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JERICO-S3 Pilot Supersite monitoring strategies

DELIVERABLE NUMBER: **D4.1.**

WORK PACKAGE N° and NAME: WP4 Pilot Supersites for innovative coastal monitoring

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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 D4.1 WP4 Pilot Supersite monitoring strategies
Description	The deliverable provides regionalized innovative monitoring and science strategy at each Pilot Supersite. Implementation plan for each PSS is given, to address the key regional research questions, including sampling strategy, PSS integration strategy, best practices used, identification of data flows, QC routines and products, dissemination plan, and links to other regional observatories, PSSs and RIs.
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V0.2	14.10.2020	Draft of sections 2 and 3	Seppälä, Frangoulis, et al.
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APPROVALS

	Name	Organisation	Date	Visa
Coordinator	Delauney Laurent	Ifremer	06 May 2021	LD
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Diffusion list

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1. EXECUTIVE SUMMARY

WP4 provides a practical demonstration of how JERICO-RI Pilot Supersites (PSS) are to be implemented in order to become a network of Supersites, by establishing or improving, their communication and steering at multiple levels, and their links to other observatories, RIs and regional initiatives.

The key objective of this deliverable is to provide implementation strategies for JERICO-RI PSS. PSSs are used to demonstrate how transnationally and transinstitutionally integrated multidisciplinary and multiplatform observations may add value to our ability to answer the multiple key scientific and social challenges the coastal ocean is facing. During the JERICO-S3 project, PSSs are tested for a short period (approx. 2 years), across the European coastal seas, covering a wide range of environmental conditions and research topics.

This deliverable defines the concept of coastal Supersites, highlighting the differences to the terrestrial ones. A coastal Supersite must provide observations at the appropriate nested spatiotemporal scales of coastal processes. To yield the required vertical, horizontal and temporal resolution, and for a set of multidisciplinary lists of variables (EOVs and EBVs), coastal observations need to be performed in an integrated way using multiple. In most regions this requires active collaboration between different actors performing observations (institutions, monitoring programs, industry, etc.) and feedback from users. The deliverable provides a first list of key requirements for JERICO-RI PSSs and eventually for coastal Supersites.

Science strategy for PSSs provides an outlook for a range of scientific challenges in the coastal ecosystems. As the resources are limited, the actual work with PSSs will focus on selected specific regional challenges, including also pan-European ones, testing and effectively reviewing collaboration mechanisms within the PSSs. Besides advancing the coastal science, a key priority of PSS studies is the elaboration of organizational challenges. When integrating coastal observations, the technical, administrative, legal and cultural aspects need to be assessed and adapted accordingly. Thus, PSSs aim to improve national, regional and pan-European collaboration for consistent observations while working on solutions and best practices for organizational challenges.

The deliverable highlights the need of collaboration between PSSs and other Research Infrastructures and other observing communities, as well as with user communities including especially coastal modelling and Earth observations. For this purpose, the key groups of regional actors and user communities are identified, and the most critical gaps in multidisciplinary data provision have been recognized.

Finally, the deliverable provides a detailed implementation plan for each PSS (Baltic Sea, Northwest Mediterranean, North Sea and English Channel and Cretan Sea), with specific Actions identified for each PSS. These Actions are interlinked studies, each with coordinated partnership, objectives and description of activities. Each Action has identified the main results expected, the key users and links (internal within PSSs, within JERICO-S3 and with other communities) as well as a dissemination plan. The single Actions are linked together in many ways. Within the region, they provide insight on how the Supersites may operate and which parts of the integration need to be improved. Within various research topics (e.g. carbonate system, phytoplankton), various Actions will collaborate and share knowledge and practices, advancing the pan-European integration towards sustained and consistent observations. Towards other RIs and communities, together with other JERICO-S3 WPs, PSSs will progress the visibility of JERICO-RI actions and demonstrate their augmented capacities.

The content of this deliverable (actors, users, links, implementation plan etc.) will be assessed and refined in D.4.2 after 1 year of PSS implementation and with feedback from other WPs.

2. INTRODUCTION

Environmental Research Infrastructures (RIs) are designed to provide long-term sustained observations and information products to scientific and other user communities, helping them to understand and manage the grand environmental challenges such as climate change, biodiversity loss or food and water security, to name a few. Because the Earth systems are dynamic and heterogeneous, observations must be made at multiple locations to adequately cover the diverse conditions of the ecosystems. The optimal design of the RI network should reflect the heterogeneity of the regions and the complexity of the systems studied, as well as the full size of the area under study (Hari et al 2016). In addition, RI must cope with economic, political and logistical challenges, and must optimally also have interfaces with other RIs and other related observation structures and initiatives.

Environmental RIs promote the integration, interoperability and coordination of observing systems. Hari et al. (2016) introduced a conceptual design that included three connected hierarchical levels of observatories, called Stations (mostly referring to a specific platform or permanent site), and provided examples of atmospheric, forest ecosystem, and ocean RIs. In their concept, the Standard Stations provide measurements for basic characteristics of the system, while the Advanced Stations also provide flux measurements. Both types are vital for RI to expand the spatio-temporal coverage of observations. The most advanced layer, the Flagship Stations in Hari et al. (2016) concept, operate as multidisciplinary sites with high diversity of observations, good capacity for ancillary mission-type operations, and connectivity with other RIs. Such concept of Flagships Stations, or Supersites, to name it differently, has already been introduced in many environmental RIs as discussed in Section 2.1.

The concept of a "Flagship Station" or hereinafter referred to as the "Supersite" requires careful consideration and proof-testing before it is launched in coastal areas. The first iteration of the definition of the coastal Supersite concerns the scope of the concept and is discussed in Section 2.2. The study of coastal systems often requires several observations at appropriate temporal and regional scales. Thus, the challenge for coastal Supersite is how to simultaneously address the requirements for in-depth multidisciplinary environmental information and coverage of relatively large spatial scales. As no single site or platform cannot meet such challenges, coastal Supersite need to provide a multiplatform sampling strategy and involve the required spatial coverage. The next challenge to be met is how such a multiplatform Supersite concept for coastal seas can be designed to serve a wide range of research questions and uses. Phenomena studied in many sea areas transcend national borders and in such cases Supersite logistics must be transnational, which can be challenging to implement.

The aim of JERICO-S3 WP4, "Pilot Supersites for innovative coastal monitoring" is to provide a proof of concept for coastal Supersites, to study how the coastal observations are best integrated, for provision of sustained multidisciplinary observations (Section 2.3). The actions to be piloted include new institutional and organisational collaboration schemes, making the Pilot Supersite partnership to work in concert and to provide consistent regional data, services and products for various uses. Pilot Supersites will interface with regional user communities, demonstrating the added value of integrated actions. Linking with other regional actions, especially with modelling and ocean colour communities and other RIs, will provide new knowledge on the requirements for integrated coastal data and products. Pilot Supersites will also iterate how the linkages between Supersites and other observatories should be optimally built-up for various coastal regions, and how communication between Supersites need to be structured, to meet pan-European requirements for high impact coastal observations.

2.1. Supersite concept in Environmental RIs

The term Supersite[1] is a widely used term in atmospheric, terrestrial, geological and satellite research observatory networks (Google Scholar search). But since there is no general definition for the term Supersite, in the context of the JERICO RI Supersite is considered a highly instrumented and permanent observatory with harmonized and standardized measurements and a high capacity (quality and quantity) for observations. Supersites use state-of-the-art technology to conduct high-impact research and serve as a test bench for new approaches (Hari et al. 2016, Karan et al. 2016). The spatio-temporal scale of Supersites must cover the phenomena studied, and they must be optimally located to allow comparison across different ecosystems (Karan et al 2016). The territorial coverage of Supersites is quite case-specific, as there is a trade-off between the extent of regional coverage and the comprehensiveness of the data collected, and these need to be balanced for each issue examined.

The Group on Earth Observations (GEO) uses ***Geohazards*** Supersites aiming to improve geophysical scientific research and geohazard assessment in support of Disaster Risk Reduction (https://geo-gsnl.org). On the other hand, the Committee on ***Earth Observation*** Satellites (CEOS) uses Supersite to specify satellite validation sites (https://lpvs.gsfc.nasa.gov/LPV_Supersites/LPVsites.html).

Supersites in the EU ***atmospheric*** aerosol observing network EUSAAR (European Supersites for Atmospheric Aerosol Research, http://www.eusaar.net/) were identified based on the high level of implemented instrumentation for multivariable study of atmospheric aerosols and on their atmospheric probing capacity in an identified environment. Nowadays, EUSAAR continues its activities in ACTRIS (Aerosols, Clouds, and Trace gases Research InfraStructure Network, http://actris.net/).

In ***terrestrial ecosystems*** networks (Australian, US, Canadian, European considered here) the concept of "Supersite" (often called Master Site) is defined as spatial foci for long-term observation of phenomena, status, biodiversity, processes and function of an ecosystem (White et al. 2019). They are also considered as highly instrumented, permanently operated, sites where all ecosystem compartments and fluxes are covered including experimental approaches aiming at gaining insight into mechanistic processes (Fisher et al. 2011). They cover multiple variables and may concern a specific spatial scale, volume of infrastructures, availability of long-term data, interdisciplinarity level and age of observatory (www.supersites.tern.org.au; Musche et al. 2018). These sites are grouped under the Long-Term Ecosystem Research (LTER) network umbrella. LTER studies drivers of ecosystem change at various sites, classified in three levels: (i) master or supersite, (ii) regular, (iii) emerging, extensive or pilot. Master (or Supersite) LTER Sites are permanent and highly instrumented sites which are strategically designed to the ecosystems they represent (https://www.lter-europe.net/lter-europe/infrastructure/sites-platforms/categories).

In ***marine observatory networks*** the terms used up to now appear to refer to a multiplatform "autonomous system" that is a subcomponent of a national (or international) network, addressing a specific local question/process as well as some across common themes. A "regional coastal node" in the Integrated Marine Observing System (IMOS, https://imos.org.au/nodes) of Australia, addresses a specific local science question, which is integrated into a larger multidisciplinary framework linking the open ocean and shelf/coastal components and addressing five major research themes across the Nodes (IMOS National Science and Implementation Plan). These nodes share a common data network and are connected to terrestrial, freshwater, geological and atmospheric science communities. In the

[1] Another term designating a similar concept to Supersite are Flagship stations, mastersite, topsite, LTER hub, research array and node. However, caution should be given as, in other cases, hub and node may refer to a different notion

US, a similar concept of "Coastal Arrays" (also called "Node" in older documents) is used by the Ocean Observatories initiative (OOI) to refer to a multiplatform (fixed and mobile) system addressing several of the major OOI themes (e.g. ocean atmosphere exchange, climate variability, ocean circulation and ecosystems) and a specific regional process (e.g. upwelling, shelf-slope exchange) (Trowbridge et al. 2019, www.oceanobservatories.org).

In EU marine related RIs the Supersite concept is not yet used to our knowledge. The EU river-sea system RI, DANUBIUS-RI, uses the term Supersite as natural laboratories dedicated to observation, research, modelling and innovation across the river–sea continuum at locations of high scientific importance, selected to provide investigations in contrasting environmental, social and economic systems (Bradley et al. 2017, www.danubius-pp.eu). LifeWatch-ERIC is working towards such a concept (communication by LifeWatch-ERIC CEO C. Arvanitidis). Other marine RIs and RI-projects, like EMSO-ERIC, EMBRC-ERIC, EURO-ARGO ERIC and EUROFLEETS+ are based largely on a network of nodes, single sites or platforms.

2.2. Concept of JERICO Supersite

Within the coastal seas, because of the perpetual flux of the ecosystem, interactions between physical and biological dynamics do not take place in a fixed position but generally within the mesoscale - in horizontal scales up to tens to hundreds of kilometres – with embedded 3-D sub-mesoscale processes at various, nested spatiotemporal scales. A coastal sea Supersite must therefore encompass integrated and harmonized multiplatform measurements, the combination of which is able to yield adequate horizontal coverage and vertical resolution. Supersites in coastal seas are thus in essence regional and transnational, and a network of Supersites is envisioned in the future to connect major European coastal sea regimes to jointly answer environmental and societal challenges (See section 3.1). Within this context, we elaborate the concept of JERICO Supersites below.

The JERICO Supersite is a regional (or sub-regional) coastal marine observatory. As marine observatories are considered[2] infrastructures dedicated to multiple in situ observations (from air–sea interface to seafloor interface) at appropriate spatiotemporal resolution, in a restricted geographical region[3], maintained over long timescales[4], and designed to address interdisciplinary objectives, driven by science and society needs (*Crise et al. 2018; Petihakis et al. 2018).*

JERICO Supersites have <u>the following key features</u>

- High spatial density of multiple observing platforms offering the required spatiotemporal resolution to study phenomena at nested spatio-temporal scales up to mesoscale
- Multi-interface coverage (land-sea, air-sea, offshore-coastal, pelagic-seafloor) via well-established links to other RIs and addressing, in collaboration with other RIs, themes (common being defined by the RI) at global and regional levels as well as to specific local requirements
- Multidisciplinary and interdisciplinary activities with scientific excellence
- Multivariable and adequate spatiotemporal coverage (i.e. required resolution) of essential ocean variables (EOV). Multivariable coverage of essential biodiversity variables (EBVs)

[2] The term "marine observatory" may have various meanings (Crise et al. 2018)
[3] For JERICO-RI Regional to sub-regional coastal areas
[4] For JERICO-RI an observatory is "long-term" if it has >10 years operations and dataflows

- Transnational and transinstitutional character if necessary, to obtain full spatial and variable coverage
- Generic platforms with capacity to adopt new technology (plug and play instrumentation & sensor web enablement), and acting as contact point to marine industries
- Capacity to adopt new technologies and approaches
- Centralised steering of observations
- Part of an established (or under a roadmap) National RI

In addition, JERICO Supersites have <u>the following characteristics supported by the JERICO-RI.</u>

- Well-established research themes based upon local, national, regional and global requirements driven by science and society (following the Framework for Ocean Observing).
- Shared, synoptic, interoperable, and openly available biological, biogeochemical, and physical data
- Operational delivery of data to International (EU) portals
- Coordinated and interoperable data management streams to International portals
- Well established dissemination strategy, including joint dissemination products with other Supersites
- Interoperability (including sharing) of platforms, equipment, knowledge, products, tools and services
- Common design and implementation of missions with other Supersites and other JERICO observation systems and sites
- Fully documented harmonized procedures and best practices
- Well established links to users, especially in science, society, industry and policy
- Products provision jointly with:
    - related Services (e.g. CMEMS) and Regional initiatives
    - National and EU RIs related to interfaces of land-sea, air-sea, offshore-coastal, pelagic-seafloor
    - Remote sensing and operational modelling communities
    - other Supersites and other JERICO observation systems and sites

2.3. Overall objectives of JERICO Pilot Supersites

The coastal observation platforms are scattered across the European coastline, largely based on national and regional initiatives, but to some extent also linked together for answering large-scale science questions. JERICO-S3 project studies how these structures may be developed further in JERICO-RI, aiming to develop a network of harmonized and extensive observational capabilities for major European coastal sea regimes. JERICO-RI envisions that the final coastal observation network consists of three levels of observatories, Supersites, Advanced observatories and Standard observatories, which are differentiated by their capacities to provide observations (Figure 1). While Supersites aim to provide holistic and top-level high-frequency measurements in all required scientific areas, using integrated multiplatform strategy for long-term observations, the Advanced observatories provide comprehensive and top-level measurements in specific scientific areas or services. Standard observatories provide continuous measurements of some key parameters, often for local or regional needs. All observational levels are needed, they have complementary roles and their differences are not always obvious.

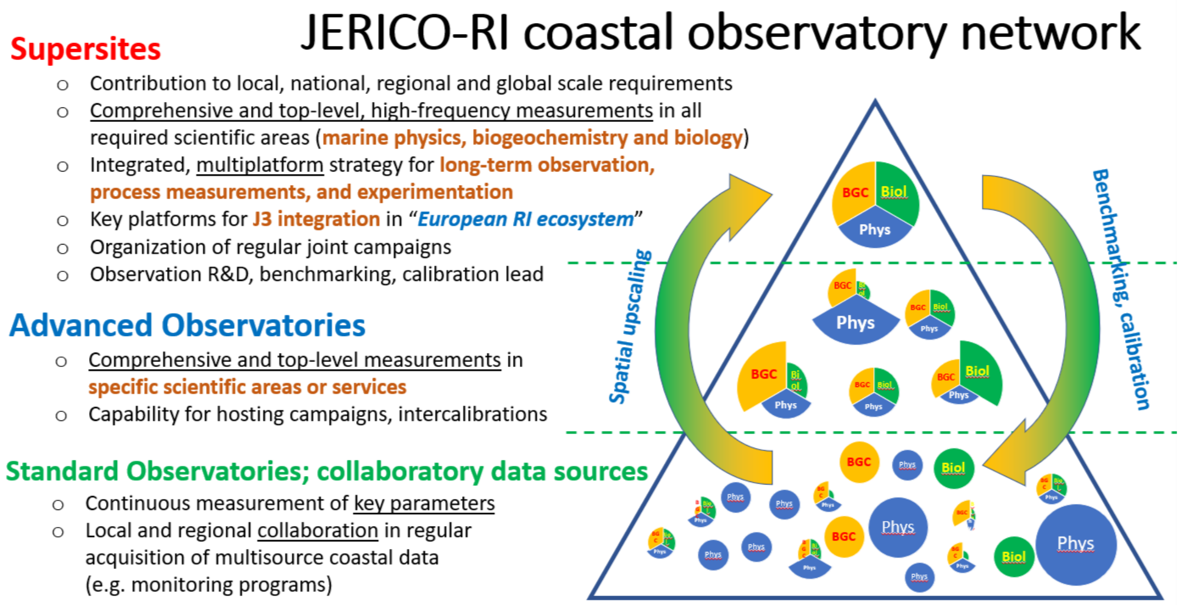

Figure 1. Illustration of JERICO-RI coastal observing facilities. Supersites enable integrated pan-European observations of complex multidisciplinary research questions. Advanced observatories provide high level integrated observations for specific questions. Standard observatories target more the regional and national questions for some key parameters.

JERICO-S3 will provide a practical proof of concept for JERICO-RI Pilot Supersites (PSS) at four coastal regions (see Section 3). PSSs operate sustained, multidisciplinary and integrated observation platforms at high technological readiness levels (TRL 7-9) addressing several specific Key Scientific Challenges (see Section 3.1). PSS data flows are established, and data products are developed. Using a series of Actions, transnational collaboration, access and governance are explored and tested (see Section 4). PSS operations are used to compare and evaluate various practices for the integration and interoperability of diverse observation platforms designed for a range of different scientific topics and societal challenges in coastal ecosystems. Interoperability and harmonization between specialized observation platforms is tested at a high technological readiness level. In addition, PSSs will provide practical collaboration-platforms to meet other RIs and observation initiatives. The demonstration of the feasibility of PSSs includes two years of integrative work with observations and their transnational management.

A Pilot Supersite complies with most of the Supersite key features (with the capacity to satisfy all) and is aiming to fully satisfy all supersite criteria (Table 1). This is done by:

A) Formulating the regional role of PSSs

- defining and prioritising of key societal information needs regarding regional marine environments (regionalization and prioritization of Grand Challenges)
- defining and prioritising of key scientific gaps in observing the regional coastal ecosystems, as required by various users
- analysing the coastal observatories operating in respective regions outside the PSS partnership

B) Demonstrating

- the added values of integrated, state-of-the-art multidisciplinary, multivariable, and multiplatform observation capabilities,

- how the sub-components are optimally operated when studying complex coastal challenges in an integrated approach,
- how interactions with other environmental RI networks can be regionally organised
- how the interactions with modelling and satellite remote sensing communities are regionally implemented
- how PSSs can upgrade, harmonise and sustain observations and products that are usable for various societal and scientific needs
- how to transnationally share and manage platforms and equipment, and plan joint missions,
- how to jointly manage the whole data lifecycle, following the FAIR principles
- how to increase the societal and scientific value of observations through data fusion and integration,
- how to transfer knowledge within the region, between regions, and between RIs.

C) Establishing

- harmonized communication & jointly steering operations between-PSS
- jointly agreed best practices and QA/QC protocols for observations and data streams
- links to other Supersites, observatories, environmental RIs (including joint studies), maritime industries, and regional initiatives of environmental management of coastal ecosystems
- common objectives, when possible, related to coastal biology and biogeochemistry such as carbon budget/carbonate system, effects of rare/extreme events, phytoplankton biodiversity and productivity etc.
- an optimum, innovative monitoring and science strategy
- joint dissemination plans
- joint communications with key regional stakeholders

D) Evaluating

- PSS implementation phase as input to the planning phase of JERICO-RI
- new technologies and new sensor packages
- self-evaluation using metrics of implementation, performance, data delivery and impact

E) Improving

- cost-efficiency, innovative use and scientific and societal impact of observations
- links to users, especially in science, society, maritime industry as well as in regional environmental management and policy
- provision of Transnational Access and Virtual Access
- data flow, QC practices, coverage of Regional EOVs and EBV and operational delivery of data for all variables to International (EU) portals
- Merged access to derived new products
- validation of model results and ocean colour data

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Table 1. Criteria for JERICO-RI Pilot Supersites and those for final JERICO-RI Supersites

Criterion	PILOT Supersite	Supersite
Specific environmental characteristics and/or society needs	Existing	Well defined and addressed
Multi-platform at high spatial density *Multi-scale* coverage up to mesoscale	Existing capacity	Coverage at required resolution
Multi-*interface* coverage (land-sea, air-sea, offshore-coastal, pelagic-seafloor)	Existing capacity	Full coverage via well-established links to other RIs
Multi-variable coverage *(EOVs and EBVs)*	EOVs at coverage higher than surrounding areas	EOVs and EBVs at required resolution
Multi-disciplinary and interdisciplinary activities with scientific excellence	Existing	Joint with other (sites, RIs etc) and enhanced via Supersite approach
Generic platforms with capacity to adopt new technology	Existing	Valid for all platforms
Shared, synoptic, interoperable, and openly available biological, biogeochemical, and physical data. Data delivery to International (EU) portals	Partly operational delivery for most variables	Operational delivery for all variables
Products	Existing and delivered to international portals	With a Supersite added value. Joint products with other Supersites, initiatives and RIs
Local, national, regional and global requirements	Capacity to reply all four levels	Common and well-established themes driven by science and society. Addressing all levels via links to other RIs
Centralised and harmonised management	Within PSS (optional)	Well established within and between Supersites
Sharing of platforms, equipment, knowledge, products, tools, services	Existing	Centralised management and well-defined conditions
Common mission design and implementation	Existing (optional)	Well established
Transnational and/or Transinstitutional character	Mandatory, if necessary, to obtain full spatial and variable coverage	
Procedures and practices	Existing within the PSS	Harmonised and fully documented and common with other Supersites
Dissemination	Existing plan at PSS level (optional)	Well established strategy among Supersites with joint products
Supersite is part of one or several National RIs	Established or under a National roadmap	Established National RI
Communication between Supersites	Existing (Optional)	Well established
Communication with Integrated Regional Sites (IRS)	Existing (Optional)	Fully established at least with geographically adjacent IRSs
Links with marine, river, terrestrial, atmospheric RIs	Existing (Optional)	Well established. Joint products
Links with Remote Sensing community	Existing	Well established. Joint products
Links with Operational Modelling community	Existing	Well established. Joint products
Trans-sectoral links (Coastal SMEs)	Existing (Optional)	Well established partnerships.
Connections to Local and Regional monitoring programs	Existing (Optional)	Well established
Links to Services/Initiatives (CMEMS, EMODnet, GOOS, GEO,…)	Existing	Well established. Joint products

3. SCIENCE STRATEGY FOR PILOT SUPERSITE IMPLEMENTATION

The conceptual design of the future JERICO-RI network for coastal areas, including the Supersites, must consider the advice of past and ongoing RIs plans and be adapted to the specificities of coastal ecosystems. The specific challenges faced by coastal RIs that need to be considered in planning relate to the complexity of coastal ecosystems and the huge number of scientific issues involved (sections 3.1-3.3). Coastal RI has several domain-specific interfaces (terrestrial, atmospheric, open ocean) with other RIs (section 3.4) and involves many user communities (sections 3.4, 3.6) that need to be considered. The proposed RI structure must reflect the already established local, national and regional observation structures, but recommend changes as necessary to ensure the impact of RI at the regional and pan-European level (sections 3.4-3.5). Finally, the proposed design should improve existing activities, especially in filling the contemporary gaps in multidisciplinary data provision for user needs (section 3.7).

3.1. Key common scientific questions within JERICO-S3

JERICO-RI will address a large diversity of scientific, environmental and societal issues. The Key Scientific Challenges (KSC) are divided in three subgroups and they are elaborated in detail in the JERICO-S3 WP1, especially in the Deliverable D1.1.

1. KSC#1: Assessing and predicting the changes of coastal marine systems under the combined influence of global and local drivers

2. KSC#2: Assessing the impact of extreme events on those changes

3. KSC#3: Unravelling the impacts of natural and anthropogenic changes

As a background information for the existing regional observation capacities, we have analysed the observational capacities of European coastal regions to tackle the KSCs of JERICO-RI (Tables 2 and 3). The regional analysis is based on sub-selection of European coastal regions which are represented by the contemporary JERICO-RI community. These regions include the JERICO-RI Pilot Supersites and Integrated Regional Sites (IRS, dealt within JERICO-S3 WP3, see Deliverable D3.1), selected to explore in practice the transnational and transinstitutional integration of observations within JERICO-S3, especially providing a proof of concept and feasibility. In order to analyse how JERICO regions have their observational capacity fit-for-purpose to answer the key scientific questions (as identified in JERICO-S3 D1.1), an exercise based on the self-evaluation by JERICO-RI experts for each coastal region is presented in Tables 2 and 3. It is worth noting that, although the expert assessment was carefully conducted, the precision of results may still be improved for some questions (like more harmonization of the answered categories from Very Good to Not known). We opted to follow the basic rule of ranking the regions based on their best examples. This analysis can be useful as a starting point to define which science questions can be answered using existing observations within each region, and to identify clear gaps in the observations.

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Table 2. JERICO-RI internal expert assessment of the observational capacities in the different European coastal regions regarding the Key Scientific Challenges KSC#1 and KSC#2. The analysis provides an overall overview of the maturity of the state-of-the-art observation system regarding the different processes and or parameters.

Observations and data flows

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

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

Table 3. As Table 2, regarding the Key Scientific Challenge KSC#3

Observations and data flows

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

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

JERICO-RI observation capacity covers a wide range of topics, as illustrated in Tables 2 and 3. The analysis shows JERICO-RI strengths in covering most of the topics in various coastal regions. But of course, the capacities vary between regions and between Key Scientific Challenges and their subtopics. These gaps need to be analysed further and prioritised to guide the future developments.

The analysis above (to be elaborated in detail in JERICO-S3 D1.1) provides the background for development of JERICO-RI Supersites. It gives the first indications, which are scientific and societal elements to be included in the first iteration of Pilot Supersites.

3.2. JERICO-S3 Pilot Supersite regions

In JERICO-S3 project, four locations are selected as PSSs; the Gulf of Finland (GoF PSS), the North-Western Mediterranean (NW-MED PSS), the North Sea and English Channel (NSEA and CHANNEL PSS), and the Cretan Sea (CRETAN PSS). These sites will collect the first-hand experience on the organisational (transinstitutional, transnational etc.), data flow, and research challenges of the concept, in order to formulate an ambitious, but realistic framework for building a geographically representative array of integrated Supersites for JERICO-RI, as an outcome of the JERICO-S3 project. This activity is done in parallel with another integrative action, as JERICO-S3 WP3 is working towards networking of existing coastal observing activities and initiatives at several other coastal regions (called as Integrated Regional Sites, IRS). PSS and IRS actions will be streamlined throughout the JERICO-S3 lifetime and transfer of knowledge is done during joint workshops. It is expected that PSS networking actions will contribute to the development phase of JERICO-RI and the experiences will be directly communicated towards JERICO-DS -project.

European coastal ecosystems vary, as do the regional organisation of observations. To gain sufficient knowledge how JERICO-RI Supersites need to be constructed, in the planning phase of JERICO-S3 it was decided that the number of PSSs to be experimented need to be large enough to cover different conditions and practices within pan-European coastal regions, but due to economic and practical reasons the number of sites need to be constrained. Thus, the PSSs represent a fraction of JERICO-RI partnership and observation capacities, but the whole network will benefit from the shared experiences gained in the PSSs. It was further decided that each PSS starts with a relatively small number of partners and platforms, and thus with somewhat limited geographical and scientific focus. This initial constraining of PSSs was done to guarantee the focus on well-defined objectives for each PSS. Within each PSS, a clear coordination role was assigned for one partner. The aim of this decision was to ensure a consistent flow of information from PSS partners to WP and project coordination.

The actual selection of PSS sites was an iterative process (for requirements see also Table 1). It was expected that PSS has an existing, continuously operated, and sustainable multiplatform RI. They were requested to have documented measurement capability for physical, biogeochemical and biological variables in spatiotemporal scales allowing analysis and modelling of their interactions. In addition, they need to have a documented observation data delivery to European data portals. For their region, they should show good capacity for transinstitutional and transnational integration of activities, when needed for specific scientific questions and links to regional actors in satellite remote sensing and modelling communities. It was further expected that PSSs have an adequate coverage of the currently defined EOVs and at least the potential to cover EBVs. Finally, it was requested that PSSs have demonstrated or convincing potential for regional interaction with other RI networks.

The four PSS regions selected are briefly introduced below (see Figure 2). While two of the PSS regions (the Gulf of Finland, and the Cretan Sea) represent relatively condensed actions at sub-basins of the Baltic Sea and the Eastern Mediterranean Sea, the North-Western Mediterranean PSS, covers the regional sea area more comprehensively. The fourth region (combination of the North Sea and English Channel) is even larger, and it also studies how the neighbouring PSSs could collaborate and streamline observations, practices and actions. Such a diversity of PSS scales allows us to draw conclusions, which are the desired regional scales of Supersites and how the optimal scales may vary between regions and scientific topics.

The description of PSS regions highlights the similarities and differences in their scientific topics and objectives. Based on these identified communalities and specificities, objectives for PSSs were selected, as identified in the follow-up sections.

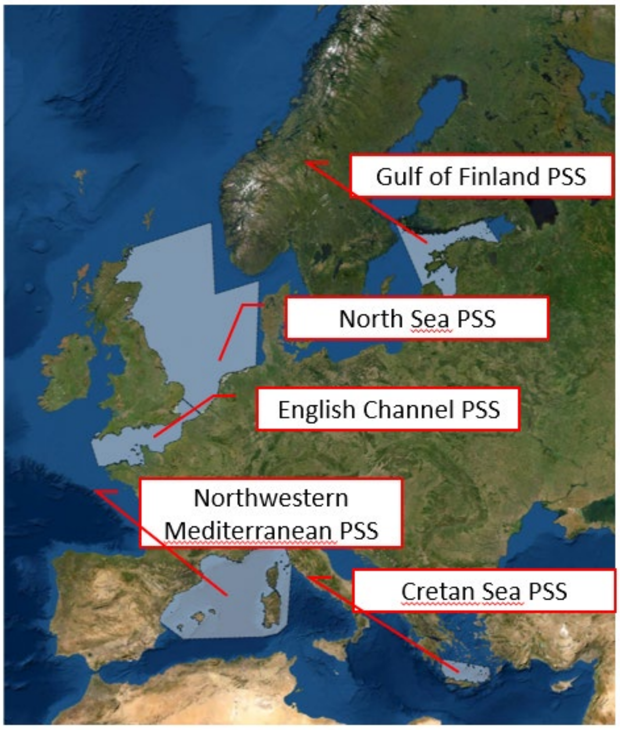

Figure 2. JERICO-S3 regions for Pilot Supersites

The main characteristics of the five sea areas (a subselection from Tables 2-3), which the PSS regions cover entirely or are subpart, are presented below together with their specific scientific topics and objectives.

The **NORTHEASTERN MEDITERRANEAN SEA** (to which the Cretan Sea is a subpart) is an ultra-oligotrophic basin of the Mediterranean Sea, and it acts as a heat, salt, and oxygen reservoir. The area is characterized by multiple scale circulation patterns and intense mesoscale variability. In the region, vertical mixing leads to intermediate and deep-water formation. It is a hotspot of biodiversity; however, biodiversity long-term data sets are still limited. There is also sparseness of carbonate system data, to understand its role as source or sink of CO_2. As the other parts of the Eastern Mediterranean, the region is vulnerable to disturbances by invasion of alien species due to proximity to the Suez Canal. The northern part (North Aegean), is affected by material transport (nutrients, contaminants) from the Black Sea, large cities and rivers. In the southern part, atmospheric deposition is the main source of nutrients in the euphotic zone, other than the vertical mixing of water during winter. However, their exact contribution to the balance of nutrients and the resulting impact on productivity remains uncertain.

Specific regional scientific topics and objectives.

- Insight into the role of the NE Mediterranean Sea as source or sink of CO_2.
- Effects of the upper general circulation seasonal and interannual variability (in particular, the Black Sea waters) on the thermohaline circulation of the Aegean Sea.
- Resolve the coupling of intermediate and deep-water formation with biochemical functioning.
- Monitor and assess the impacts of river inputs and the effect of Black Sea waters on marine ecosystems
- Investigate the climate change effects on marine productivity and biodiversity through warming, acidification, nutrient-oxygen dynamics and extreme atmospheric events.
- Study the contribution of mesoscale activity to the general circulation of the Aegean Sea

- Contribute to societal demands like protection of marine environment from pollution (e.g. oil spill accidents) and support for handling coastal erosion.

The **NORTH WESTERN MEDITERRANEAN** basin is one of the most dynamic regions in the Mediterranean Sea. In this area, the intense open sea convection, shelf water cascading events, storm and flood events, occurring in wintertime, affect the distribution of sediments, nutrients and organic matters in the land-to-sea continuum and all over the water column. In addition, the subsequent intense spring bloom represents the most important biological process of the basin which impacts the carbon exports. The main drivers of these dynamic processes are the winds forcing and the cyclonic circulation, which is characterized by an intense boundary current, the Northern Current (NC), flowing from the Italian to the Spanish coasts. The general circulation of the NC is affected by seasonal variability as well as synoptic processes and constitutes an important dynamic barrier between the open sea and coastal waters.

Specific regional scientific topics and objectives.

- Study the effects of Northern Current (NC) transport: water mass circulation, particles and plankton species, plastics, contaminants
- Evaluate the impact of major rivers inputs (on ecosystems) in the coastal area (Ebro and Rhône Rivers)
- Study the shelf water cascading events: dense water formation, organic and contaminants plumes
- Assess the occurrence of extreme events, like storms (Medicane), flash flooding, and heavy rains.
- Understand Big cities impacts on e.g. eutrophication and contaminants

The **ENGLISH CHANNEL** is a shallow inter-regional coastal continuum influenced by the Atlantic Ocean and the North Sea. The physical configuration (bathymetry, coastline) gives rise to specific hydrological structures (fronts, gyres) that control advection and dispersion and affect transboundary fluxes of nutrients, pollutants and plankton. In terms of hydrodynamics, the most outstanding feature is the tidal current intensity. The region is also strongly impacted by swells and waves coming from the Atlantic or generated locally by wind events. The system is largely affected by the riverine input of freshwater, nutrients and particulate matter. These hydrological and biogeochemical conditions are favourable for intense development of seasonal primary production that can be locally associated with eutrophication issues and harmful algal blooms. The region represents a significant economic zone where several human activities take place: tourism and leisure, international ports and freight associated with an intense maritime traffic and the exploitation of living (fisheries, aquaculture) and non-living resources (marine aggregates).

Specific regional scientific topics and objectives.

- Advance the use of regional data in the WFD and MSFD implementation, and in accordance with OSPAR Science Agenda and Assessment Procedure (Eutrophication); contribute to improving ecological status assessments.
- Facilitate knowledge exchanges and sharing between RIs on land-sea continuum.
- Identify gaps in observations (sampling resolution, optimized parameters list considering EOVs and EBVs, QA/QC procedures, data processing, etc) to move forward an Integrated Observation System (Physics, Biogeochemistry & Biology) at the English Channel level.
- Sort out the spatio-temporal variability of pressures controlling phytoplankton dynamics (incl. biomass and productivity), from the local to the regional scale, and including eutrophication, climate change and extreme events issues.
- Assess the spatio-temporal variability of SPM dynamics, especially related to hydro-meteorological forcing, continental inputs, biophysical interactions and human activities.

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

- Integrate interactions between organic and mineral SPM and advance the coupled hydrodynamics, sediment and ecological models for a comprehensive evaluation of the biophysical ecosystem functioning
- Aggregate multi-source and multi-parameter *in situ* observations, remote sensing and models for 4D evaluation of the coastal environmental dynamics and anticipate forecasting needs.

The **NORTH SEA** is a shallow shelf sea characterized by complex interdisciplinary processes governing a large range of interconnected length and time scales. It is characterized by diverse ecosystems, strong physical influence on biological and biogeochemical processes, high riverine inputs, and significant connectivity to adjacent sea areas. Coastal areas in the North Sea are characterized by strong tidal influences. It is a highly productive area with recurring phytoplankton blooms. As a whole, the North Sea is regarded to be a sink for carbon dioxide. Since the North Sea is surrounded by densely populated, highly industrialized countries, it is influenced by multiple, often conflicting uses, such as fisheries, waste disposal, oil drilling, transportation, coastal defence, offshore wind farms or recreation. While the North Sea is one of the best investigated shelf sea areas around the globe, the understanding of the interconnected forces that govern energy budget, material fluxes, balances, and the factors directly controlling ecosystem dynamics are still patchy at best.

Specific regional scientific topics and objectives.

- Refine the regional carbon budget including terrestrial inputs, coastal carbon cycling, and biological carbon fluxes and identify gaps in observations and interactions on a variety of temporal and spatial scales
- Impact of offshore-windpark structures on hydrography and bio-geochemical processes
- Resolve the impact of small- to large-scale hydrographic structures (e.g. fronts and eddies) on ecosystems
- The impact of floods and other extreme events such as severe storms on energy and matter budgets, biological productivity and coastal protection
- Impact of sea level rise on coastal environments, aqua-culture, and coastal protection Merge information from diverse and scattered communities with easy data access Improve stakeholder consultation processes, for example to improve spatial planning
- Facilitate exchange with other RIs, especially DANUBIUS-RI

Integrate knowledge about biological processes, such as plankton and particle distributions from in-situ imaging, models and remote sensing.

The **BALTIC SEA** (to which the Gulf of Finland is a subpart) is seasonally ice covered, enclosed and brackish sea area, with harsh climatic conditions, and it is affected by various anthropogenic pressures. Riverine load of nutrients, dissolved carbon and fresh water largely modifies the coastal ecosystems. The salinity gradient shapes the physical, chemical and biological characteristics of the sea area. The seasonal thermocline and permanent halocline separate water layers and affect the vertical fluxes and biogeochemical cycles, and form barriers reducing the atmospheric forcing. The Baltic Sea is highly productive, due to high nutrient load, and several areas suffer from eutrophication, related algae blooms, and shifts in species composition and ecosystem functioning. As a combination of high algae production, high sedimentation, and reduced mixing, large areas with anoxic bottoms have developed. Oxygen depletion in the seafloor is accompanied with a release of inorganic nutrients. Occasional intrusions of oxygen-rich high saline water from the North Sea ventilate the deep parts of the Baltic Sea, reducing the extent of anoxic bottoms. Sub-basin differences in alkalinity loads lead to different buffer capacities and an increase of alkalinity over the last decades might partly mitigate the effect of acidification. Climate change, increasing the occurrence of mild winters, intensifies carbon load from land, affecting also carbon cycling, balance of autotrophy vs. heterotrophy and brownification, all having cascading effects in the ecosystem.

Specific regional scientific topics and objectives.

- Resolve how the state of the Baltic Sea is affected by human pressures
- Advance the integration of monitoring at land-sea continuum
- Clarify the interplay of biological (e.g. algae blooms), biogeochemical (carbon fluxes, oxygen depletion), and physical (currents, mixing, weather forcing, water exchange) processes in the region.
- Assess whether the countermeasures to reduce eutrophication and pollution have an effect
- Improve understanding on the functioning of marine ecosystems and biogeochemistry, by coupling observations, experimentation and modelling
- Provide improved knowledge framework for sustainable development in the Baltic Sea and the emergence of a blue economy

3.3. Common and region-specific scientific research topics for PSSs

The identified set of Key Scientific Challenges (KSC) for European coastal regions (Tables 2 and 3) illustrate the wide range research topics JERICO-RI Supersite observations may contribute to. The sub-selection of actual topics to be studied during JERICO-S3 PSSs implementation is naturally much smaller (summarized in Table 4). While the details of PSS studies carried out during the implementation phase are described in Section 4, here we provide insight on the current scientific objectives of PSSs (with overall objectives of a PSS presented in Section 2.3). First, we describe the key PSS-specific objectives, then we assess how well the selection covers the KSCs and finally indicate which are the main common topics several PSSs share, and for which provide pan-European added value.

The activities in PSSs will contribute to and benefit from the pan-European approach being developed by the JERICO-RI community to resolve several grand challenges. As identified by the key contributors for each PSS, their scientific objectives are summarised as:

CRETAN PSS: The understanding of the carbon budget/carbonate system (KSC1), of the biodiversity and ecosystem functioning (KSC1), and of Climate change impacts on productivity (KSC3), will significantly benefit by new carbonate observations, additional biogeochemistry-ecosystem data as well as estimations of the significance of solubility and biological pumps, of air-sea carbon fluxes and improved approximations of primary productivity. In parallel, our knowledge of rare/extreme events (KSC2) will benefit from analysing how extreme atmospheric events affect phytoplankton communities in the area. Finally, long-term datasets of biogeochemistry and biodiversity as well as regional modelling will be improved (KSC3).

NW-MED PSS: The study of the Northern Current (NC) circulation and instabilities will provide information for sediment, contaminants and biological species transport (KSC1). The NC intrusion on the shelf will affect the river plumes and water mass characteristics which are sensitive to extreme events (e.g. storms in autumn) (KSC2). These topics will be supported by autonomous and multidisciplinary observing systems (e.g. SOCIB, MOOSE) which integrated several platforms (e.g. moorings, gliders, buoys), variables and models to cover the different spatial and temporal scales necessary to study the complexity of the NW Mediterranean Sea coastal system, including long term trend (KSC3). Specific actions for NW MED-PSS include reconstructing the 3-D coastal Northern current dynamics for mass and particles transport and evaluating the impacts of freshwater and particles discharge from major rivers to coastal marine environment.

CHANNEL PSS: Actions will contribute especially to assessing regional eutrophication status, phytoplankton biodiversity and productivity, and their modulations and also, jointly (inter-PSS, particularly with NSEA PSS), to identify gaps in observations and interactions that hamper regional studies of carbon cycle and eutrophication (KSC1). The scientific objectives can be summarised as: assessing and predicting the trajectories of coastal marine systems under the combined influence of global and local drivers (KSC1), assessing the impact of rare/extreme events on those trajectories (KSC2) and unravelling the impacts of climate and anthropogenic changes/pressures (KSC 3). CHANNEL PSS work also to assure coherence in plankton observations between countries, analyse phytoplankton (incl. Harmful Algal Blooms (HAB)) dynamics and underlying physical forcing, analyse top-down and bottom-up effects for phytoplankton, integrate phytoplankton (incl. HAB) distribution (contrasted areas) using *in situ* data and update 3D models of phytoplankton productivity through the water column.

NSEA PSS: At NSEA PSS, new measurements and increased coherence and accessibility of carbon and nutrient parameters enhance the understanding of carbon budgets and the carbonate system, as well as the role of productivity, biodiversity and their variability, especially in the context of a changing climate (KSC1, KSC3). Merging and use of previously untapped data sources in collaboration with colleagues from the limnic and terrestrial realm (for example, through DANUBIUS) will enable the creation of more robust budgets and help identify variability patterns of different temporal and spatial scales, thus providing a basis for future scenarios (KSC3). The subtopics include assuring coherence of carbon observations between platforms and institutes and identification of observational gaps, assure coherent integration of relevant carbon sources and sinks over compartments (air-sea, land-sea, pelagic-benthic, and microbial processes), and ensure “smooth” interfaces with neighbouring PSS (CHANNEL PSS) and IRS (Kattegat, Skagerrak, Eastern North Sea)

GoF PSS: Key objectives for GoF PSS are i) resolving how the state of the Gulf of Finland is affected by regional climate change and various human pressures, and ii) clarifying the interplay of biological (algae blooms), biogeochemical (carbon fluxes, oxygen depletion), and physical (currents, mixing, weather forcing) processes in the region. GoF PSS actions are largely related to how the region is affected by nutrient and freshwater input through rivers, and how these influence on phytoplankton blooms, carbonate system and ultimately the oxygen conditions of deep basins (KSC1). Observing and modelling harmful cyanobacterial blooms are one key objective for GoF PSS, as well as improving dissemination of these blooms to the public. A specific action in GoF PSS is related to transnational harmonisation of practices and creation of coherent datasets, especially useful for sorting out long term trends (KSC3). Linking actions to AQUACOSM-RI and ICOS ERIC is an essential topic for GoF PSS.

COMMON to all or several PSSs: Using the list of Key Scientific Challenges of JERICO-RI (Tables 2 and 3), and going through the actual plans for PSS implementation (see Section 4), we may build a matrix illustrating which are the most common scientific topics for PSSs (Tables 4 and 5). Impacts of land-based discharges are studied in all PSS, except at CRETAN PSS. Within the region connectivity and transport of water masses and materials is covered by all PSSs, as well as pelagic biogeochemical processes and interactions and carbon fluxes and budgets. Long term observations to resolve climate change impacts are considered in all PSSs for temperature, salinity, nutrients and for biogeochemistry datasets. The second, more detailed, look on the common study topics will be taken once the implementation of PSSs is ongoing and the table will be modified accordingly and presented in D4.2. The purpose of this cross-cutting analysis is that it allows identification of topics where the transfer of knowledge on PSS functioning is most fluent between PSSs and where PSSs need to learn from others, guiding also the content of future joint workshops.

Table 4. The JERICO-RI Key Scientific Challenges (KSC#1 and KSC#2) PSS study phase will contribute to. The grey columns are copied from Table 2, while white columns indicate in which topic PSSs will mainly contribute to.

Observations and data flows

- High level
- Moderate
- Low level, but needed
- Not needed
- Not known

	NE Mediterranean Sea	CRETAN PSS	NW Mediterranean Sea	NW-MED PSS	English Channel	CHANNEL PSS	North Sea	NSEA PSS	Baltic Sea	GoF PSS
KSC1: Land-Ocean continuum: impacts of land-based discharges and exchange with open ocean										
Nutrients	Moderate		Moderate		Moderate	✓	Moderate	✓	Moderate	✓
Particles and organic matter	Moderate		Moderate	✓	Low level, but needed	✓	Moderate	✓	Low level, but needed	✓
Inorganic carbon	Moderate		Moderate		Low level, but needed	✓	Low level, but needed	✓	Low level, but needed	✓
Litter and contaminants	Moderate		Moderate	✓	Moderate		Moderate		Moderate	
KSC 1: Sea-Atmosphere interface: quantification of inputs										
Particles	Moderate		High level		Low level, but needed		Low level, but needed		Not known	
Nutrients	Moderate		High level		Low level, but needed		Low level, but needed		Moderate	
Contaminants	Moderate		Moderate		Low level, but needed		Low level, but needed		Moderate	
KSC 1: Connectivity and transport pathways of water masses and materials										
Within region	Moderate	✓	High level	✓	High level	✓	Moderate	✓	Moderate	✓
Between other coastal regions	Moderate		Moderate	✓	Moderate	✓	Moderate	✓	Moderate	
Between region and open ocean	Moderate		High level	✓	Moderate	✓	Moderate	✓	Not needed	
Within region retention dynamics	Moderate		Moderate		Moderate	✓	Moderate	✓	Moderate	
KSC 1: Biodiversity trends										
Phytoplankton	Moderate	✓	Moderate		Moderate	✓	Moderate		High level	✓
Zooplankton	Moderate		Moderate	✓	Moderate		Low level, but needed	✓	High level	
Benthos	Low level, but needed		Low level, but needed		Moderate		Moderate	✓	High level	
KSC 1: Ecosystem biogeochemical processes and interactions										
Pelagic	Moderate	✓	Moderate	✓	Moderate	✓	Low level, but needed	✓	Moderate	✓
Benthic	Low level, but needed		Low level, but needed		Moderate		Low level, but needed	✓	Moderate	
Pelagic-benthic coupling	Low level, but needed		Low level, but needed		Moderate		Low level, but needed	✓	Moderate	✓
KSC 1: Carbon budget and carbonate system										
Carbon fluxes and budget	Low level, but needed	✓	Moderate	✓	Low level, but needed	✓	Low level, but needed	✓	Moderate	✓
Carbonate system trends	Low level, but needed	✓	Moderate	✓	Low level, but needed		Low level, but needed	✓	Moderate	✓
Effects of acidification	Low level, but needed	✓	Moderate		Low level, but needed		Low level, but needed		Low level, but needed	
KSC 2: Impact of rare and extreme events										
Floods	Low level, but needed		High level	✓	Moderate		High level	✓	High level	
Storms, large waves	High level		High level	✓	Moderate		High level		High level	
Heat waves	High level		High level	✓	Moderate		High level	✓	High level	✓
Landslides, sudden erosion	Low level, but needed		Moderate		Low level, but needed		Moderate		Moderate	
Harmful algae blooms	Low level, but needed		Moderate		Moderate	✓	Moderate	✓	High level	✓
Pollution due to accidents	Low level, but needed		Moderate		Moderate		Moderate		Moderate	

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

Table 5. As Table 4, regarding JERICO-RI Key Scientific Challenges (KSC#3).

Observations and data flows

- High level
- Moderate
- Low level, but needed
- Not needed
- Not known

	NE Mediterranean Sea	CRETAN PSS	NW Mediterranean Sea	NW-MED PSS	English Channel	CHANNEL PSS	North Sea	NSEA PSS	Baltic Sea	GoF PSS
KSC 3: Long term observations to resolve Climate Change impacts										
Temperature	High level	✓	High level	✓	High level	✓	High level	✓	High level	✓
Salinity	High level	✓	High level	✓	High level	✓	Moderate	✓	High level	✓
Currents	High level		High level	✓	High level		Moderate	✓	Moderate	
Sea level	High level		High level		High level		High level		High level	
Waves	High level		High level	✓	High level		High level		High level	
Biological production	Low level, but needed	✓	Moderate	✓	Low level, but needed	✓	Low level, but needed	✓	Low level, but needed	
Species distribution ranges	Low level, but needed		Moderate		Moderate	✓	Low level, but needed		High level	✓
Nutrients	Moderate	✓	Moderate	✓	High level	✓	Moderate	✓	High level	✓
KSC 3: Observations to resolve impacts of various anthropogenic disturbances										
Eutrophication	Moderate		Moderate		Moderate	✓	Moderate	✓	High level	✓
Habitat and biodiversity loss	Low level, but needed		Moderate		Moderate	✓	Low level, but needed		High level	
Contamination	Moderate		Moderate		Moderate		Moderate		Moderate	
Coastal engineering	Low level, but needed		Moderate		Moderate		Moderate		Moderate	
Use of marine space	Low level, but needed		Moderate		Moderate		Moderate		Moderate	
Use of marine nonliving resources	Low level, but needed		Moderate		Moderate		Moderate		Moderate	
Use/cultivation of living resources	Moderate		Moderate		Moderate		Moderate		Moderate	
Invasive species	Low level, but needed		Moderate		Moderate		Low level, but needed	✓	Moderate	
Maritime traffic	Moderate		Moderate		Not known		Moderate		Moderate	
Underwater noise	Low level, but needed		Moderate		Moderate		Moderate		Moderate	
KSC 3: Interoperable and integrated long term data sets										
Biogeochemistry datasets	Moderate	✓	Moderate	✓	Moderate	✓	Moderate	✓	Moderate	✓
Biodiversity datasets	Low level, but needed	✓	Moderate		Moderate	✓	Low level, but needed	✓	Moderate	✓

3.4 Common and region-specific organizational challenges for PSSs

The functionality of coastal Supersites, as part of JERICO-RI to answer Key Scientific Challenges (section 3.1) and with overall Pilot Supersite objectives described in Section 2.3, requires integration of current observatories. Though in some regions transinstitutional and transnational collaborations have already been well established, various organisational challenges have been identified in all PSSs. Gaining the first-hand experience on these challenges during the implementation actions (section 4), communicating these efficiently between PSSs, finding solutions and best practices for the key identified challenges and transferring the gained knowledge further towards JERICO-S3 WP1, WP2 and WP9, and JERICO-DS, are the main priorities of PSS implementation.

The organisational challenges PSSs will face may be technical, administrative, cultural, legal, or arising from different scientific uses and user groups of subcomponents. Sharing of platforms and sensors may be obstructed by different technologies used by partners, or by methods used not comparable with each other. Administrative burdens may prevent efficient cooperation, while legal matters may even restrict making some observations in certain areas or with certain technologies. Data aggregation may be complicated as methods for observations and quality control differ. Different cultural aspects related to the open sharing of data and metadata, sharing of workloads, or even working habits and times, may affect the punctuality in responses and affect the quality of joint products. Scientific and societal needs of various subcomponents of PSSs are different (or at least differently prioritised), and the required shifts to meet joint Supersite requirements are not always easily done or financed. An important challenge may be lack of commitment by some partner, lack of competences in partnership, or poorly established collaboration with other RIs and communities.

To get the first-hand evaluation of organisational challenges PSSs will meet, PSS lead partners evaluated their sites for some obvious ones. The Table 6 provides the first outlook of this analysis, and it needs to be noted that this analysis is done well before the PSS implementation phase, so it may change considerably during the process. It is highly desirable that various new challenges, even serious ones, arise during the PSS implementation, rather than remain hidden and will be discovered only when moving further towards Supersite construction. In this regard, the large number of various Actions PSSs will carry out and number of links to other networks and initiatives favours the discovery of main obstacles.

The analysis in Table 6 indicates that most PSSs considered the transinstitutional and transnational challenges are “low” or “medium”, with some dispersion of answers. Challenges in the sharing of knowledge were considered mostly as “medium”, while connecting to users and other actors, as well as promoting the use of observation data were considered mostly “highly” challenging.

Besides these common challenges, there may be very specific regional ones. Again, PSS region leads were asked to provide information on the most obvious ones, summarised below.

CRETAN PSS

- How to maintain the operation (i.e. maintenance funding) of existing infrastructures
- How to strengthen the trans-institutional collaboration via National RI (HIMIOFOTS)
- How to establish platforms with endurance in neighbouring countries
- How to expand spatio-temporal coverage

NW-MED PSS

- How to facilitate the creation and maintenance of sustained national infrastructures in the region
- How to create and maintain links and synergies with others RIs
- Need to steer how to improve sampling of EOVs and sub-mesoscale coverage

CHANNEL PSS

- How to improve governance and sharing within PSS, and outside of it, towards more integrated and optimized observations systems/strategies
- How to promote a Joint Integrated Monitoring Programme at the PSS, including various scales of observations.
- How to harmonize actions and ecologically relevant strategies supporting WFD, MSFD and OPSAR Monitoring Programmes devoted to Eutrophication and Pelagic Habitats (Plankton).

NSEA PSS

- Need to identify gaps in observation and analysis system with regards to carbon and nutrient cycling
- How to deal with the lack of official PSS partner in the UK and Denmark

- How to develop joint monitoring plans as many players in the North Sea region with diverse interests

GoF PSS:

- How to improve logistics, practicalities and legal aspects in cross-border missions (FerryBox, Glider), especially to cover regions not part in JERICO-RI
- How to communicate the added value PSS observations for various stakeholders.
- How to team up with commercial observations

Table 6. Organizational challenges that were identified before the implementation phase of JERICO-S3 Pilot Supersites. Ranking of various challenges is done by PSSs lead partners and the table will be modified during the Pilot Supersite implementation to reflect findings during the implementation phase.

Ranking 1 Low challenge 2 Moderate challenge 3 High challenge	CRETAN PSS	NW-MED PSS	CHANNEL PSS	NSEA PSS	GoF PSS
Transnational/-institutional governance of observations within PSS region	1	1	1	1	2
Transnational/-institutional sharing and operating platforms, equipment and use data	2	2	1	1	2
Transnational/-institutional managing of joint data products	1	2	1	3	3
Transnational/-institutional managing joint data value chain	1	2	1	2	3
Sharing of knowledge inside PSS region (e.g. Best Practices)	2	2	2	2	2
Sharing knowledge between RIs inside PSS region (e.g. Best Practices)	2	3	2	2	3
Sharing knowledge between PSS regions (e.g. Best Practices)	3	3	1	2	3
Connecting to other actors in the region (data collection, modelling, satellite communities)	2	2	3	2	1
Connecting with scientific users in the region	1	3	3	3	2
Connecting with other users in the region (management, private sector)	3	3	3	3	3
Connecting other RIs in the region	3	3	2	2	2
Promoting the use of coastal observation data and results in society	3	3	3	3	3

3.4. Links to other RIs and overall user communities

Coastal Supersites could effectively be important contact points for JERICO-RI to other environmental RIs. Several PSSs Actions planned (see section 4) connect to other RIs, user groups and end users (see also Table 13). The strategic planning of these connections is however done in JERICO-S3 WP2, and only practical details of those connections are given here.

As a joint approach for GoF PSS, NW-MED PSS and CRETAN PSS, connecting experimental work (mesocosms studies jointly with AQUACOSM RI) and coastal observing systems is done, to better understand impacts of global warming and extreme coastal events on phytoplankton communities. Within these PSSs, a joint planning has been done, to study how extreme climatic events affect phytoplankton communities. Such connections cannot be derived using only experimental approach (lacking relevant scales of the events) or only observations (lacking in possibilities for depth studies in causalities after manipulation of environmental conditions).

NW-MED PSS and CHANNEL/NSEA PSS will link to DANUBIUS-RI for impacts of freshwater and particle discharge from major rivers. They will share observations to study coastal dynamics in many PSS actions (see Section 4) and improve linking between JERICO-RI PSS and DANUBIUS-RI sites.

All PSSs have links to ICOS ERIC, in many cases in making observations but also related to databases, dataflows and common practices. Additional links to ACTRIS, EURO-ARGO ERIC, EMBRC-ERIC, EMSO-ERIC, EUROFLEETS+ and LifeWatch-ERIC are also visible in one or several PSSs (see Table 13).

All PSS share work with regional modelling communities and to some extent with ocean colour communities, and will elaborate the links further, improving the use of observational data and increasing the awareness of observations. As well, each PSS links to regional initiatives, like conventions (e.g. HELCOM, OSPAR, UNEP-MAP) and EUROGOOS ROOSes and disseminate how the Supersites may improve the integration of observations and usability of data.

3.5. Common societal and economic impacts

Besides scientific impacts, coastal Supersites are expected to have various societal and economic impacts. As the implementation phase (see section 4) is relatively short and the list of Actions is limited, not all impacts can be studied during the PSS phase. We expect, however, that most of the topics listed below are covered to some extent and quite some advice can be provided to WP1 and WP9 for the next planning phases of JERICO-RI technical and operational design.

Foremost, it is expected that coastal Supersites will intensify the observations, in a way that multidisciplinary and consistent datasets, as well as new or improved products, are much better available for various regional European coastal seas, and usable for various user groups. Reliable and sustained observation data will contribute to EU directives, regional conventions and various regional and local assessments. This will impact the management decisions at several levels (from local to global), improve capacities of societies to adapt to modifications in the environment due to climate change and mitigate better the human induced transformations in coastal ecosystems. Improvements in the coverage and reliability of coastal data will contribute to advances in ecosystem modelling and earth observation validation, thereby improving the abilities of societies (and the EU in large) to observe, forecast, and anticipate coastal processes.

Supersites aim to advance especially multidisciplinary observations of the coastal seas, thereby contributing to optimising the pan-European monitoring of complex environmental challenges like marine contaminants, carbon cycling and biodiversity trends. Several of Key Scientific Challenges (see Tables 2-5) will be targeted in PSSs and efficiently disseminated and communicated to a wide range of target groups (see section 4).

JERICO-RI Supersites will improve understanding of the functioning of coastal ecosystems and their global role. This directly impacts the societies, contributing to healthy and productive seas. The information flow and dissemination of results will provide the public trustworthy knowledge on the status of coastal regions, including various specific products used by the public in large or targeting specific user groups. Supersites will contribute to Ocean literacy and provide data and platforms for higher education.

Inherent for the Supersites is the efficient use of resources for observations, as sensors, platforms and operative work are shared among partners as much as possible. Coordination and integration of actions is in pivotal role in many Actions of the implementation plan (see section 4) and though the economic savings are not likely to be countable during the short PSS phase, at least the estimate of the potential should be available by the end of exercise. Another way the Supersites will improve the economic efficiency of coastal observations is through improved knowledge of technological solution together with joint optimal sampling strategy and thereby a reduction of erroneous investments, fair sharing of competences, skills and software tools including smart specialisation among partnership, joint actions for (sensor/platform/system) development, testing and intercalibration, decreases duplication of work among partners.

The observation data collected, information products derived, and technology developed within Supersites will contribute to blue economies and Blue Growth sectors. Some data is directly usable for maritime industries, like transport, fisheries and offshore oil and gas, and improvements in e.g. observation accuracies and spatio-temporal coverage may increase the applied use of coastal data. Technology developments and academia-industry partnership will be fostered by coastal Supersites (though actually not that visible in short lived PSS phase) providing data and tools of marine biotechnologies (e.g. biodiversity related ones), aquaculture (sensor and data technologies for monitoring), mineral resources (better spatial mapping of resources and mapping technologies), and renewable energy (siting of platforms and their impacts on ecosystems). Various products for coastal and maritime activities will be improved (e.g. forecasts for waves, temperature and algae blooms) during PSS implementation.

3.6. Key regional actors and user communities

In the pan-European scale, Supersites will link to various Ocean data portals (EMODnet, Copernicus Marine Services), EC marine and environmental actions and initiatives (European Environment Agency, JPI Ocean, Joint Research Centre, European Marine Board) and environmental research infrastructures (e.g. EMSO-ERIC, EMBRC-ERIC, ICOS ERIC, EURO-ARGO ERIC, LifeWatch-ERIC, AQUACOSM-RI, DANUBIUS-RI, EuroGOOS, etc.).

In the regional scale, the number of actors and user communities, Supersites will connect to, is even higher. Mapping all of those is hard, but likely the most important ones are already well known. This section will review the key regional actors PSSs link to in observations, modelling and remote sensing. The list will evolve together with PSSs activities. The section continues by analysing which user communities within each PSS regions are already linked to JERICO-RI actions and may benefit from improved observation capacity by Supersites. This analysis will link to WP2 and WP9 of JERICO-S3 working with links of JERICO-RI and progressing sustainability of RI, respectively.

Key regional actors (data collection, modelling, remote sensing) for different PSSs were identified by PSS lead partners (Table 7). It is likely that not all the actors listed will be directly communicated during PSS implementation, but they are likely to be linked through regional work and PSS dissemination, e.g. through ROOSes. Mapping the regional actors is a

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continuous process in PSS work, carried further by Supersites, as linking with all key regional activities is one target of Supersites.

Table 7. Some of the Key regional actors for PSS regions for Observations, Modelling and Remote sensing

PSS region	Observations	Modelling	Remote sensing
GoF PSS	DE: IOW EE: TALTECH, EMI FI: SYKE, FMI, RU: Roshydromed, RAS SE: SMHI All: Regional environmental administration, Universities	DE: IOW, HZG, BSH DK: DMI EE: TALTECH, EMI FI: FMI, SYKE SE: SMHI, Stockholm university	DE: HZG, IOW EE: TALTECH, EMI, Tartu Observatory FI: FMI, SYKE PL: IOPAN SE: SMHI, Stockholm University
NW-MED PSS	FR: IFREMER, CNRS IT: CNR, ENEA, LAMMA, DLTM, ARPAL, ARPAT, CIBM, ISPRA, OGS, NATO-CMRE SP: SOCIB, PdE, Obsea	FR: IFREMER, CNRS IT: CNR, ENEA, LAMMA, ARPAL, DICCA (Università di Genova), OGS SP: SOCIB	FR: ACRI, CNES IT: CNR, LAMMA
NSEA-PSS	DE: BSH, HZG, AWI, ICBM, THÜNEN NL: DELTARES, RWS, NIOZ BE: VLIZ, RBINS UK: Cefas, PML, SAHFOS DK: DMI NO: IMR, NIVA, NORCE	NL: DELTARES DE: HZG, BSH, ICBM DK: DMI UK: PML, CEFAS, Southh.Univ. NO: Nansen Centre, MET NO, IMR, NIVA, NORCE	DE: HZG, DLR NL: DELTARES UK: PML BE: RBINS, VLIZ NO:Nansen Centre, MET NO, IMR, NIVA DK: DMI, DTU-Space
CHANNEL-PSS	FR: IFREMER, UMR LOG, BOREA laboratory, Roscoff Marine Station UK: Cefas, PML, Southampton Univ. Be: RBINS, VLIZ NL : Deltares, RWS	FR: IFREMER, UMR LOG UK: Cefas, PML, Southampton Univ. Be: RBINS, VLIZ NL : Deltares, RWS	FR: IFREMER, UMR LOG, ACRI/ARGANS UK: PML Be : RBINS, VLIZ NL: Deltares
CRETAN PSS	GR: HCMR, University of Crete	GR: HCMR, Univ.of Aegean, Univ. of Crete, Univ.of Athens, Univ. of Thessaloniki IT: OGS, CMCC	GR: HCMR, University of the Aegean, University of Athens

The analysis of JERICO-RI users and usage strategy will be created in WP9 (Task 9.2). Here we briefly summarise preliminary results already obtained as relevant for PSSs. The analysis identified a large number of users for each region, after the JERICO-RI region representatives compiled the information for JERICO-ESFRI application purposes. The analysis is done per region, not per PSS, but the differences are not likely very large. The results are also very preliminary as not all users were yet identified for each region.

Number of users varied from 24 to 67, for regions where PSS activities will take place (Figure 3). In all these regions, except in the North East Mediterranean, the public users were the largest user group. Academia was noted as the second largest group of users, except in the North East Mediterranean it was the largest group. Private companies were identified as an important user group in all regions as well, while the NGO's were noted as a minor group.

This distribution of user groups does not consider the actual number of individual users (e.g. number of scientists within a given university using JERICO-RI results), or the amount of used information per user. This analysis, just highlighting the number of users identified, needs to be followed by a more thorough one where the needs, effectiveness and impacts of various users are also considered in detail. Such analysis will take place in JERICO-RI WP9 and PSS will deliver a reconsideration of their user communities during the implementation phase.

As a starting point, however, this analysis shows the diversity of user communities and that the overall number of users will likely be very high (expected eventually >100 per region, if thorough analysis is done). This has clear implications that Supersites need to serve a large community and the products, services and capacities need to be planned accordingly.

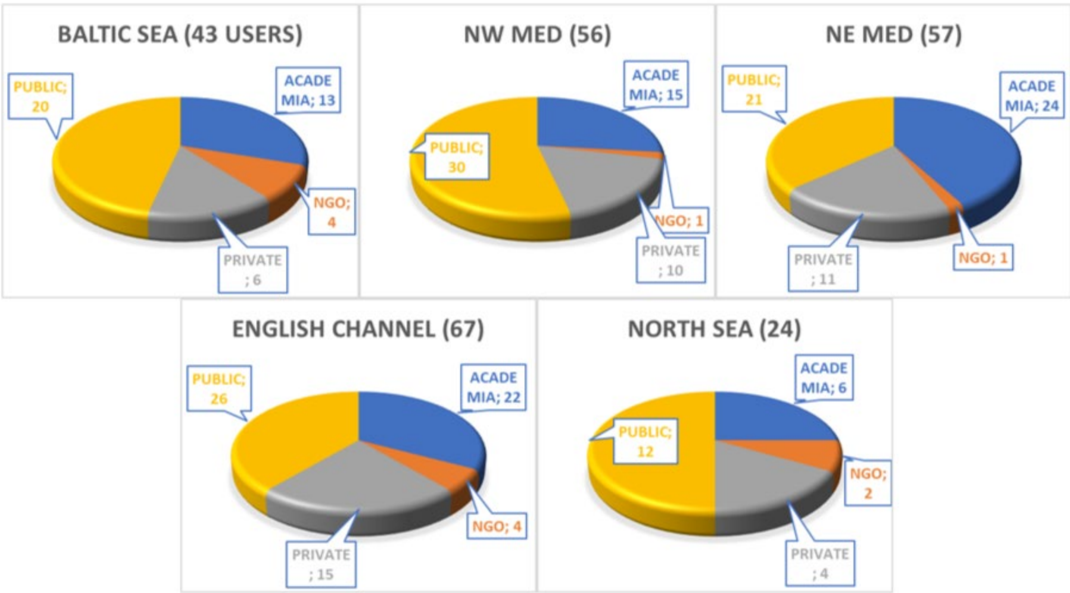

Figure 3. Number of users for regions with Pilot Supersite activities. The number of users and their categories was collected by JERICO-RI region representatives while compiling the information for JERICO-ESFRI application.

3.7. Critical gaps in multidisciplinary data provision for user needs

Summarising the materials presented in previous sections, it is evident that some gaps in the current data provision, for the needs of various users, exist. In some cases, these gaps are due to lack of methodologies, or deficiencies in the spatio-temporal distribution of observations. The primary reasons for the gaps, not analysed in depth here, may be related to the lack of knowledge, expertise or funding, or related to non-optimal structuration of observation capacity. The original priorities for making observations (location, timing, methods, variables, accuracy) may be different than requested by various users and prevent further uses of data. In addition to the technical and economic reasons, gaps may also be due to not adopting FAIR principles in data distribution, or not using adequate QA/QC measures degrading the usability of data. In this section we aim to provide outlook, which are the major gaps for PSS regions, especially referring to set priorities KSC#1-3.

All PSS regions agree on the importance of investigating and considering the Land-Ocean continuum, while the actual pressures and the relevant coastal characteristics vary a lot between regions. In some regions nutrient and particulate loads from rivers are the main concern to be studied. In other areas, the exchange between the coast and ocean is considered as a prominent driving force, whereas in other areas, it is the exchanges with the atmosphere. The related questions are very complex and require extensive multidisciplinary and integrated observations, and all regions identified this as a point for further developments. For this topic, the developments may be best achieved by coordinated collaborations within regions and between adjacent regions, as well as all-embracing transfer of knowledge.

Sustained observation for the quantification of atmospheric loads and studying their impacts is not very developed in most regions. This may reflect the lower impact of these loads, but also technological difficulties in performing reliable measurements. For the southern regions, the topic is important due to the influence of Sahara dust events in oligotrophic areas (e.g. phosphorus limitation), while in all regions the industry and traffic are important sources for emissions (anthropogenic sources).

The connections within regions, between adjacent regions and Ocean are well established within some regions. NW Mediterranean Sea, for example, have integrated platforms, variables and models readily available. Overall, this topic was well covered in most regions.

Biodiversity variables are well covered in the Baltic Sea, whereas in other areas, such as the Cretan Sea, there are few long-term biodiversity studies. Overall, the observation capacities for zooplankton and benthos biodiversity trends are lower than those for phytoplankton. When studying the ecosystem processes, the analysis identifies clear deficiencies in many regions. Such analysis is awkward even using traditional sampling and laboratory techniques and requires complicated setups when studied using sensor deployments. For long term observations, biological data storage remains also complex and not yet harmonized between regions.

The same difficulties apply when measuring carbon fluxes and budgets, and these are typically carried out during short-term studies, and few of them are sustained for long term observations (e.g. ICOS ERIC Oceanic Stations). Although carbonate system variables are quite well studied, the results indicate a low level of sensor integration (few pCO_2 and pH sensors are ready for sustained observations). This may reflect the uncertainties in the measurements in coastal areas with high dynamics in the carbonate system, and requirements for more accurate technologies and in situ sampling to validate the autonomous measurements.

The JERICO-RI experts consider that in many regions the observations of rare events and their impacts are well covered, in particular for the Baltic Sea, the North Sea and the NW Mediterranean Sea. While this issue was also considered as important for the English

Channel, only recent specific studies considered high resolution data and associated reliable numerical processing methodologies to define extreme events and their dynamics and consequences.

The long-term observations for variables reflecting the environmental shifts due to climate change seem to be quite well covered in most regions, especially related to physical variables. In this respect, Cretan Sea and NW Mediterranean, and English Channel showed thoroughness in observations. Much more improvements are required for observations to resolve impacts of anthropogenic disturbances. Answering such complicated and regionally varying questions is not easy, especially using traditional non-dynamic observation networks. Subsequently, the sampling strategies need to be improved, which is a key point for development within JERICO-RI in the future. Moreover, extracting the most relevant ecological information from such complex datasets requires the implementation of optimized or new numerical methodologies (e.g., Machine Learning, Artificial Intelligence). The same applies to integration of various long-term datasets for studying issues related to biogeochemistry and biodiversity.

The analysis indicates JERICO-RI strengths in covering most of the topics in various coastal regions. But of course, the capacities vary between regions and between Key Scientific Challenges and their subtopics. These gaps need to be analysed further and prioritised to guide the future developments. The existing observation capacity does not mean, however, that all of the required pan-European observational products and/or services are in place. It will be a task of JERICO-RI to make this capacity fully operational by harmonizing operations and integrating observations. This integrative work needs to consider regional specificities, as the key support to major part of observations still comes from regional and national initiatives. Therefore, one big task of JERICO-RI will be balancing between pan-European and regional aspects, trying to optimise and rationalise the use of coastal RI.

4. IMPLEMENTATION STRATEGIES FOR PILOT SUPERSITES

The implementation of JERICO-RI Pilot Supersites includes a list of Actions for each PSS. Originally the implementation phase was planned for 2 years, but the start is slightly delayed due to covid-19. The current implementation period is from January 2021 to August 2022.

PSSs implementation plan provides a brief outlook on the map of the region and how observations are spatially distributed (Figures 4-7). The operational observation systems included in PSS are listed and their operational status has been indicated (Tables 8-11). The main parameters included in each observatory are also shown.

Each PSS includes several JERICO-RI partners, contributing to the operational observations. An exception from this is Cretan Sea, where HCMR is solely responsible for operational observations, but where several other partners, from other PSS regions, join by providing additional specific competences. For each PSS and for each Action, one partner has been nominated for coordination, being the main contact point and leading the reporting actions.

Each Action starts by describing its own objectives. The partnership and observation platform used are given, including also other data sources and external partners when necessary. Details of the Action provides an outlook how it improves the regional and pan-European integration of observations and how the topic of Action is approached. Most of the Actions include collection of new data, and the related best practices, data flows and QC actions are described. Plan continues by identification of key results of each Action, identification of key users and links (inside JERICO-S3 project as well as outside it), and by planning the dissemination. The PSSs Actions links inside and outside JERICO-S3 are presented all together at the end.

4.1. Implementation strategies: Gulf of Finland Pilot Supersite

JERICO-S3 subtask 4.3.1. Pilot Supersite at Gulf of Finland, Baltic Sea; GoF PSS (Lead partner SYKE, partners FMI, IOW, TALTECH)

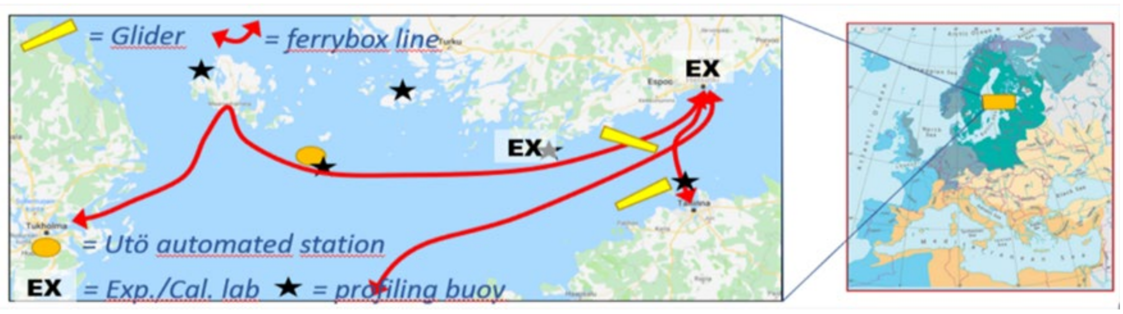

Figure 4. Map showing the key GoF PSS sustained platforms. Red lines represent FerryBox lines, stars are for profiling buoys, EX stands for experimental facility or calibration lab and the orange oval symbol is for Utö Atmospheric and Marine Station.

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Table 8. Platforms in GoF PSS

Operational observation systems & platforms in the region	Operational status	Parameters
FerryBox: Silja Serenade and Finnmaid (SYKE, FMI, IOW), Silja Europa (TALTECH)	operational (Silja Serenade and Silja Europa not running at the time of writing 11/2020 due to Covid)	T, S, Chla-Fluo, CDOM-Fluo, Turbidity, Phycocyanin-Fluo, Phycoerythrin-Fluo, O_2, pH, CO_2, sampler
Utö Observatory (FMI, SYKE), Keri Observatory (TALTECH)	operational	Utö: T, S, Chla-Fluo, CDOM-Fluo, Turbidity, Phycocyanin-Fluo, O_2, pH, CO_2, Meteorology, IFCB, Cytosense, FRRF, discrete samples Keri: T, S, Chla-Fluo, Turbidity, Phycocyanin-Fluo, O_2, Meteorology
Gliders (FMI, TALTECH)	operational	T, S, Chla-Fluo, CDOM-Fluo,
Argo floats (FMI	operational	T, S, Chla-Fluo, O_2
Profiling buoys (FMI, SYKE, TALTECH)	operational, some components under maintenance	T, S, Chla-Fluo, CDOM-Fluo, O_2, Phycocyanin-Fluo,
Wave riders (TALTECH, FMI),	operational	wave height
monitoring by R/V (All).	occasional	Annual program with several cruises & stations in the GoF area.
experimental and calibration facilities (SYKE)	as needed	

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GoF PSS #1 Harmonized observations

Objectives: The Action aims in improving harmonisation of GoF PSS data, produced by various institutes. Such harmonisation is the first step in merging data from different sources and creation of consistent datasets for multiple uses. Harmonisation protocols are demonstrated especially for observations on phytoplankton communities, HABs, oxygen and carbonate system dynamics. Shared management actions and communication schemes, and joint QC/QA practices for key observations will allow unified data flows and products, which will also facilitate their discovery, access, and use.

Action Lead and other Partners (with contact persons): SYKE (Seppälä, Haavisto), FMI (Laakso), TALTECH (Liblik, Kikas), IOW (Rehder)

JS3 Platforms included: FerryBox: Silja Serenade and Finnmaid (SYKE, FMI, IOW), Silja Europa (TALTECH), Utö Observatory (FMI, SYKE), Keri Observatory (TALTECH); Gliders (FMI, TALTECH), profiling buoys (FMI, SYKE, TALTECH), Argo floats (FMI), monitoring by R/V (All), calibration lab (SYKE).

Other data sources and external partners for implementation: Additional partners from JERICO-S3 and other national/international collaborators and private sector representatives may participate in the workshops and calibration and validation activities. This may expand the regional impact of study.

Overall timetable of Action: Jan 2021 - August 2022

Description of Action: Joint actions in calibration and validation, as well as improving and sharing the best practices, will provide a baseline for collecting comparable data for the region. Sharing maintenance actions may provide economic benefits and improve the data coverage due to decreased downtime of sensors.

The practical work includes (Timetable, Lead, partners):

- joint workshops for improving and sharing best practices, QA/QC methods and for sharing sensor/platform maintenance (winter 2021 and 2022, SYKE, all)
- joint workshops for sensor calibration (winter 2021 and 2022, SYKE, TALTECH, IOW, FMI)
- joint cruises for validation of automated measurements (FerryBox, Gliders, Argo floats, profiling buoys) (tentative cruises in autumn 2020, spring 2022, FMI, SYKE, TALTECH; tentative FerryBox co-trips in spring 2021, SYKE, IOW)

Best practices used or developed: Several new best practices agreed for the region, aiming to harmonized measurements for phytoplankton, oxygen and carbonate system dynamics.

Data flows: Action will not collect new observation data but provide means for improved data quality and interoperability.

Data QC routines: Sharing Best Practices for QA/QC agreed and discussed among best practices

Data management issues: Metadata issues noted in best practices

Expected results: Conceptual protocols for transnational platform maintenance, harmonization of observations, and QA/QC protocols, including the analyses of challenges. New transnational practices for sharing sensor calibration, data validation, and platform maintenance action, including Best practices documentation.

Users of results: Primarily GoF PSS partners but shared to the Baltic monitoring community in large. Disseminate the conceptual work for other PSS as well

Dissemination of results: Results (best practices) shared by JERICO e-infrastructure, aiming to scientific publication of the most advanced practices. The transnational interoperability concept links to GoF PSS #9 and #10.

Links: Results will be efficiently communicated for other PSS, aiming to future joint harmonization workshops. As well, the experiences on transnational knowledge transfer as disseminated towards WP1 and WP3.

Link to WP5, T5.2, T5.3

Link to WP6, T6.3

Link to WP7, T7.5 especially aiming to provide demonstration of shared documentation for D2PTS

Links to metrology community expected, especially following the development of INFRAIA project MINKE.

GoF PSS #2 The performance of operational forecast models

Objectives: The Action will analyse and disseminate discrepancies in hydrography and biogeochemistry between in-situ and CMEMS operational forecast model products at the GoF PSS. The main outcome of the topic is the conclusive report of the model performances in the area. Possible sources of the discrepancies will be discussed and instructions for users of the products will be provided.

Action Lead and other Partners (with contact persons): TALTECH (Liblik), SYKE (Seppälä, Ehrhart), FMI (Laakso), IOW (Rehder)

JS3 Platforms included: FerryBox: Silja Serenade, Finnmaid, Silja Europa (SYKE, FMI, IOW, TALTECH), Utö Observatory (FMI, SYKE), Keri Observatory (TALTECH); Gliders (FMI, TALTECH), profiling buoys (FMI, SYKE, TALTECH), Argo floats (FMI), monitoring by R/V (All),

Other data sources and external partners for implementation: Data from the data repositories, such as ICES HELCOM database will be included if necessary.

Overall timetable of action: Data will be collected in February 2020 - September 2021, analysis will be conducted from October 2021 – May 2022.

Description of action: The GoF is well known by its rapid temporal changes in the physical and biogeochemical parameters. Thus, the core analysis will be based on measurements at observatories (Keri and Utö) and FerryBox systems. Latter will be supported by the data from other sources. To compile comprehensive analysis of the model performance, data will be shared transnationally and transinstitutionally. The enhanced understanding of the model performance will lead to increased societal value of observations and CMEMS operational forecast model products.

Further actions are planned:

- Collection of the data (February 2020 - September 2021).
- Compiling the datasets (August - October 2021)
- Analyses of the discrepancies between in-situ measurements and CMEMS operative model products in hydrography and biogeochemistry (November 2021 - March 2022).
- Compiling conclusive report (April-May 2022)

Best practices used or developed: Validation characteristics, e.g. necessary temporal and spatial resolution, which most adequately describes the processes in the GoF will be agreed among partners.

Data flows: Action will not arrange operative data flows but collects the data from partners in autumn 2021. This link the action to WP7 T7.5 D2PTS, where regional data products will be generated.

Data QC routines Action not deal with QC routines but relies on GoF PSS #1 and on WP7 T7.5 D2PTS.

Data management issues: Minor issues can occur, when partners must agree on data formats.

Expected results: The Action streamlines observations and modelling by different partners of GoF PSS. Main result from this collaboration is the improved understanding on the operative model performances in the GoF PSS area. The discrepancies between the observations and model results, and the observed challenges in the process, will provide valuable feedback for future improvements.

Users of results: Researchers dealing with Eastern Baltic Sea, authorities responsible for the assessments of the environmental status of marine areas.

Dissemination of results: Results will be shared by JERICO e-infrastructure. The Action provides information to the GoF PSS #5. Results will be disseminated both to the modelling and observing communities, e.g. through BOOS annual meetings.

Links: The Action will provide input to WP2 T2.4 in providing insight on existing observational and technological gaps in the region. Action has direct link to WP7, T7.5, regional pilot of D2PTS #3, which provides regional multiplatform observations products.

GoF PSS #3 Optical data for Ocean Color product validation

Objectives: Ocean Colour algorithm development and product validation benefit largely from in situ measurements of optically active compounds, their concentrations and/or specific optical properties, and match-up (synoptic) measurements at different sites. Key challenges with some optical sensors (fluorescence, turbidity) are that results are not clearly traceable and in effect they are represented in the relative scale. The lack of standards for sensors and their calibration and validation make the intercomparison between sensors difficult. This task builds on the results of GoF PSS #1, intercalibration between sensors and improved QC. It provides Regional Data, as consistent as possible within technological limits, to Ocean Colour groups for evaluation.

Action Lead and other Partners (with contact persons): SYKE (Seppälä, Ylöstalo), TALTECH (Liblik, Salm)

JS3 Platforms included: FerryBox: Silja Serenade and Finnmaid (SYKE), Silja Europa (TALTECH), Utö Observatory (SYKE), Keri Observatory (TALTECH); calibration lab (SYKE).

Other data sources and external partners for implementation: Ocean Color data from Sentinel satellites. Work includes remote sensing groups of participating partners.

Overall timetable of action: January 2021 - August 2022

Description of action: Optical sensor measurements of aquatic optically active compounds are often rather incomparable between actors, due to lack of standardised methods. This hinders the use of such data for Ocean Colour match-ups and ground-truthing. To improve the use of multisource sensor data, joint steering of the sensor QA/QC and sharing sensor validation practices and data are required. This topic will demonstrate transnational collaborations in production of multisensor data.

The practical actions include sensor intercomparison workshops (winter 2021 & 2022, jointly with GoF PSS #1). Optical multisensor data will be collected in 2021 at fixed platforms and FerryBoxes, including optical proxy measurements (Chla and CDOM fluorescence), measurements of inherent optical properties (absorption, scattering) and specific inherent optical properties for water quality parameters (algae, CDOM).

Best practices used or developed: For optical measurements we aim to follow best practices developed for satellite ocean color sensor validation by The International Ocean-Colour Coordinating Group (IOCCG). Their further adjustments for Baltic conditions will be done as needed.

Data flows: Primary data from FerryBoxes flows to EMODnet Physics and CMEMS. Fixed Station data and data from exploratory sensors remain at the hosting institutes and is available on request. Opening these datasets is desirable via VA (WP11) during the PSS implementation, through developments made in WP7 T7.5 D2PTS,

Data QC routines: New steps in operational data QC protocols are required for temperature compensation of CDOM fluorescence and for spike detection of Chla fluorescence.

Data management issues: Review of data vocabularies need to be carried out, as data measured with various methods and sensors are not directly comparable.

Expected results: The topic will provide evidence how using Regional Data and shared QC of optical measurements decreases uncertainties in their use in EO product validation. Secondly, the topic provides improved estimates of how well the sensor data (fluorescence) describes the actual variability of the phytoplankton and CDOM abundance in the Baltic Sea as estimated by satellite data or traditional laboratory methods.

Users of results: Ocean Colour community

Dissemination of results: Dissemination is primarily targeted to remote sensing groups in the Baltic Sea, via participation in workshops, seminars and by targeted contacting groups asking them to evaluate the data for scientific use.

Links: Action will open a dialogue with WP 2, T2.3 on how the JERICO-RI observations may be promoted to Ocean Colour community.

GoF PSS #4 Detection of cyanobacterial blooms

Objectives: The Action aims to improve transnational and transinstitutional joint observations for HAB detection and creating concepts and mechanisms for sharing the information and production of HAB reviews. Task will gather comparable and complementary data to analyse spatiotemporal variability of cyanobacteria blooms in the Gulf of Finland. The collected online data will support weekly HAB reviews, carried out by SYKE. These reviews are targeted for public and different marine users and are distributed through SYKE web-pages and press releases. The concept of HAB reviews will be demonstrated to other partners within the PSS and between PSSs. In addition, QC data will promote scientific analyses of the causes and consequences of the blooms.

Action Lead and other Partners (with contact persons): SYKE (Seppälä, Lehtinen), TALTECH (Liblik, Kikas)

JS3 Platforms included: FerryBox: Silja Serenade and Finnmaid (SYKE), Silja Europa (TALTECH), Utö Observatory (SYKE), Keri Observatory (TALTECH); profiling buoys (SYKE), calibration lab (SYKE).

Other data sources and external partners for implementation: monitoring by RV (depending on the cruises), observations from public, Ocean Color

Overall timetable of action: Data collection and reviews done in summer 2021 and summer 2022.

Description of action: Algae blooms in the Baltic Sea are each summer affecting the use of marine areas and have also effects on marine ecosystems. These events are of public concern and SYKE provides weekly updated information on the status of blooms and prediction on their developments. Sensor observations at fixed stations and FerryBoxes support these reviews by providing real time data. This topic will improve the transnational availability of data, thereby improving the reliability of the reviews. The joint harmonisation of measurements (GoF PSS #1) and developments in Ocean Colour methods (GoF PSS #3) and in modelling approaches (GoF PSS #7) together with coordinated data flows improve further the timeliness of HAB reviews. The concept of HAB review, its organisational structuration, usage of multisource data and dissemination policies, are presented in partnership.

Cyanobacterial abundance is measured using phycocyanin fluorescence sensors installed on platforms (all) and Imaging Flow Cytobot at Utö (or in ferry in 2022). Data collection covers cyanobacteria growth seasons (June-August) in 2021-22. Visual maps and trajectories of the data will be used by SYKE in making weekly HAB reviews. Intercomparison of the methods is carried out during laboratory tests (Action GoF PSS #1) and partners share best practices for sensor calibration, validation and maintenance through e-infrastructure.

Best practices used or developed: Structural concept for HAB reviews, using multisource data and involving various national actors, will be created.

Data flows: As phycocyanin fluorescence is still considered as explanatory variable, the flow to EMODnet or CMEMS has not been realised. Potential to do so will be examined. Partners are responsible for their own data flows, storage and distribution to data aggregators and at minimum data is available on request. As well, the data aggregator and related data flows for phytoplankton image data are still under construction. The developments in WP7, T7.5. D2PTS, Ecotaxa are closely followed. Within D2PTS a joint aggregation of results will be carried out, utilizing commonly agreed QC procedures.

Data QC routines. Sensor calibration routines are used as recommended at GoF PSS i) and robust real-time QC routines are further developed, as for the applications like here informing the public, the reliability of data is of concern.

Data management issues: Vocabularies and metadata are not well developed for all of the methods used in this topic and need to be targeted.

Expected results: The Action will create online data for cyanobacteria distribution (also for species abundance) supporting weekly HAB reviews. The concept for HAB reviews will be published. Delayed mode QC data will provide input for developments in Ocean Colour methods (GoF PSS #3) and in modelling approaches (GoF PSS #6).

Users of results: General public, fisheries and aquaculture, enterprises providing coastal services, cities. Ocean Colour and modelling communities. Coastal sea management.

Dissemination of results: Data is disseminated through publishing online data and weekly HAB reviews by SYKE. We aim to produce a joint press release in Finland and Estonia, demonstrating the value of joint observations in bloom detection. HAB Algae reviews will be further disseminated in regional and international workshops, especially including other PSSs and IRSs.

Links: Links to WP6, T6.2.3. providing input to combining citizen observations with sensor observations.

Links to WP7, T7.4 in image recognition methods.

GoF PSS #5 Mapping the deep-water oxygen conditions

Objectives: Sub-surface oxygen conditions in the Gulf of Finland are very sensitive to the atmospheric forcing. The area occupied by hypoxic water varies between 0 – 7000 km^2 and considerable changes can occur within a few days, i.e. in much shorter time-scales than conventional monitoring can capture. Main aim of the topic is to estimate oxygen distribution in the gulf with at least weekly temporal resolution. Latter allows calculation of statistics of the near bottom oxygen conditions.

Action Lead and other Partners (with contact persons): TALTECH (Liblik), SYKE (Seppälä), FMI (Laakso), IOW (Bittig)

JS3 Platforms included: Utö Observatory (FMI, SYKE), Keri Observatory (TALTECH); Gliders (FMI, TALTECH), profiling buoys (FMI, SYKE, TALTECH), Argo floats (FMI), monitoring by R/V (All).

Other data sources and external partners for implementation: HELCOM ICES database and operational model data from CMEMS, including the input from GoF PSS topic ii).

Overall timetable of action: collection of data February 2020 – September 2021, compilation of weekly near-bottom oxygen maps and statistics April 2021 - April 2022.

Description of action: The oxygen depletion issue in the near bottom layers of the Baltic Sea is a cross-border issue and its monitoring needs a coordinated international collaboration. The Action includes data collection, developing the mapping method and producing the near-bottom oxygen maps in the GoF. The core in-situ dataset will be based on measurements at observatories (Keri and Utö), monitoring by R/Vs and Argo float measurements. The two possible directions for the oxygen maps production can be foreseen: 1) Available CMEMS biogeochemical operative modelling product dedicated to the Baltic Sea will be validated with in-situ measurements (GoF PSS topic ii) and if possible, systematic empirical corrections for the modelled fields will be estimated. If the corrections are reliable over time and/or various states of the sea, they will be used to estimate near-bottom oxygen conditions in the GoF by CMEMS products; 2) Spatial maps compiled by conventional monitoring will be combined with the high temporal resolution measurements conducted at observatories. The linkage between the two could be utilized to create oxygen maps in a weekly temporal resolution. The topic calls for coordinated international collaboration in planning long term deployments and short-term missions and sharing of results. The action needs to include a joint identification of vulnerable areas and especially communicating which are the most important areas lacking consistent observations. Planning the new observation sites, sharing experiences in the deployments and communicating best practices for QC are important components of the topic. The flow of data into joint databases (e.g. CMEMS) needs to be guaranteed for all platforms. The implementation of the topic is a step forward in the coordinated international monitoring of the subsurface oxygen distributions in the area of PSS.

Timetable for Action:

- Collection of the data (February 2020 - September 2021).
- Compiling the datasets (April 2021 - October 2021)
- Developing the method for the compilation of oxygen maps (May 2021 - September 2021).
- Compiling the oxygen maps, adjusting the method (November 2021 - March 2022).
- Compiling the report on the oxygen dynamics (April-May 2022)

Best practices used or developed: The best method(s) for the estimation of near-bottom oxygen distribution in the GoF will be documented.

Data flows: Action will not arrange operative data flows, but collects the data from partners in autumn 2021.

Data QC routines: Action will not deal with QC routines, but relies on GoF PSS #1.

Data management issues: Minor issues can occur, when partners must agree on data formats.

Expected results: The main result is the time-series of the near-bottom oxygen distributions (maps) in relevant timescales for the GoF.

Users of results: Researchers dealing with Eastern Baltic Sea, authorities responsible for the assessments of the environmental status of marine areas.

Dissemination of results: Results will be shared by JERICO e-infrastructure, At least one scientific paper is planned to publish on the topic during the project period. Results will be introduced to the relevant working group in HELCOM.

Links: The Action links to WP2 T2.4 highlighting the coupling of observations and modelling communities, further detailing how these connections may be improved.

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

GoF PSS #6 Biological interplay with the carbonate system

Objectives: Eutrophication, and with it changes in primary production and mineralization, are of major concern for the Baltic Sea and the GoF PSS area in particular. The inorganic carbon cycle can be used as a powerful quantitative indicator in this complex interplay, as it is the major constituent of organic biomass, and the oxidation of organic carbon is by far the largest contributor to the oxygen demand in deeper waters. It becomes more and more evident that not only the summer N-fixation period, but also the later part of the spring bloom show high variability in C/N/P ratios, thus the link of production of biomass to oxygen demand requires tracing of the carbon cycle. Homogenization of data flows and data quality, definition of gaps and integrated assessment and interpretation are essential to make full use of these data for ecosystem assessment in the GoF PSS target area.

Action Lead and other Partners (with contact persons): IOW (Rehder , Bittig), SYKE (Seppälä), FMI (Laakso, Honkanen), TALTECH (Lips, Kikas)

JS3 Platforms included: FerryBox: Silja Serenade and Finnmaid (SYKE, FMI, IOW), Silja Europa (TALTECH), Utö Observatory (FMI, SYKE), Keri Observatory (TALTECH), monitoring by R/V (All)

Other data sources and external partners for implementation: potential inclusion of data submitted to the SOCAT database on CO2 parameters in the area (e.g. SOOP Tavastland, Shark database entries of SMHI, data from other projects in the area).

Overall timetable of action: Some data are collected continuously over the course of JERICO-S3 as part of long-term measurement programs of the partners. Major focus will however lie on data collected over the years 2021-2022.

Description of action: We will assess the availability of carbon system data provided in the area and identify gaps and needs for quality control in the area. Surface pCO2 measurements are continuously operational on SOOP Finnmaid using ICOS-conform methodology, as well as on Silja Serenade and Silja Europa (assuming the current stop of operation due to the COCID 19 pandemic will end in spring 2021). The Action will promote transfer of knowledge on data QA/QC, and improve homogenization and inter-comparability of data and protocols. The group will assess how the carbon system, biological and physical data may be jointly analysed and provide outlook if there are needs to improve coordination of observations and if some key parameters need to be further included.

Best practices used or developed: pCO2 measurements are in general following SOCAT recommendations; CT, AT measurements are well established, yet currently calibrated by the entire community against an open ocean standard (CRM, Scripps). Currently, round robin tests are on the way to check whether this is fully appropriate for brackish water samples. For pH, spectrophotometric measurements are now more and more established and will be further monitored and introduced for the monitoring of brackish waters. Streamlining and QC here will strongly follow and interact with the WP 6, Task 6.3.3.

Data flows: pCO2 and continuous surface carbon parameters via SOCAT, discrete measurements from RV-based monitoring through established databases.

Data QC routines: SOCAT / ICOS routines and QC-ing as documented in the Guide for Best Practises for Ocean CO2 measurements (Dickson et al., 2007) will be followed and/or established for all data streams.

Data management issues: Data management issues are jointly analysed with WP6 T 6.3.3 with expected synergistic effects.

Expected results: The action will improve partners capacity to provide consistent high-quality carbonate system measurements and to analyse the results with auxiliary biological and physical data. The Action improves the overall coordination of carbonate system measurements in the region and contributes to pan-European integration.

Users of results: Scientist working with climate change and ecosystem functioning; managers making assessments of the effects of climate change, eutrophication, and acidification; other parties involved in carbonate measurements.

Dissemination of results: Results will be disseminated during scientific and management-supporting meetings and workshops, including those of JERICO-S3, ICOS ERIC, BOOS and HELCOM.

Links: The action links to WP6 Task 6.3.3. working with the guidelines and strategy for carbonate systems data management. It also links to carbonate system actions in other PSS; the already existing link to the ICOS ERIC will be intensified.

GoF PSS #7 Forecast models for cyanobacterial blooms

Objectives: Forecast modelling of cyanobacteria growth and their blooms are challenging tasks but there is a growing demand for such action. Depending on the time horizon, different modelling tools may be used. Long-term scenario models (months) are based on ecosystem models supported by observations of nutrients as a key driver of blooms and expert opinions. The short-term models (days-weeks) may include more detailed parameterization of cyanobacteria vs. other algae groups and taking into account the weather as key drivers. This Action will analyse the performance of the forecast models for cyanobacterial blooms in the Gulf of Finland by comparing to in-situ data obtained from the GoF PSS. Estimate the performance and greatest challenges of the current models and develop ideas on how the models could be advanced.

Action Lead and other Partners (with contact persons): FMI (Laakso), SYKE (Seppälä, Lehtinen)

JS3 Platforms included: FerryBox: Silja Serenade and Finnmaid (SYKE, FMI), Utö Observatory (FMI, SYKE), profiling buoys (FMI, SYKE), monitoring by R/V (SYKE, FMI).

Other data sources and external partners for implementation: ERGOM operational model forecasts for the Baltic Sea are available from The Baltic Monitoring Forecasting Centre (BAL MFC). Action has links #2 and #5, which target biogeochemical parameters.

Overall timetable of action: Data will be collected in 2021-22, model performance analysis and advancing modelling 2021-22.

Description of action: Action will improve the availability of observations for the modelling community. The adjustment of observations (time/location/parameters) will be jointly discussed. Though not each PSS partner is participating in this topic, the availability of additional data will be screened.

The Action will merge the relevant observation data from data producers for 2021 and 2022. Model performances will be analysed by comparing the results with in-situ data. This will follow by joint analyses to identify the biggest challenges in model performance. The outlook will be created, with the institutes involved, how to further develop the models.

Best practices used or developed: The best practices as developed in GoF PSS #1 will be followed

Data flows: Data from Action #1 and # 4.

Data QC routines Quality controlled data from topics GoF PSS i) and GoF PSS iv) will be used.

Data management issues: No particular issues foreseen.

Expected results: Improved understanding on cyanobacterial bloom forecast model performance in the GoF area. Plans on improvements on models.

Users of results: Researchers, model developers, people responsible for giving cyanobacterial bloom information to the general public

Dissemination of results: Results will be shared by JERICO e-infrastructure.

Links: Topic will link WP2 T2.4 by analysing the current status of cyanobacteria modelling and providing future outlook how it needs to be advanced further.

GoF PSS #8 Extreme events affecting phytoplankton - AQUACOSM collaboration I

Objectives: Plankton ecosystem reacts rapidly to the shifts in various environmental pressures. These responses may be tracked using high-resolution observations with state-of-art sensors, but still many of the interactions in the planktonic realm may remain hidden. For example, rate measurements and food web interactions are hard to measure without enclosing the plankton communities for the period when measurements are done. As well, understanding the responses of planktonic systems to some specific perturbations may require that part of the ecosystem is isolated and studied experimentally. This topic will study how the Baltic Sea phytoplankton communities are affected by extreme climatic forcing, in collaboration with experimental work of AQUACOSM-plus and supported by long-term observational data.

Action Lead and other Partners (with contact persons): SYKE (Seppälä), FMI (Laakso)

JS3 Platforms included: FerryBox: Silja Serenade and Finnmaid (SYKE, FMI), Utö Observatory (FMI, SYKE), Gliders (FMI), profiling buoys (FMI, SYKE), Argo floats (FMI), monitoring by R/V (All), calibration lab (SYKE).

Other data sources and external partners for implementation: Possibility to open a TA in collaboration with AQUACOSM-plus will be explored, allowing other research groups to join the experiment.

Overall timetable of action: Planning of the experiment in 2021, experiment period in summer 2022.

Description of action: The Action will discover how observations and experimentation may improve our knowledge on ecosystem responses to perturbations. It includes analyses of existing timeseries, to understand which are the frequencies, ranges and durations of extreme events (e.g. unusual temperature shifts, extreme riverine loads), jointly with observation and experimental communities. This work is also shared between NW-MED PSS and CRETAN PSS, with similar approach.

Experiment is planned for 2022, likely studying the combined effects of temperature and river load of humic materials (to be precised during 2021). Water (4 m^3) will be collected from the open Baltic Sea during a research cruise. In the research laboratory it will be distributed into 12 300-L mesocosm units, which are individually controlled for temperature and light. Mesocosm experiment will last 2-3 weeks and the responses of the plankton system will be followed continuously using AQUABOX-device, developed under AQUACOSM project, measuring the key biological, chemical and physical variables. The online measurements are supported by an array of laboratory measurements to get relevant insight on plankton processes. The observed shifts in the plankton community will be analysed against trajectories observed in nature.

Best practices used or developed: Best practices created and used by JERICO-RI and AQUACOSM-RI communities are compared.

Data flows: Experimental data will form a separate package, and made openly available with DOI

Data QC routines QC routines for continuously collected online experimental data are under scrutiny and the developments benefit from experiences of JERICO-RI

Data management issues: Likely the data will be available through host institute,

Expected results: Primary result of the Action, jointly with similar Actions under NW-MED PSS and CRETAN PSS is advancing the communication between different coastal marine research disciplines, in studying similar phenomena. The conceptual steps in this collaboration includes analysing which types of available observations may support experimental studies, e.g. by showing how common the studied disturbances may be in the region, or which regions may be most affected. Then, the results of the experimentation may guide the observations further, e.g. by showing if the observation capacities are optimal for following such events and their effects. Naturally the experiment combined with relevant time series of observations is expected to produce relevant and new scientific data and publications.

Users of results: Scientific community, management of seas areas and planning countermeasures

Dissemination of results: Results will be disseminated both in the JERICO-RI and AQUACOSM-RI communities in their annual meetings. Another target group for dissemination are ministries and institutes financing coastal studies, showing that such collaborative schemes may yield very important and focused information for specific questions. Additional dissemination in scientific workshops.

Links: Strong between PSS-link and link to AQUACOSM-RI community are evident. Additional link to between RI-collaboration in WP2, T2.2, showing how the collaboration within region and between regions may be arranged.

GoF PSS #9 Promotion of the use of PSS data and products

Objectives: Aims of PSSs are to harmonize regional observations, integrate transnational operations, jointly steer data collection, provide joint products with added value and to connect to other regions. Such actions have a strong need for regional coordination, which is not only the task for JERICO-RI, but also other regional initiatives. This action will disseminate the results from GoF PSS to major regional actors and ask for their feedback to develop observation strategies further. The integrated coastal observations done within GoF PSS, as well as the overall sampling strategy of coastal JERICO-RI Supersites, will be communicated to regional actors, especially HELCOM, EUBSR, and BOOS.

Action Lead and other Partners (with contact persons): TALTECH (Lips), IOW (Rehder), SYKE (Seppälä)

JS3 Platforms included: FerryBox: Silja Serenade and Finnmaid (SYKE, FMI, IOW), Silja Europa (TALTECH), Utö Observatory (FMI, SYKE), Keri Observatory (TALTECH); Gliders (FMI, TALTECH), profiling buoys (FMI, SYKE, TALTECH), Argo floats (FMI), Wave riders (TALTECH, FMI), monitoring by R/V (All), calibration lab (SYKE).

Other data sources and external partners for implementation: HELCOM ICES database and CMEMS operational and re-analysis products; input from GoF PSS #2-#8

Overall timetable of action: Analysis of applicability of PSS data for indicators to be used in indicator-based assessments (2021). Sharing of the potential use of data and the product development plans with the environmental authorities, including HELCOM, getting feedback (2021). Presentation of the impact of using PSS data for indicators/assessment and presentation of PSS products, adjustments, if needed (2022). Publication and recommendations of potential use of PSS data and products in the future (2022-2023).

Description of action: An analysis will be carried out to define what PSS data could be used for the indicator-based assessments, either combined into the already developed indicators (e.g. HELCOM core indicators as Chlorophyll-a, Oxygen debt, etc.) or indicators under development (acidification indicator, shallow water oxygen indicator, etc.). Demonstration of the impact of combining PSS data into the indicator assessments (e.g. increased spatial and temporal coverage leading to a better confidence of assessments). Demonstration of PSS products from GoF PSS #2-#8 and their use to the national and local environmental authorities and HELCOM. Development of recommendations of the potential use of PSS data and products in the future to meet the needs of local and regional authorities (e.g. for MSFD).

Best practices used or developed: Best practices of the use of PSS data and products to meet the needs of local and regional environmental authorities.

Data flows: No operational data flows are arranged but collects the data from partners and other sources. Recommendations for the data flows in the future will be developed.

Data QC routines: The Action relies QC routines developed/agreed in GoF PSS #1.

Data management issues: The agreements between partners must be in place.

Expected results: Indicator-based assessment products with confidence estimates when combining conventional data with PSS data.

Users of results: Local and regional environmental authorities (including HELCOM).

Dissemination of results: Results will be shared via JERICO e-infrastructure, potentially also via HELCOM web site, if agreed so.

Links: The topic links to WP2 T 2.5 in analysing which type of environmental policy needs there exist in the region and if PSS actions may contribute to those needs.

GoF PSS #10 Connecting the other RIs in the region

Objectives: Many of the Grand Environmental Challenges affect several environmental domains (land-sea-air) and cannot be studied in isolation within one domain only. Streamlining observations, experimentation and data-analysis within European RI-landscape requires that regional and practical bottom-up collaborations between RIs develop parallel to higher level and strategic top-down collaborations (which are dealt in WP2). Connecting RIs at the regional level will highlight existing synergies, helps to identify overlaps and research topics where collaboration needs to be strengthened. Specifically in GoF PSS we seek to establish connections to other RIs by contributing to carbonate system measurement guidelines for coastal seas (ICOS ERIC), sharing data (AQUACOSM-plus, EURO-ARGO ERIC, ICOS ERIC), and seeking possibilities for future joint activities (ACTRIS PPP, EMBRC-ERIC, EUROFLEETS+, MINKE)

Action Lead and other Partners (with contact persons): FMI (Laakso), TALTECH (Liblik, Lips) , IOW (Rehder), SYKE (Seppälä)

JS3 Platforms included: FerryBox: Silja Serenade and Finnmaid (SYKE, FMI, IOW), Silja Europa (TALTECH), Utö Observatory (FMI, SYKE), Keri Observatory (TALTECH); Gliders (FMI, TALTECH), profiling buoys (FMI, SYKE, TALTECH), Argo floats (FMI), Wave riders (TALTECH, FMI), monitoring by R/V (All), calibration lab (SYKE).

Other data sources and external partners for implementation: TBD

Overall timetable of action: January 2021- August 2022

Description of action: The action starts by defining and contacting the key regional actors of other RIs. Already shared actions and collaborations will be mapped. For practical regional work, the geographical, scientific and technological interfaces between RIs will be identified. Some actions at GoF PSS (6 and 8) already have clear between-RI components and these demonstrations will be analysed in terms of scientific advances and other synergies achieved and disseminated towards other RIs and also between PSS. Potential new schemes of collaborations will be mutually discussed.

Best practices used or developed: Sharing the best practices between RIs will be promoted.

Data flows: Sharing data flows will be promoted

Data QC routines Action will support the transfer of knowledge on QC

Data management issues: Data management practices of different RIs will be studied

Expected results: This action will result in improved exchange of knowledge between regional actors of various RIs. It is expected that opening the forum for joint activities and planning will result in improved efficiency of observations and use of data. Action will also inform WP2 on the ongoing practical collaborations, future collaboration possibilities and possible obstacles to cooperation, providing important bottom-up feedback on how future RI-collaborations need to be developed.

Users of results: All RIs, JERICO-S3 WP3 and WP9, JERICO-DS, also national RIs and national authorities responsible for RIs

Dissemination of results: Work is disseminated during workshops where several RIs are present

Links: Action provide direct inputs to WP2 T2.2 and various task in WP9

4.2. Implementation strategies: North-West Mediterranean Pilot Supersite

JERICO-S3 subtask 4.3.2. Pilot Supersite at North-West Mediterranean; NW-MED PSS (Lead partner CNRS, partners CNR, PdE, SOCIB, UPC)

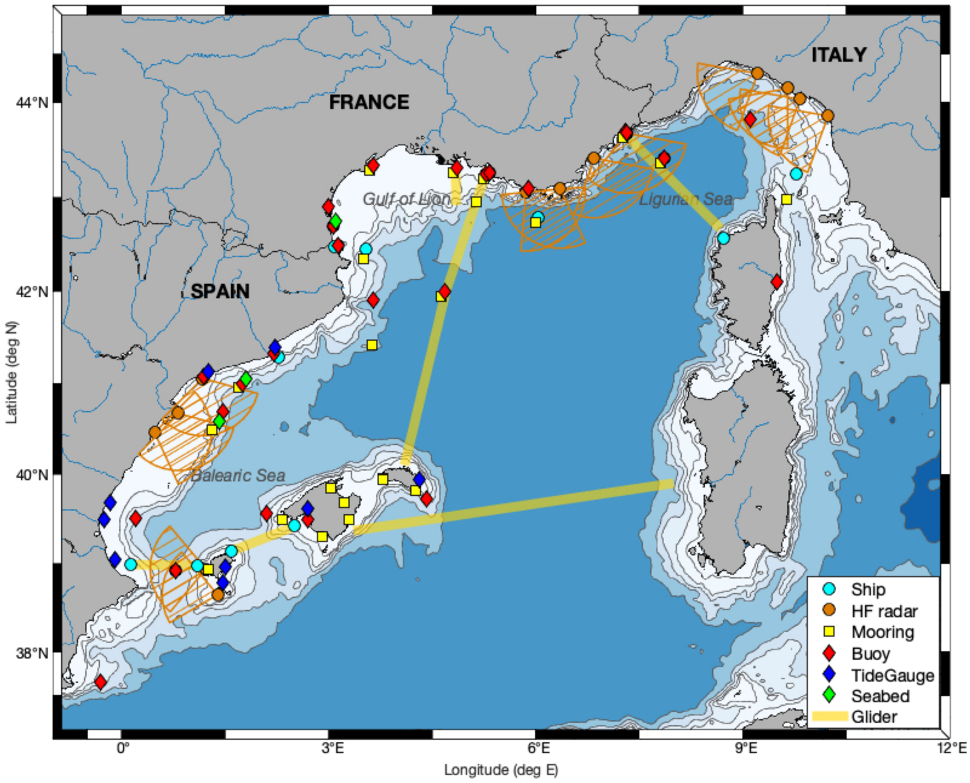

Figure 5. Map showing the key NW-MED PSS sustained platforms and existing stations

Table 9. Platforms in NW-MED PSS

Operational observation systems & platforms in the region	Operational status	Parameters
Ships (ILICO, SOCIB, CNR)	operational (different frequency)	Profiles: T, S, O_2, fluorescence Bottles: nutrients, carbonate, zooplankton, phytoplankton, genomics
HF radars (CNR, PdE, ILICO, SOCIB)	operational	surface currents (speed, direction)
Moorings (ILICO, CNR)	operational	T, S, O_2, currents, particle flux, images
Buoys (ILICO, PdE, UPC, SOCIB)	operational	meteorology, currents, waves, PAR, T, S, O_2, fluorescence, pH, pCO_2

Tide gauges (PdE, SOCIB)	operational	sea level
River stations (ILICO)	operational	Discharge, particles load, nutrients, metals
Seabed (UPC)	operational	T, S, depth, currents, waves, underwater sound. seismometer, video-camera, biodiversity
Gliders (ILICO, SOCIB)	operational	T, S, fluo, turbidity, O2, CDOM, BB700 (routinely), particles size, current motion (occasionally)
Numerical models (SOCIB, IFREMER, PdE, CNRS)	operational/semi-operational	(3D) T, S, currents, waves, sea level

NW-MED PSS #1: Reconstruction of the 3D coastal dynamics

Objectives: This Action provides a transnational approach to study the Northern Current overall dynamics, encompassing and connecting specific sea areas under investigation by the partners involved. It uses the Regional Data in the Northern Current region, to reconstruct the 3-D coastal dynamics and, in combination with modelling, to analyse dispersion of marine life (larvae, jellyfish, phyto- and zooplankton) in different current scenarios, with possible applications to distribution of pollutants, jellyfish, alien species and in support of fisheries and regional management. [Action is a combination of original topics i & ii]

Action Lead and other Partners (with contact persons): CNR (Berta, Griffa), SOCIB (Mourre), CNRS (Coppola), PdE (Sotillo), UPC (del Rio)

JS3 Platforms included: ILICO gliders, coastal buoy (CNRS), HF radar network (CNR), Corsica Channel mooring with imaging (CNR), gliders, HF radar, moorings and numerical model from the Coastal Ocean Observing and Forecasting System (SOCIB), OBSEA Expandable Seafloor Observatory (UPC), PORTUS observing and forecasting system (PdE); Additional infrastructure: HF radars (CNRS, PdE), buoys (CNRS, PdE), tide gauges (PdE), coastal moorings, river stations (CNRS), monitoring by R/V (SOCIB, CNRS, CNR), SIROCCO modelling system (CNRS)

Other data sources and external partners for implementation: CMEMS satellite and model data. The CMEMS Mediterranean forecasting model will provide boundary conditions for our high-resolution models. Possibly data is also obtained from LABMARE mooring (CNR, ENEA, DLTM, INGV, IIM), additional HFR antennas (LAMMA consortium), ALBATROSS mooring (EMSO-ERIC) and new bio-glider (LOV CNRS), pre-operational forecasting modelling system MENOR and coastal buoy (MESURHO, IFREMER).

Overall timetable of action: Dec 2020 - Aug 2022

Description of action: The planned multiplatform network covering the NW-MED will include a wide range of observations managed at transnational level. Several observing systems based on autonomous platforms are already active and will cover the whole duration of the project (remote and in situ fixed stations, example HF radars and moorings). Other targeted field activities and samplings (ships and gliders) will be planned by each partner during 2021-2022. The Action will explore best practices to integrate the multiplatform observations (at the sea surface and at depth) and investigate the overall dynamics at various scales. In-situ measurements can be used to validate/calibrate remote measures. The investigation of circulation effects on dispersion of biological and pollutant particles will be supported by historical dispersion datasets in the NW-MED (e.g. drifters at various depths, CMEMS products) and targeted in situ trajectories collected in specific sites of the PSS.

Several numerical models will also be used in this action. The data-assimilative WMOP hydrodynamic model (SOCIB) will integrate multiplatform coastal observations from HF radar, gliders and moorings along the whole path of the Northern Current. The results of the MENOR pre-operational model (IFREMER) covering the whole PSS area will be made available both for comparison with recorded data and dispersion modelling. Two-way nested zooms (with a horizontal resolution in the range of 400 m) will be activated in chosen aeras (mainly where radars are installed) allowing local comparison with observations. Moreover, the SYMPHONIE/SIROCCO model (CNRS) will be used to specifically analyse cross-shelf exchanges and dispersion associated with the meandering of the Northern Current. Model intercomparisons using the whole set of PSS observations will be carried out to better understand model performance and limitations. This activity will benefit from the availability of standardized and quality-controlled coastal data made available by the different countries and institutions involved in the NW-MED PSS, demonstrating the added value of transnational data integration.

Best practices used or developed: Application of best practices as provided in WP5 and WP6.

Data flows: Data will be made available by the national coastal research infrastructures through their threads or other web servers.

Data QC routines: QARTOD QC routines can be used for RT data flagging, including links to WP5 and WP6.

Data management issues: Some issues need to be clarified during the Action, e.g. if data is provided in real-time or periodically, and which formats will be used

Expected results: Improved coordination of independent and complementary observing and modelling systems for the characterization of the 3D coastal dynamics over the NW-MED coastal area, allowing a better understanding of the variability and instabilities of the slope current and the analysis of the dispersion of nutrients, fish larvae, contaminants, plastics or jellyfish. The organic suspended matter as well contaminants distribution driven by currents affects water quality, whose characterization provides useful information for fisheries and marine regional management.

Users of results: Scientific community, managers of coastal areas in the NW-MED PSS region

Dissemination of results: Results will be made available as peer-reviewed publications and presentations in conferences related to coastal ocean dynamics.

Links: Links to WP1 for multidisciplinary integrated observations approach, WP 5 and 6 for infrastructures and data management, WP 7 (technological innovations introduced within specific PSS infrastructures), WP9 (sustainability of observations), WP10 (communication), WP2 (interaction with complementary RIs in the region), WP11 (VA of data).

NW-MED PSS #2: Impacts of river discharge to coastal ecosystems,

Objectives: This Action deals with the quantification and characterization of riverine inputs of particles as well as nutrients and contaminants and estimate their potential impact in the coastal adjacent area (accumulation rates and impact on benthos, partition between deposit and plume). Mediterranean rivers are characterized by short-term but violent flash-flood events. There is a need to augment and coordinate regional river observations of riverine particle load and their coastal impacts and develop scenarios how riverine inputs and flooding may affect coastal ecosystems and how it should be observed.

Action Lead and other Partners (with contact persons): CNRS (Bourrin), CNR (Cantoni), UPC (del Rio)

JS3 Platforms included: ILICO gliders, coastal buoy (CNRS), HF radar network (CNR), Corsica Channel mooring with imaging (CNR), Coastal Ocean Observing, Forecasting and Monitoring System (SOCIB), OBSEA Expandable Seafloor Observatory (UPC), PORTUS observing and forecasting system (PdE). Additional infrastructure: Gliders (SOCIB), HF radars (CNRS, PdE), buoys (CNRS, PdE, SOCIB), tide gauges (PdE), coastal moorings, river stations (CNRS, SAIH Ebro), monitoring by R/V (SOCIB, CNRS).

Other data sources and external partners for implementation: IFREMER (Verney, Pairaud) for land to sea interface particle fluxes and behavior in the coastal area for the Rhône River. Ocean colour data (COPERNICUS) for turbidity in front of rivers. DANUBIUS-RI (Ebro delta, Vicente Gracia Garcia, UPC)

Overall timetable of action: January 2021-August 2022

Description of action: We will focus on 3 sub-actions:

A) We need to increase transnational access to databases for river input data in terms of river discharge, particle and nutrient loads. There are national databases (Spain, France, Italy) and even local databases which need to be gathered and mentioned in the same document. Timetable: due at the end of 2021.

B) Extreme events such as flash-floods are typical of the Mediterranean climate and can have a strong impact (economic, coastal erosion, and biological impact). There is a need to access high-frequency and high-resolution data through coastal monitoring stations (buoys, gliders) and satellite data, to address those impacts. We propose here to focus on extreme events (i.e. Gloria events of January 2020) which affected the whole NW-MED Sea to access the impact of such events in the coastal area. We will gather all available data or papers from this extreme event and analyse the impact on each side of the NW-MED PSS. Timetable: due in August 2022

C) We propose here to design a suitable research infrastructure and conduct experiments to monitor the impact of extreme events (i.e. flash-flood and storm) on the coastal ecosystem in the Mediterranean environment. A joint monitoring of river inputs (from river quality station), coastal buoys, HF radar and glider will be set in the Ebro ROFI in fall 2021 to address the impact of potential events in the coastal area. A similar experiment was designed in the Rhone ROFI inside the DeltaRhone French project and will focus on the impact of riverine inputs to the delta and prodelta bottom sediments and associated benthic ecosystem. Timetable: due in August 2022

The definition of common questions should lead to answers based on local dataset. It should be followed by an enhanced collaboration across river-coastal systems to define commonalities and differences between the systems. This would lead to a better understanding of the main common constraints on these marine systems, and thus a better understanding of the main drivers of their functioning. These actions would require the organisation of an inter-system workshop (or mini-conference with round tables) at the JERICO level for several river-coastal systems (with all PSSs and IRSs having river-coastal activities).

Best practices used or developed: The Action will apply best practices defined in DANUBIUS to JERICO-S3 river system network

Data flows: The Action will check interoperability of river quality databases. Experimental data (gliders, buoys, river stations, HF radar) will be available to JERICO-S3 consortium.

Data QC routines: QC routines from regional observatories will be adapted to those employed in DANUBIUS-RI.

Data management issues: Databases are hosted by the different national agencies and there is no common database.

Expected results: Gather regional river databases following DANUBIUS-RI best practices and QC routines. Define a research strategy to observe river inputs and their impact in the coastal area at the level of Mediterranean systems (and others). An example experiment following the defined research strategy will be tested in the Ebro delta in fall 2021.

Users of results: National water agencies, marine protected areas

Dissemination of results: Results will be disseminated in NW-Med PSS meeting and J3 general assembly. Results could also be disseminated inside DANUBIUS-RI meetings.

Links: Link to Po River system in the Adriatic system (WP3), Ebro River in DANUBIUS-RI (WP2).

NW-MED PSS #3: Extreme events affecting phytoplankton - AQUACOSM collaboration II

Objectives: Phytoplankton communities are affected by extreme coastal events and global warming. Phytoplankton is often responding very rapidly to perturbations and impacts of those cannot always be studied effectively using observations only, but an experimental approach is required. The strategic plan of this Action is to improve synergies between JERICO-S3 observing community and AQUACOSM-plus mesocosm experimenting community in studying dynamics of coastal phytoplankton populations. The Regional Data of NW-MED PSS can be used to identify the range of the water temperature, conductivity, turbidity, nutrients, timing of phytoplankton bloom, etc. Such information can improve the mesocosm experimental plans and protocols, in defining realistic experimental treatments. In addition, the range of some other parameters such as dissolved organic carbon (DOC) concentrations and water temperature can be considered for an experimental mesocosm investigation to study separate and combining effects of DOC load and temperature increase in the phytoplankton community responses.

Action Lead and other Partners (with contact persons): CNRS (Mostajir), CNR (Cantoni)

JS3 Platforms included: All platforms providing data on extreme events and global warming: gliders, buoys, rivers, ships. ILICO gliders, coastal buoy (CNRS), HF radar network (CNR), Corsica Channel mooring with imaging (CNR), Coastal Ocean Observing, Forecasting and Monitoring System (SOCIB), OBSEA Expandable Seafloor Observatory (UPC), PORTUS observing and forecasting system (PdE); Additional infrastructure: Gliders (SOCIB), HF radars (CNRS, PdE), buoys (CNRS, PdE, SOCIB), tide gauges (PdE), coastal moorings, river stations (CNRS), monitoring by R/V (SOCIB, CNRS).

Other data sources and external partners for implementation: AQUACOSM-plus data/results and experiments. Additional collaborations may be achieved by opening this mesocosm experiment through transnational Access (TA) of AQUACOSM -plus.

Overall timetable of action: Experiment spring 2021

Description of action: The Action shows the use of observation data to improve experimental mesocosm plans, contributing to more realistic treatments. In addition, mesocosms experiments would help scientists (observers) to parametrize specific processes in “controlled” conditions, processes difficult to observe and understand fully on the field (need to modify/adapt measurements frequency, additional variables, etc.). Combining experiments and models, the results could provide answers on the trends and anomalies recorded in the time series.

A mesocosm experiment to simulate an “extreme event”, alone, and combined also with water temperature increase was scheduled to carry out between April 19 and May 21 of 2021 (if COVID restrictions permit). This experiment will be realized in the frame of French ANR national project entitled: *Microbial responses to terrestrial dissolved organic matter input in freshwater and marine ecosystems in a changing environment (RESTORE)* on the MEDIMEER infrastructure (https://www.aquacosm.eu/mesocosm/medimeer).

Best practices used or developed: Best practices created and used by JERICO-RI and AQUACOSM-RI communities are compared.

Data flows: The data produced or measured during the mesocosm experiment by participants benefiting from TA of AQUACOSM-plus will be registered in the AQUACOSM-plus web site.

Data QC routines: QC of experimental data is done according to AQUACOSM-plus practices.

Data management issues: Experimental data is available through ANR project members, according to their Data Management Plan.

Expected results: Primary result of the topic, jointly with similar topics under GoF PSS and CRETAN PSS is advancing the communication between different coastal marine research disciplines, in studying similar phenomena. Experimental results obtained will guide the sampling strategies for future improvements of observations. On the other hand, information from observations will guide the determination of realistic experimental plans in future experiments. Collaborative schemes created for the region and for pan-European communities will facilitate future collaboration for various scientific questions.

Users of results: Scientific community, science-based management of the area.

Dissemination of results: Results will be disseminated both in the JERICO-RI and AQUACOSM-RI communities in their annual meetings. Additional dissemination in scientific workshops and in between-RI events, by publishing the results of the collaboration between two communities of observation and experimentation as "Success Story".

Links: Strong links between PSSs and to AQUACOSM-RI community are evident. Additional link between RI-collaboration in WP2, T2.2, showing how the collaboration within region and between regions may be arranged.

NW-MED PSS #4: Biogeochemical data and ocean colour products

Objectives: Harmonise and implement joint QC for regional data (biogeochemical and optical) to improve regional ocean colour (OC) and BGC regional models products. This action will consist in the elaboration of matchups between OC derived products and in situ measurements (Chla, SPM, turbidity, IOP) for the whole PSS. For regional models, there is still a need of in-situ data to evaluate the performance of BGC models, including nutrients (nitrate, phosphate, silicate), oxygen, chlorophyll-a and carbon-related variables (pH, pCO2, DIC, ALK, DOC, POC). At the end, this action will establish the needs in terms of BGC/optical variables for in situ coastal observations to improve models and quality of ocean color products for coastal waters. It will help to elaborate new BGC indicators for the NW-MED, indicators useful for end-users and stakeholders: acidification (pH indicator), eutrophication/hypoxia (nutrient and oxygen indicators), HABs (chlorophyll-based indicator) and water quality (chlorophyll-based indicator or SST) with applications for future CMEMS services. [Action is a combination of original topics v and vi]

Action Lead and other Partners (with contact persons): CNRS (Coppola, Doxaran, Ulses), SOCIB (Allen)

JS3 Platforms included: Several JERICO platforms: gliders, coastal moorings, buoys, repeated R/V cruises. Other platforms: ocean colour satellite products, Argo floats

Other data sources and external partners for implementation: Other data sources include CMEMS, in situ data for cal/val (BOUSSOLE), coastal gliders from CNRS, model SIROCCO SYMPHONIE-Eco3MS from CNRS and Mercator BGC forecasting models. The Action connects to external partners ACRI, MERCATOR and LEGOS.

Overall timetable of action: Spring 2021 - summer 2022

Description of action: For BGC regional models, a focus of CO2 variables and O2 between the water column and the atmosphere in the shelf area is planned in the Gulf of Lion (SIROCCO SYMPHONIE-Eco3MS). The BGC in situ data will also be used in assimilation, a field under development at Mercator as well as at our European partners within the framework of CMEMS. For the coastal environment, the aim is to improve river inputs (nutrients, carbon and suspended solids) as well as exchanges with the sediment. For OC products, cal/val method will be applied for coastal waters using existing in situ data and algorithms.

The Action aims to avoid duplication of efforts by coordination of existing and new infrastructures across the PSS observing and forecasting platforms and networks. It will adopt common strategies, standards and dissemination routes with a focus on common EOVs.

The Action will use the regional knowledge of marine BGC to support the QC procedures and the validation of OC derived products compared to in situ data. The spatial representation of OC products will complete the punctual sampling of in situ sensors (gliders, buoys) and could provide a consistent and comprehensive picture of the daily situation.

Having identified societal and scientific requirements for biogeochemical observations, monitoring and forecasting, we will coordinate existing infrastructures to leverage the individual elements for connective multi-parameter analyses across the NW-MED region.

The BGC platforms are already active in the PSS area. For satellite QC products, the in situ sampling points will be listed and will be used for the automatic matchup tool. For moving devices, a list of locations will be updated every week/month to compute and deliver the matchups.

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

Best practices used or developed: The Action applies best practices developed in EURO-ARGO ERIC and EMSO-ERIC

Data flows: BGC EOV observation data flows into EMODnet. Satellite products are obtained from CMEMS, EUMETSAT and HERMES data server. SYMPHONIE-ECO3M & Mercator products are available in CMEMS

Data QC routines: Automatic flags (clouds, haze, glint, hilt) are implemented in satellite data processing software (e.g., in the Sentinels Application Platform: http://step.esa.int/). Protocols have been defined and recently updated for ocean Color product validations in comparison with in situ measurements (EUMETSAT 2019).

Coastal moorings will follow EMSO-ERIC & OceanSites QC protocols.

Glider inter-calibration techniques will follow the recommendations of EURO-ARGO ERIC (e.g. O2, Chla).

Data management issues: The validity of ocean colour algorithms in turbid and highly absorbing coastal waters still represents an issue. This must be highlighted by ocean colour experts. A significant effort is still required to multiply quality matchups between satellite and in situ data in such waters, notably using autonomous field platforms.

Expected results: Validated ocean colour satellite products (water turbidity, concentrations of suspended particulate matter and chlorophyll-a with associated uncertainties). Harmonising approaches across the PSS will provide the synthesis for quantifying critical region wide processes such as community and export production, nutrient cycling, ocean acidification, coastal eutrophication and pollution.

Users of results: Persons in charge of water quality monitoring based on in situ field sampling and scientists in charge of biogeochemical models and in situ observations (eg. time series)

Dissemination of results: during regional/MONGOOS workshops and annual JERICO-S3 meetings

Links: T2.4 to improve connectivity and identifying the gaps, WP5 & WP6 to elaborate best practices on BGC variables and QC procedures.

NW-MED PSS #5: RI interactions

Objectives: Establish strong links with existing open ocean and land-coastal RIs EMSO-ERIC, EURO-ARGO ERIC, EMBRC-ERIC and ICOS ERIC, to secure littoral-coast-open sea continuum in observations and modelling. The open sea observatories, especially EMSO-ERIC, will provide open access data for NW-MED PSS needs and the expertise on biogeochemical sensors and QC procedures will be shared. The repeated observations of biodiversity in the PSS region (through imagery and genomics approaches) is also a strong opportunity to set up interactions between EMBRC-ERIC and JERICO and reinforce collaborations between the communities.

Action Lead and other Partners (with contact persons): CNRS (Coppola), UPC (del Rio), SOCIB (Allen), CNR (Cantoni, Bozzano)

JS3 Platforms included: Coastal moorings & buoys, seabed platforms (OBSEA)

Other data sources and external partners for implementation: AQUACOSM: see Action #3; EURO-ARGO ERIC: BGC-Argo floats are deployed regularly in the PSS area; EMSO-ERIC: fixed observatories (cabled and standalone): Dyfamed, Albatross, Lion; ICOS buoys: W1M3A, Dyfamed; Benthic crawler in EMSO-ERIC Ligure will be deployed in 2020 for observing and monitoring the deep-sea environment in the nearshore NW-MED in the framework of EMSO-France.

Overall timetable of action: Spring 2021-Aug 2022

Description of action: In the NW-MED PSS there are strong interactions between RIs regarding the platforms locations and variables observed. To harmonize efforts and investments, the Best Practices and data QC procedures will be proposed for the different RI platforms considering the specific needs for JERICO-RI (variables accuracy, biofouling maintenance…). Joint workshops/projects between RIs should reinforce the interactions. A pCO2 sensors calibration exercise from ICOS is planned in June-July 2021. EMSO-ERIC and JERICO-PSS partners will join this exercise (CNRS, CNR). In this PSS, imagery and genomic approaches in observing systems have started between EMBRC-ERIC and ILICO during repeated summer cruises (MOOSE-GE) in order to improve the impacts of climate/anthropogenic changes on biodiversity. In EMSO-ERIC a benthic crawler and oxygen electrode will be deployed in 2021 in EMSO-ERIC Ligurian Sea. This oxygen sensor will be used near the Rhone delta area in 2021 for oxygen inventory in the sediments (ILICO site).

Best practices used or developed: Many RIs have already produced BP (ICOS ERIC, EMSO-ERIC and EURO-ARGO ERIC). OceanSites & EMSO-ERIC will work on a new version of BP with EUROSEA WP3.

Data flows: Existing data flows from others RIs

Data QC routines: Existing GDACs (as CORIOLIS) manage Argo, EMSO-ERIC/OceanSites, gliders, GO-SHIP datasets with QC and format procedures. They are based on different cookbooks established during DMT meetings. These cookbooks allow to harmonise data QC procedures provided by different platforms. OBSEA is using QARTOP QC routines to flag real time data generation. Some discussion and demonstrations took place within some EMSO-ERIC partners to use such routines

Data management issues: For EMSO-ERIC discussions with the global consortium (OceanSites) is planned through H2020 EUROSEA WP3 to improve and establish common BP and metadata catalogue. This includes especially BGC variables provided by moorings.

Expected results: BP and QC procedures common for several RIs

Users of results: Scientists, operational oceanography

Dissemination of results: Through RIs disseminations (workshops, reports, annual meeting)

Links: T2.2 and WP5 for best practices

NW-MED PSS #6: Transnational integration

Objectives: The NW-MED will promote integration of the regional and European initiatives like MONGOOS (EUROGOOS) and UNEP-MAP to disseminate results, new products and to align its strategy (new variables, new tools) towards a regional integrated observing system. The PSS products will be presented regularly during MONGOOS and EUROGOOS workshops and general assemblies.

Action Lead and other Partners (with contact persons): CNRS (Coppola, Bourrin), PdE (Pérez Gómez), SOCIB (Allen), UPC (del Rio), CNR (Cantoni, Berta)

JS3 Platforms included: All JERICO-RI platforms will be involved here:

Other data sources and external partners for implementation: MONGOOS observation task team

Overall timetable of action: Summer 2021-Summer 2022

Description of action: A data flow assessment will be performed for the NW-MED PSS observation platforms, to ensure their availability and contribution to existing regional programs or activities, identify potential improvements and provision of new data, detect gaps and deficiencies, and generate recommendations. The most relevant programs in the region are: MONGOOS, UNEP-MAP, EuroGOOS (EuroGOOS Coastal Working Group), and CMEMS.

The PSS community is represented through the MONGOOS observations task team and it will promote the PSS initiatives and products during annual workshops and GA. The EuroGOOS Coastal Working Group will be connected to the PSS community in the analysis of the entire value chain from coastal observations (in-situ and satellite), to models, products and services for final coastal users, along European coasts. In this context, the PSS will harmonize its strategy by getting closer to this group. The In Situ TAC of CMEMS ensures a consistent and reliable access to a range of in situ data for the purpose of service production and validation. The PSS will promote the in situ observations activities and new variables to disseminate its actions.

Best practices used or developed: Not relevant for Action

Data flows: Not relevant for Action

Data QC routines: Not relevant for Action

Data management issues: Not relevant for Action

Expected results: Identification of gaps, problems and new products & variables of interest for the mentioned programs and activities

Users of results: task team leaders, MONGOOS coordination

Dissemination of results: Workshops, reports, collaborations through joint promotion with CS PSS and Adriatic IRS to MONGOOS, UNEPMAP

Links: to WP2

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

4.3. Implementation strategies: North Sea and English Channel Pilot Supersite

J-S3 Subtask 4.3.3. Pilot Supersite at North Sea and English Channel; NSEA PSS and CHANNEL PSS (Lead partners HZG, IFREMER, partners AWI, CEFAS, CNRS, DELTARES, IMR, NIVA, RBINS, RWS, VLIZ)

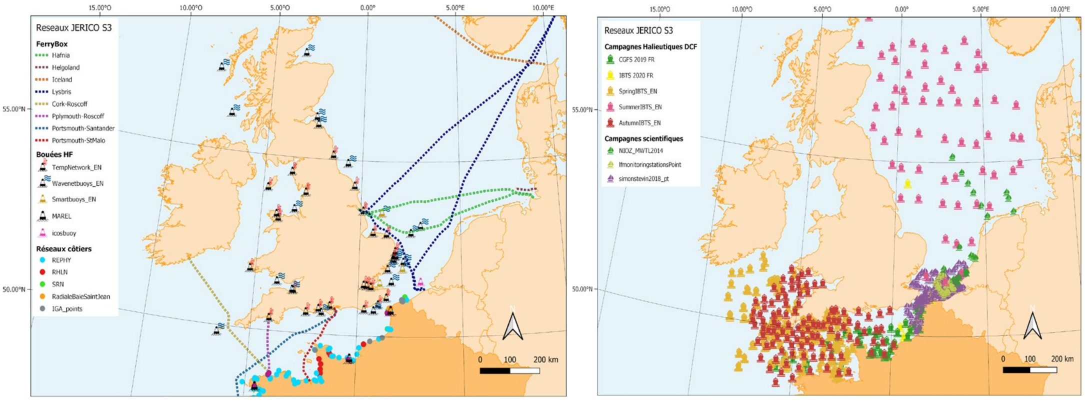

Figure 6. Left, a map showing the region of the NSEA and CHANNEL PSSs with FerryBox routes (existing, potential and stopped routes). Stationary platforms and other measurement platforms operated by the partners are also mapped and listed in the table below. Right, a map showing the locations of the main sampling stations from ecosystemic/scientific cruises.

Table 10. Platforms of NSEA and CHANNEL PSS

Operational observation systems & platforms in the region	Operational status	Parameters
MAREL Carnot instrumented station (IFREMER)	Operational from 2005 onward	Temperature, salinity, turbidity, fluorescence, oxygen conc. + Nutrients, PAR and meteo to be implemented in 2021.
Smile buoy (Ifremer, CNRS)	Operational from 2017 onward	Temperature, salinity, turbidity, fluorescence, oxygen conc.
Scenes buoy (Ifremer)	Operational from 2017 onward	Temperature, salinity, turbidity, fluorescence + benthic lander: Temperature, salinity, turbidity, waves, currents
Astan buoy (CNRS)	Operational since 2007	Temperature (air/water), wind, atm. pressure, salinity, fluorescence, oxygen, pCO2

Warp and /WestGabbard (2 x SmartBuoys)	Operational 2000	Temperature (water), salinity, fluorescence, oxygen, turbidity, PAR (0, 1 and 2 meters), phosphate, silicate, ammonia, nitrate, nitrite, phytoplankton (species abundance)
Thornton buoy (VLIZ)	Operational since 2015	Temperature, salinity, conductivity, pH, turbidity, dissolved oxygen, current intensity
Benthic Lander MOW1 (RBINS)	Operational since 2005	Temperature, salinity, acoustic and optic backscatter (turbidity and SPM concentration), turbulence, current velocity, suspended particle size
Lysbris FerryBox (HZG)	operational (routes changed in 2019)	fluorescence, DO, pCO_2, pH, salinity, temperature, turbidity, TA
Magnolia Seaways FerryBox (HZG)	operational	CDOM, fluorescence, DO, pCO_2, pH, salinity, TA, temperature, turbidity
FunnyGirl Ferry Box (HZG)	operational (April - October)	CDOM, pH, DO, fluorescence, salinity, temperature, turbidity,
Cuxhaven (stationary) Ferry Box (HZG)	operational	DO, salinity, temperature, CDOM, fluorescence, PAR, pH, turbidity, phosphate, silicate, ammonia, nitrate, nitrite
Norrona FerryBox (NIVA)	installed, but has technical issues, and we cannot access the ship due to COVID	salinity, temperature, turbidity, chl a and cDOM fluorescence, DOsat, DOconc, pCO_2/pH (in 2021)
Connector FerryBox (NIVA / RWS)	installation is delayed, but we expect installation to be complete by early 2021.	salinity, temperature, turbidity, chl a and cDOM fluorescence, DOsat, DOconc, pCO_2/pH (in 2021)

RV Thalassa FerryBox (IFREMER) RV Côtes de la Manche (CNRS) RV Antéa (IRD) RV Sepia II (CNRS)	FB operational since 2018	Temperature, salinity, oxygen conc. and saturation, turbidity, spectral fluorescence. Temperature, salinity, possibility of connecting other sensors Temperature, salinity, possibility of connecting other sensors Temperature, salinity, possibility of connecting other sensors
RV Cefas Endeavour FerryBox (CEFAS)	since 2009	Temperature, salinity, fluorescence, turbidity, oxygen, spectral fluorescence (possibility connection with flow cytometry)
RV Simon Stevin underway system (VLIZ)	Operational since 2001	Temperature, conductivity, turbidity, oxygen, nutrients (nitrate, phosphate and silicium), surface pCO_2 and fluorescence
COSYNA Helgoland cable observatory (AWI/HZG)	Operational since 2012	Temperature, salinity, turbidity, fluorescence, oxygen, underwater camera system
Vertical Profiling Lander Helgoland (AWI/HZG)	Operational since December 2020	Temperature, Salinity, turbidity, fluorescence, plankton and particle imaging, seafloor properties

NSEA PSS #1 Harmonised observations of regional C fluxes.

Objectives: At NSEA-PSS, regional data is augmented with data related to carbon cycling, which will advance the regional carbon budget by improving coherent observations of regional C fluxes (air-sea, land-sea, pelagic-benthic, and microbial processes). First objective will be to harmonise measurements from available platforms in the NSEA-PSS, including applying respective QA/QC. Whenever possible, data will be harmonized with available measurements from the ICOS ERIC. After this is achieved, another objective will be to combine the quality-controlled data with available models and earth observations.

Action Lead and other Partners (with contact persons): HZG (Voynova, Möller, Brix), NIVA (Frigstad), AWI (Fischer, Bussmann), DELTARES (Blauw), IMR (Wehde)

JS3 Platforms included: FerryBox: Lysbris Seaways (HZG), Magnolia Seaways (HZG), FunnyGirl (HZG), Norrona (NIVA), Connector (NIVA/RWS, projected), Cabled observatory COSYNA Helgoland and Profiling Lander (AWI, HZG); Additional infrastructure: monitoring by R/V

Other data sources and external partners for implementation: RWS monitoring programme including precise measurements of pCO2, pH, DIC and alkalinity and satellite images and remote sensing algorithms developed. DANUBIUS-RI infrastructures delivering river data

Overall timetable of action: Dec 2020 - Aug 2022.

Description of action: To create carbon budgets for a large shelf sea such as the North Sea a coordinated effort and methodology to capture natural and anthropogenic variability as well as trends is needed. This is especially relevant for analysing and closing measurement gaps. Measuring both greenhouse carbon compounds (CH4 and CO2) in the dissolved and atmospheric phase together with basic oceanographic and meteorological data will allow better understanding of sea - air flux of these compounds and is necessary. The Action will investigate the coherence of current carbonate system parameters in the NSEA-PSS ($p\mathrm{CO_2}$, pH, A_T, DIC) available from partners involved in NSEA-PSS region (HZG, NIVA, AWI within JERICO-S3, and other relevant partners). It compares available operational data to data from the ICOS ERIC, from the SOCAT database measurements, as well as from other available measurements (example: Macovei et al., in review). Transfer of knowledge will be facilitated through a collection of available data, information and data base locations that will be made publicly available. Active cooperation with other RIs, especially DANUBIUS-RI, will be established and expanded

Best practices used or developed: Currently we are working on SOPs for automated carbonate system sensors from SOOPs, in relation to best practice for operation, but also data quality control. This is still being explored and developed within the scientific community. Furthermore, best practices of biological imaging with respect to high-resolution observation and quantification are developed in collaboration with partners in WP6.

Data flows: Information about location of data will be collected. Data managers will be contacted to facilitate cross referencing and data exchange whenever possible. For instance, databases such as the HZG's COSYNA database, AWI's O2A and Pangea will be included. Data will be shared with Deltares to allow model validation and 'smart interpolation' in time and space. Imaging data will be transferred to EcoTaxa (contribution to WP11) and OBIS via new developed API (WP6 effort)

Data QC routines: Data (e.g., from SOOPs) that are reported in near real time are usually QC'd automatically and need to undergo the process of delayed QC before they can be assigned finalized data quality flags. Carbonate system parameters in particular require rigorous and delayed mode QA/QC. Existing processes for QA/QC will be analysed and to the extent possible harmonized.

Data management issues: N/A, but QA/QC procedures will be investigated and alignment between institutions will be initiated, data archiving options explored.

Expected results: Improved understanding of carbon budgets including the sea to air flux of GHG CH4 & CO2, support for identification of gaps

Users of results: Scientists within the carbon community, scientists and stakeholders within the NSEA PSS, and other regions within JERICO-S3.

Dissemination of results: Results will be disseminated to the scientific community, and to relevant stakeholders through reports within JERICO-S3, scientific publications, and workshops and international meetings.

Links: WP2 (connection to other RIs, tasks 2.3 and 2.4), WP3 (IRS), WP5 (Harmonization), WP6 (task 6.3.3). DANUBIUS-RI, ICOS ERIC

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

NSEA and CHANNEL PSS #2 Riverine input to the North Sea.

Objectives: This task aims to compile data of river water runoff and composition from different ongoing measurements. The purpose of this analysis will be the creation of temporally and spatially explicit information about carbon and nutrient transport from land to the North Sea and the Channel that can be used as input values and/or boundary conditions for carbon and nutrient budgets. Collaboration with other RIs (especially DANUBIUS-RI) is central for this task.

Action Lead and other Partners (with contact persons): HZG (Brix, Voynova, Kaiser), AWI (Fischer), DELTARES (Blauw), NIVA (King, Frigstad),

JS3 Platforms included: FerryBox Land Station Cuxhaven (HZG), Simon Stevin (VLIZ)

Other data sources and external partners for implementation: many state/country governments provide access to data from monitoring stations, e.g. France (https://sextant.ifremer.fr/ and http://hydro.eaufrance.fr/), Germany (http://undine.bafg.de/index.html), Netherlands (https://waterinfo.rws.nl/#!/nav/index/), Denmark (https://arealinformation.miljoeportal.dk/html5/index.html?viewer=distribution), and Norway (Vannmiljø (miljodirektoratet.no))

Compiled databases/repositories are kept by e.g., NIOZ (Texel, Netherlands) and IfM (Hamburg, Germany)

Overall timetable of action: Dec 2020 - Aug 2022.

Description of action: This task aims to compile data of river water runoff and composition from different ongoing measurements. Due to their heterogeneity in spatio-temporal resolution, in the number and type of recorded parameters and metadata, and in the ease of access, harmonization of metadata and data quality control is needed. This task will therefore compile available information, enabling tracking, for example, the effects of land use change and extreme events, as well as corresponding changes in estuarine and coastal biogeochemistry and their bottom-up consequences including changes in eutrophication status and phytoplankton production and biodiversity. Concentrated information of riverine inputs will also aid the improvement of descriptors of (coastal) ecosystem status. This work will make use of the collaboration efforts with DANUBIUS-RI and will also facilitate cooperation with the NW-MED PSS. This task will contribute to the identification of observational gaps in data availability and measurement efforts.

Best practices used or developed: Investigation of state-of-the-art BP with regard to metadata.

Data flows: Data sources will be compiled in a document and made available to all interested parties. The project will work towards a shared database, the structure of which is yet to be determined with guidance from WP6 and DANUBIUS-RI.

Data QC routines: Issues regarding harmonization of units, timestamps, parameter codes, missing value place holders; screening of existing QC flags in the data; application of one (established) quality flag system to all data; where/if appropriate additional statistical QC following existing standards/ recommendations (e.g., eurogoos.eu/download/Recommendations-for-RTQC-procedures_V1_2.pdf) will be noted.

Data management issues: given the large number of potential sources regular and consistent data acquisition cannot be predicted; a potential resulting database may be very large.

Expected results: easy to use inventory and access possibilities to harmonized river water discharge and composition data for the North Sea PSSs; common statement with regional DANUBIUS-RI sites/representatives on data exchange and standards.

Users of results: scientific community, other RIs (incl. DANUBIUS-RI), potentially government agencies / management

Dissemination of results: website (hosting either at HZG or through JERICO), communication / report of results to DANUBIUS-RI

Links. Links to other PSS (especially CHANNEL PSS, joint studies, shared best practices, merging data for pan - European products)

Link to other WP2 regarding cooperation with DANUBIUS-RI

Link with regional DANUBIUS-RI sites

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

CHANNEL PSS #3 Harmonised observations of plankton biomass, diversity and productivity dynamics.

Objectives: The English Channel and the southern North Sea are characterised by diverse ecosystems of strong hydrodynamical influence on biogeochemical and biological processes (as primary productivity) and plankton accumulation and dispersion, low to high riverine inputs, and significant connectivity to adjacent sea areas. These two marginal seas are considered as areas of medium to high productivity and recurring phytoplankton blooms (some of them being considered as Harmful Algal Blooms-HABs of potential impact on marine food webs as well as human health and economy). We aim to harmonise our in situ observation, and data processing to better characterise and understand the drivers of phytoplankton outbursts and community occurrence and changes at the different scales and consequently implement the ecosystem approach monitoring.

Action Lead and other Partners (with contact persons): CNRS-LOG (Artigas, Lizon), IFREMER (Lefebvre, Wacquet), CEFAS (Creach, Greenwood), Deltares (Blauw), VLIZ (Debusschere, Mortelmans), CNRS-BOREA (Claquin), RBINS (Fettweis), HZG (Voynova)

JS3 Platforms included: Thalassa (IFREMER), Côtes de la Manche (CNRS), Sepia II (CNRS), Antéa (IRD), RV Cefas Endeavour (CEFAS), Connector (NIVA/RWS), Simon Stevin (VLIZ); Buoys: ASTAN (CNRS), SMILE (IFREMER, CNRS), SCENES (IFREMER), WARP and WEST GABBARD (CEFAS), Thornton (VLIZ); Benthic lander MOW1 (RBINS); Fixed Station MAREL-Carnot (IFREMER); Additional infrastructure: monitoring by R/V.

Other data sources and external partners for implementation: The collection of phytoplankton biomass, diversity and productivity data is also carried out outside the framework of automated platforms, with measurements constituting time series along environmental gradients in the eastern Channel. These data are available in national data infrastructures as well physical, chemical and biogeochemical data. ICES databases, CMEMS products and EMODnet (biology, physics and chemistry) data infrastructures will be used if needed.

Overall timetable of action: Dec 2020 - Aug 2022.

Description of action: The practical work will include:

- Workshops (virtual and non-virtual) for:

1. discussing the way to implement QA/QC methods at sensor/platform level (spring 2021 and 2022), and to facilitate the data flow to the institutional, national (e.g. ODATIS, MEDIN) or European data infrastructures (SeaDataNet and EMODnet). The discussion will focus mainly on automated flow cytometry, imagery and multispectral fluorometry (link WP5 and WP6) (CNRS-LOG and all).
2. testing new data processing tools and approaches (link to WP7) between partners for improving the data flow and forecasting phytoplankton diversity and outbreaks (IFREMER and all)
3. sharing experience for measuring in situ primary production and investigating the use of the data in ecosystem approach monitoring (CNRS-LOG + CNRS-BOREA and all).

- Determine the added value of the data from emerging technologies in regular assessment for WFD and MSFD (Eutrophication, Biodiversity, Food Web) in combination with other approaches such as modelling and remote sensing (2022, CEFAS and all) (Link to actions # 4 and #8).

- Participating in common surveys (besides the regular ones) in 2021 and 2022 as a proof of concept for sharing best practices using guidelines from WP5 for emerging technologies (Flow cytometry, imagery and multi-spectrofluorometry) (VLIZ and all).

Best practices used or developed: We will test, develop and apply our best practices according to dedicated work on WP5.

Data flows: Data will be shared preferably from existing portals, so other partners can download and process the data with automated scripts that can be easily updated in the future. Where this is not feasible, the data files can be shared with other ad-hoc approaches, such as mails or cloud servers. Data flows will follow recommendations from WP6 (particularly subtasks 6.3.1 and 6.3.2 for phytoplankton data).

Data QC routines: Each institute is responsible for the QC on its own data. The data from emerging technology will follow the discussed and defined QC processes from WP5 (raw data treatment) and WP6 (processed data). Phytoplankton analysis will follow the OSPAR JAMP phytoplankton monitoring guidelines.

Data management issues: To be discussed in the frame of WP6.

Expected results: A realistic frame of what augmented approaches can be persistently implemented in both the NS and the EC, consolidating national observatories and RIs (as ILICO in France) and establishing lasting regional collaboration in common recurrently joint actions benefiting of the existing platforms and programmes, adding innovative approaches developed during JERICO- NEXT and other previous projects.

Users of results: OSPAR/MSFD working groups for eutrophication, biodiversity, food web and ocean acidification, marine researchers, national and European water managers and the scientific community.

Dissemination of results: actions will take place from January 2021 to August 2022 and the results will be presented in workshops, symposia and will be published; participation to ICES working groups (WGPME, WGHAB).

Links: Link to adjacent PSS (Baltic) and IRS (Bay of Biscay), and other remote PSS and IRS (i.e., with more contrasted conditions and trophic regimes: Iberian Margin (combined upwelling conditions), NW Mediterranean (meso oligotrophic), Northern Adriatic Sea (important blooms) Cretan Sea (oligotrophic) through workshop on harmonisation of best practices and data management (WP10). Links with WP5 (best practices in biological plankton sensors), WP6 (data management), WP7 (development/improving of software tools for automated data treatment and analysis), WP8 & WP11 (TA and VA), WP1 & WP2 (overall strategy and link with environmental management and policies).

CHANNEL PSS #4 Products for Eutrophication Status Assessment.

Objectives: High resolution (in time and/or in space) monitoring programmes from the Channel-PSS combines different types of biological observations across the region and will be used for demonstrating new shared products to support/complement eutrophication assessments as defined by EU Directives and Regional Sea Convention. These products should help to provide a final classification when there is some doubt about pressure/impact relationship for a given assessed eutrophication area.

Action Lead and other Partners (with contact persons): IFREMER (Lefebvre, Devreker), DELTARES (Blauw), CEFAS (Collingridge, Creach), CNRS (Artigas), VLIZ (Debusschere, Mortelmans)

JS3 Platforms included:FerryBox: Thalassa (IFREMER); RV Cefas Endeavour (Cefas); Buoys: SMILE (IFREMER, CNRS), SCENES (IFREMER), WARP TH1 and WEST GABBARD (CEFAS), Thornton (VLIZ); Fixed Station MAREL-Carnot (IFREMER); Additional infrastructure: low resolution monitoring by R/V.

Other data sources and external partners for implementation: SIMM/ODATIS data portal (coastal and offshore MSFD specific data) for data within Fr Marine Regions, ICES Database, VLIZ Database. External partners: OFB, Fr, (Vincent), French Water Agencies.

Overall timetable of action: Dec 2020 - Aug 2022.

Description of action: The action will communicate with MSFD Descriptor 5, OSPAR Eutrophication and WFD, aggregation and integration methods. It will contribute to data integration (*in situ*, satellite, modelling). The Action will provide a comparison of assessment results between EU Directives and Regional Sea Convention and between countries (transboundary issue). It will interact with policy makers and stakeholders towards better assessment and management plan definition working groups. It will contribute to the development of new metrics, thresholds and reference values.

Best practices used or developed: Work based on existing assessment methodologies (such as the MSFD Good Environmental Status assessment, the OSPAR Common Procedure) and ongoing development under specific national and EU research projects.

Data flows: MSFD data flow.

Data QC routines: QC from MSFD-supporting monitoring programmes.

Data management issues: MSFD data management (from national to regional level).

Expected results: Contribution to the optimisation and implementation of existing eutrophication assessment procedures with emphasis on procedure harmonization, data sharing and integration, shared transnational assessment results providing good basis for management plan issues.

Users of results: MSFD/OSPAR/WFD and scientific communities, stakeholders, Society at large.

Dissemination of results: MSFD/OSPAR/WFD specific reports; Accessibility to Fr reports via Archimer; contribution to MSFD/OSPAR/WFD Working Groups.

Links: Links to Bay of Biscay, GoF PSSs (shared products => contribution to a pan - European approach as needed for Directives and Regional Sea Convention implementation).

Links to EC PSS Actions #2 Riverine input to the North Sea and the English Channel, #3 Harmonized observations of plankton biomass, diversity and productivity dynamics, #5 Intercomparison of phytoplankton distribution using data integration, #6 Identification of Observational Gaps, #8 Support to EU directives and ecosystem management.

NSEA and CHANNEL PSS #5 Intercomparison of phytoplankton distribution using data integration.

Objectives: Create and integrate representation of phytoplankton combining different data sources: *in-situ* observations from various platforms and sensors, satellite data and model data. This activity involves a range of drivers of phytoplankton dynamics, including hydrodynamic transport, river loads (through models), underwater light climate and associated turbidity, and suspended particulate matter (SPM) dynamics. It aims at quantifying the impacts of phytoplankton dynamics in terms of eutrophication and carbon fluxes. This action will also evaluate the potential of merging multi-source knowledge to estimate the spatial and temporal variability of phytoplankton and SPM concentration in response to intense/extreme events and long-term trends.

Action Lead and other Partners (with contact persons): DELTARES (Blauw, Van Kessel), IFREMER (Lefebvre, Verney), CNRS (Artigas), CEFAS (Collingridge, Greenwood), VLIZ (Debusschere), HZG (Voynova) RBINS (Fettweis).

JS3 Platforms included: FerryBox: Lysbris (HZG), Magnolia Seaways (HZG), FunnyGirl (HZG), Thalassa (IFREMER), Côtes de la Manche (CNRS), Sepîa II (CNRS), Antéa (IRD), Norrona (NIVA), Connector (NIVA/RWS), Simon Stevin (VLIZ); Buoys: ASTAN (CNRS), SMILE (IFREMER, CNRS), SCENES (IFREMER), WARP TH1 and WEST GABBARD (CEFAS), Thornton (VLIZ); Benthic lander MOW1 (RBINS); Cabled observatory COSYNA Helgoland (AWI, HZG); Fixed Station MAREL-Carnot (IFREMER); Additional infrastructure: monitoring by R/V

Other data sources and external partners for implementation: Available satellite data on chlorophyll-*a*, suspended particulate matter, primary productivity and sea surface temperature could provide useful additional data with good spatial and temporal coverage.

Overall timetable of action: Dec 2020 - Aug 2022.

Description of action: Despite the presence of observational platforms in both the Channel and North Sea, observational infrastructures are operated by regional and national entities and have been hardly connected so far. Usually the field data are obtained from different locations and times and cannot be directly compared. Satellite and model data are available for the whole area (both Channel and North Sea) for long periods. For this action the models of DELTARES and IFREMER (ECOMARS-3D) will be used as 'smart interpolation' tools of observation data. These will provide coherent baselines in space and time to cross-validate the different available data sources and gain a better understanding of the drivers of spatial and temporal variability of phytoplankton and carbon fluxes and underlying nutrient and SPM concentration fields. Therefore, we will first start with creating the overview of available in situ and remote sensing observation data and making (part of) these data available for model validation. Processing of existing data files into coherent datasets that have comparable variable definitions with model variables will be done as far as feasible. Some data files may require too much work to be processed in this context or lack knowledge on how to convert them.

The Action will investigate how the aggregation of coastal observatory databases, satellite ocean colour databases and model results can resolve the spatio-temporal variability of phytoplankton, carbon and SPM dynamics. This question will be examined from regional to inter-regional and PSS spatial scales and will look for innovative methods to decipher the contribution of « expected seasonal dynamics », unexpected, rare or extreme events and long-term trends.

This action will not involve additional monitoring activities. However, the results of the comparison will provide information on the comparability of data from different platforms and equipment. This supports the planning of the next steps towards more coherent monitoring, which will possibly involve the sharing of platforms and equipment.

Best practices used or developed: N/A as no specific sampling planned.

Data flows: Partners collecting *in situ* marine data will share these data with other partners working on the comparison with satellite and model data.

Data QC routines: Each institute is responsible for the QC on its own data. When sharing the data with other partners involved, the metadata on applied QC procedures will be shared as well.

Data management issues: Data will be shared preferably from existing portals, so other partners can download and process the data with automated scripts that can be easily updated in the future. Where this is not feasible, the data files can be shared with other ad-hoc approaches, such as mails or cloud servers.

Expected results: The comparison of the various sources of *in-situ* data with coherent satellite and model data is expected to provide information on: 1) the comparability and quality of the sensor-based *in-situ* data and 2) the reliability of the satellite and model data and 3) possible next steps to reduce differences between information from different data sources.

Users of results: An integrated representation of eutrophication indicators (nutrients, chlorophyll-a) and biodiversity indicators (primary production and phytoplankton species composition) would enable more complete and coherent ecosystem assessments for OSPAR and MSFD. Furthermore, JERICO partners and OSPAR member states can improve their monitoring and QC strategies based on our experiences with combining data from different monitoring methods.

Dissemination of results: Results will be presented in relevant meetings of the project, conferences and OSPAR/MSFD meetings.

Links: This action will contribute to Action #6 (Identification of Observational Gaps) by identifying gaps in data availability and measurement efforts and is linked to tasks 2.3 (satellite data), 2.4 (linking across different scales and regions; coupling of observations and modelling communities) and task 2.5 (linking to political realm).

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

NSEA and CHANNEL PSS #6 Identification of Observational Gaps.

Objectives: Based on a census of existing monitoring programmes (low and high resolution strategies, incl. ecosystemic/scientific cruises, fixed stations, buoys and FerryBox/SOP, observational gaps will be analysed in both regions, especially related to biological and biogeochemical (including carbon cycle) variables (link to EOV, EBV concept). Analysing needs for institutional interactions will aim to improve regional integration of observations in forthcoming Supersites.

Action Lead and other Partners (with contact persons): HZG (Brix, Möller, Voynova), IFREMER (Lefebvre, Verney), CEFAS (Creach, Greenwood), Deltares (Blauw, van Kessel, Gwee), RBINS (Vanderzande, Fettweis), VLIZ (Debusschere), CNRS (Artigas, Lizon, Claquin), AWI (Fischer), NIVA (King), IMR (Wehde).

JS3 Platforms included: not relevant for this action.

Other data sources and external partners for implementation: To be defined in early 2021.

Overall timetable of action: Dec 2020 - Aug 2022.

Description of action: As gap analyses have so far only been done in a very local and not coordinated approach (if at all), a shared gap analysis will be undertaken taking the entire NSEA and CHANNEL PSS regions into consideration. In particular, the national partners will create an inventory of existing measurements of biological, biogeochemical and carbon cycle quantities, including riverine input data. Efforts will be made to begin investigating these inventories and recommendations will be formulated on how to fill the gaps.

Best practices used or developed: not relevant for this action.

Data flows: Topic will not collect new observation data but provide means for improved observation and data collection.

Data QC routines: not relevant for this action.

Data management issues: not relevant for this action.

Expected results: Overview of observational gaps in the EC and NSEA PSS, recommendations on how to address these gaps.

Users of results: scientific community, stakeholders, policy makers, RIs.

Dissemination of results: specific reports, oral communications and posters during working groups and colloquia/symposium during the course of the project.

Links: Links to other PSS (joint studies, shared best practices, merging data for pan - European products, shared use of tools for identification of gaps).

WP1 (feed into scientific concept), WP2 (connection to other RIs), WP3 (IRS), WP9 (design).

Links outside JS3: Links with scientific projects: CPER MARCO (Fr), CPER ROEC (Fr), CPER ObsOcean (Fr), InterReg S3 EUROHAB (Fr, UK), CPER Vallée de la Seine Phresque2 (Fr), GIP Seine Aval (Fr), ANR CO2COAST (Fr).

Links with EU Directives and Regional Sea Conventions working groups (focus on monitoring program's needs).

NSEA and CHANNEL PSS #7 Cross-regional communication between PSSs (North Sea and Channel).

Objectives: The aims of a cross-regional communication in the PSS are to highlight in situ technology innovation and implementation, investigate the possibility of transfer to each region of the PSSs (North Sea and Channel) as well as the platforms, and investigate how to share approach/tools and knowledge from experience between partners to be applied at the regional scales for scientific and societal purposes.

Action Lead and other Partners (with contact persons): CEFAS (Creach), HZG (Brix), IFREMER (Lefebvre), Deltares (Blauw), RWS (Enserink), VLIZ (Debusschere), NIVA (Frigstad).

Other data sources and external partners for implementation: not relevant for this action

Overall timetable of action: Jan 2021 - Dec 2022.

Description of action: communication will consist in:

- informing partners on status for actions #1, #2, #3 and #4 by the action leaders and possibility of closer collaboration with partners interested in the actions during specific workshops (GA of J-S3) and in between (virtually).
- Involve partners from the Channel and SE North Sea together for the specific actions like action #1 & 2 (Riverine input to the North Sea): IFREMER (Lefebvre, Devreker), VLIZ (Debusschere), CEFAS (Greenwood, Graves).
- Involve all partners and particularly agencies and organisations in charge of national water quality, biodiversity and food webs monitoring in action #8 (Support to EU directives and ecosystem management.): CEFAS (Graves).
- identify the users and their needs in the PSS area in collaboration with the subtask 9.2.

Best practices used or developed: not relevant for this action.

Data flows: not relevant for this action.

Data QC routines: not relevant for the action.

Data management issues: not relevant for the action.

Expected results: Definition of an optimised organisation in connecting between PSSs and with the users from other PSSs and RIs and JERICO-RI in general when developing PSS concept further.

Users of results: not relevant for the action

Dissemination of results: this action will use the communication channel of JERICO-S3 (WP10) for highlighting the main achievements in the PSS. Annual workshops during the GA of J-S3 and virtual workshops will be established.

Links (may be later aggregated in a table): link to WP1, WP2, WP9.

NSEA and CHANNEL PSS #8 Support to EU directives and ecosystem management.

Objectives: Strongly interface with WP2, task 2.5., this action will contribute to identifying new tools and products developed or optimised within the EC PSS to address WFD/MSFD/OSPAR water quality assessment needs. EC PSS tools and products will be used as proof of concept (from the sensors to the data, from the data to the indicators then, from the indicators to the environmental status assessment). Action #8 results should contribute to EU Directives and Regional Sea Convention monitoring programmes definition and implementation and, to coastal ecosystem assessment and management improvement (IFREMER, HZG, Deltares, RWS).

Action Lead and other Partners (with contact persons): RWS (Enserink), IFREMER (Lefebvre, Devreker), CNRS-LOG (Artigas), VLIZ (Debusschere), HZG (Brix), DELTARES (Blauw).

JS3 Platforms included: Not relevant for this task, as this is a networking activity.

Other data sources and external partners for implementation: networking activity including participation to MSFD, OSPAR, NOOS working groups => new partners and collaborations to be identified during the course of the project.

Overall timetable of action: Jan 2021- Aug 2022.

Description of action: The EC-PSS is part of the OSPAR Region II (Greater North Sea). One of OSPAR's tasks is to develop Quality Status Reports (QSR) in a 6-year cycle. These reports form the joint basis for OSPAR contracting parties that are also EU member states for their MSFD reporting. Eutrophication (MSFD Descriptor 5), Biodiversity - Pelagic habitats (Descriptor 1) and Food webs (Descriptor 4) are the main themes that link with the actions in this PSS.

For the next QSR 2023 an attempt will be made to involve tools that are currently used for the assessment of eutrophication (i.e., Satellite, buoys and ferry box observations, hydrodynamic modelling) in the assessments of eutrophication and biodiversity, notably pelagic habitats. This is also supported by a newly started EU project (NEA PANACEA). Some contributors to action #8 are also involved in this project and can thereby make a good link with the EC PSS.

Any new tools and products developed in the EC PSS may not be in time to contribute to the QSR 2023 but can be useful for the next cycle of assessments. Iterations with the relevant OSPAR groups will improve the suitability of the tools for the work of OSPAR. This will be done through the meetings of the relevant OSPAR groups, where members of this action's team are regular participants.

Best practices used or developed: networking activity.

Data flows: not relevant for the action.

Data QC routines: not relevant for the action.

Data management issues: not relevant for the action.

Expected results: Integration and implementation of new tools and products from the EC PSS (and NS PSS, through active collaboration via action #7) into EU Directives and Regional Sea convention assessment procedures.

Users of results: MSFD, OSPAR, JRC, EEA, NOOS, government authorities, stakeholders, policy makers.

Dissemination of results: Participation to and interaction with MSFD, OSPAR Regional Sea Convention and North West European Shelf Operational Oceanographic System

(NOOS) Working Groups according to their own schedules (Example: OSPAR Intersessional Group on Eutrophication in January each year) ; specific networking activities via Virtual Meetings ; specific contributions such as Meeting Document or communications during MSFD/OSPAR/NOOS meetings to highlight main results and share experiences.

Links: Links to WP2, Task 2.5 (Interfacing with monitoring programmes, non-European OOS and the political realm).

Link to products and services prototyped in WPs 3, 4 & 9.

Links to WP4 Bay of Biscay, GoF PSS (shared products => contribution to a pan - European approach as needed for Directives and Regional Sea Convention implementation).

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

NSEA and CHANNEL PSS #9 Interaction with other RIs on ecosystem studies, eutrophication, coastal management and carbon fluxes.

Objectives: PSSs will interface with other RIs (DANUBIUS-RI, EMBRC-ERIC, ICOS ERIC, LifeWatch-ERIC) by cooperating on key competences of PSSs and RIs on coastal ecosystem studies and data related to carbon cycling and eutrophication (nutrients particularly) which will advance the interaction with DANUBIUS-RI in resolving land-sea carbon and nutrients fluxes and to facilitate forthcoming collaborations. Particularly, the creation of a network of scientists is sought to be constructed that will allow for better coordination of shared research interests.

Action Lead and other Partners (with contact persons): HZG (Brix), VLIZ (Deneudt), IFREMER (Lefebvre).

JS3 Platforms included: Not relevant for this task, as this is a networking activity.

Other data sources and external partners for implementation: All RIs as listed in WP2, task 2.2, are identified where present and established contacts will be used to connect to these partners and establish mutual data access.

Overall timetable of action: Dec 2020- Aug 2022

Description of action: The Action will connect to other RIs within the PSS region to discuss data and information sharing, coordinate campaigns, identify overlap and gaps in measurement programs. Action will develop a roster of activities and people and develop shared sampling strategies. In addition, the Action will investigate data and technology sharing opportunities, compare approaches to data processing, storage and dissemination, use of FAIR principles and develop strategy to facilitate access to data, merge where possible. Action will share knowledge about existing dissemination and outreach efforts. The above will be actualized where added value can be found and existing connections can be exploited.

Best practices used or developed: Build on existing connections to inquire about best practices used and work toward.

Data flows: N/A

Data QC routines: N/A

Data management issues: N/A

Expected results: list of cooperation possibilities and facility overlap / synergies.

Users of results: scientists, public administrations, etc.

Dissemination of results: Report of Actions; Dissemination to other RI through, for example, activities in TNAs, reports at regional meetings; also as part of WP2 activities and deliverables.

Links. Links to other RIs and all J-S3 PSS and IRS sites (mainly during J-S3 GAs).

Links to other WPs in JS3 (e.g. citizen science, D2PTS ...).

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

4.4. Implementation strategies: Cretan Sea Pilot Supersite

JERICO-S3 Subtask 4.3.4. Pilot Supersite at Cretan Sea; CRETAN PSS (Lead HCMR, partners CNRS, NIVA, SYKE)

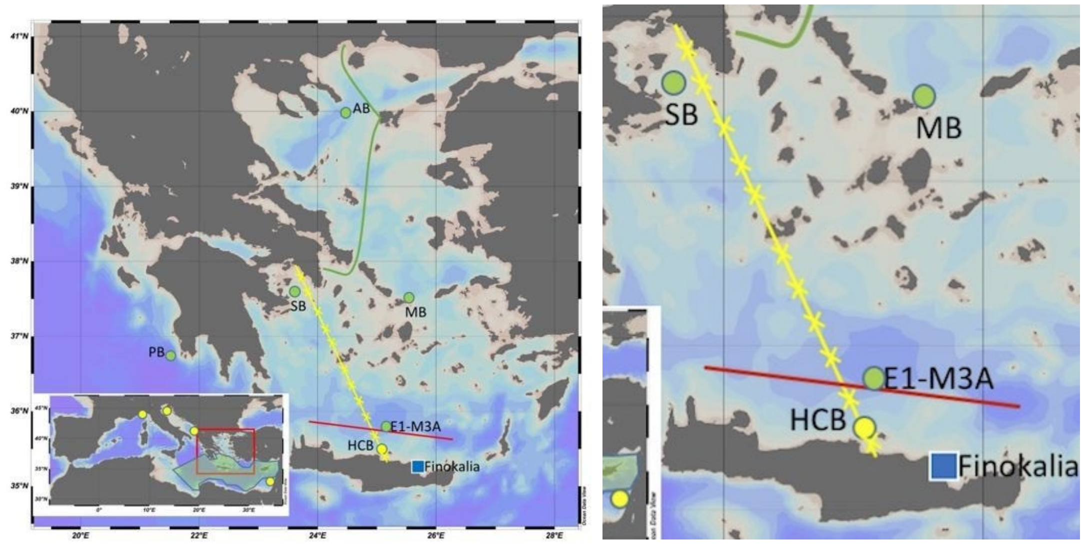

Figure 7. Map showing the location of the POSEIDON system platforms at CRETAN PSS (AB: Athos Buoy, MB: Mykonos Buoy, PB: Pylos Buoy, SB: Saronikos Buoy, E1-M3A Buoy), glider endurance line (red line) and Ferrybox routes (yellow and green line).

Table 11. Platforms in CRETAN PSS

Operational observation systems & platforms in the region	Operational status	Parameters
Ferrybox PFB	Interrupted due to upgrade. Planned to be back on in spring 2021	T, S, Fluo, O_2 +CO_2 planned +sampler planned
Fixed platform HCB,	Operational	meteo; SSS, SST; pH (sensorlab) air+water CO_2 (ProOceanus)
Fixed platform E1-M3A	Operational	meteo; SSS, SST; T, S, Chl-a, O_2 at 20, 50, 75, 100 m; T, S at 250, 400, 600, 1000 m
Fixed platform SB	Interrupted due to accident. Eventually back in fall 2021.	meteo; SSS, SST;

	Data from Mykonos buoy can be used instead	
Glider PG	Operational	T,S, O2 every 1m down to 1000m Monthly transects
Argo floats	OK (if available in the area)	T, S (O2)
Calibration Lab	Operational	T, S, O2, pH, Fluorescence
Monitoring by R/V	Operational	Monthly visits at HCB Biannually visits at E1-M3A -CTD cast (T, S, O2, Fluo, Turbidity, PAR, Phycoerythrin) -Niskin 2,10,20,50,75,100,120m (pH, CT&AT, inorganic nutrients, Chla, bacteria to phytoplankton) -zooplankton net

CRETAN PSS #1 Solubility and biological pumps

Objectives: Study air-sea CO_2 fluxes and pH using several tools/approaches to understand their variability and main drivers in an area where there is a sparseness of carbonate system data, pH trends are unknown and the existing AT-S relationships are inadequate. The action targets an optimum strategy in the area to understand its role as source or sink of CO_2 as well as the links between carbon, nutrients cycles and primary productivity.

Action Lead and other Partners (with contact persons): HCMR (Frangoulis), NIVA (King, Marty)

JS3 Platforms included: a) For carbonate variables: Core platforms: HCB, Ferrybox, Additional platforms: monitoring by R/V at HCB, Calibration lab (for pH analysis), lab for CT/AT analysis. b) For carbonate associated/interpretation variables. Core platforms: HCB, E1-M3A, Glider, Mykonos buoy or Saronikos Buoy. Additional platforms: Argo float data (when available in the area), satellite data

Other data sources and external partners for implementation: Other data includes, a) simulated sea surface pH, pCO_2 and PP from HCMR 3-D coupled model, b) nearby atmospheric station Finokalia (air pCO2) and nearest ICOS marine stations and c) estimates of carbonate system variables from temperature and salinity using existing or improved (see action #5) regional algorithms

Overall timetable of action:

Dec 2020 to Aug 2022: Carbonate system data collection from HCB (fixed platform + RV visits).

Jan 2022: Submission of CO_2 data to SOCAT

Oct 2021 to Aug 2022: Carbonate system data collection activities expanded to Ferrybox.

June 2022 to Aug 2022: estimates of carbonate system variables from optimum algorithms

Description of action:

Key PPS features: capacity to provide additional EOVs at required resolution. Multi-interface coverage. Collaboration elements: i) transfer of knowledge from other partners, ii) connecting with other regional initiatives measuring carbon parameters and iii) linking observations with modelling

Measurement of carbonate variables using the complementarity of a fixed platform (HCB, with regular RV visits) and FB. In addition, measurement of associate variables in all platforms, to allow interpretation of carbonate system variability and to test (improve) empirical algorithms providing estimates of carbonate variables (input of Action #5).

Best practices used or developed: contribution from/to Guidelines for carbonate system data management (T6.3.3.), providing recommendations for Best Practices

Data flows: (i) Carbonate system associated variables (T, S, meteo, O_2, Chl-a) handled, by CMEMS In Situ Thematic Assembly Center (INS TAC), (ii) carbonate system variables will be sent to related databases (e.g. SOCAT) with input from T6.3.3.

Data QC routines: QC procedures for carbonate system associated variables collected from POSEIDON platforms comply with the CMEMS INS TAC. Carbonate variables QC will be defined during the first year.

Data management issues: None expected at this stage

Expected results: Carbonate system data available via related databases (e.g. SOCAT). Improved understanding of the CO_2 solubility and biological pump functioning; creation of reference carbonate system database in the Eastern Med. New collaborative schemes for sustained carbonate system observations. Results on optimum sampling strategy (maximum number of variables, best platforms, data minimum frequency) (common with action #5).

Users of results: Scientists, ERICs (ICOS), Databases (SOCAT), educators, students, media, Regional Sea Conventions, Ministries, local authorities, UN Sustainable Development goals.

Dissemination of results: During the first year, progress disseminated via tweets and JERICO-S3, POSEIDON websites. First results shown in DL4.3. After the first year of data collection communication of the annual cycle results in meetings, related initiatives (e.g ICOS ERIC, SOCAT, EuroGOOS coastal group) and conferences.

Links: to carbonate system actions in other PSS; to ICOS ERIC, SOCAT, MonGOOS (via action #6 and T2.2), contribution from/to Guidelines for carbonate system data management (T6.3.3), VA of carbonate system data (WP11)

CRETAN PSS #2 Improved approximations of Primary Production

Objectives: Improve primary productivity estimates in oligotrophic waters where a large part of primary production is held most time of the year at depths that are not at satellite reach. Reliable measurements of PP are critical for understanding the carbon cycle and ecosystem function. Estimates will be done by optimising the quality of current datasets feeding model PP predictions and by going through innovative observation systems.

Action Lead and other Partners (with contact persons): CNRS-MIO (Thyssen), HCMR (Frangoulis, Tsiaras), NIVA (King, Marty), SYKE (Seppälä, Ylöstalo)

JS3 Platforms included: Core platforms: E1-M3A and HCB fixed platforms, glider. Additional platforms: RV visits at HCB and E1-M3A

Other data sources and external partners for implementation: Simulated Primary Production (PP) from HCMR 3-D coupled model (POM-ERSEM-HALTAFALL), supported/validated by in situ data from platforms (T, Chla, O_2, nutrients, plankton)

Overall timetable of action:

Dec 2020 to August 2022: In situ data collection for model improvement

Feb 2022 to August 2022: Upgrading model with data collected

Description of action:

Key PSS features. Collaboration elements: i) transfer of knowledge from other partners, ii) linking observations with modelling, iii) linking with industry on PP sensing devices

Upgraded model PP predictions tuned and validated against the collected data from several platforms: E1-M3A fixed platform (T, Chla, O_2 at 20, 50, 75, 100 m); HCB fixed platform (SST; pH, pCO2); glider (T, S, O_2 every 1m down to 1000m), RV visits at HCB and E1M3A (nutrients, plankton from subsurface until 120m). Focus will be given to improve quality of Chl-a data (better QA of fluorescence sensors- see Action #5). Links between in situ variables and remote sensing products will also be examined. Eventually also PP estimation data from sensors applied in situ (depending on outcome of Action #5)

Best practices used or developed: to be defined with input from subtask 6.3.2.

Data flows: in situ data handled by CMEMS INS TAC

Data QC routines: QC procedures comply with CMEMS INS TAC.

Data management issues: None expected at this stage

Expected results: improved understanding of primary production, prospecting deep layers (Deep Chlorophyll maximum) and of the implications to C export and trophic status. Evaluation of innovative sensors for trial and validation under oligotrophic conditions.

Users of results: Scientists (biologists, modelers), educators, students, EU directives (MSFD).

Dissemination of results: During the first year, progress disseminated via tweets and JERICO-S3, POSEIDON websites (common with in action #1). First upgraded model results shown in D4.3. Dissemination to modelling community workshops/conferences.

Links: Link to T2.4 for the coupling of observations and modelling communities. Direct links with WP5 and WP6 for data management and best practices for optical sensors. The use and testing of the elaborated best practices will be implemented. Link with Sea Water Sensing Laboratory @ MIO Marseille datasets and testing of similar tools will be done. Especially on the study of pulsed events. AQUACOSM studies on pulsed events will be combined for integrated study at the Mediterranean scale. Coupling between NW-MED PSS data sets on PP as an integrative study may arise.

CRETAN PSS #3 Extreme events affecting phytoplankton - AQUACOSM collaboration III

Objectives: The Action identifies the extreme events in the CRETAN PSS area. It studies the improved ways to analyse effects of extreme events on phytoplankton communities with existing systems, via multiple sensors, multiple platforms and mesocosms. In parallel, improved calibration practices for sensors used in oligotrophic conditions are examined. A joint mesocosm experiment is planned with AQUACOSM-plus, aiming to provide support in the continuous monitoring of phytoplankton responses in mesocosms. The Action improves regional synergies between experimental and observational marine communities studying the same ecological questions

Action Lead and other Partners (with contact persons): SYKE (Seppälä, Ylöstalo), HCMR (Frangoulis), CNRS-MIO (Thyssen), NIVA (King, Marty)

JS3 Platforms included: Poseidon Calibration Lab (PCL). Non JERICO-S3 platforms: HCMR mesocosm, HCMR underwater biotechnological park (UBPC)

Other data sources and external partners for implementation: Meteo, atmospheric data from nearby meteo and atmospheric stations (e.g. Finokalia)

Overall timetable of action:

Dec 2020 to Dec 2021: Collection of field data

Jan to April 2021: Analysis of field data to identify relationships to extreme events.

May 2022: Optimal sensors used in a mesocosm experiment with participation of HCMR, CNRS-MIO, SYKE, NIVA, and other partners from AQUACOSM-plus

Description of action: Key PPS features: Collaboration element between RIs JERICO-S3 - AQUACOSM-plus to address common themes, establish long-term cooperation with co-design actions and priorities setting.

Based on the outcome of various tests of sensors (see Action #5), a set of phytoplankton and carbonate JERICO-S3 tested sensors will be used during a mesocosm experiment simulating an extreme event. Planning of this activity will be made jointly with other PSSs having similar activities (GoF PSS, NW-MED PSS) and Task 2.2.

In parallel, analyse field data to spot relationships with various extreme events. Communicate outcome of analysis (parameters to monitor) to AQUACOSM-plus.

Best practices used or developed: exchange of procedures, practices, methodologies with AQUACOSM-plus.

Data flows: in situ data handled by CMEMS INS TAC. Mesocosm data flow following principles set by AQUACOSM-plus.

Data QC routines: QC procedures comply with CMEMS INS TAC. Mesocosm data QC follow principles set by AQUACOSM-plus

Data management issues: Joint data management with AQUACOSM-plus during mesocosm experiments

Expected results: improved calibration of sensors, improved monitoring of mesocosms, feasibility and comparability of methods under oligotrophic conditions

Users of results: Scientists, industry

Dissemination of results: During the mesocosm experiment presentations between AQUACOSM-plus and JERICO-S3 participants. In addition, dissemination in

AQUACOSM-plus meetings, jointly with GoF PSS and NW-MED PSS. Via tweets and JERICO-S3, AQUACOSM-plus websites.

Links: Strong between PSS-link and link to AQUACOSM-RI community are evident. Additional link to between RI-collaboration in WP2, T2.2, showing how the collaboration within region and between regions may be arranged.

CRETAN PSS #4 Upscale of Regional Data to a wider area

Objectives: The action aims to more realistically simulate air-sea CO_2 fluxes using a 3D hydrodynamic/BGC/Carbonate ecosystem model (LTL, based on ERSEM). The model will be validated with CRETAN PSS in situ and satellite data via the enhancement of corresponding data acquisition (Action #1) to identify potential biases and necessary modifications (CT/AT initial fields and land-sea inputs, air-sea CO_2 flux parameterisation etc). The final 3D model version will be used to evaluate the representativity ("footprint") of the Cretan Sea solubility pump (air-sea exchanges and carbonate system) in the wider Eastern Mediterranean Sea, to promote the upscaling value of the Regional Data from CRETAN PSS.

Action Lead and other Partners (with contact persons): HCMR (Tsiaras), NIVA (King, Marty)

JS3 Platforms included: Core platforms: HCB fixed platform, E1-M3A fixed platform, Ferrybox, glider; Additional platforms: RV visits at HCB, RV visits at HCB & E1-M3A, Argo floats (see Action #1)

Other data sources: Satellite (SST, Chl-a from CMEMS or other sources).

Overall timetable of action: Feb 2022 to Aug 2022: Upgrading model with data collected (during

Dec 2020- Aug 2022 from Action #1)

Description of action: Key PSS features: Delivery of products with added value (upscaling). Collaboration element: linking with modelling and satellite community.

The Action includes: Data collection for model validation (input from Action #1). Comparison of simulations of Cretan Sea with wider eastern Mediterranean Sea. Update of the existing 3D physical-BGC-CO_2 model (POM-ERSEM-HALTAFALL) to more realistically simulate air-sea CO_2 exchanges, based on input from in-situ measurements of atmospheric and seawater *p*CO2, pH. The simulated pH, pCO_2 will be also compared with derived data from algorithms based on satellite (SST, SSS, Chla) and in situ carbonate system-associated variables (links with actions i, ii).

Following Henson et al. (2016) methodology, the 3D model simulated CO_2 will be analysed to identify the Cretan Sea (HCB station) footprint in the wider Eastern Mediterranean.

Best practices used or developed: NA

Data flows: Field data (see Action #1). Model data in POSEIDON database

Data QC routines: NA

Data management issues: None expected

Expected results: improved understanding of air-sea CO_2 fluxes, observing effort and observing gaps

Users of results: Scientists (chemists, modelers), ERICs (ICOS ERIC, EURO-ARGO ERIC), Databases (SOCAT)

Dissemination of results: First upgraded model results shown in D4.3. Dissemination to HCMR modelling team which will further disseminate them via modelling community workshops/conferences.

Links: enhanced cooperation with COPERNICUS via improved use of satellite products (T2.3), contribution to linking between scales by upscaling to a wider area (T2.4)

CRETAN PSS #5 New sampling strategies, new technologies, best practices

Objectives: Design new sampling strategies, evaluate novel technologies, improve estimation algorithms, and revisit best practices to promote the biological measurements in low-biomass areas. Increase linking with industry and other technology-related projects. Plan with other RI common benefit sampling strategies.

Action Lead and other Partners (with contact persons): HCMR (Frangoulis), CNRS-MIO (Thyssen), NIVA (King), SYKE (Seppälä, Ylöstalo)

JS3 Platforms included: Core platforms: PCL, Ferrybox, HCB. Additional non JERICO-S3 platforms: UBPC, mesocosms

Other data sources and external partners for implementation: NA

Overall timetable of action:

Dec 2020 to April 2022: Lab tests, field tests at UBPC

Sep 2021 to Aug 2022: Field tests on Ferrybox and HCB

Jan 2022 to May 2022: Validation of carbonated system regional algorithms (see action #1)

Description of action:

Key PSS features. Benefiting from PSS multiplatform, multisensor approach and experience to test new sampling strategies, technologies, practices. Capacity to support EBVs provision. Capacity to adopt new technology. Collaboration elements: linking with industry, transfer knowledge between PSSs, linking with other technology related projects, linking with other RIs.

The action will screen new technologies of phytoplankton automated observation and PP estimation (considering the review of recent sensor developments task 7.3) with potential application in oligotrophic waters. It evaluates and identifies optimum optical sensors (including optimum combinations) for phytoplankton sensing under low phytoplankton biomass. It aims to test selected phytoplankton and carbonate system related sensors under oligotrophic conditions. These will include phytoplankton abundances and biomass at high frequency and assessment of PP estimates from automated sensors. Outcome will contribute to Actions #2, #3.

In addition, the Action helps in adopting the optimum sampling/deployment strategies for carbonate system, i.e. which variables are need at the least and at what frequency to get description of the system (outcome to Action #1, link to WP1).

Best practices used or developed: As in the Actions #1, #2, #3. Action will consider procedures and best practices from T5.3

Data flows: As in the Actions #1, #2, #3

Data QC routines: New QC tests evaluated, e.g. a multi-platform approach QC (neighbour test)

Improved QA practices for sensors

Data management issues: As in the Actions #1, #2, #3

Expected results: Based on the tests done in the Action, one can define best sensors for in situ tests on FerryBox and HCB (outputs to action #2). Action allows improving regional algorithms for estimates of carbonate system variables, using carbonate system data (output to Action #1). Action provides feasibility and comparability of methods and best practices in oligotrophic conditions (Eastern Mediterranean).

Users of results: scientists (from Mediterranean and other oligotrophic seas), sensor manufacturers

Dissemination of results: Test results will feed the Actions #1 and #2. A publication (white paper) of most successful practices for oligotrophic waters will be considered (e.g. at Ocean Best practices).

Links: action considers the review of recent sensor developments and provides needs of multisensor package (task 7.3) and receives/provides procedures and best practices (T5.3). The Action aims to use TA to improve linkages with industry and to link with other technology related projects to screen all related new technology (e.g. NAUTILOS, MINKE, GROOM II). Action will contribute to tests of new practices for sensor validation using mesocosms linking to the AQUACOSM-plus (see action #3).

CRETAN PSS #6 Partnership building

Objectives: The Action works at three combined and multiple levels of partnerships:

(i) Collaboration schemes between **PSSs and IRSs**, transfer of knowledge, supply of supporting hardware and human resources, in order to tackle regional and common research questions (feed to WP1, WP3, WP9).

(ii) Alliance with other environmental **RIs,** to enable joint studies and get access/provide supporting data, new technologies. Mapping of environmental RIs in the region (strategy, responsibles etc) and demonstration of cases of partnership/collaboration

(iii) Promote the added value of integrated coastal observations to **regional initiatives** by providing demonstration of PSS activities. Added value of integrated observations and new products resulting from a PSS approach disseminated to regional initiatives, specifying opportunities, challenges and future needs.

[combination of original topics vi, vii and viii in DoA]

Action Lead and other Partners (with contact persons): HCMR (Petihakis, Frangoulis), CNRS-MIO (Thyssen), NIVA (King), SYKE (Seppälä)

JS3 Platforms included: All

Other data sources: See the Actions #1, #2, #3

Overall timetable of action:

Dec 2020- Dec 2021: Contacts for planning strategy of common interest activities (link T2.2). Identification of links, planning of training and collaboration activities

Jan 2022 - Aug 2022: First year dataset distributed, refinement of collaboration strategy, demo of collaborations, promotion activities

Description of action:

Key PSS feature. Collaboration elements: building effective partnerships, linking with regional initiatives, other RIs, other PSSs and IRSs

1) Establish a list of contact points with regional initiatives, other RIs (collaboration with WP2) and other PSSs.

2) Demonstrate a collaboration mechanism that could become common to all PSSs allowing to: spot and tackle common questions, tackle a specific problem in one PSS using knowledge from other PSSs, as well as common dissemination and other products.

A common question of Cretan Sea PSS, with GoF PSS and NW-MED PSSs: "how phytoplankton communities are influenced by extreme coastal events". To tackle this question knowledge, hardware and human resources will be mobilized (CNRS-MIO: phytoplankton, NIVA: carbonate chemistry, SYKE: optics) during field and mesocosm studies (see the Actions #1, #2, #3).

3) Exchange of experience/knowledge for joint promotion plan to regional initiatives of Cretan Sea and NW-MED PSSs activities (action #6 NW-MED PSS)

4) Identify all RIs within the Cretan Sea PSS and explore common ground for collaboration.

Examples of collaboration demonstration cases that will be explored are given below:

- AQUACOSM-plus: access to mesocosm for calibration of sensors //provision of mesocosm monitoring via sensing (see action #3)

- ICOS-ERIC: access to supporting data (CO_2 data in the region), training activities, guidelines best practices / provision of data of carbonate system carbonate in an area with sparseness (see action #1)

- EMBRC-ERIC: access to new technologies providing additional EBV data / provision of samples and access to related physicochemical data

- LifeWatch-ERIC: access to additional EBV data/ provision of related physicochemical data (e.g. pH)

- EURO-ARGO ERIC: access to supporting data/ provision of reference data (see actions #1, #2)

Contacts with initiatives (e.g. MONGOOS, UNEP-MAP) are established (input from WP2).

Best practices used or developed: develop partnership practices with other PSSs, RIs and regional initiative with: shared vision, common understanding and joint approach to tackle KSC, well defined specificities/differences, performance indicators, joint communication strategy, shared measurement/data systems.

Data flows: facilitate data flows between RIs

Data QC routines: exchange of QC procedures between RIs

Data management issues: link of data provided from different RIs and collected at the same infrastructure

Expected results: feasibility and comparability of methods, improved sensor calibration, additional EBVs

Users of results: Scientists, Regional initiatives, Governments, media, environmental managers (e.g. MPA managers), environmental NGOs

Dissemination of results: to meetings/workshops of regional RIs AQUACOSM-plus, ICOS ERIC, EMSO-ERIC, EMBRC-ERIC, LifeWatch-ERIC, EURO-ARGO ERIC. Joint promotion plan to regional initiatives (e.g. MONGOOS, UNEPMAP) of Cretan Sea and NW-MED PSS, as well as Northern Adriatic Sea IRS, activities (via WP2). Dissemination of results to regional initiatives with focus on new variables, new products and strategy alignment.

Links: Collaboration ground with several ERICs will be explored together with T2.2 (AQUACOSM-plus, ICOS ERIC, EMBRC-ERIC, LifeWatch-ERIC, EURO-ARGO-ERIC). Demonstration of PSS activities to Regional initiatives with establishment of contact points (MONGOOS, UNEP-MAP).

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4.5. PSS links and interfaces

Based on the above, a first synthesis of PSSs implementation actions links to JERICO-S3 WPs and to external interfaces is presented in Tables 12 and 13, respectively. It should be mentioned that this is a first outlook, prior to the implementation phase, that does not show the maturity state of the linkages nor the number of actions per WP or interface reflects the effort to be given. In addition, missing links should not be considered as gaps at this stage, but as means to spot existing (but not yet mentioned) or potential new linkages.

All PSSs have presented at least one action linked to all other WPs (Table 12). They interact on planning, strategy provision (WP1, WP2 and WP3), Best Practices (WP5 and WP6), data flows (WP6, WP11), technology developments (WP7), VA and TA (WP11, WP8), design (WP9). All actions have dissemination plans but some of them give a particular focus to it (WP10).

Table 13 details interfaces (potential or existing) that connect to regional initiatives and other environmental RIs (WP2). This table will be also useful for WP9 user strategy development.

Overall, the synthesis will be a good starting point for WP and task leaders to spot actions to follow up in order to provide to or request from PSSs contribution. Within WP4, it allows identification of and where PSSs can learn between and within them, guiding the content of future joint workshops.

A refinement exercise of this synthesis will be done while implementation of PSSs is ongoing with feedback from PSS leads and other WPs, and the table will be modified accordingly and presented in D4.2.

Table 12. Synthesis of links between PSSs implementation actions and JERICO-S3 WPs

	GoF PSS Actions	NW-MED PSS Actions	NSEA & CHANNEL PSS Actions	Cretan PSS Actions
WP1	All	All	All	All
WP2	2, 3, 5, 7, 8, 9, 10	1, 2, 3, 4, 5,6	1, 2, 3, 5, 6, 7, 8, 9	1, 2, 3, 4, 6
WP3 **(with IRS)**	1, 10	2, 6	1, 3, 4, 6, 8, 9	6
WP4 **(between PSS)**	1, 4, 6, 8	2, 3, 6	1, 2, 3, 4, 6, 7, 8, 9	1, 2, 3, 6
WP 5	1, 5, 7	1, 4, 5	1, 3	2, 5
WP 6	1, 4, 6	1, 4	1, 2, 3	1, 2
WP 7	1, 2, 3, 4	1	3	5
WP8	8	3	3	5
WP9	10	1	3, 6, 7, 8	6
WP10	All, especially 9	All, especially 5, 6	All, especially 8, 9	All, especially 6
WP11	3	1	1, 3	1

Table 13. Synthesis of PSSs implementation actions interfaces with: RIs, communities, databases, regional initiatives and directives

		GoF PSS Actions	NW-MED PSS Actions	NSEA & CHANNEL PSS Actions	Cretan PSS Actions
RIs	ACTRIS	10			
	Aquacosm+	8, 10	3,5		2, 3, 6
	DANUBIUS		2	1, 2, 9	
	ICOS ERIC	6, 10	5	1, 9	1, 4, 6
	EURO-ARGO	1, 2, 5, 8, 10	4, 5		4, 6
	EMBRC	10	5	9	6
	EMSO		1, 4, 5		6
	EUROFLEETS+	10			
	LifeWatch			9	6
Communities	Modelling	2, 5, 7	1, 4	1, 5	2, 4
	Earth obs	3, 4	1, 2, 4	1, 4, 5	2, 4
	In situ obs	1, 3, 4, 5	1, 2, 3	1, 2, 3, 4, 5, 6	1, 2
	Industry	1			2, 5
	Metrology	1, 10			5
Databases & Products	EMODnet	3, 4	4	3	
	SOCAT	6		1	1, 4
	CMEMS	2, 3, 4, 5, 9	1, 4, 6	3	1, 2, 3, 4
	ICES	2, 5, 9		3, 4	
	SeaDataNet			3	
Regional Initiatives	MONGOOS	NA	4, 6	NA	1, 6
	UNEP-MAP	NA	6	NA	6
	HELCOM	2, 5, 6, 9, 10	NA	NA	NA
	EUBSR	9	NA	NA	NA
	BOOS	2, 3, 4, 6, 7, 9	NA	NA	NA
	NOOS	NA	NA	8	NA
	OSPAR	NA	NA	3, 4, 5, 8	NA
Directives	MSFD	9		3, 4, 5, 8	2
	WFD			3, 4, 8	

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

5. OUTREACH, DISSEMINATION AND COMMUNICATION ACTIVITIES

Outreach, dissemination and communication actions of JERICO-RI Pilot Supersites will be done at various levels throughout the period of implementation. Overall strategy will be planned jointly with the lead partner of JERICO-S3 communications WP (WP10) and project coordination. Key points to be communicated and disseminated will be identified. All PSS partners are expected to participate in the activities, as relevant for their role and the Actions they participate in. All outreach, dissemination and communication will be documented according to the instructions from JERICO-S3 communications team.

First, in the implementation plan, each Action (Section 4) has its own plan for dissemination, the identified users for results and links within JERICO-S3 and outside. This planning specifically includes only the activities of the Action, together with collaborative Actions, or sometimes jointly with other JERICO-S3 tasks. These activities are often very well specified beforehand, targeting a limited audience, group, or individuals. Thus, this part of dissemination and communication is about the subcomponents of PSS studies and done by PSS partners. However, a joint message needs to be passed along, putting the subcomponent into appropriate context. For this purpose, some communication materials (templates, key messages) are needed from the JERICO-S3 communications team.

Second, each Action is expected to provide, at least once, communication within social media. A plan when messages are to be expected is created with the JERICO-S3 communication team, for them to be able to plan and assist in communications if needed. Such communication may also be more continuous (e.g. updates of the activities in Twitter, publications of videos, blogs), if relevant for the Action.

In the level of each PSS, a coordinated dissemination of key results should be planned. This may include e.g. regional workshops, scientific symposia or publications. Communication at the PSS level needs to be planned as well, (in some cases with neighbouring PSSs and/or IRSs), so that key audiences of the region are reached in a coordinated way.

The overall PSS communication and dissemination activities, including all PSSs and other relevant elements of JERICO-S3, need to be planned with the JERICO-S3 communications team as well. These start with joint press release (or other relevant publication) at the start of PSS implementation in early 2021. Other targeted activities may include participation in relevant European workshops and providing presentations during appropriate meetings with the key audiences. It needs to be taken care of, however, that the roles of various JERICO-S3 WPs do not get mixed, and the messages are taken by appropriate groups. This requires good internal communication.

Internally, within each PSS a constant flow of communication between partners is needed, and an increase of such communication is already one key element in the several Actions of the implementation plan. Between PSS, communication and dissemination will take place during JERICO-S3 All Region Workshop-weeks (once per year) and during major virtual PSS meetings (every 6 months). More frequent communication is done as needed through virtual ad hoc meetings. All partners also participate in other WPs where PSSs are expected to provide and receive input. It needs to be secured that all such requests and provided inputs are also communicated to PSS leads and WP leads.

Finally, the whole PSS period needs to be appropriately communicated and disseminated. This should include participation in relevant European and/or global scientific symposia, to provide a review of the exercise. It needs to include a publication of lessons learned and best practices obtained in creation of coastal Supersites. The results need to be clearly and honestly documented in the final deliverables, as well as throughout the process, assisting the design phase of JERICO-RI.

Coordination of communication/outreach/dissemination is clearly a demanding task for PSSs activities, with four geographical sites, tens of different Actions, and roughly 20 partners. This may need some level of structuration, for example by assigning a person for each PSS in charge of activities related to communications and dissemination, to assist partners and to link them to JERICO-S3 communication team when needed. This, or any alternative structure, will be discussed in the early phases of the PSS implementation. This may also provide insight, how the communication and dissemination activities of the actual Supersites need to be organised and thus it is also a big step forward in planning impactful coastal RI.

Any communication/outreach/dissemination activity related to Pilot Supersite Actions, or overall activities needs to acknowledge the EU funding JERICO-S3 has received, according to the grant agreement. This acknowledgement should appear in all materials produced including e.g. (but not limited to) press releases, social media, websites, presentations, publications and articles and code.

6. OUTLOOK OF JERICO-RI SUPERSITES

This deliverable provided a first proposal on how the hierarchy of coastal observation systems should be organised (see Figure 1), to reach an integrated pan-European component for coastal observations. A key component in the proposed structure is a network of coastal Supersites.

To provide an insight into the Supersite's progression stages, one must first analyse their position relative to other observatories. Some coastal observations are done primarily for local or regional needs, or they include a limited number of variables fulfilling the requirements of some specific needs. In the Chapter 2.3 we named sites providing such observations as Standard observatories. Such observatories may have large-scale coverage and are crucial for coastal research due to their specialisation and expertise, but they are not created to host multidisciplinary measurements. Instead, the Advanced observatories, as named in Chapter 2.3, are built for such multidisciplinary measurements targeting some specific research questions. A network of such observatories can already provide high level input to various pending scientific questions, like those listed in Tables 2 and 3. While fundamental part of coastal observations, these Advanced observatories are however not coordinated within Europe, nor integrated for sustained multinational and multiplatform observations. At this point the Supersites will come along, to provide yet another level of integration, at pan-European level. With this reasoning, Supersites will not substitute other observatories, but rather their aim is to provide optimal observational structures to study the most complex coastal scientific questions not solved using contemporary scattered observations. Neither can a Supersite be formed by simple merging of other observatories, as the additional layers of observational capacity and level of integration within and between Supersites require coordinated transnational actions.

The initial specifications for coastal JERICO-RI Supersites are given in Table 1. The current deliverable describes the planning of the first steps in which Pilot Supersites will mature in fulfilling these criteria. This is done by implementing different Actions, described in Chapter 4. However, the project lifetime of 2 years, given for this task, is relatively short for complete maturation of Supersites. The Actions planned, jointly with output provided by other JERICO-S3 Work Packages, will provide insight for all of the criteria listed in Table 1, how this transition should be done.

In short term, next milestones to evaluate the Supersite concept, criteria for Supersites and the progress made, are the follow-up deliverables: D4.2 Refined PSS monitoring strategies, D4.3 Progress report on PSS implementation and D4.4 Assessment of PSS implementation. The links with other Work Packages within JERICO-S3 will bring additional elements to this evaluation and refinement of Supersite concept, as related to overall JERICO-RI scientific strategy, connections to other communities, and developments of new technologies and e-infrastructure solutions, to mention some of them. Parallel to this, JERICO-DS will interact with Pilot Supersite Actions, in searching solutions how to best design technical and organisational aspects of JERICO-RI. Finally, it will be a task of JERICO-RI preparatory phase project to outline which is the desired form of coastal Supersites.

Finally, in the long term, the creation of Supersite structures as part of JERICO-RI will largely depend on how different EU Member States see the benefits of building and maintaining such structures. This requires governments to commit to pan-European coastal issues in addition to local and regional ones. Such a transition, though considered influential from scientific, ecological and economic perspectives, may be considered as complicated one from political or organisational point of views as it requires a systemic change how top-level observations are coordinated. Therefore, it is a most important task of JERICO-S3 Pilot Supersite phase to demonstrate which may be the societal and scientific benefits of coastal Supersites, both in regional and pan-European studies.

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