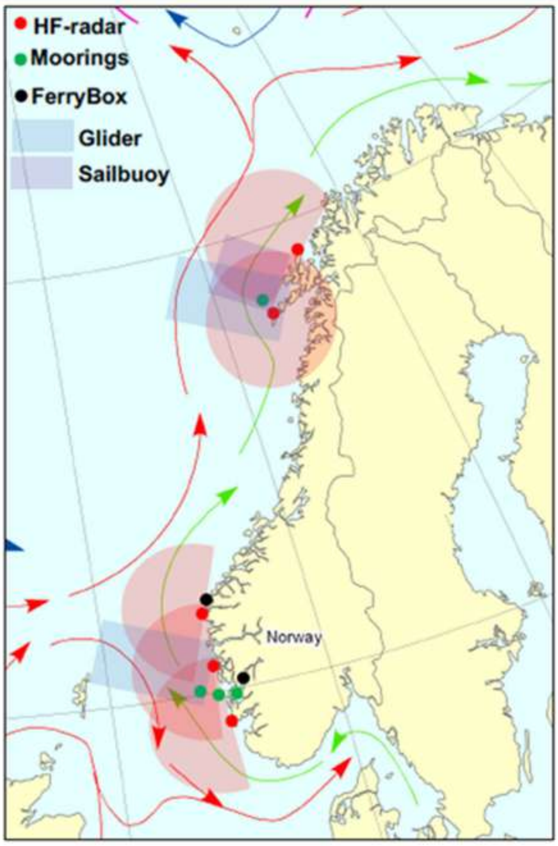
Future development will also involve **further mapping and involvement** of coastal observation infrastructure and expertise in the region but currently not yet involved in JERICO-S3 activities.

### 3.1.5 Norwegian Sea

#### 3.1.5.1 Scientific partner institutions

The Institute of Marine Research (IMR) in Norway is one of the biggest marine research institutes in Europe. Its main activities are research, advisory work and monitoring.Through it, the IMR seeks to help society to continue exploiting the valuable assets in the sea sustainably.

The Norwegian Institute for Water Research (NIVA) is Norway's leading institute for fundamental and applied research on marine and freshwaters. Its research comprises a wide array of environmental, climatic and resource-related fields. NIVA combines research, monitoring, evaluation, problem-solving and advisory services at international, national and local levels.

| Norway: Network of OS/Consortium of Institutes | | | |
|---|---|---|---|
| | **Infrastructure:** | **COASTWATCH** | |
| | **Legal Status:** | **Under establishment** | • **Homogenise fragmented coastal research and monitoring capacity within Norway and with JERICO partners**<br><br>• **Optimize cost efficiency of the Norwegian waters,**<br>• **Foster and participate in the development of the JERICO e-Infrastructure**<br>• **Aiming for a development of a seamless dataflow in Europe** |
| | **Coordination** | **IMR** | |
| | **Accredited by a national roadmap:** | **Yes** | |
| | **Data management plan:** | ***✓ - NMDC (Norwegian marine data center) adapted to COASTWATCH*** | |
| | **Yearly number of publication:** | | |
| **Geographical Extend: North Sea, Norwegian Sea, Barents Sea** | |  | |



### 3.1.5.2 Main scientific and societal challenges

**Scientific Scope :**

Research and development associated with environmental monitoring, climate change, marine pollution, blue growth and ecosystem management greatly benefit from accurate descriptions of the physical, chemical and biological state of the ocean. The strongest currents and overall highest variability are found on the continental shelf and along the shelf break, while the complex geometry of the coastline leads to the creation of small-scale circulation features important for nearshore spreading and dispersion. Hence, the coastal regions and the shelf seas are particularly challenging to resolve in numerical models and observe in a representative way. However, increasing levels of activities at the interface between fjords and the coastal sea place a clear demand on the accuracy in predictions of e.g. marine ecosystem connectivity and pollutant exchange. Establishing a consistent research infrastructure enabling a coherent approach through combined coastal observations and ocean modelling is therefore imperative to secure a sustainable pursuit of the goals of the Norwegian government and international obligations, such as the UN Sustainability Development Goals (SDGs).

As a consequence, the **integrated coastal observing system COASTWATCH** with the main partners IMR, NIVA and NORCE provides key sites along the Norwegian coast as a much-needed infrastructure supporting research and knowledge-based management as well as Norway's contribution in the European integrated and multidisciplinary coastal observing system – JERICO. In order to adequately address the complex coupled processes inherent of coastal regions and delivering essential ocean variables, our infrastructure will implement a multiplatform-multi-sensor approach integrating observations from fixed platforms, HF radar systems, coastal gliders, ships of opportunity, surface AUVs and a framework for testing and utilizing other observation sources such as satellite-based remote sensing, connected into into Supersites of high societal relevance. This provides Norwegian and international researchers and managers a permanent source of near real-time information of physical, biogeochemical and biological state of coastal and shelf regions, supporting an ecosystem approach for analytical studies of stressors and impacts. Furthermore, the infrastructure represents a hub for easy integration of all observation sources in the area (e.g. salmon farms, national monitoring programs) and a model-based extrapolation beyond the key sites to the entire coast through data assimilation and data-driven machine-learning. We stimulate technology development to better observe the biogeochemical processes and facilitate cross-disciplinary research on coastal processes and assessment of the combined climate change and human impacts.

**Socio-economic Scope :**

The overall aim for COASTWATCH is increasing the knowledge and provide advice for rich and clean sea and coastal areas. That is conducted via the provision of research-based advice and building strong links to ministries as well as providing international development cooperation via the directorate for Development Cooperation (NORAD) and the Food and Agriculture Organizations of the United Nations (FAO).

Focal points of the COASTWATCH infrastructure is to serve the following socio-economic fields:

- Aquaculture
- Harmful Algal Blooms
- Land-Coastal-Ocean interactions
- Human Impact
- Sustainable fisheries management
- Integrated Ecosystem Assessment

### 3.1.5.3 Observational strategy

Table 10 and Table 11 list the currently active coastal observation infrastructure of the JERICO-S3 IRS Norwegian Sea.

*Table 10 coastal observations infrastructures currently active in the Norwegian Sea*

| COUNTRY | INSTITUTE | NATIONALRI | NAME | TYPE | PARAMETER |
|---|---|---|---|---|---|
| | | | | | |
| NORWAY | NIVA | NO | M/S Trollfjord (TF) | Ferrybox (Bergen-Kirkenes, Norway) | Water T°,Salinity/Conductivity,Dissolved O2,Chl-A (Fluorescence),CDOM ,Turbidity,pH,pCO2,Radiance and irradiance,Water samples |
| NORWAY | NIVA/FAMRI | NO | M/S Noronna (NO) | FerryBox (Denmark-Faroe Islands-Iceland) | Water T°,Salinity/Conductivity,Dissolved O2,Chl-A (Fluorescence),CDOM ,Turbidity, Water samples |
| NORWAY | NIVA | NO | M/S Norbjørn | Ferrybox (Tromsø-Svalbard, Norway) | Water T°,Salinity/Conductivity,Dissolved O2,Chl-A (Fluorescence),CDOM ,Turbidity,pH,pCO2,Radiance and irradiance,Water samples |
| FAROE ISLANDS | FAMRI | NO | FAMEOS (Faroese Marine Ecosystem Observing Study | Manual sampling | |
| GERMANY | AWI | COSYNA | AWIPEV Underwater Node Spitzbergen | Bottom-based obs. | |
| NORWAY | NORCE | NO | Station M | Fixed platform | |
| NORWAY | NORCE | NO | Station M | Manual sampling | |

*Table 11 Phytoplankton observations in the Norwegian Sea*

| Country | Organization | Description | Geographical Extent | Frequency |
|---|---|---|---|---|
| Norway | Norwegian food safety monitoring program HA and biotoxins | Weekly March to October, Harmful algae and biotoxins in blue mussels. | ~35 (whole Norwegian coast) | ~1-3 days |

| | | | | |
|---|---|---|---|---|
| Norway | National marine monitoring program - ØkoKyst (WFD) | Monthly February to October all phytoplankton excluding phototrophic picoplankton | ~20 (whole Norwegian coast) | 1-12 months, reported annually |
| Norway | IMR Monitoring program for environment and plankton. | Monthly, all phytoplankton excluding phototrophic picoplankton | ~15 (whole Norwegian coast) | 1-12 months, |
| Norway | Regional monitoring programs (fjord systems) | Monthly February to October, all phytoplankton excluding phototrophic picoplankton | ~20 (whole Norwegian coast) | 1-12 months, reported annually |

### 3.1.5.4 Regional organization

Norway is also involved in the following list of European research infrastructures: EURO-ARGO, ICOS, EuroGOOS, Seadatanet, EMODNET, Eurofleets, EPOS, EMBRC.

IMR, NIVA, and NORCE are generally well organized, and mostly visible/evident through JERICO-RI and COASTWATCH. The Ministry for Trade, Industry and Fisheries has provided direct support for the Coastwatch approach by introducing a specific item in the annual IMR budget. There are no specific Jerico RI MOUs existing between the institutes within the IRS Norwegian Sea. But NIVA and FAMRI have an MoU about cooperation of M/S Norrona FerryBox.


In terms of data handling the Norwegian Sea data is organized by the collaboration within the IMR led **Norwegian Marine Data Centre** activity which is a collaboration between 17 national partners among which the IRS partners are members. The provision of data to the **Copernicus Marine Service** is ensured via IMR leading the Arctic part of the CMEMS InSitu Thematic Assembly center (TAC) where all data are planned to be gathered. The Arctic is in this relation defined as all areas north of 60 degrees North. The more southern data is published via the North West Shelf (NOOS) data portal operated by the German Bundesamt fuer Seeschifffahrt und Hydrographie. The close collaboration with the NOOS activities is ensured via the IRS leader as he was the NOOS chair for eight years from 2011-2019 and the involvement of IMR and NIVA as contributors to NOOS.
There is anyway a challenge that the observational communities have chosen a platform dependent data handling approach, which is organized for the pan European regions. However, the challenges faced due to that approach are tackled via the activities by the central EuroGOOS, and the overall CMEMS InSitu TAC activities. Acting as a Board of directors member and being the Vice chair of EuroGOOS since 2018 the Norwegian Sea IRS leader and IMR being the Arctic InSitu TAC lead ensures that those developments are leading to a better integration for the Norwegian Sea as well.  EmodNet is feeding their databases by connecting to the regional data delivery from the EuroGOOS regions (ROOSs) so that this part is organised as well. The data included in the EmodNet data bases and not included in the ROOSs data portals is ensured aligned via an existing MOU between the InSitu TAC and EModNet. In addition, the InSitu TAC operates other MOUs in order to ensures the most complete data provision as possible (such as MOU between InSitu TAC and Seadatanet) The InSitu Tac data handling was in the earlier phases mostly limited to physical parameters but the parameters included were extended to biogeochemical parameters such as the data obtained from the ICOS network, which is now distributed via the InSitu TAC as well.

Further integration and regional organization effort is undertaken with the application of the COASTWATCH program, which is illustrated in Figure 6 and Figure 7.

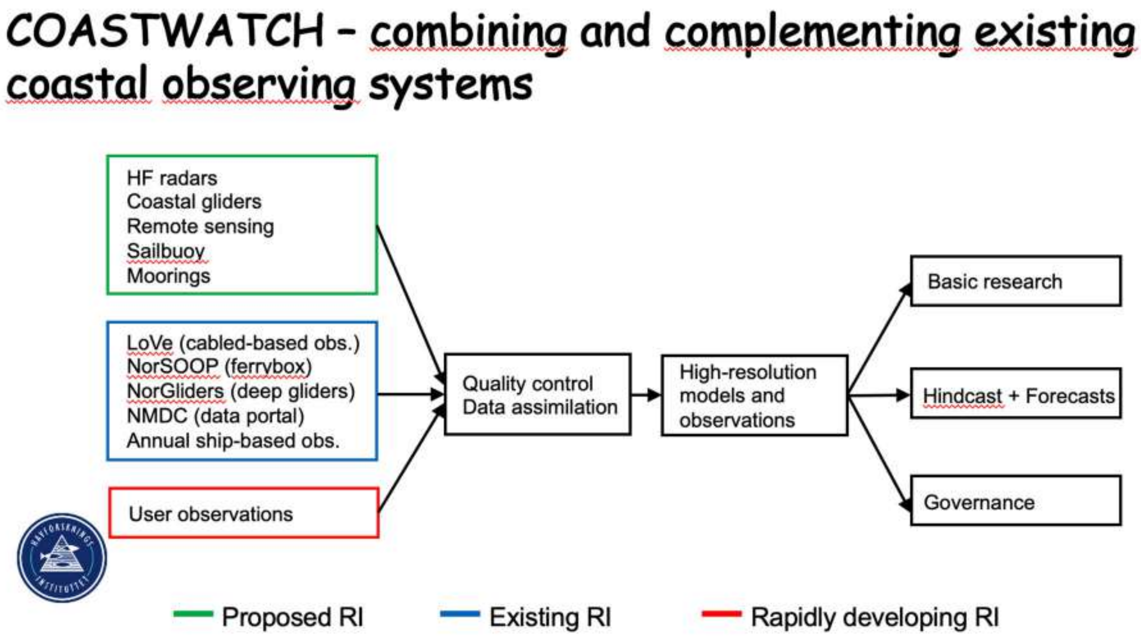



*Figure 6 Coastwatch application for the Norwegian sea*

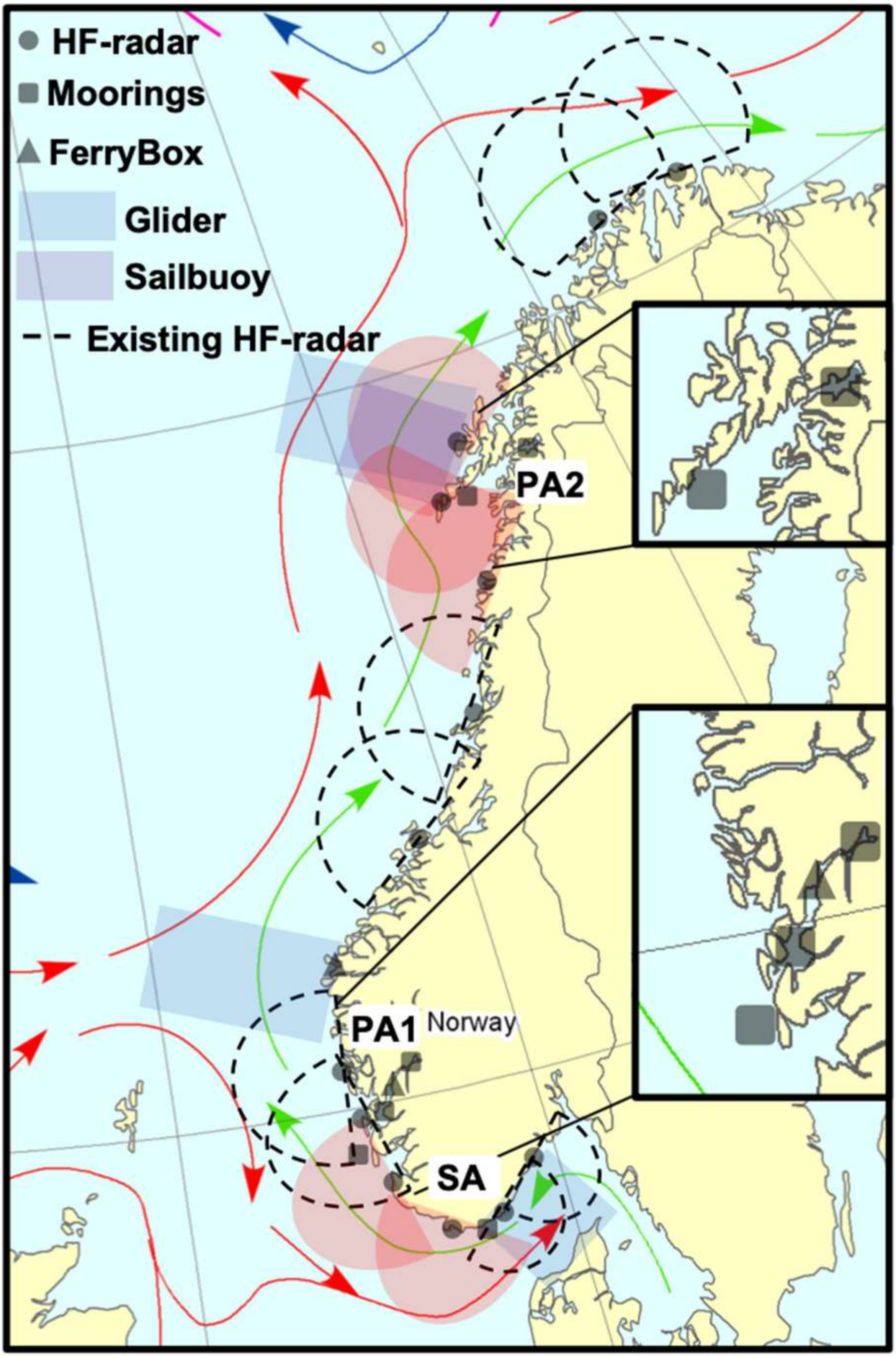



*Figure 7 COASTWATCH spatial coverage*

### 3.1.5.5 Financial sustainability plan

Table 12 shows an initial self-estimation of costs for the currently active coastal observations in the Norwegian Sea

*Table 12, Initial cost estimation Norwegian Sea*

| JERICO-RI Application costs | | ANNUAL OPERATIONAL COSTS (eg. for 2019) | | | | |
|---|---|---|---|---|---|---|
| **Member State** | **Institution(s)** | **General RI maintenance 1** | **Personnel 2** | **Ships/Vessels3** | **Data related4** | **Building Running Costs5** |
| **Norway** | IMR | € 300,000 | € 300,000 | € 400,000 | € 100,000 | € 200,000 |
| | NIVA | € 400,000 | € 400,000 | € - | € 35,000 | € 200,000 |
| | NORCE | | | | | |

**In Norway NIVA and IMR have funding from the Research Council of Norway 2018-2023 for FerryBox observations across Norway incl. KASKEN, and after 2023 it is expected that the operation is self-sufficient (NorSOOP)**. The main players for funding sustainability for NIVA+IMR in KASKEN are likely the Ministry of Trade, Industry, and Fisheries and the Ministry of Climate and Environment. But also some small support by the Oslofjord research councils and the Norwegian Environment Agency (who are under the Ministry of Climate and Environment). IMR and NIVA (and other Norwegian partners are applying for long-term infrastructure funding from the Research Council of Norway to organize and build coastal observations across Norway incl. KASKEN in the Norwegian node of JERICO-RI that will be called COASTWATCH. Another upcoming activity is AlgeStatus with information about harmful algae.

### 3.1.5.6 Plans for the future development during JERICO-S3

Through the activities planned within WP3 of JERICO-S3 the research infrastructures involved in the IRS alongside with national authorities will meet and further develop

- **the common observational strategy**
- **the integration of observational infrastructure**
- **the integration of data**

At national level the research infrastructures will meet with national authorities to further develop the

- **formal organization**
- **funding structure**

of **national (possibly organized at regional level) research infrastructures for coastal observations.**

Future development will also involve **further mapping and involvement** of coastal observation infrastructure and expertise in the region but currently not yet involved in JERICO-S3 activities.

# 4 Synthesis

## 4.1 Summary of the observational capacities in the Integrated Regional Sites

The following tables (Table 13 and Table 14) summarize the observational capacities within the Integrated Regional Sites examined. The presented information is a result of a self-evaluation effort within the mentioned regions as performed by the JERICO-S3 member organizations. The member organizations took the entirety of the currently existing observational capacities within the regions into account into the ***qualitative*** self-evaluation.
The evaluations of observational capacities are grouped by Key Scientific Challenges (KSC) and generally agreed on overarching scientific questions that are shared across all European Coastal Seas, Integrated Regional Sites and Pilot Super Sites (see WP4 and respective deliverables D4.1).

The KSCs and respective scientific strategies are described and discussed in detail in the JERICO-S3 deliverable D1.1 document.

Differences in operational capacities and in particular regional needs of improvements in observational capacity result from regional differences in priorization of observational needs. A commonly shared need for improvement of observational capacity was concluded for the Key Scientific Challenges "Ecosystem biogeochemical processes and interactions" and for "Carbonate budget and carbonate system".

*Table 13, Qualitative assessments of the degree to which IRS are addressing key scientific challenges (KSCs).*

Observations and data flows

- Very good
- Good
- Improvement needed
- Not needed
- Not known

| Observations and data flows | Adriatic Sea | Iberian Atlantic Margin | Bay of Biscay | Kattegat-Skagerrak | Norwegian Sea |
|---|---|---|---|---|---|
| **KSC1: Land-Ocean continuum: impacts of land-based discharges and exchange with open ocean** | | | | | |
| Nutrients | Good | Improvement needed | Good | Good | Good |
| Particles and organic matter | Good | Improvement needed | Good | Good | Good |
| Inorganic carbon | Good | Improvement needed | Good | Good | Good |
| Litter and contaminants | Good | Improvement needed | Good | Good | Very good |
| **KSC1: Sea-Atmosphere interface: quantification of inputs** | | | | | |
| Particles | Improvement needed | Improvement needed | Improvement needed | Not known | Good |
| Nutrients | Improvement needed | Improvement needed | Improvement needed | Good | Good |
| Contaminants | Improvement needed | Improvement needed | Improvement needed | Not known | Good |
| **KSC1: Connectivity and transport pathways of water masses and materials** | | | | | |
| Within region | Good | Good | Good | Good | Good |
| Between other coastal regions | Good | Good | Good | Good | Improvement needed |
| Between region and open ocean | Improvement needed | Good | Good | Not needed | Improvement needed |
| Within region retention dynamics | Good | Good | Good | Good | Improvement needed |
| **KSC1: Biodiversity trends** | | | | | |
| Phytoplankton | Very good | Good | Good | Good | Very good |
| Zooplankton | Good | Good | Good | Good | Good |
| Benthos | Good | Good | Good | Good | Good |
| **KSC1: Ecosystem biogeochemical processes and interactions** | | | | | |
| Pelagic | Very good | Improvement needed | Improvement needed | Good | Very good |
| Benthic | Good | Improvement needed | Good | Improvement needed | Good |
| Pelagic-benthic coupling | Good | Improvement needed | Improvement needed | Improvement needed | Good |
| **KSC1: Carbon budget and carbonate system** | | | | | |
| Carbon fluxes and budget | Good | Improvement needed | Good | Improvement needed | Good |
| Carbonate system trends | Good | Improvement needed | Improvement needed | Improvement needed | Good |
| Effects of acidification | Good | Not known | Improvement needed | Improvement needed | Improvement needed |
| **KSC2: Impact of rare and extreme events** | | | | | |
| Floods | Improvement needed | Good | Very good | Very good | Good |
| Storms, large waves | Improvement needed | Very good | Very good | Very good | Improvement needed |
| Heat waves | Improvement needed | Good | Good | Good | Very good |
| Landslides, sudden erosion | Not needed | Improvement needed | Very good | Not known | Improvement needed |
| Harmful algae blooms | Very good | Good | Good | Good | Good |
| Pollution due to accidents | Good | Good | Very good | Good | Good |

*Table 14 Qualitative assessments of the degree to which IRS are addressing key scientific challenges (KSCs).*

Observations and data flows

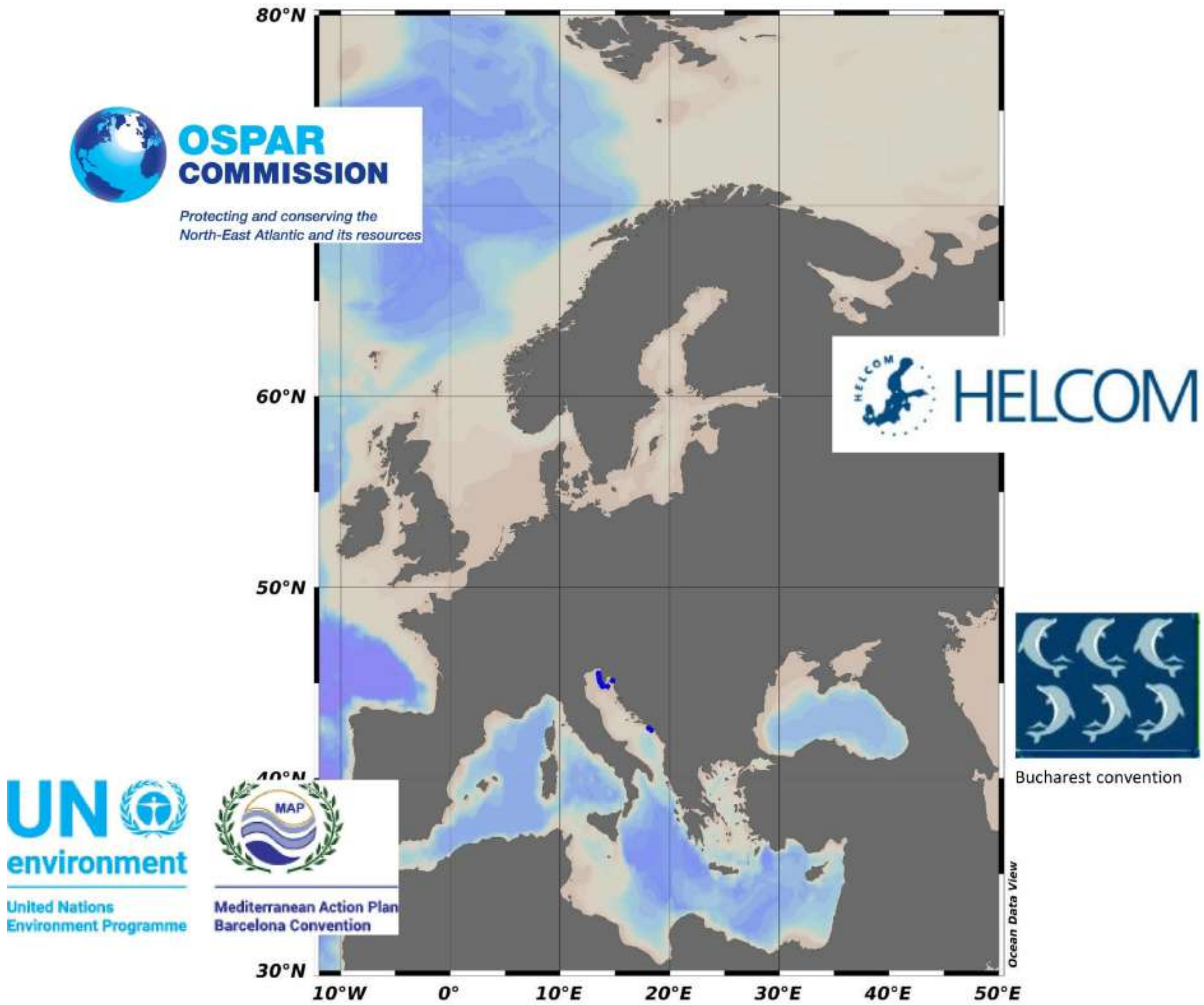
- Very good
- Good
- Improvement needed
- Not needed
- Not known

| | Adriatic Sea | Iberian Atlantic Margin | Bay of Biscay | Kattegat-Skagerrak | Norwegian Sea |
|---|---|---|---|---|---|
| **KSC3: Long term observations to resolve Climate Change impacts** | | | | | |
| Temperature | Very good | Very good | Good | Good | Very good |
| Salinity | Very good | Good | Good | Good | Very good |
| Currents | Good | Very good | Good | Improvement needed | Improvement needed |
| Sea level | Good | Very good | Very good | Very good | Improvement needed |
| Waves | Good | Very good | Very good | Very good | Improvement needed |
| Biological production | Good | Improvement needed | Improvement needed | Good | Good |
| Species distribution ranges | Good | Not known | Good | Good | Good |
| Nutrients | Very good | Improvement needed | Good | Very good | Good |
| **KSC3: Observations to resolve anthropogenic disturbances** | | | | | |
| Eutrophication | Very good | Good | Very good | Good | Good |
| Habitat and biodiversity loss | Very good | Improvement needed | Good | Good | Improvement needed |
| Contamination | Good | Good | Good | Good | Good |
| Coastal engineering | Improvement needed | Good | Good | Good | Improvement needed |
| Use of marine space | Good | Improvement needed | Good | Good | Good |
| Use of marine nonliving resources | Good | Improvement needed | Good | Good | Good |
| Use/cultivation of living resources | Improvement needed | Good | Very good | Good | Good |
| Invasive species | Very good | Good | Good | Improvement needed | Good |
| Maritime traffic | Good | Good | Good | Good | Good |
| Underwater noise | Good | Good | Good | Improvement needed | Good |
| **KSC3: Interoperable and integrated long term data sets** | | | | | |
| Biogeochemistry datasets | Very good | Good | Good | Good | Good |
| Biodiversity datasets | Very good | Improvement needed | Improvement needed | Good | Good |

## 4.2 Monitoring strategies

Currently implemented observational strategies most prominently reflect **national responses to EU requirements under the Marine Strategy Framework Directive** (**MSFD**).

The following picture illustrates the regional conventions under the EU MSFD that aim at considering regional characteristics for the regional implementation of the MSFD regulations and requirements for monitoring and comparability of monitoring efforts as well as data interpretations.




The Marine Strategy Framework Directive (MSFD) is a European Directive aimed at achieving or maintaining Good Environmental Status in the European seas. While the Member states of the European Union are bound to the regulations of the MSFD, Norway is not bound to the MSFD and it has has not implemented the MSFD. Norway has since 2002 worked on developing a holistic management plan, with an indicator based monitoring program, for its marine areas. There are now regional management plans implemented and regularly updated for the: Barents Sea and the Lofoten area (first version adopted by the Norwegian Parliament in 2006); Norwegian Sea (adopted by parliament in 2009) and North Sea and Skagerrak (adopted by parliament in 2013). The main goal of the management plan is to allow for sustainable use while ensuring the health of the ecosystem. It aims to establish a holistic and ecosystem-based management of the activities in the seas around Norway and to set an overall framework for both existing and new activities in these waters, facilitating co-existence of different industries, such as fishery industry, maritime transport and petroleum industry.

The Water Framework Directive (WFD), Directive 2000/60/EC, was adopted in 2000 as a single piece of legislation covering rivers, lakes, groundwater and transitional (estuarine) and coastal waters. Its objectives include the attainment of good status in water bodies that are of lesser status at present and retaining good status or better where such status exists at present.
The WFD requires the establishment of two primary monitoring programs: the Surveillance Monitoring (SM) and the Operational Monitoring (OM) networks for surface waters and groundwater. In the case of groundwater monitoring a separate quantitative monitoring program is required. The role of investigative monitoring is also outlined as appropriate within each water category section. These programs were required to be operational by 2006.

Additional directives like e.g. the "DIRECTIVE 2006/113/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 December 2006 on the quality required of shellfish waters" also led to unified and interoperoperable observations in European coastal seas, where shellfish farms are active. Those observation programs concern priority elements, toxins, and health threatening plankton organisms of natural and fecal origin.

The **United Nations Environmental Program** and its **Mediterranean action plan** (https://www.unenvironment.org/unepmap/) aims at the integration of Monitoring activities within the Mediterranean Sea. The **OSPAR Commission** aims at the integration of monitoring activities in the north-eastern Atlantic region (https://www.ospar.org/). The **Helsinki commission** (HELCOM) or Baltic Marine Environment Protection Commission aims at the integration of monitoring activities in the baltic seas (https://helcom.fi/).
The following Table 15: EU monitoring requirements and regional conventionslists the Integrated regional sites and the respective regional conventions they operate under.

*Table 15: EU monitoring requirements and regional conventions*

| | | |
|---|---|---|
| **IRS** | **EU monitoring requirements** | **Regional convention** |
| **Northern Adriatic Sea** | MSFD, WFD | UNEP-MAP, Barcelona Convention |
| **Iberian Atlantic Margin** | MSFD, WFD INSPIRE | OSPAR Commission |
| **Bay of Biscay** | MSFD, WFD | OSPAR Commission |
| **Kattegat-Skagerrak Eastern North Sea** | MSFD, WFD | OSPAR Commission |
| **Kattegatt** | MSFD, WFD | HELCOM(Kattegat is also included in OSPAR) |
| **Norwegian Sea** | WFD | OSPAR Commission , Norwegian management plans |

Next to the abovementioned European legislation the European Global Ocean Observing System **EuroGOOS** (https://eurogoos.eu) is a major integrative effort that furthers interoperability within and inbetween IRSes as well as global integrations through the Global Ocean Observing System GOOS. EuroGOOS supports five Regional Operational Oceanographic Systems (ROOS): Arctic ROOS, Baltic ROOS, Nort-West Shelf ROOS, Ireland-Biscay-Iberia ROOS, Mediterranean ROOS.

However, in each region the scientific community maintains research and national monitoring programs that go beyond the monitoring activities required in the frame of the EU MSFD and answer scientific questions of characteristic importance to the regional marine coastal ecosystem in question.

In this initial assessment **no regional governance system could be identified that would be responsible for the implementation of a region wide coastal observation system. Neither could we identify a regional governance system that would ensure financial sustainability of coastal ocean observations at regional level.**

At national level we could identify several levels of organization:

- National research infrastructure with national research strategy development:
  - ILICO in France (IRS Bay of Biscay) is a national research infrastructure that encompasses a number of coastal research infrastructures / research institutions and develops a national strategy for coastal observations.
- Individual coastal observation infrastructures loosely collaborating in the frame of:
  - Operational oceanography (e.g Puertos del Estado, IRS Iberian Atlantic Margin)
  - National implementations of the MSFD
  - Individual research projects
  - Regional sections of the GOOS

## 4.3 Links between Integrated Regional Sites and other JERICO-S3 components

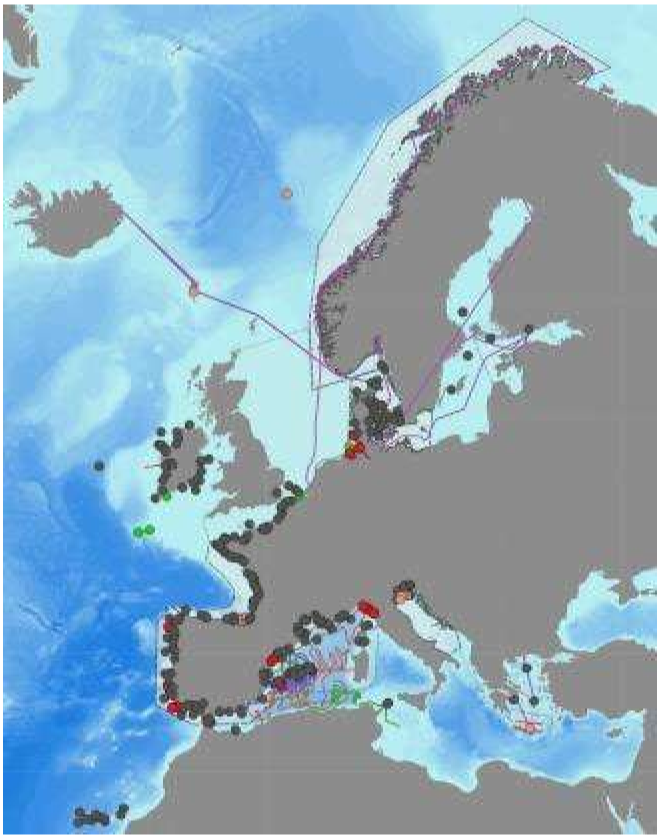
JERICO-S3 integrated regional sites are mainly involved in networking activities, where **the implementation of governing structures, organizational features and integration strategies are catalogued and developed**. This development is closely accompanied by exchange of knowledge and experiences with pilot supersites (PSS) from the JERICO-S3 work package 4, where the regionally integrated implementation of research approaches and scientific strategies are showcased and further developed. IRS furthermore deliver information (e.g. governing structures, scientific strategies, key scientific challenges, financial structures and sustainability, user structure, …) that informs the developments in JERICO-S3 work packages 1 and 6 whose results are then again implemented within the IRS. The development of coastal observation structures and strategies with in IRS informs the list and description of key scientific challenges in WP2 and at the same time receives information about pan-European scientific challenges that require observational data at regional and sub-regional level and that guide and add to the regional coastal observation strategies. WP 6 develops the strategy for data management and data flows along with virtual access products. The IRS will develop their data flows in accordance to the aforementioned strategies.

## 4.4 Commonalities amongst Integrated Regional Sites

All Integrated Regional Sites have very detailed insights in and understandings of their respective coastal marine ecosystems. The individual research infrastructures in the IRS areas appear to agree on the need for transnational and regional collaboration, which is apparent from scientific collaborations and bilateral collaboration agreements and MOUs. However, multilateral and region wide MOUs are not reported so far, neither are transnational collaborations on government levels concerning coastal observation strategies. .
National collaborative research infrastructures with a common governing structure and common budget plans are reported for France (ILICO), Spain (EusKOOS) and Norway (COASTWATCH).

Other countries report national integration of coastal observations in the frame of national monitoring programs or topical monitoring programs (like e.g. food safety).
All IRS report coastal monitoring programs in the frame of the MSFD.
All IRS report funding sources from national monitoring programs, national and European research programs. France and Portugal report a national budget strategically dedicated to coastal observations.
All IRS report the existence of extensive established observations, mostly from monitoring programs in the frame of the MSFD and from operational oceanography for meteorology and safety at sea, that need to be integrated into the regional coastal observatories to reach strategic goals and meet the need to complete regional observational capacity to face key scientific challenges in the regions.

A range of basic coastal oceanographic parameters is well covered by all IRS. The most prominent amongst them are: SST, Waves (height, direction, frequency), Chlorophyll a, Salinity.



The **best spatiotemporal coverage is catalogued for Sea surface temperature** (SST). All integrated regional sites have **extensive observation programs for seawater temperature that can easily be integrated (are interoperable) across all IRSes**. This parameter also offers the opportunity for integration between IRSes and PSSes as also the Pilot Super Sites have all extensive observation programs for seawater temperature. The following Figure 8 shows the geographical distribution of seawater temperature observatories across the Jerico-S3 IRS and PSSes.

*Figure 8, Display of JERIICO-S3 SST observatories*

All IRS do report scientific collaborations between individual research infrastructures on national, regional and transregional scale. Collaborations range from common publications, experiments and projects to MOUs on specific topics and exchange of researchers and expertise.

## 4.5 Gaps in Integrated Regional Sites

With ILICO, The French national RI, the IRS Bay of Biscay is the only IRS that reports a national strategic budget commitment to a complete and multidisciplinary set of coastal

observations. Financial sustainability in all other IRS is mostly achieved through scientific and monitoring programs at institutional and national level.
None of the IRS did report a region wide transnational governance structure for coastal observations. Governmental commitment to a region wide strategy and budget for coastal observations is not reported so far.
None of the IRS did report a region wide financial strategy or budget structure, which indicates a lack of transnational region wide financial commitment.
The MSFD with its regional conventions and EuroGOOS with its ROOS are the only structural elements reported that foster trans regional integration and interoperability. Intercalibration efforts are reported for individual technologies, not for interdisciplinary observation programs. They are furthermore reported at the level of individual research groups or organizations, not at national, regional or transregional level. However, participants for individual intercalibration efforts do come from a wider geographic range covering regions or several regions.

The biggest, common gaps we found are:

- Lack of formalization of national (multilateral) commitment to regional strategies for coastal observations.
- Lack of convergence of multidisciplinary data flows.
- Lack of a formal framework for common strategies in coastal observations
- Lack of multidisciplinary interoperability from planning to analysis and application across borders at regional and pan-European level.

Financially, structurally and strategically we found commitment to regional or European coastal observation programs at institutional level, but not at national or regional level.
**All IRS did report coastal observation infrastructure and programs that are not yet integrated in interdisciplinary, regional or national coastal observation strategies or programs, albeit, the national strategies do complement each other within regions as a result of a common understanding and agreement of the KSCs identified by the nations within regions.**

## 4.6 Suggestions for further development of Integrated Regional Sites

All IRS show the lack of and need for the development of a **regional and trans regional strategic framework that ensures integrity, stability and sustainability of coastal observations**. Strategic governance as well as financial commitment currently resides mostly within individual institutions, albeit, in the case of monitoring within the MSFD it resides at ministery/national level. To ensure strategic and financial sustainability it appears reasonable to shift this commitment and framework towards a regional or European level.

Creating/formalizing **a framework for common strategy development** and region wide interoperability

Table 13 and Table 14 show the degree to which the IRS currently cover key scientific challenges with their respective coastal observations capacities. Gaps in observational capacity will have to be addressed. The integration of already existing observational capacity that is to date still outside of integrated and interdisciplinary coastal observation networks appears to be a feasible and effective primary strategy. Further development will have to be based on additional financial commitment and enlargement of observational capacities in the regions. Strategic management of coastal observations with integration at national and regional level appears to be in need of development in all regions.

Formalize **financial commitment to coastal observation** strategies and infrastructure to ensure sustainability.

**Mapping and integration of additional observational capacity** and expertise is a key activity identified by all IRS.

Common tasks towards the final assessment exercise in all IRS are:

- Finish the mapping and possibly start the integration of additional existing observational capacity in the regions.
    - Use information and dissemination material to present JERICO.
    - → Identify observational capacity that should and can be integrated into JERICO?
- Progress on the formalization of national frameworks for coastal observations (e.g. using the experience from ILICO).
    - Workshops and meetings with stakeholders and government structures (including the ESFRI aspect)
    - → What form of national framework that will ensure sustainability of coastal observations is adequate and achievable in each nation?
    - → Identify the implementation of national roadmaps
- Progress on the formalization of regional frameworks for coastal observations, common strategies and matching national organization.
    - Regional workshops.
    - Identify feasible regional framework structures for coastal observation strategies.
- Exchange information on the progress and experiences between IRSs and PSS
    - An all regions workshop
- Improve the links between regions
    - An all regions workshop
    - → Identify and further develop links that integrate coastal observations across regions.

The following Table 16 will be used as a roadmap tool for the further development of each IRS in the course of this Project:

*Table 16, Roadmap tool for the further development of IRS*

| Sustainability plan | | | | | |
|---|---|---|---|---|---|
| Type of objectives | Objectives | methodology: Actions plan + indicator def. | timeline (intermediate deadline and targeted ones) | initial value of indicator to define | Targeted value |
| A] Intregation objectives (Institutions, people, EU RIs and initiatives etc...) | | | | | |
| Regional integration | Identifiy all Coastal observation infrastructures not yet involved in JERICO that potentially improve the regional observational strategy | Regional RI mapping | 2021 | 0 infrastructures | >1 |
| Regional integration | Contact identified infrastructures, inform about JERICO and develop a strategy for possible integration | Communication and outreach | 2021 | 0 infrastructures | >1 |
| Integration with ERICs | Integrate with existing ERIs | Communication and outreach | | | |
| | Integrate with other IRS and PSS | make observations available and interoperable, | | | |
| B] Interoperability/harmonisation objectives | | | | | |
| | increase level of interoperability at regional level (systems, data sets ...) | Regional integration of observational data | | | |
| | Make Observations available | Availability of datasets and observational data | | | |
| | apply interoparability procedures | Intercalibration efforts | | | |
| | Develop regional, common strategy for coastal observations | Transnational agreement on KSCs and observational strategy | | | |
| C] Business case progress objectives | | | | | |
| User case | Objective: to contact a certain number of users to engage them ( nb to define per IRS) | refer to the user table, possible indicator: Nb of users aware of JRI/number of potential users | June-Sept 2021: Oct-Dec 2021: | Initial Nb of users aware of JRI/number of potential users | |
| Financial sustainability | National commitment to observational capacities | | | | |

| D] Organizational/structural objectives | | | | | |
|---|---|---|---|---|---|
| | MoU | MoU at national and regional level (between national RIs or between nations) | | | |
| | new project signed? | Development of a regional project on coastal observatories | | | |
| | National RIs | Establishment of or roadmap to national RIs | | | |

## 4.7 OUTREACH, DISSEMINATION AND COMMUNICATION ACTIVITIES

This document will be published in the **archives of the JERICO-S3 project website**. This document will also be **circulated within the WP1-6** and it will be a **working document for the regional workshops** of WP3 and WP4 as well as for national efforts of IRS development in the form of **outreach activities towards national governing bodies**.

Each IRS will use the JERICO-S3 communication materials to reach out to local and national governments as well as to coastal observation infrastructures to further develop and formalize regional coastal observatories and to further develop national roadmaps for coastal observation research infrastructures.

## 4.8 CONCLUSIONS

This initial assessment of IRS capacities demonstrated a substantial amount of scientific, professional, organizational, strategic and infrastructural capacity for coastal observations in the integrated regional sites of the JERICO-S3 project.
**The observational capacities cover the observational need of key scientific challenges in the European seas reasonably well**.
Strategies for coastal observations are currently driven by regional or national key societal and scientific challenges as well as by the requirement for environmental monitoring programs at national level and in the frame of the MSFD and the WFD. However, strategic and financial sustainability is currently fragmented and ensured mainly at institutional or at most national level. Governance structures of, and commitments to coastal observation programs need further development at national level and elevation towards regional and pan-European levels. However, given that the respective infrastructure and strategies are already in place and implemented as a result of "a bottom up" common understanding of KSCs, structural, strategic and financial sustainability merely appear to require efforts in formalization of existing capacities.
**National and regional roadmaps to this end need to be documented and compared to allow for early stage homogeneity in the approaches and for interoperability of the national and regional approaches. To this end national, regional and all regions workshops will be instrumental.**