The JERICO-DS project is funded by the European Commission's H2020 Framework Programme under grant agreement No. 951799. Project coordinator: Ifremer, France.

JERICO-DS DELIVERABLE

Joint European Research Infrastructure of Coastal Observatories - Design Study

DELIVERABLE #, WP# and full title	JERICO-DS D17 / D5.3 - WP5 - "JERICO-RI Conceptual Design Report"
5 Key words	strategy, societal, impact, sustainability, governance, label, design
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Contributors	Every JDS partners
Submission date (dd/mm/yyyy)	17/07/2024

Nature : **R**

X R = Report, ☐ P = Prototype, ☐ D= Demonstrator, ☐ O = Other

Dissemination level : **CO**

X PU ☐ PP ☐ RE ☐ CO

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

GRANT N°: 951799
PROJECT ACRONYME : JERICO-DS
PROJECT NAME : Joint European Research Infrastructure network of Coastal Observatories - Design Study
COORDINATOR : Laurent DELAUNEY - Ifremer, France - design.jerico@ifremer.fr

DOCUMENT TECHNICAL DESCRIPTION

Document ID	JERICO-DS-WP5-D5.3-170724_V1.5

REVISION HISTORY

Revision	Date	Modification	Author
V1.0	12/10/2023	First draft	L.Delauney, A.Epinoux
V1.1	08/03/2024	Second, well consolidated draft	L.Delauney, A.Epinoux
V1.2	14/03/2024	Pre-final version after receiving small missing inputs	L.Delauney, A.Epinoux
V1.3	29/03/2024	Final version after inputs by partners	L.Delauney, A.Epinoux
V1.4	19/04/2024	Minor correction to the science strategy	A.Epinoux
V1.5	17/07/2024	Revision following review report	L.Delauney, A.Epinoux

APPROVALS

	Name	Organisation	Date	Visa
Coordinator	Delauney Laurent	Ifremer	17/07/2024	X
WP Leaders	Delauney Laurent	Ifremer	17/07/2024	X

Diffusion list

Consortium beneficiaries	Third parties	Associated Partners	other
X			

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EXECUTIVE SUMMARY

The Joint European Research Infrastructure for Coastal Observations' (JERICO) objective is to become a reference for coastal research scientific excellence, monitoring and services. It aims to do this by developing a centrally-coordinated, distributed, and harmonised observation infrastructure able to federate European coastal capacities and stand as a leading reference for coastal research and services, which will attract key stakeholders and influence future coastal monitoring techniques and approaches. To favour European coastal research and economic activities, transnational access to fully integrated, state-of-the-art facilities, expertise, equipment and multidisciplinary datasets are proposed.

Coastal areas are complex and fragile, and are under increasing anthropogenic pressures. In fact, the impacts of the multiple stressors thus far identified may lead to decreased ecosystemic services, in turn impacting human activities. As of the writing of this document, even though the European Environmental Research Infrastructure (RI) landscape is already quite complex, no entity is specifically dedicated to the study of the coastal ocean, although it interfaces significantly with the other surrounding systems already monitored at the pan-European level. This gap is to be filled by JERICO, capitalising on the scientific excellence, the technical expertise and the interdisciplinarity of its growing consortium.

In the present document, the sustainability of JERICO is demonstrated through various topics, such as the envisioned governance & possible legal structures, its User Strategy, Communication Strategy, Business plan, societal impacts, technical design and labelling process. They are succinctly presented and the reader is referred to specific deliverables in each case, both from the JERICO-DS project and its sister project JERICO-S3.

To facilitate the integration of JERICO's versatile and spread-out observations into a well-functioning RI entity, the governance structure was designed to be as simple and adaptable as possible, in order to maximise efficiency and service provision to users. Mission, Vision, Values of JERICO were updated, together with the scientific strategy as new scientific topics linked to the Blue Economy were proposed during the course of the project (*e.g.* aquaculture, marine renewable energy). It also establishes a roadmap for the next steps until the full implementation of the RI as a legal entity, as well as the services to be put into practice in the various implementation phases of JERICO. Indeed, already existing services that are mainly focusing on infrastructure access, physical or virtual, are so far defined. The virtual ones are planned to be supported by the JERICO-CORE e-infrastructure pilot, developed in the co-occurring JERICO-S3 project. This web-based 'one-stop-shop' entry point allows to discover, manage and draw from all intertwined sources of coastal data, easing the task of scientists and other stakeholders alike, significantly increasing the added value and sustainability of JERICO.

The present deliverable D5.3 can be seen as the summary of JERICO's design, updated from the previous ESFRI application and the resulting various recommendations. More detailed information pertaining to each key element described can be found in the relevant JERICO-DS deliverables (refer to the table in chapter 1).

With the present Design Study, JERICO seeks to enter the 2026 ESFRI Roadmap.

1. Introduction

The aim of JERICO is to become a Distributed Research Infrastructure (DRI) of a pan-European scale, focused on providing harmonised and multidisciplinary observations of the coastal environment, leading *in-fine* to better services and data products. It will facilitate all types of research being undertaken on European coastal seas, as well as the sustainable use of marine resources, by enhancing, harmonising and integrating physical, chemical, and biological time series and practices. Without such an entity covering all European coastal seas, services and data products will remain fragmented and of lower added value for the scientific community, the Blue Economy sector, and European citizens.

The purpose of the present deliverable, producing a synthetic Design Study, is to support the application of JERICO to the 2026 ESFRI Roadmap by underlining its significant added value as a consolidated legal entity providing services, up from a so-far successful - but limited in capacities - network of institutions.

To that end, it will synthesise the key outcomes of the documentation issued during the course of both JERICO-DS and JERICO-S3 projects (see Table 1). These key learnings pertain to (1) the overall sustainability of the Research Infrastructure (RI), and (2) the technical design of its diverse elements. Sustainability will be obtained through sound and straightforward organisation, step by step implementation and governance mechanisms, an innovative User engagement strategy based on UX-Design, the use of tailored KPIs for the assessment of scientific and Socio-Economic Impacts, and a realistic and customised business plan. Together, these elements bring the rationale for a DRI of a pan-European scale and an internationally-recognised leader on coastal environment topics, part of both the European Ocean Observing System (EOOS) and the Global Ocean Observing System (GOOS).

JERICO has been supported since 2011 by a series of 3 successive phases of 4-year projects, funded by the European Commission (EC). The first one, JERICO-FP7 (2011-2014), constituted the initial effort in terms of harmonisation and integration of coastal data, as unconnected communities unified into a dedicated consortium, mainly around automated, high-frequency observation systems. The second EC-funded project, JERICO-NEXT (2015-2019), as the number of partners increased (from 27 to 34 partners), was more focused on biological observations and integrating new measuring systems. Moreover, a cost-benefit analysis was done with the aim to ensure the sustainability of the future RI.

More recently, JERICO-DS (2020-2024) and JERICO-S3 (2020-2024) are consolidating both scientific progress and sustainability and the observation integration. JERICO-DS (17 partners) concluded a Design Phase, addressed with the present document, and also initiated several tasks asked for during the Preparatory Phase of an ESFRI process. On the other hand, JERICO-S3 (39 partners) aimed at reinforcing scientific integration with consideration of both local and regional ecosystems, and an access offer to different kinds of dedicated services (Virtual access and Physical access).

As a benefit of this long-term effort, JERICO has developed a unique position, filling in a major gap in the landscape of European Environment RIs. JERICO has developed the

conceptual and practical expertise aiming at providing high-quality coastal observations and services to the marine scientific community at large and to a range of local, regional and European end-users. Moreover, several European countries have recently restructured their national effort to better address their coastal priorities into National RIs dedicated to national coastal observations, which clearly constitute the national basis of JERICO.

However, Europe still lacks an integrated RI addressing the complexity of marine coastal systems and the diversity of scientific/environmental issues and stakeholders within different national frameworks. JERICO clearly aims to fill this critical gap and become a significant sustained part of the EOOS implementation. As a result, it will enable cutting-edge European coastal research and continuous observations to reach a sound understanding of changes and adaptations of marine coastal systems.

Because JERICO is a quite spread-out DRI, it faces particular governance and organisational challenges. To cope with these constraints, a simple yet specific and adaptive governance model was chosen, so as to guarantee the sustainability of the DRI and the provision of quality P&S. The sustainability will also be secured by adopting a legal status, so that JERICO appears as a proper single consolidated entity rather than as a sum - or a network - of partners. Different legal statuses are considered for JERICO, and the final decision shall be taken during the Preparatory Phase of the ESFRI Roadmap, in collaboration with institutional and national partners. The relationships between the different components of the DRI shall be regulated by Service Level Agreements (SLAs), as each component will retain its legal and administrative independence. A Central Management Office (CMO) will administer, manage the RI's activities, mainly performed by Service Offices controlling specific products and services (P&S) in accordance with local expertise.

A federated cloud-computing infrastructure component, called JERICO-CORE based on the pilot's name, will provide a single-entry-point to a Service Architecture revolving around stakeholders requirements. This infrastructure will facilitate (and in certain cases enable) the use of dedicated tools, both hardware and software, for analysis, processing and communication of the scientific production of JERICO. Its development is also based on major existing European initiatives so as to reduce risks in development and optimise acquired knowledge and experience. JERICO-CORE will be a unified, web-based, central hub useful to discover, access, manage and interact with all JERICO resources, including Transnational Access to JERICO's physical infrastructure. It shall be a community platform providing the means and the opportunity to share information between all members.

An important and high-value service of the future JERICO should be to centralise actions with a pan-European vision so that regions would collaborate more and share their data and expertise. In addition, a growing requirement is to increase the consideration of societal factors through the contributions of scientists, policymakers and managers of the coastal marine environment, in the co-design of the JERICO strategy.

In summary, the production of **this Design Study aims to present in a clear and concise manner the salient features of the future JERICO DRI, ensuring its sustainability**. The organisation, governance, implementation and components elaborated during the different JERICO projects will constitute the basis of JERICO's claim to the 2026 ESFRI Roadmap.

This deliverable JERICO-DS D17/D5.3 is primarily based on the outcomes of various deliverables from the JERICO-DS and JERICO-S3 projects. The list of deliverables used can be found hereby.

Table 1 - Key deliverables contributing to the JERICO Design Study.

Project	Deliverable number	Deliverable title	Input to the Design Study
JDS	D1.1	Preliminary report for long term scientific plan including input from national strategies	Formulation of a science strategy at least partly based on the development of Data-to-products Thematic Services (D2PTS) addressing specific national societal needs
JDS	D1.2	First elements to unify environmental RI efforts at national level: national scientific expectations across RIs (specific goals, expertise, data)	Provision of a description of the European environmental RI landscape, and formulation of suggestions towards the implementation of partnerships
JDS	D1.3	Final report for a long-term scientific plan: a mutually beneficial strategy to bridge national and EU landscape	Proposition of a refined overall scientific framework based on the outcomes of JERICO-S3, and of a refined Mission, Vision and Values statement
JS3	D1.1	Early inputs towards sustainability	Formulation of propositions so as to optimise the contribution of Integrated Regional Sites (IRSs) and Pilot Super Sites (PSSs), and definition of the pelagic sensors to be used
JS3	D1.2	Regional approach	Formulation of recommendations towards the consideration of societal factors through the contributions of scientists, policy makers and managers of the coastal marine environment in the co-design of the JERICO strategy
JDS	D2.1	Technical and technology outlook for coastal observatories	Mapping of the current technical and technological capacities of the various partners of JERICO-DS.
JDS	D2.2	Gap analysis for JERICO-RI technologies	Assessment of the technical and technological gaps to be addressed in the framework of JERICO

JDS	D2.3	Roadmap for technological implementation of the JERICO-RI	Provision of possibilities for a technological roadmap, with proposals for strategy, structure, systems, and staff and skills to be used in the RI
JDS	D3.1	Outlined JERICO virtual resources Access and Security policies	Provision of a User and Stakeholder engagement strategy concerning access and security of virtual resources of the RI, and of a Funding framework
JDS	D3.2	e-JERICO technical design	Provision of a User and Stakeholder engagement strategy concerning the overall architecture of e-JERICO, and of a Funding framework
JDS	D3.3	Preliminary operational Plan for e-JERICO service- delivery	Provision of a Funding framework and of a schedule for envisioned services
JDS	D3.4	Data Management Plan for e-JERICO added value products	Provision of a Data Management Plan for existing e-JERICO services, and of a template for future ones, contributing to the User and Stakeholder engagement strategy
JDS	D3.5	Outlined e-JERICO Strategic Plan for implementation	Provision of an implementation plan for e-JERICO structure and services
JS3	D6.1	Data Management Plan for multidisciplinary coastal data	Provision of the main data management procedures to be used in JERICO
JS3	D6.3	Data Management Best Practices report for physical and BGC platforms	Provision of the main data management best practices to be used for HF Radars, gliders and Ferryboxes in JERICO
JS3	D6.4	Best Practices and recommendations for plankton imaging data management	Provision of the main data management best practices to be used for plankton imaging devices in JERICO
JS3	D4.1	Pilot Super Sites monitoring strategies	Provision of a proposal on how the hierarchy of coastal monitoring systems should be organised
JS3	D4.2	Refined Pilot Super Sites monitoring strategies	Assessment and refinement of the monitoring strategy exposed in JS3 D4.1
JDS	D5.1	Report on the conceptual design model of JERICO including structure,	Assessment of the envisioned conceptual architecture for JERICO, and description of the envisioned

		external relation and Human Resources	components and their connection
JDS	D5.2	Report on updated JERICO Label	Updating of the set of technical guidelines that falls under the "JERICO Label"
JDS	D6.2	Communication strategy of the JERICO	Presentation of JERICO's Communication Strategy, with a two-step design, and description of the organisational aspects of JERICO communication
JS3	D9.1	User requirement and classification	Provision of a typology of potential users and stakeholders of JERICO
JS3	D9.2	User engagement strategy plan with metrics to assess user satisfaction/ expectations	Provision of a user engagement strategy plan for JERICO, and of proposals for user satisfaction assessment metrics
JS3	D9.3	The JERICO-RI business plan	Provision of a financial framework for the operation of JERICO during the implementation phase and beyond
JS3	D9.4	Proposed organisation, structure, and long-term governance	Provision of an organisation scheme and of a set of governance mechanisms

2. JERICO, main elements

This chapter aims at providing a comprehensive overview of the main elements of the JERICO DRI, encompassing its specificities, vision, mission, values, and strategic approaches. The sections within this section cover the unique characteristics of coastal oceans, JERICO's strategic framework, and the complementary national and regional approaches facilitated by JERICO-DS and JERICO-S3 respectively. Additionally, it examines the marine research infrastructure (RI) landscape in Europe and summarises the overarching strategy of JERICO.

It is important to note that several elements presented in this chapter are derived from deliverables of the sister project JERICO-S3. There is a partial overlap between the various key characteristics coming both from JERICO-DS and JERICO-S3, to ensure continuity and coherence in the presentation of the development and implementation of JERICO's objectives. This chapter integrates insights from both projects so as to provide a **holistic understanding of JERICO's role and impact**, ultimately seeking to advance coastal research and observation capabilities across Europe.

2.1. Coastal ocean main specificities

The coastal ocean is located at the interface between the continent, the open ocean and the atmosphere and is in tight interaction with these adjacent systems. Both its structure and functioning are affected by a large variety of fluxes originating from those systems. Interplay between major river discharges, prevailing currents and density-driven water movements create Regions Of Freshwater Influence (ROFIs), which are largely differing from the surrounding ocean regarding their physics, biogeochemistry and biology, whereas changes in coastal ocean biodiversity and biological productivity are largely cued by climatic processes/oscillations primarily affecting the open ocean. Spatial heterogeneity therefore clearly constitutes a first major characteristic of the coastal ocean.

The coastal ocean is also showing strong dynamics over a large range of temporal scales. These include a number of nested components: (1) long term (*e.g.* in relation with climate change), (2) interannual (*e.g.*, in relation with climatic oscillation), (3) seasonal (in temperate areas), (4) mesoscale related and (5) short term, including episodic events (*e.g.* in relation with the occurrence of rare/extreme events that constitute key factors in controlling the structuration and the functioning of coastal marine systems).

The coastal ocean is the most productive part of the world ocean and is one of the major sources of food for humans, and an upcoming major source of energy. Biological productivity in coastal waters results from a complex interplay between biological, biogeochemical and physical processes. The coastal ocean is providing a large variety of other services including: (1) transportation, (2) availability and access to raw materials and resources for industry, (3) spreading and accumulation of contaminants, and (4) leisure and cultural resources. The coastal ocean is by far the most economically valuable component of the global ocean and the economic values of the littoral components can be comparable and even higher than the highest ones of continental biomes. The exploitation of these services results in the densification of human coastal populations and the intensification of their activities (40% of the world population living in the vicinity of coasts). The coastal ocean is therefore the component of the world ocean most affected by anthropogenic disturbances. Heavy changes are also induced by other systems (open ocean, atmosphere, continent), also affected by human activities.

An exhaustive review of environmental threats in European coastal regions was conducted during the JERICO-NEXT project, and was presented in its deliverable D1.1 in April 2017, based on questionnaires. In short, physical modifications of the coastal area include coastal erosion, artificial constructions and obstructions, water abstraction activities, and thermal and salinity changes. Coastal pollution involved wastewater disposal and marine litter, dispersal of chemical contaminants (also *via* unexploded ordnances), atmospheric inputs, catchment management, and shipping, mining, oil and gas industry activities. The third and last category, biological threats, encompassed organic and inorganic nutrient enrichment (leading to eutrophication events), destructive fishing practices, importation of alien species and aquaculture activities.

Major impacts were clearly identified on coastal areas, sometimes leading to food supply or public health issues. These significant impacts were population changes (often depletion of economically exploited standing stocks), modification of ecological equilibrium by invasive

species, underwater noise disturbance, habitat loss or destruction, and contamination. Other impacts included physical damage, physico-chemical changes (hydrology, turbidity and thus light availability, sediment composition) and biological changes (species range and loss of habitat protection, primary production, mortality of marine life, biofouling, harmful algal blooms). Links between the various threats and impacts were analysed, and clearly underlined their interconnected and cumulative nature (Figure 1). In fact, while many impacts are directly anthropogenic, some external pressures such as regime changes are indirectly linked to human activities due to climate change.

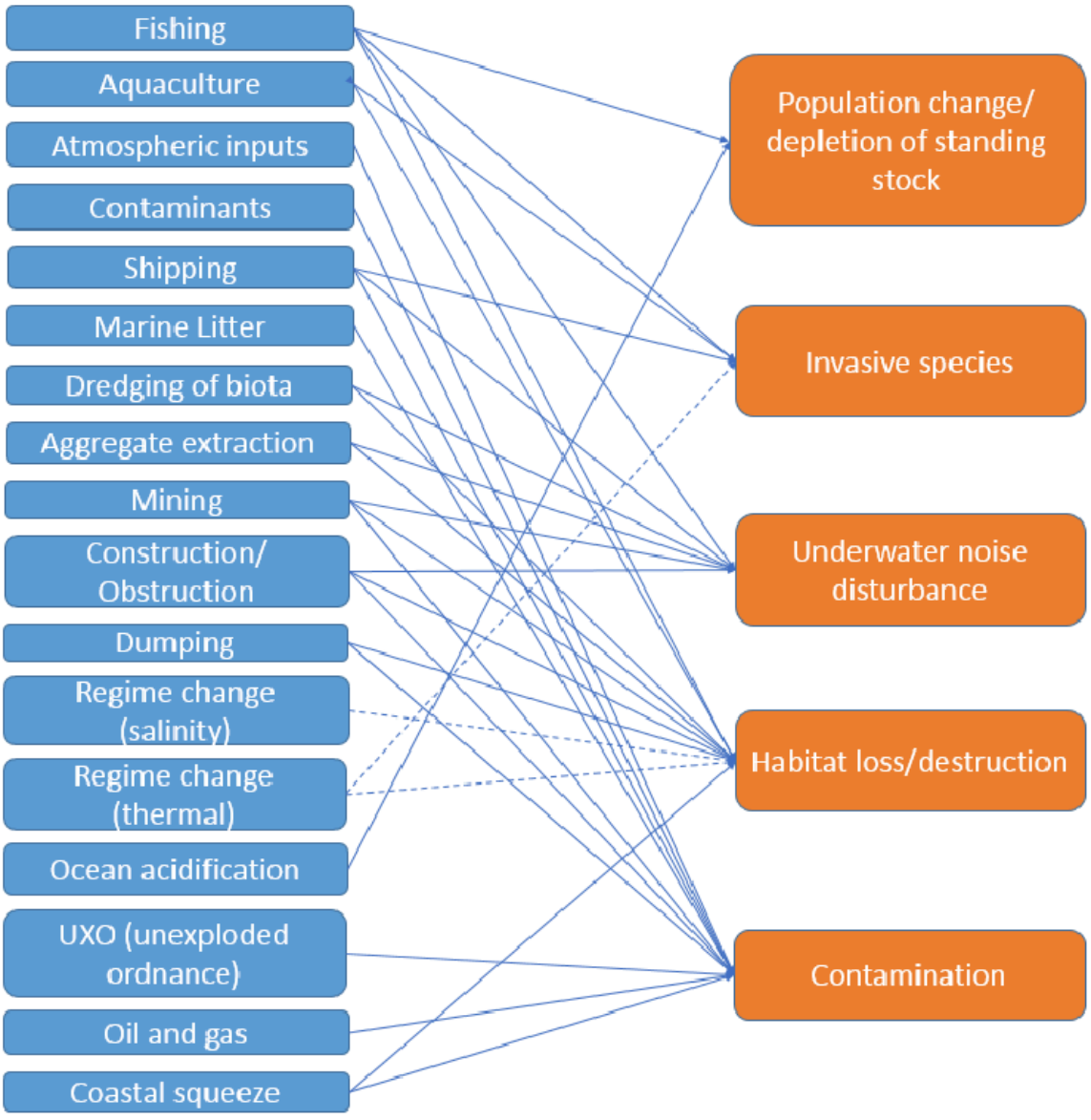

Figure 1 - Links between threats (pressures, in blue) and the major impacts on coastal areas, per the responses of the questionnaire. Dotted lines indicate indirect impacts. Reproduced from JERICO-NEXT D1.1.

These impacts indirectly or directly affect human activities. Depletion of standing stocks of economically important species influence food supply, while Harmful Algal Blooms due to increasing eutrophication lead to public health issues. As such, different public policies were put in place over the years (Marine Strategy Framework Directive, Water Framework

Directive, Common Fisheries Policy, Bathing Water Quality Directive) to prevent or alleviate actual and future hazards. These various policies resulted in the creation or adaptation of coastal monitoring programmes. However, as highlighted by the responses to the questionnaire analysed in JERICO-NEXT D1.1, current monitorings were considered only partially adapted at best, or inadequate. In particular, the spatio-temporal scales at which samplings take place are deficient, and in some cases the parameters that are being monitored are not sufficient.

This sampling deficiency highlights the need for a greater operational oceanography output in coastal areas, as the Blue Economy sector (related with marine and maritime activities) grows following the increasing number of coastal services, including but not limited to food, energy, recreation and even flood prevention.

Both marine living (fishing, aquaculture, processing) and mineral resources (*e.g.* oil, gas, sand) as well as renewable energies (*e.g.* tides, waves, off-shore wind) would profit substantially from a sustainable provision of P&S aimed at European coasts. Other noteworthy actors include port activities and shipbuilding, maritime transport, and defence activities.

As the development of the European Blue Economy sector is to be done in a sustainable fashion, **there is an increasing requirement for good management practices** from local to international level. **This, in turn, requires more, finer, better integrated and better managed datasets across and within regions** so as to tackle complex and highly variable processes. Big challenges going with that requirement include the deployment and maintenance of adapted sensors and systems to ensure the coverage and representativeness of coastal observations, as well as data integration and management across and within European regions.

Due to the underlined specificities and complexities of the coastal ocean, and having in mind its economic and cultural importance, meeting modern policy standards involve process-driven sampling strategies following FAIR (Findable, Accessible, Interoperable, Reusable) principles and considering long-term, geographically extensive applications of best practices at European level.

Observing, understanding and ultimately predicting changes of coastal marine systems over a large range of spatio-temporal scales constitutes a key objective for JERICO.

2.2. Vision, Mission, Values

In JERICO-DS deliverable D1.3, a revision of JERICO's Vision ('why does JERICO exist?'), Mission ('what future does JERICO want to create?') and Values ('what is important for JERICO?') was proposed, following a course of the Bicocca university of Milan. At the same time, the Purpose statement was discarded, because of its similarity with the Mission one. The revised and official Vision, Mission and Values statements of JERICO are

- **JERICO Vision statement:**

"JERICO will be the pan-European integrated gateway to long-term scientific and harmonised observations and related services for coastal marine systems."

- **JERICO Mission statement:**

"The JERICO mission is to enable a sound understanding of the responses of coastal marine systems to natural and anthropogenic stressors. To do so, JERICO adopts a systematic approach to monitor, observe, explore and analyse coastal marine systems in order to reach reliable information of their structure and functioning in the context of global change. JERICO encompasses the whole range of environmental sciences, technologies and data sciences. It achieves observations at global, regional and local scales, through the implementation and the harmonisation of a set of complementary platforms and multidisciplinary observation systems. JERICO enables open-access to state-of-the-art and innovative facilities, resources, FAIR data and fit-for-purpose services, fostering international science collaboration."

- **JERICO Values statement:**

1. "JERICO cares about the marine environment: it contributes to the understanding and monitoring of the changes of coastal marine systems; it provides data-driven information for the protection and the sustainable management of coastal resources.

2. JERICO declines scientific excellence through a regional approach: it identifies scientific marine coastal challenges common to regional sites, gathering all major coastal observing systems throughout Europe; it has a strong scientific community and leadership developed and demonstrated during several previous EU-funded projects.

3. JERICO implements multiplatform and multidisciplinary observation systems: it uses scientifically sound observations of physical, chemical and biological parameters and innovative biogeochemical observing technologies; it recognizes that scientific excellence in coastal areas can be achieved only through multisystems as these areas are characterised by many high-variable scales, both in time and in space.

4. JERICO seeks for collaboration and co-creation: it interacts with many other environmental RIs to take a holistic approach to the marine environment, from the coastline to the open sea, as a global ecosystem; it listens to its stakeholder and users to include their desiderata in its future development.

5. JERICO removes barriers: it enables open-access to state-of-the-art and innovative facilities, resources, FAIR data and fit-for-purpose services; it encourages transparent policies for the access, recruitment procurement and its governance; it promotes equal opportunities for its members considering gender equality and under-represented communities."

2.3. JERICO specificities

Coastal observation remains a quite challenging task, even at the national or subnational scales, where it most often occurs. This is due to the complexity of the coastal environment, but also to technological limitations of observations that must be overcome. Aggregating

data from different observation programs, and upscaling/downscaling them through models (in particular so as to fill gaps between observations) is a quite complex issue, because common standards are not always available and applicable, integration remains very complex and is still too often lacking despite dedicated efforts for the Ocean Observation community. Indeed, historically, national observation and monitoring programs of the coastal ocean were designed separately, with tools available at the time, to answer different scientific questions. During the last decades a lot of harmonisation, regarding the observing methods/approaches, has been implemented through the Regional Sea Conventions. Still, different standards of measurement are often used in monitoring programs, especially when comparing different regions, further limiting the capacity to assess and fill spatio-temporal gaps. Finally, coastal data management and dissemination is usually done within directly involved communities, sometimes regionally but most often locally: data sharing is thus extremely limited despite an increasing need for upscaled multidisciplinarity. These elements warrant a significant integration effort, which JERICO proposes to foster, among other added values.

The specificities of the future JERICO directly stem from the challenges inherent to the coastal marine environment presented in the previous section. Most phenomena of interest occur at nested spatio-temporal scales, thus a single type of observation system would only deliver a part of the data needed: a significant future challenge of JERICO lies in the pluridisciplinarity needed to answer scientific questions. Due to the diversity of scientific/environmental issues, a single type of observation system would only deliver a part of the information and data needed to reach overall scientific coastal objectives. This leads to a multiplicity of sensors to be deployed for coastal monitoring (coastal cabled observatories, coastal profilers and profiling floats, Ferryboxes and other flow-through systems, gliders, AUVs), some of them being land-based (tide gauges, fixed platforms, High Frequency radars, metrology facilities) which complicates further integration efforts. During the JERICO ESFRI lifecycle, these lists will be updated by incorporating new technologies and systems to keep JERICO at the forefront of research, with innovation and excellence as the main target to reach. Integration will be achieved by (a) connecting and unifying the already existing networks of observatories that regionally structures coastal monitoring, (b) defining and adopting FAIR principles and best practices for all involved measurement platforms and sensors, and c) strengthening regional, transnational and pan-European collaboration at various levels.

The current status of marine coastal observations reveals a significant gap in integration and multidisciplinarity. While physical data such as temperature and salinity are consistently generated and shared through standardised operational processes, biological data and particularly image-extracted data remain primarily confined to local research purposes. This fragmentation leads to a significant challenge across the entire data lifecycle, from collection to utilisation. Platforms used for data collection vary in coverage and sensing capabilities, necessitating their coordinated use to effectively address KSCs outlined in JERICO. A critical aspect demanding attention is the uncertainty associated with measuring variables, influenced by factors ranging from sensor maturity to usage modality. JERICO aims to fix these issues by fostering collaboration, standardisation and innovation across oceanographic disciplines, thus enhancing the integration and reliability of marine coastal observations.

Overall, JERICO will also create an impact in terms of training and education in the field of coastal observations, by organising workshops, courses and meetings where scientists will be able to exchange knowledge. By supporting the development of common standards and methodologies, JERICO will foster the development of new technologies and tools that will be of use for coastal observatories, but also potentially for the Blue Economy sector. Best Practices will concern data collection and management procedures to be harmonised, so as to allow comparison and/or integration of data from different coastal regions leading to a better upscaling of data, but will also concern maintenance and operation practices.

It will also facilitate collaborative and interdisciplinary research related to the coastal ocean, as a necessity to address key scientific challenges related to coastal processes, climate change impacts and ecosystem dynamics. Moreover, the emphasis put on User Engagement will guarantee the sustainability of the RI, by keeping users and stakeholders satisfied with the services and products delivered, while a mechanism will allow to consider suggestions coming from the user base. In the end, the aim is to deliver valuable and accessible data and P&S that will also contribute to informed decision-making.

2.4. JERICO strategy

A number of elements of the 2021 ESFRI were taken as a basis for an upgraded scientific strategy, among which the Key Scientific Challenges (KSCs) that were defined in response to the heterogeneity of the coastal domain. The JERICO community updated its scientific concerns in these 3 KSCs:

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

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

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

Indeed, in coastal areas, tackling scientific questions is inherently multidisciplinary and a major challenge is considering the needs of this multiplicity of users. The JERICO scientific strategy highlights the integration of observations of different types, the avoidance of duplication of efforts, and the close involvement of stakeholders. The goal of the process is to build a sustainable observation strategy of the coastal ocean, also interfacing closely with other RIs and initiatives.

The scientific strategy elaborated for the 2025 ESFRI application directly stems from that laid out in the previous application, with numerous and significant refinements considering both the regional and national perspectives. In particular it aims at a refined, adaptable and sustainable long-term vision, ensured by both a scientific and a development strategy. The development strategy as laid out in the previous ESFRI application involved 3 "Pillars":

- **Fostering societal impact for a larger community of stakeholders**
- **Developing innovative technologies for Coastal Ocean observing and modelling**

- **Interfacing with other Ocean Observing initiatives**

These 3 pillars still represent the backbone of the JERICO development strategy.

2.4.1. National approach ensured by JERICO-DS

The JERICO-DS project and its WP1 aimed to define and refine the scientific strategy through the lens of national viewpoints (needs, assets and strategies), to engage participating nations in designing the RI, and to establish the long-term socio-economic impact at national, European and global levels. To this end, it was deemed necessary to also draw the boundaries of the future JERICO in the different national observation systems, and to define Key Performance Indicators (KPIs) that would underline scientific performance.

A survey was designed by WP1 leaders and co-leaders so as to collect national scientific inputs, priorities and societal needs, and put them in relation with KSCs. This resulted in the identification of 6 scientific topics and 3 integrated themes to be presented in the survey:

- **Scientific Topics**
  - Biodiversity trends
  - Hydrology and Transport
  - Eutrophication
  - Chemical contaminants and marine litter
  - Land/Ocean continuum
  - Coastal Carbon
- **Integrated Themes**
  - Ecosystem approach: integration of physics, chemistry and biology observations as a system
  - Coastal forecasting
  - Impact of extreme events

For each identified Topic and Theme, their scale and their relation to societal needs were defined (Figure 2).

	Specific/Individual Scientific Topics		
	Topic	Scale of the societal needs	Relation to KSCs
#1	Biodiversity trends	• Multinational: latitudinal migration, non-indigeneous species • National: networking, legislational support, contribution/support to MSFD implementation (Descr#1) creation of national inventory, biological indicators • Local: impact of local disturbances	KSC#1
#2	Hydrology and transport	• Multinational: climate change scenarios • National: networking, legislational support, contribution/support to MSFD implementation (Descr#7) Maritime Spatial Planning, oil spills, fishery management • Local: navigation, aquaculture	KSC#1
#3	Eutrophication	• Multinational: trans-national management of regional seas (Baltic and Adriatic seas) • National: networking, legislational support, contribution/support to MSFD implementation (Descr#5) • Local: impacts on fisheries, biodiversity, tourism, amenity	KSC#3
#4	Chemical contaminants and marine litter	• Multinational: support to international conventions/agreements • National: networking, legislational support, contribution/support to MSFD implementation (Descr#8, #10) • Local: localized impacts, localized measures for protection	KSC#3
#5	Land/ocean continuum (only from the marine point of view)	• Multinational: mass fluxes in the marine environment • National: • Local: riverine input (particles, nutrients, contaminants) in the marine environment, fishery management, influence of transport of nutrients and metals	KSC#1
#6	Coastal carbon	• Multinational: coastal zone CO_2 sequestration (carbon budget) for climatic reasons • National: national carbon budget CO_2 sequestration • Local:	KSC#1

	Integrated Scientific Themes		
	Theme	Scale of the societal needs	Relation to KSCs
#1	Ecosystem approach: integration of physics chemistry and biology observation as a system	• Multinational: support/contribution to coordination, management of trans-national ecosystem approach • National: networking on management • Local: local management	KSC#1
#2	Coastal forecasting	• Multinational: coordination of oil spill spreading forecasting • National: effects of climate changes, oil spill spreading, sea-ice forecast • Local: localized effects of climate changes, Port management, MPA management, marine offshore industry	KSC#1 KSC#2 KSC#3
#3	Impact of extreme events	• Multinational: contribution to understanding effects of extreme events on large and long scales • National: contribution to disaster readiness/remediation, navigation safety, sea-state • Local: data on local probability, return time estimates, maritime engineering works, impact/effects of storms and floodings on coastal infrastructures and ecosystems	KSC#2

Figure 2 - List of the societal needs, their scales and relations to KSCs for each Topic and Themes identified during the WP1 activities for the survey. Reproduced from JERICO-DS D1.1.

All NJR responses were received by February 2022, and their analysis constituted the backbone of Deliverable JDS D1.1. The reader is kindly redirected to D1.1 for the analysis of results, which led to the formulation of preliminary observations and recommendations.

For the assessment of the performance of JERICO, a set of KPIs was discussed and agreed upon (see JERICO-DS Milestone MS1.5 for further details). They are crucial in order to evaluate JERICO and its activities both in terms of scientific excellence and socio-economic impacts. For this reason, KPIs must be strongly intertwined with the strategy and long-term goals of the future RI.

The geographical distribution of societal needs' implementation levels was further analysed in deliverable JDS D1.3. In particular, clear regional patterns were reckoned for 2 Topics (Biodiversity and Eutrophication) and 1 Theme (Coastal Forecasting). This showed that the national viewpoint explored by JERICO-DS was closely related to the regional viewpoint explored by JERICO-S3 (see next section). This may warrant the use of PSSs and IRSs to address national needs as well.

2.4.2. Regional approach ensured by JERICO-S3

The JERICO-S3 project, through its WP1, also sought to refine the science strategy initiated during JERICO-NEXT and refine a long-term vision that shall anticipate the coastal observation systems of the future, both technologically and methodologically. In doing so, a major starting goal was to identify common scientific questions on which the science strategy shall be based. The JERICO-S3 involves the implementation of the 3 main pillars mentioned earlier: Fostering societal impact for a larger community of stakeholders; Developing innovative technologies for Coastal Ocean observing and modelling; Interfacing with other Ocean Observing initiatives.

JERICO-S3 covered a regional approach by defining Integrated Regional Sites (IRS) and Pilot Super Sites (PSS) across coastal regions in Europe. As of the writing of this document, 5 PSSs and 5 IRSs are operating in JERICO (see Figure 3).

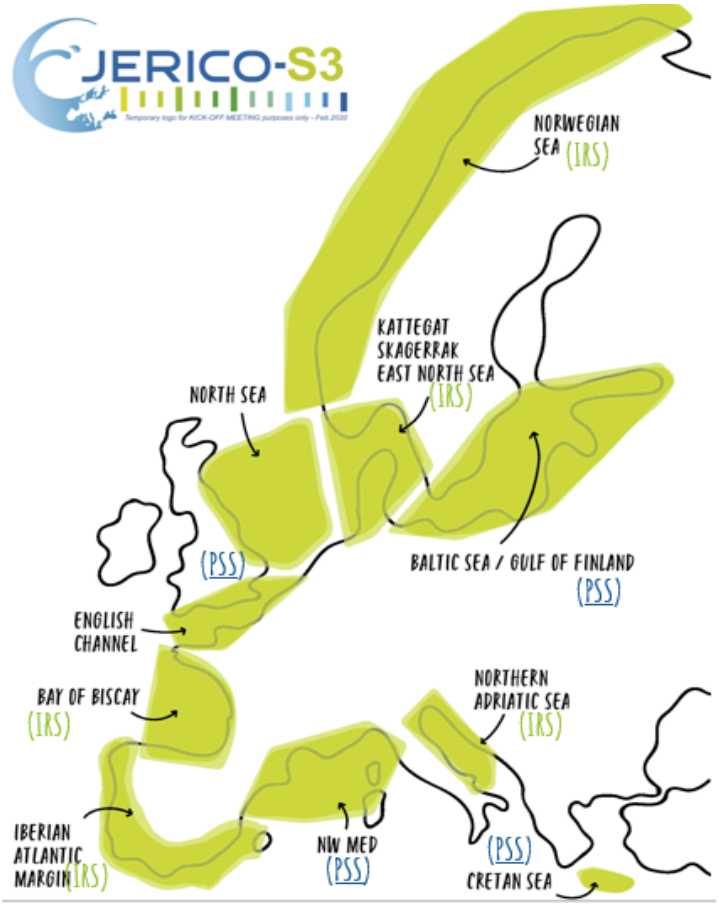

Figure 3: Map showing the geographical locations of the PSSs and IRSs part of JERICO-S3. Reproduced from JERICO-S3 D1.1.

The first deliverable of JERICO-S3 WP1, D1.1, built the basis of the science strategy by identifying common scientific challenges, and providing spatial patterns for them and the way they are addressed across the network. Through a process that involved most of the partners, 40 scientific questions and objectives to be addressed by PSSs and IRSs were grouped into 16 Specific Scientific Challenges (SSCs), further grouped into the 3 KSCs inherited from the 2021 ESFRI application (Table 2).

Table 2 : List of the 16 SSCs addressed by the PSSs and the IRSs as identified during the the JERICO week #1, and grouped by KSC. North S: North Sea, EC: English Channel, NWM: Northwestern Mediterranean, CS: Cretan Sea, BS/GF: Baltic Sea/Gulf of Finland, BOB: Bay of Biscay, NAS: Northern Adriatic Sea, IAM: Iberian Atlantic Margin, K/S: Kattegat/Skagerrak, Nor S: Norwegian Sea. Reproduced from JERICO-S3 Deliverable D1.1.

		Pilot Super Sites					Integrated Regional Sites				
KSCs	**Specific Scientific Challenges**	North S.	EC	NWM	CS	BS/GF	BOB	NAS	IAM	K/S	Nor S
Assessing and predicting changes under the combined influence of global and local drivers	Land-Ocean Continuum	X		X			X		X		X
	Sea-atmosphere interface										
	Connectivity and transport			X			X		X	X	
	Biodiversity		X				X		X		
	Primary Productivity		X		X					X	
	Ecosystem functioning	X			X	X		X		X	
	Carbon budget & carbonate system	X				X				X	
Assessing the impacts of extreme events	Extreme events: impacts on ecosystems			X	X	X	X	X			
	Extreme events: coastal hazards						X		X		
	Harmful Algal Blooms		X			X				X	X
Unravelling the impacts of natural and anthropogenic changes	Climate change impacts					X	X		X	X	
	Eutrophication		X	X		X					
	Impact of big cities			X							
	Litter and plastic			X			X	X	X	X	
	Contamination			X					X	X	X
	Unravelling impacts					X	X				X

JERICO-S3 deliverable D1.2, in turn, presented an accurate assessment of which KSCs and SSCs were being addressed by each region. It reckoned that only few platforms were designed to acquire biological variables (*e.g.* phytoplankton and zooplankton counting and characterization, benthic observations), which were however increasingly crucial. It was also pointed out that the challenge of data harmonisation and merging increased substantially with the inclusion of satellite observations and modelling tools.

In fact, challenges to be tackled are quite dependent on their geographical scale. A key role identified in JERICO-S3 D1.2 for JERICO should be to centralise KSC3-type actions ("unravelling the impacts of natural and anthropogenic changes"), as the impact of climate change is of concern for the whole European coastal area, and calls for a pan-European vision and strategy to promote increased collaboration in terms of data and expertise. **This very point demonstrates the added-value of JERICO as a fully-fledged DRI, rather than as a mere network answering regional challenges**. Following the question raised in the JS3 D1.1, the decision was taken to eventually erase the distinction between PSSs and IRSs, so as to pool them in common regions (see section 4.2).

2.4.3. Marine RI landscape in Europe

A number of relationships have been initiated over the different JERICO projects, however the need for a clear structuration around the challenges of the coastal areas warranted further efforts in tying JERICO with surrounding RIs (see Figure 4 for a representation of the current landscape).

Figure 4: The EU environmental marine landscape around JERICO-RI. Reproduced from JERICO-DS D1.2.

The evaluation report of the last ESFRI application of JERICO did underline the importance of a potential RI focused solely on the coastal area, and warmly welcomed the scientific framework provided by JERICO. In fact, JERICO clearly filled a gap that was pointed out in the Landscape Analysis of the Strategy Report on RIs of the 2021 ESFRI Roadmap:

"As the coastal ocean is currently a key component of the UN decade of Ocean Science for Sustainable Development and has become a high priority on the worldwide environmental political agenda, Europe needs dense enough, well-instrumented sites and regions to study, observe and monitor water off the coastal shelf. The comprehensive analysis of the changes in the coastal ecosystems requires an integrated basin approach to understand the impact of different drivers and to find measures for coastal preservation, management and planning. The long-term observation is needed to address transversal scientific and societal challenges acting at various spatio-temporal scales, and to understand large-scale processes that can significantly impact coastal and littoral areas. This could only be achieved at the plan-European level."

The first steps were conducted within JERICO-S3 as a top-down approach, on the basis of a series of meetings of the JERICO Board of RIs which led to agreements on common subjects of collaboration. Whenever deemed appropriate, the establishment of Memorandums of Collaboration (MoCs) was planned, and concrete regional scientific collaborations were initiated in JERICO regional sites to refine future collaboration frameworks, under the responsibility of JERICO-S3 WPs 3 and 4. In JERICO-DS, a process to draw the boundaries of JERICO in the different national landscapes involved was performed, in order to optimise the contribution of JERICO to the future of global coastal observation. Indeed, the current Environmental RI landscape in Europe is fragmented, and on some occurrences, overlapping. As it is planned, JERICO will interface with many other initiatives (data management institutions, regional to global observing systems), and will thus dedicate a significant effort into building a collaboration framework with other RIs. This

two-way approach was built by investigating scientific needs, expertise and data that are expected from each RI.

In Deliverable D1.2 of JERICO-DS, an initial collaboration framework with other RIs of the European landscape is described, so as to optimise the role of JERICO in the current marine RI landscape. A detailed description of the strategy to be employed was presented, in order to clarify expected interactions with related RIs, depending on the level of interaction. This strategy involves the mapping of surrounding RIs and of the interactions taking place between them and JERICO, in order to characterise them (Table 3).

Table 3: The different levels of interaction of the JERICO community with the other RIs.

Local level	Collaboration motivated by the sharing of equipment, techniques or expertises for the ecosystemic observation of a given environment. *Example: the Northern Adriatic region observed by DANUBIUS and JERICO.*
Institutional level	Collaboration motivated by the expertise of an institute strategically positioned to coordinate observational infrastructure. *Example: Marine Institute in Ireland, national node for EURO-ARGO, EMSO-ERIC, JERICO-S3.*
National level	Collaboration decided by a national scientific strategy from the national ministries (often Ministry of Research) or by an inter-organisational agreement. *Example: in France, the recently created Fr-OOS (French Ocean observing system) aims to coordinate the interactions of the various infrastructures at national level. Its constitutive agreement was established in consultation with all the scientific institutes in charge of ocean observation.*
European level	Collaboration decided by the management teams of the two European infrastructures. *Example: Draft agreement to develop joint Transnational access between AQUACOSM and JERICO*

As a matter of fact, national commitments and collaboration frameworks strongly vary between JERICO-DS partner nations, and that has to be acknowledged when building national commitments. To cope with this difficulty, task 4.2 of WP4 tracked national commitments towards observing coastal seas, in order to embed JERICO as best as possible in national coordination mechanisms concerned with Ocean Observing initiatives. The French network of scientific 'attachés' shall help to foster bilateral discussions on the unification of RI actions at the national level. This will help to address priorities related to the coast on a case-by-case basis, and act accordingly.

Given the heterogeneous situation of national RI coordination mechanisms, and the nesting of all potential collaborations with surrounding RIs, it was determined that the most reliable way to build interactions at the national scale was to focus on common societal needs. Indeed, in JERICO-DS deliverable D1.1 a survey highlighted 6 high-priority needs shared by 13 out of 14 partner countries, which have to be strongly considered when devising new D2PTS. In JERICO-DS D1.2, this is taken further, by deciding to build agreements with other RIs based on each RI's contribution to these identified crucial societal needs. In doing so,

JERICO will put more added-value in the service-oriented approach while leaving wiggle room to adapt to national specificities.

This approach is further developed in JERICO-S3 deliverable D2.4. The aim of Memorandum of Cooperation (MoCs) is to create a clear collaborative framework, where roles and relationships of each RIs shall be written on the basis of common services to be provided. It is a point of particular attention that MoCs between JERICO and other RIs are written with specific, concrete objectives to reach rather broad statements. Thus, all collaborations that will take place between JERICO and other environmental RIs will answer common societal needs, by providing common services, based on a seamless cooperation structure and mechanisms.

2.4.4. JERICO strategy summary

Towards the end of JERICO-DS, a misalignment of the scientific framework with that of JERICO-S3 was observed, as a result of different decisions taken and their timing. This issue was solved by a series of meetings between WP1 members of both projects, resulting in the adoption of the JERICO-S3 scientific framework as the official framework of JERICO for the upcoming ESFRI 2026 application. This decision was taken as a practical approach, considering that JERICO-S3 is larger (thus more representative) and longer (thus receiving more feedback), and that regional patterns were also observed in national implementation levels of societal needs.

3. Sustainability of the RI

3.1. Envisioned legal structures & governance

3.1.1. Legal structure

JERICO has been established as a Distributed Research Infrastructure (DRI) coordinating, federating and integrating a network of coastal observing platforms, as well as overseeing different "Service Offices". The legal status and the governance structure are paramount to clearly define responsibilities and safeguard an efficient coordination mechanism, which partakes to the sustainability of the DRI. The importance is expressly stated in Rizzuto et al.:

"An important aspect to obtain a satisfactory outcome of the efforts and resources invested in an RI is to distinguish, from the beginning and in all phases, the governance (who develops the strategy and defines the rules, commits the resources needed to reach the scope and goals, and then evaluates the outcomes) and the management (who is given the executive power and bears the responsibility to obtain the results)"

The JERICO is a DRI that collates world leading research expertise, observational facilities and the seamless provision of data and knowledge. JERICO-S3 binds together 40 partners and more than 600 platforms in almost all European seas, thus an adapted governance and P&S delivery system were designed (see in the following sections), but no decision about the legal entity to be aimed for has been made. Up to now, JERICO appeared as a sum of partners, but it is deemed crucial in the long-term to have it established as a legal entity, able to partake in initiatives and funding calls as a single body. Several were considered during

the monthly NJR meetings (ERIC, AISBL, European Grouping of Territorial Cooperation, Stitching), but the final decision shall be taken in tight collaboration with the partners, both at the institutional and national levels, during the Preparatory Phase of the ESFRI Roadmap.

Surveys were performed to envision the commitment of nations and institutions. JERICO-DS deliverable D4.2 ("National Commitment Framework and Strategy Report") gives a detailed situation on the commitment towards JERICO for each Nation part of the JERICO-DS project.

As shown in Figure 5, as of the writing, 4 countries have declared a funding commitment to JERICO: Finland, France, Italy and Croatia (red dot). According to the JERICO Vision, Mission and Values, it is not realistic to rely on only these 4 countries to be successful, as JERICO aims to be pan-European. In addition, the scientific case also relies heavily on the potentially extensive spatial coverage, allowing upscaled scientific results. If we enlarge the consortium to countries where institutes are ready to commit to JERICO (dark blue + green), the number of countries involved rises to 12 leading to a much more relevant covering of European coastal seas. 3 countries are just JERICO partners, that is to say without any political commit: Sweden, UK and Belgium. For Belgium, the political commitment will depend on upcoming political change. 4 countries part of the Black Sea and 3 additional countries part of the Baltic Sea (violet) were contacted and agreed to be part of the upcoming ESFRI roadmap application.

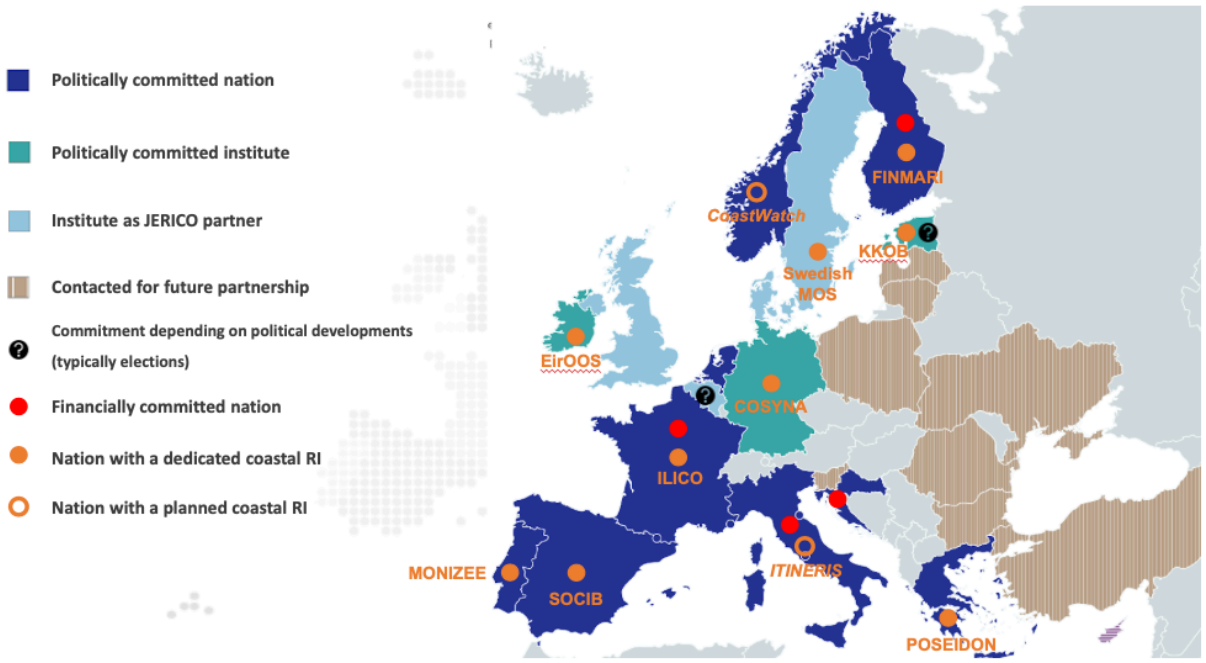

Figure 5: Nation's commitment to JERICO, as of the writing of the document.

The ESFRI application envisioned in 2026 remains relevant, however the target status must be well consolidated in order to elaborate this application with a maximised chance of success.

3.1.2. Governance

Ontology

To clearly define the terminology that will be used in the ESFRI Roadmap 2026 application and avoid confusion between partners, JERICO is developing an ontology to specifically identify key terms and provide a simple definition of those terms. This document will use the following ontology terms as currently defined.

Governance: the system by which an organisation makes and implements decisions to achieve its goals.

Assembly of Members: one representative from each Member State (the national delegate) that may be accompanied by one or more advisors. The national delegate is appointed by the Member State.

Scientific, Technical and Ethical Advisory Committee: a collegial body appointed according to specific rules to provide advice to the Assembly of Members.

Director General: the legally responsible Head of JERICO appointed by the Assembly of Members for a fixed period.

Central Management Office: Performs the administrative functions of JERICO-RI (legal, contract, financial accounting, HR, etc).

Executive Committee: a collegial body elected from their peers, according to specific rules, for the operation and management of the JERICO.

Service Office: performs the managerial function of planning, organising, directing and controlling. These managerial functions are related to office management. They are needed to achieve office objectives. An office can be virtual or physical.

Expert Centre: a group of experts responsible for discussion and strategy within some specific key scientific or technological domains, needed for activities and the generation and operation of specific centres. An expert centre can be virtual or physical.

Services: actions and activities carried out for the benefit of targeted users and providing assistance to these users. They can be internal if addressing internal needs of the JERICO, or external when addressing JERICO external users' needs.

Governance Principles

A clear emphasis is put on a simple and adaptable structure, that will be able both to perform its mission (delivering services of high added-value) with a few initially fully-committed countries, and to accommodate new countries as they join the DRI.

Good governance often depends on clear relationships between executive and governing bodies, especially in wide-ranging international organisations, such as a DRI. It stands as a necessity to unambiguously separate a structure's governance (which establishes the strategy, commits resources, evaluates results) from its management. A DRI can grow as more countries get involved, and the burden on its governing body can become tough to manage. To overcome this, advisory committees can help the governance by investigating specific topics and reporting matters relevant to the governance.

The highest level of governance in JERICO will be the **Assembly of Members** who have the ultimate decision-making powers of JERICO (Figure 6). The Assembly of Members will be advised by the **Scientific**, **Technical** and **Ethical Advisory Committee** of independent experts.

The **Director General** will report to the Assembly of Members on the strategic, scientific, legal, financial and operational aspects of JERICO. The Director General will be supported in these activities by the JERICO **Central Management Office** which performs the administrative functions of JERICO (legal advice, financial accounting, HR services, etc.).

The **Executive Committee** will be responsible for the operation and management of JERICO and report to the Director General.

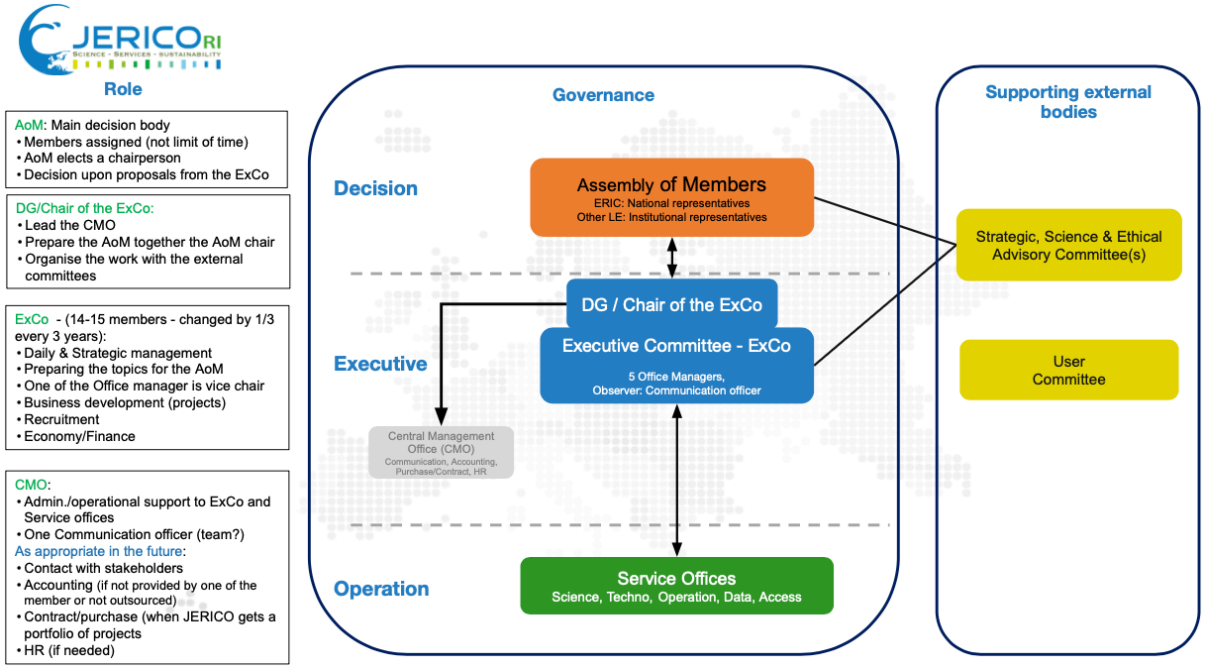

Figure 6: Governance, management and executive bodies of JERICO.

The operations and management of JERICO that the Executive Committee is responsible for are done through **Service Offices** (see Figure 7) providing JERICO's **P&S**. The Executive Committee has the possibility to propose to establish or discontinue a Service Office, under the agreement of the Director General if the Assembly of Members validate the decision. The Executive Committee will be composed of one "National Coastal Observation" representative appointed by each Member State, and one delegate elected from each Service Office.

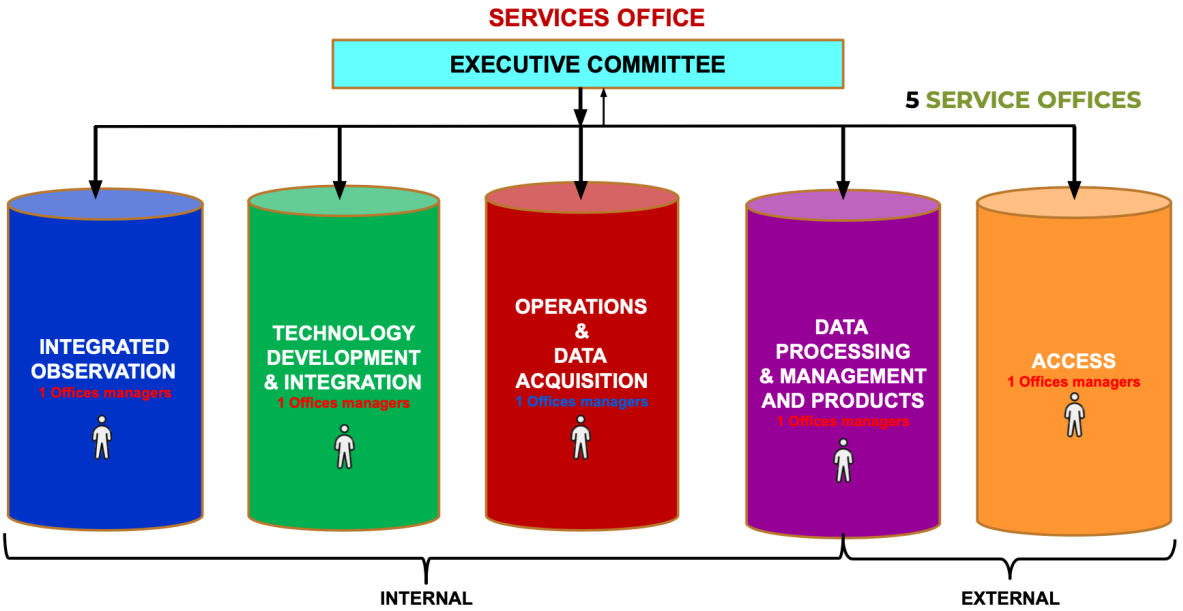

Figure 7: Service Offices of JERICO.

3.2. Envisioned Services structure

JERICO will propose so-called 'internal' and 'external' services. Internal services will be dedicated to "internal" users, who are in fact part of the nation's members of JERICO. External users' services will be composed of access to virtual or physical facilities. As well, as shown by figure 7, external services from the "Data Processes & Management" Service Office will be proposed to external users. This classification must not be taken strictly, because sometimes internal services can be proposed to external users, and *vice-versa*. For example, services from the "Technology Development & Integration" service office, can be proposed to external users; as well as marine renewable energy exploitation plant managers or aquaculture stakeholders.

The coupling of the service office with the executive part of the governance was shown in the previous chapter. The present chapter describes how the various service offices are organised and as well interactions with other RIs and European data and products aggregators.

Each Service Office will consist of one or more **Expert Centers** (see Figure 8). Each Service Office has the possibility to establish or discontinue an **Expert Center** under its control, subject to the agreement of the Executive Committee under the agreement of the Director General if the Assembly of Members validates the decision.

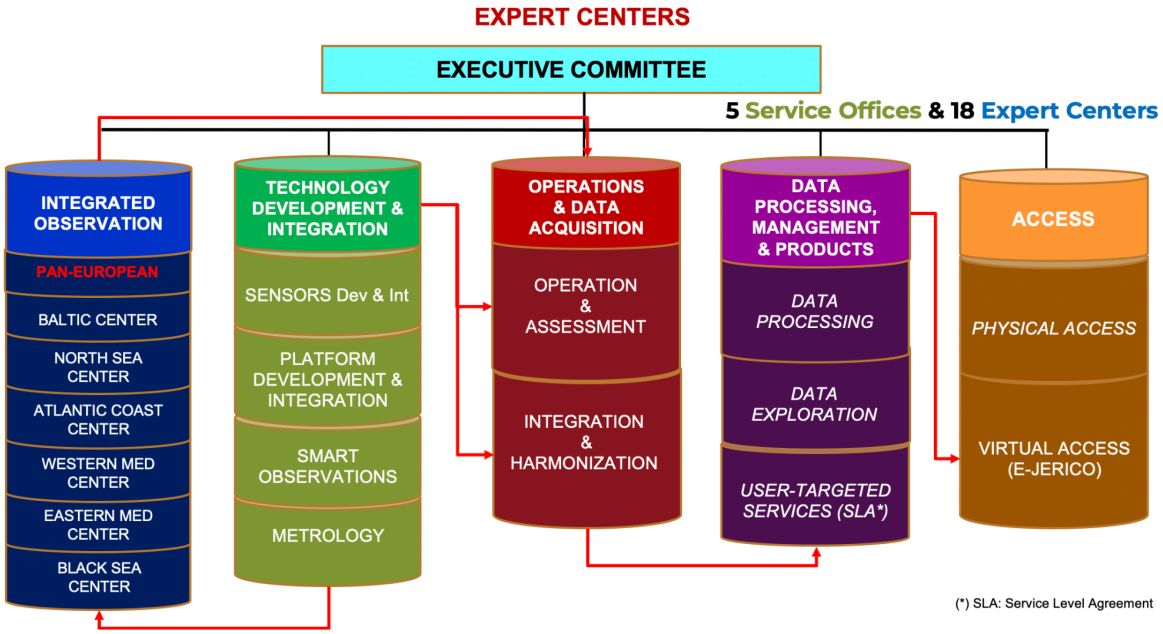

Figure 8: Expert Centers of JERICO.

Each Expert Centre will provide one or more **Product & Service(s)**. Each Expert Centre has the power to establish or discontinue a Service subject to the agreement of the relevant Service Office subject to the agreement of the Executive Committee under the agreement of the Director General if the Assembly of Members validates the decision.

Access modality to an Expert Centre, and selection process for a Service, will vary depending on the type of Service required by the user, and will be defined at a later implementation stage. Staffing of each Expert Centre will be based on in-kind contribution of partner institutions depending on expertise.

Two types of Expert Centres are envisioned. **Technical Expert Centres** are expected to gather experts in operating systems of platforms and in supporting operations of data acquisition. They will include *in-situ* operation & calibration services for instance, as well as maintenance services. These services should not be centralised but relying on the nations' and then on institutions' expertise, to be shared on the basis of mutual support to save costs at EU level. **Thematic Expert Centres** are expected to gather the expertise on the JERICO e-Services. They will be built according to the following priorities: (1) the JERICO scientific topics, (2) the needs of specific activities of our main users and stakeholders, that is to say the community of Public and Academic Users in the Coastal Protection, Fundamental and Applied Research and Ocean Forecasting domains, (3) the regional specificities.

In terms of services, a mapping of the potential services that could be proposed by each of the 5 service offices are shown below. On the figures some services marked with a green circle and an "OK" label are services that have been the subject of a proof of concept as part of the JERICO-S3 project and previous JERICO projects. These are therefore services that could be implemented from the start of the operational phase of JERICO, with only a minimal investment.

3.2.1. Services from "Technological Development & Integration" service office

The services related to the "Technological Development & Integration" service office (Figure 9) are meant to propose to the users the expertise of the JERICO community to improve the coastal observation capacity in Europe and as well to give the possibility to interact in a structured way with the related industries. 4 expert centres are proposed, "Metrology & Calval", Platforms & Sensor Package", "Smart Observations", and "Sensors". We can notice some already identified relationships with other RIs like EMBRC and ICOS for some services dedicated to the "Sensors" expert centre. The Metrology & Calval expert centre is already provided thanks to the Transnational Access in JERICO-S3 that proposes access to metrology laboratories dedicated to marine sensors and that are supported by the main JERICO partners. As well during previous JERICO projects, research and development on sensors and observation systems were performed, with links for example with the EMSO ERIC. It means that we can consider that the services dedicated to Platforms, Smart Observations and Sensors were already engaged, considering that performing such actions in the framework of JERICO will facilitate and optimise the collaboration possibilities with other marine RIs as for example EMBRC, EMSO, ICOS, and then will give more amplitude to engage European SMEs in collaborative R&D.

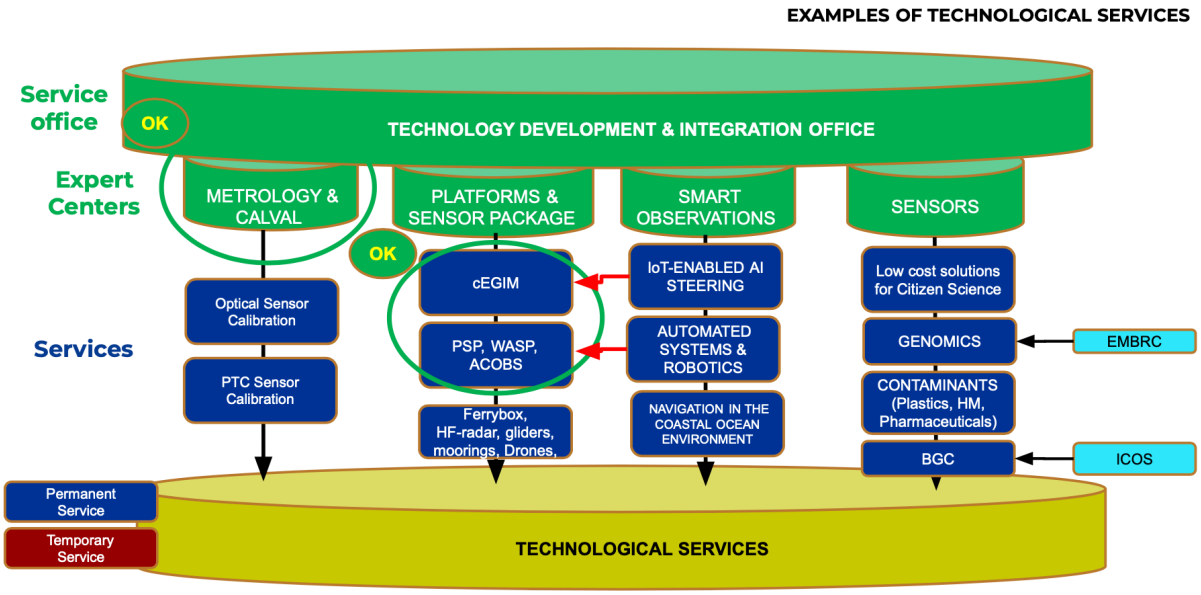

Figure 9: Technological services

3.2.2. Services from "Operation & Data Acquisition" service office

The services related to the "Operation & Data Acquisition" service office (Figure 10) are managed by 4 expert centres dedicated to DAY2DAY operation, Assessment of the RI Performance, Harmonisation and Integration. This Service Office is one of the key assets of having a Coastal Observation and RI at the European level since Harmonisation and Integration are two pillars of the JERICO objectives and can be achieved only if managed at European level and more at global level. One service dedicated to "Knowledge Transfer on

Supersite" is already proof-tested thanks to the activity of the IRS (Integrated Regional Site) and PSS (Pilot Super Site) during the JERICO-S3 project and is an asset to improve the coastal observation system at European level and to support the land-sea continuum objectives in relation with other marine RIs as for example DANUBIUS, EMBRC, EMSO, ICOS.

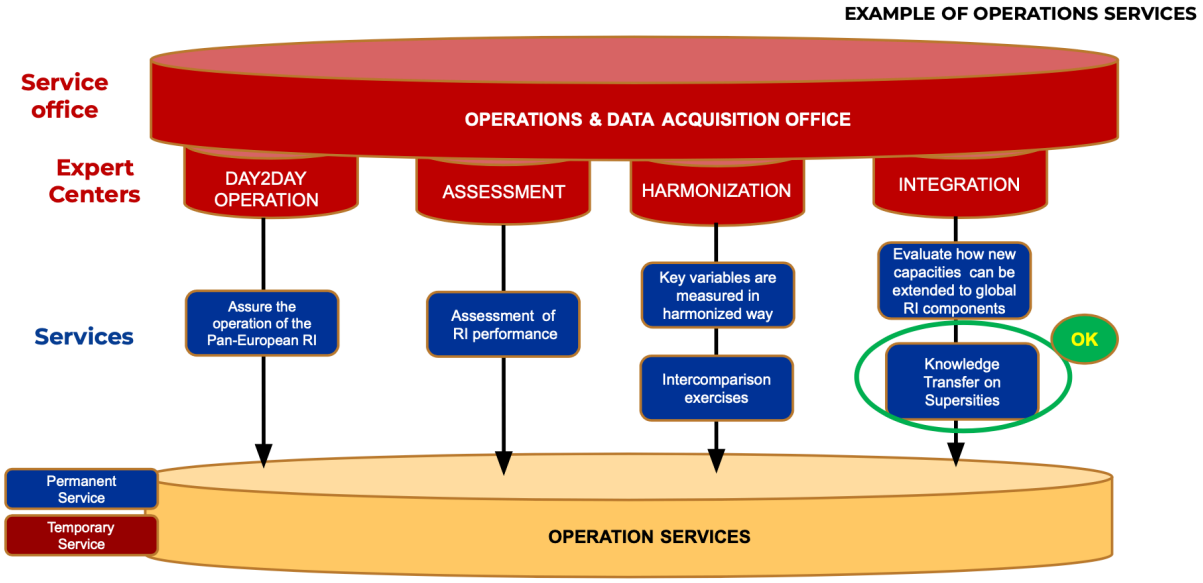

Figure 10: Operation services

3.2.3. Services from "Data Processing, Management and Products office" service office

The services related to the "Data Processing, Management and Products office" service office (figure 11) are managed by 3 expert centres dedicated to "Data Processing", "Exploration" and "User-Targeted services". This service office is supported by the Virtual Research Environment JERICO-CORE that is proof-tested thanks to the JERICO-S3 Project (hence why some services are tagged as "OK"). This service office has an important potential to expand, as many JERICO partners can offer tools for data processing that could be used in other JERICO regions, as such this is a mechanism that will be facilitated and encouraged with the JERICO framework. And implementation of adapted products delivered by other RIs can be arranged as it was done during the JERICO-S3 project with EMBRC, with the implementation of the Ecotaxa data processing tool.

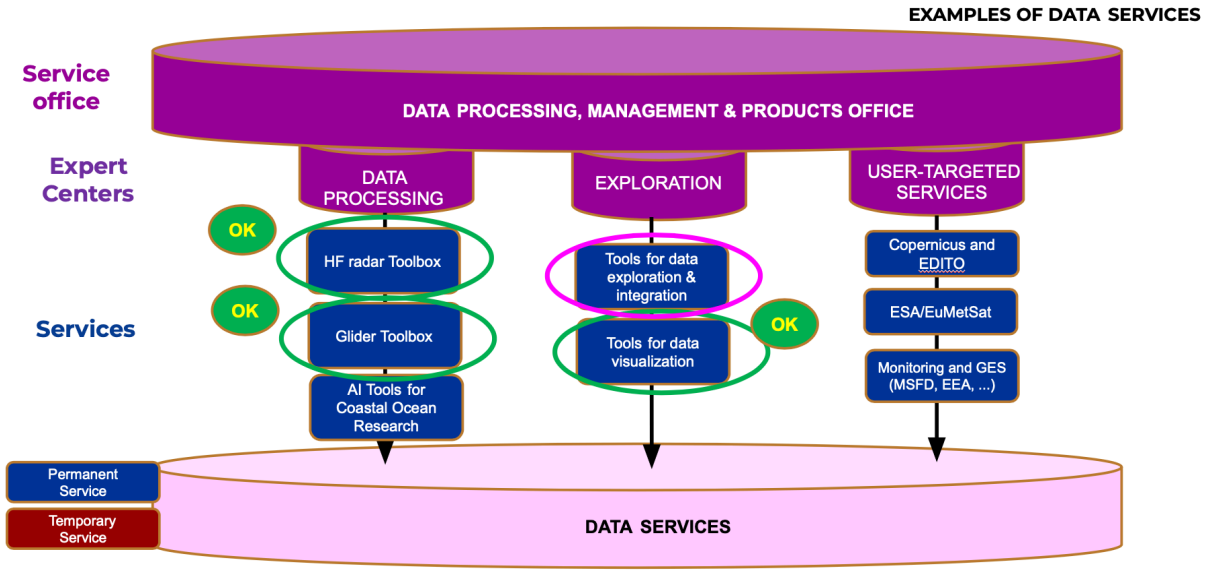

Figure 11: Data services

3.2.4. Services from "Access office" service office

The services related to the "Access office" Service Office (figure 12) are managed by 2 expert centres dedicated to "Platform Access" and "Virtual Access". These services were already successfully proposed as 51 facilities (platforms, testing sites, metrological laboratories, etc.) by the JERICO-S3 project Transnational Access, and with more than 20 Virtual Access already implemented. The advantage of operating them in a RI scheme will be to consolidate easily the permanent links with other RIs as for example EMSO, Danubius and as well with other European entities such as for example EMODNet, SeadataCloud, Blue Cloud and, for Best Practices, with OBPS.

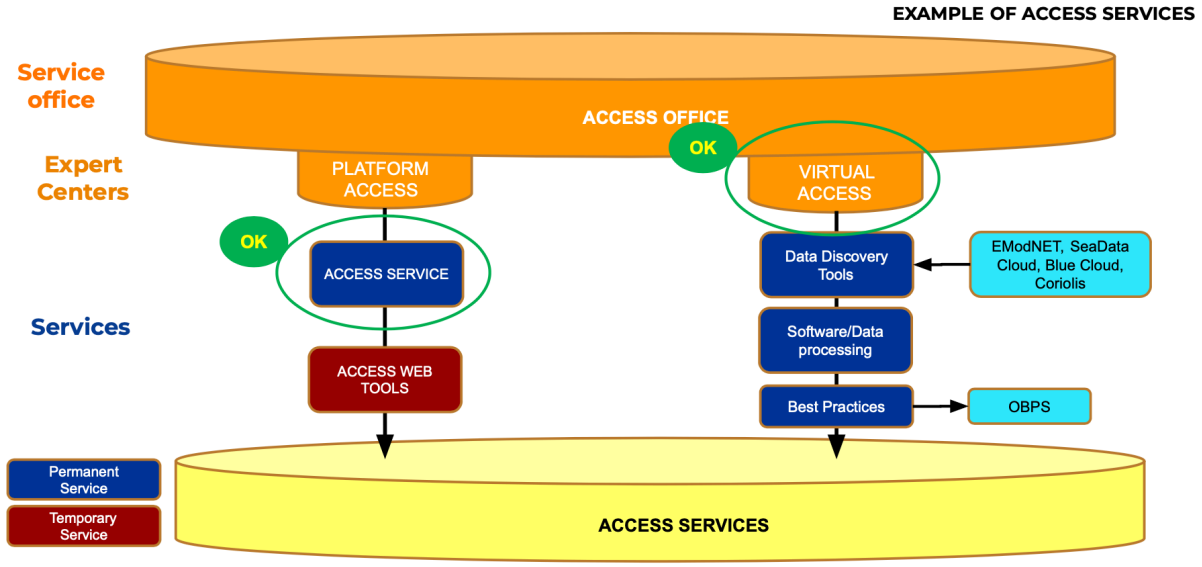

Figure 12: Access services

As a summary, JERICO services will propose federated expertise to progress on a **harmonised** and **integrated** coastal observation system to support efficient coastal research on large coastal regions and well-articulated with the other European actors and entities that are producing data, knowledge and tools.

3.3. JERICO User requirements and classification

JERICO aims at improving Ocean Observing Systems, focused on the coastal area, so that the benefits – scientific, economic, societal – increase substantially for society. To ensure that, a clear User Strategy is needed for an RI to become successfully sustainable, especially for a User-driven infrastructure such as JERICO as envisioned. The general methodology for an RI to investigate a User Strategy calls for the application of 3 successive steps:

(1) Setting of strategic objectives according to the maturity of the RI

(2) Analysing both internal and external factors

(3) Formulating recommendation and strategy to reach the objectives

In JERICO-S3, 2 strategic objectives were set, so as to elaborate the User Strategy of the future JERICO. The first objective encompasses the structuration of the RI around Users Needs and Stakeholders expectations, while the second objective lies in the build-up of a User Committee, deemed most appropriate to provide insightful feedback from users.

In doing so, information was compiled on 470 users, from 11 regions and 17 countries, which constituted the first official database of JERICO's users. This database allowed for a finer classification of each recorded user (Figure 13), based on the work of Heslop et al. (2019) as well as on pre-existing knowledge within the community.

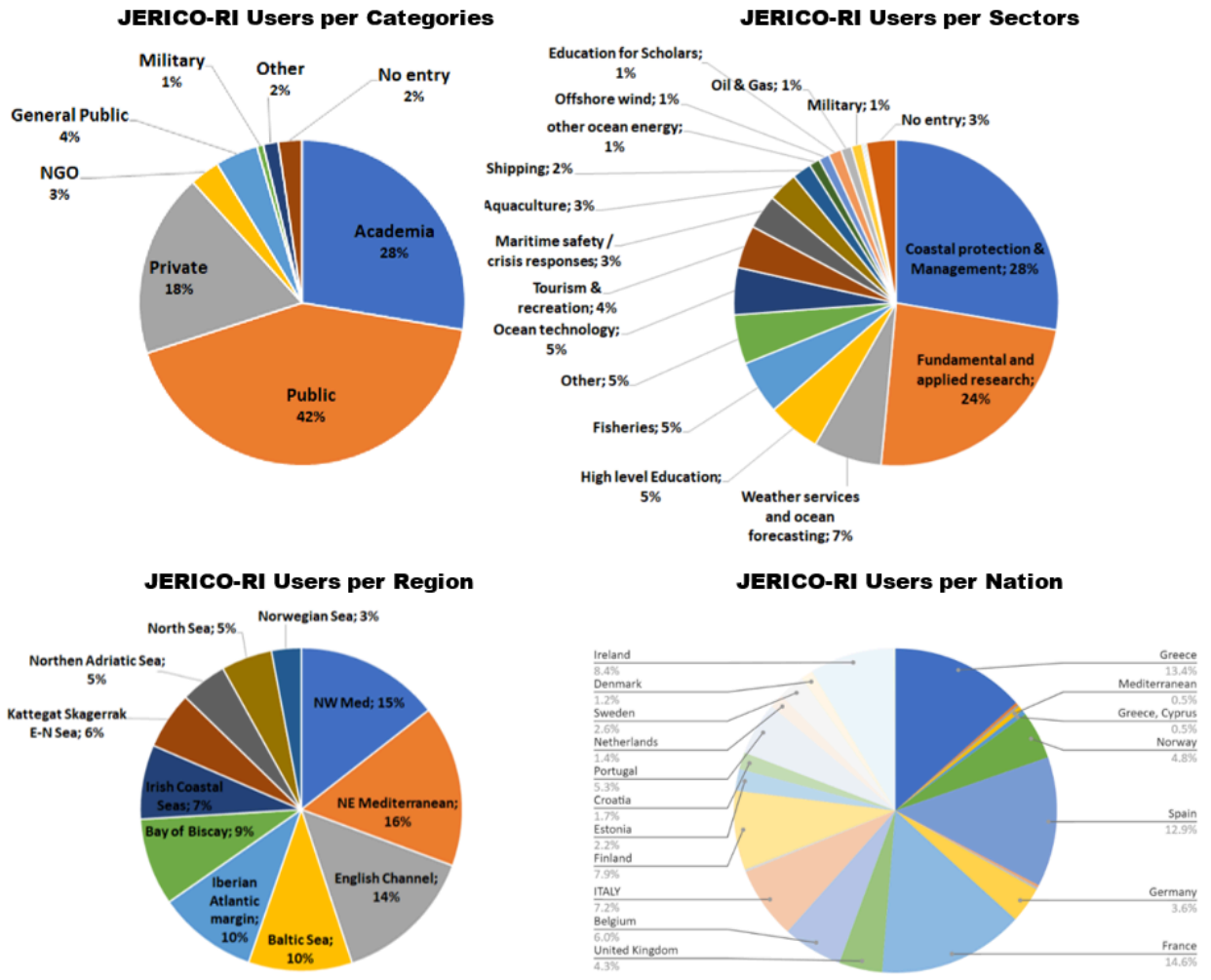

Figure 13: Distribution of JERICO users per categories, sectors, region and countries. Reproduced from JERICO-S3 D9.1.

The analysis of this table of users led to the writing of JERICO-S3 deliverable D9.1, which provides a detailed description of JERICO's user landscape, as well as an engagement strategy relative to each user's resources and interest in JERICO.

Ultimately however, different kinds of users will take advantage of the benefits provided by JERICO. Some of the foreseen advantages are listed in Table 4, but the very nature of research means that new services will undoubtedly be needed over time. JERICO thus needs a way to cope with changes in user needs, which is described in the following section.

Table 4: Added-value of JERICO for foreseen users of the RI.

Type of users	Added value provided by JERICO
Scientists	- Quality-assured, open-access data - Standardisation of observational procedures through definition of 'Best Practices' - Inter-comparisons - Physical access to observational platforms for improved *in-situ* research - Centralised access to data and services via JERICO-CORE - Increased international collaborations *via* the observation network

Policy makers	- Support for policy-driven networks - New monitoring tools in support of new policies - Support of decision-making in the long-run with high quality, long-term datasets at different spatio-temporal scales - Improved risk mitigation by tight monitoring of extreme events
Private staff	- Open-access data - Expert advice/service - Physical access to platforms and facilities, to test new products and technologies - Development of quality standards for technological development (TRL definition) - Fostering of new public-private collaborations, resulting in more start-up and spin-off companies
Education personnel	- Improved/more abundant training material - Expertise on coastal monitoring topics
Citizens	- Improved water quality monitoring and predictions - Improved awareness of environmental challenges - Improved dialogue between scientists and the general public

3.4. User and Stakeholder engagement strategy

Deliverable D9.2 of JERICO-S3 built upon – and completed – the knowledge and analysis conducted in JERICO-S3 D9.1, by formulating a multifaceted user and stakeholder engagement strategy based on UX Design philosophy. This strategy was formulated and defined using the scientific community as a reference, although it is acknowledged that the approach will be applied as well to any other interest group part of JERICO, with adaptations suited to their particularities when applicable.

This UX Design approach involves the use of 2 tools that allow for a more tailored service provision: User Personas, and User Journey Maps. A User Persona represents an 'average' user of a certain category, and embodies the tasks and needs of that category (see Figure 14). They are useful to provide a degree of subjectivity in actions undertaken in the frame of JERICO's activities (or potential activities), so as to understand the motivation behind each task.

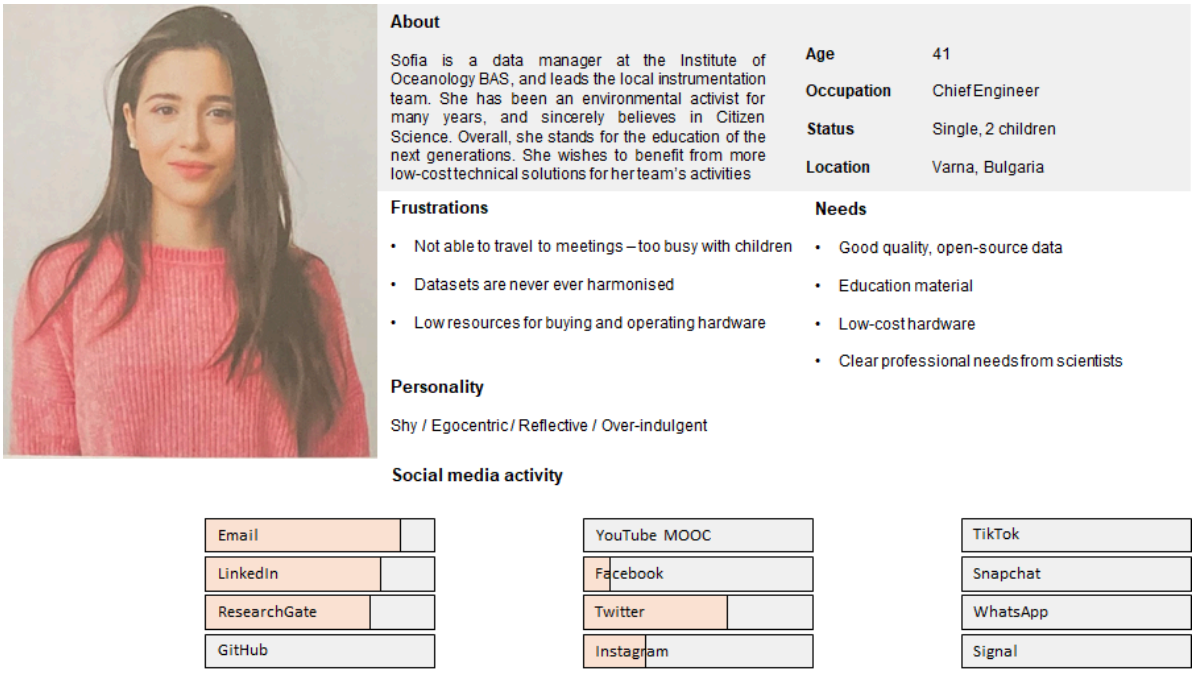

Figure 14: Example of a User Persona CV, representing an end-user category of JERICO. Reproduced from JERICO-S3 D9.2.

These User Personas are of service for making User Journey Maps, which describe the steps through which a usual goal is attained, including potential difficulties and barriers encountered in a day-to-day life (see Figure 15). Specifically, highlighting these difficulties leads to a clear vision of the primary and secondary needs of this category, therefore of the solutions JERICO can bring.

The establishment of the JERICO User Committee (JUC) will also help tremendously in devising new Products and Services. The initial version of the JUC is composed of 4 recognised experts, members of Blue-Cloud or of the Copernicus In Situ TAC. The JUC will keep meeting on a regular basis, to assess the expectations of the user base and compare them with the currently offered Products and Services. It will also assess upcoming needs, and compare them with JERICO's capacities and potentialities, in order to respond rapidly to emerging needs. The JUC will be extended to new members that will represent stakeholders with both a high Influence and Interest in JERICO and that will partake in building relations with industry partners. In general, the JUC will oversee relations with users and stakeholders, and will assess them with the use of a dashboard fed with chosen KPIs.

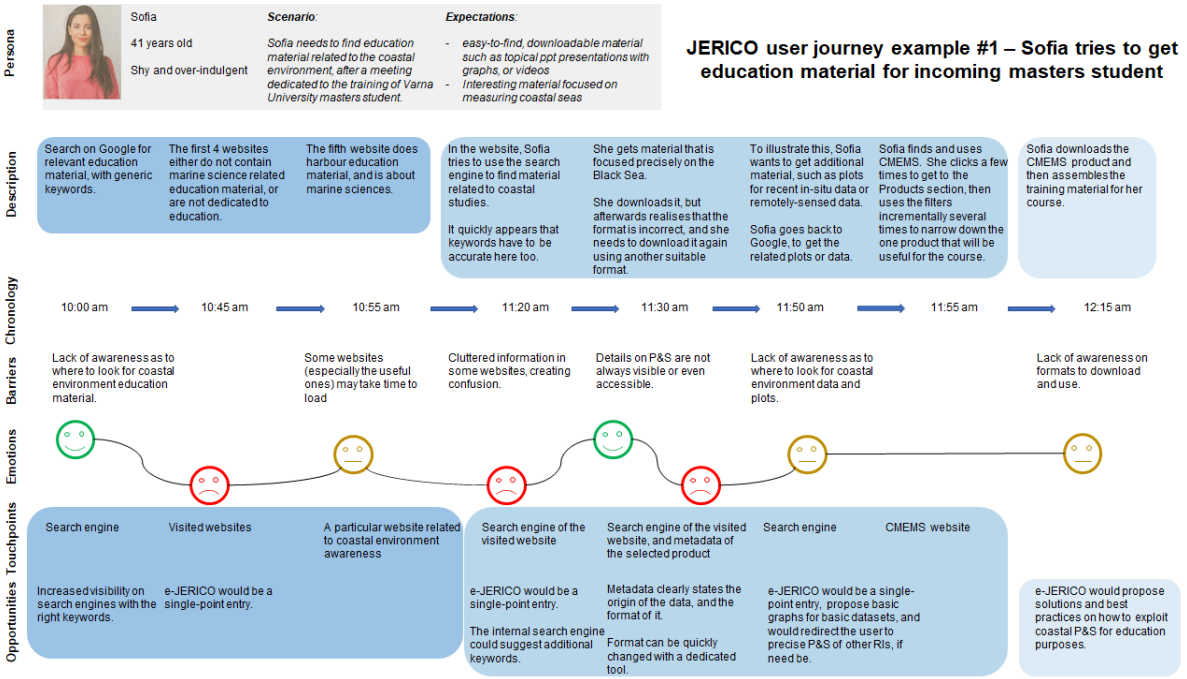

Figure 15: User Journey Map example, showing the potential added -value of the JRI. This first UJM presents the process of gathering educational material by 'Sofia' on a specific, local topic (coastal oceanography in the Black Sea). It illustrates how difficult this gathering process can be, especially without prior knowledge of the right keywords and websites: several websites have to be checked before finding one with suitable material. Data or product formats are not always properly indicated, generating confusion and loss of time. Related graphics, especially for recent data, may not be always available or at least, easily discoverable. Overall, the time theoretically spent by 'Sofia' could be significantly shortened by the envisioned RI and its virtual component.

A dedicated online forum will be created and communicated, so that JERICO users will be able to report any issue. This JERICO User Forum (JUF) will provide an official framework in which users will be able to give feedback and ask questions, maintaining a direct communication channel between the user base and the JERICO office.

Overall, JERICO will comply with the ISO 9001 norm, which helps to define a Quality Management System (QMS). This QMS will improve many areas of operation of JERICO, by increasing the detection, correction and further prevention of dysfunctions. It will be guided by a KPI-fed dashboard concerned with user satisfaction, allowing to direct efforts towards the least satisfied users. The norm also compels to document best practices, so as to be able to formalise successful processes. In the end, the QMS that JERICO intends to follow will lead, together with a seamless governance (see previous section), to a much clearer definition of responsibilities, a particular point of attention for sustainable RIs.

3.5. Business plan

3.5.1. Funding framework - monetary and in-kind contributions

The business model of JERICO - both during the different phases of the ESFRI Roadmap assuming a successful ESFRI 2026 application, and on the longer-term - is partly outlined in

JERICO-S3 Deliverable D9.3. This business model can be thought of as a broad guide for the establishment and operation of JERICO, as it articulates JERICO's Scientific Strategy (and Technological roadmap), User Strategy, and Vision/Mission/Values so to clearly describe P&S provision (both those currently offered and those that could be readily available) with referenced estimates of the resources necessary to support them. The business model focuses on the value proposition of JERICO in the European environmental research landscape, by presenting the added value of its unique features, strategies, resources and partnerships that will make it possible to address scientific challenges and support innovative research.

Another part of the Business Model is covered in JERICO-DS Deliverable D4.3, where a summary of the envisioned financial and funding framework for JERICO is provided. In order to analyse different scenarios of operation for JERICO, taking into account potential risks, two models (Financial and Cost Book) were used to examine JERICO during the different phases of implementation.

The funding framework of JERICO-CORE, the e-infrastructure part of JERICO, is described in detail in JERICO-DS deliverable D3.5, assuming that Blue-Cloud will still be used as the technical baseline for e-JERICO. Cost estimates for each of the 15 e-JERICO components are presented, together with an explanation on their calculation. Similarly to the Business Model developed by the Marine Institute, a budget for e-JERICO is described under 3 different scenarios, allowing for a clear vision on the functioning of e-JERICO. Current sources of funding of the various components by programs and partners are also presented.

3.5.2. Human resources & management

JERICO is in its nature a DRI that spans across the entirety of coastal ecosystems found along Europe's coastline. As such it encompasses a plethora of different ecological and oceanographic conditions. This in itself offers a rich resource for scientific advancement and European excellence in marine coastal research, however it also poses challenges for not only the technological implementation but also for the required human resources. Next to the challenges related to the international governance of this RI that is implemented under a large variety of national regulations and with demanding regional and international collaborations, the committed human resources also must cover/tackle the scientific, strategic and technological requirements for a vast range of very dynamic marine coastal systems while maintaining pan-European interoperability and relevance. The respective human resources hence must incorporate pan-European and global research experience with regional and local expertise **across all relevant scientific disciplines and across all relevant key scientific challenges** as identified in WP1 (Long term coastal science plan).

The governance structure as laid out in a previous section of the present document encompasses the requirements for human resources with duties of scientific, strategic, and bureaucratic/governance nature. As of the writing of this document, it is planned for JERICO to fund a minimum of 4 positions specifically for the Central Management Office: in addition to the Director General, an administrative assistant, a financial manager and a Scientific communication officer are envisioned. Other positions and functions in the governance framework will be accounted for by in-kind contributions from partners. For example, and assuming that France becomes the host country, the CMO will benefit from Ifremer's (or

CNRS's) Grant Office support, and Service Offices will be manned by local experts as part of local partners' in-kind contribution.

A survey including self-assessment approaches within the current wider JERICO community (JERICO-FP7, JERICO-NEXT, JERICO-S3 and JERICO-DS) concerning the currently committed or committable human resources that are involved in the maintenance, planning and usage/analysis of JERICO platforms and observation efforts was done. This survey provided insights into the current capacities or human resources that will ensure **state-of-the-art strategies and technological implementation for a pan-European coastal observation RI with local, regional and pan-European relevance with the aim of achieving, furthering and maintaining excellence in coastal research for Europe and Europe's seas.**

The presented figures, graphs and numbers represent the state of possible commitment of human resources in the respective nations, as of the writing of this document. Through the preparatory phase of JERICO, it is safe to assume that the respective numbers will drastically rise, as several nations require a formalised structure like *e.g.* a RI in the preparatory phase on the ESFRI roadmap. For this analysis, we gathered a database holding 1 634 entries of researchers, research fields, study areas and areas of expertise that can currently be committed to JERICO. We considered 26 sea subregions of European coastal seas as defined by the United Nations[1]. This amounts to an overall of 9 153 228 km², 7 497 927 km² of which (82%) are worked-on by JERICO-affiliated researchers. All 15 JERICO regions are covered by these sea subregions. We also gathered information about expertise in all 10 KSCs, as defined by JERICO-DS in WP1 (Long term coastal science plan), as well as in 5 oceanographic disciplines.

[1] www.marineregions.org, https://www.un.org/depts/los/LEGISLATIONANDTREATIES/subregionsandseas.htm

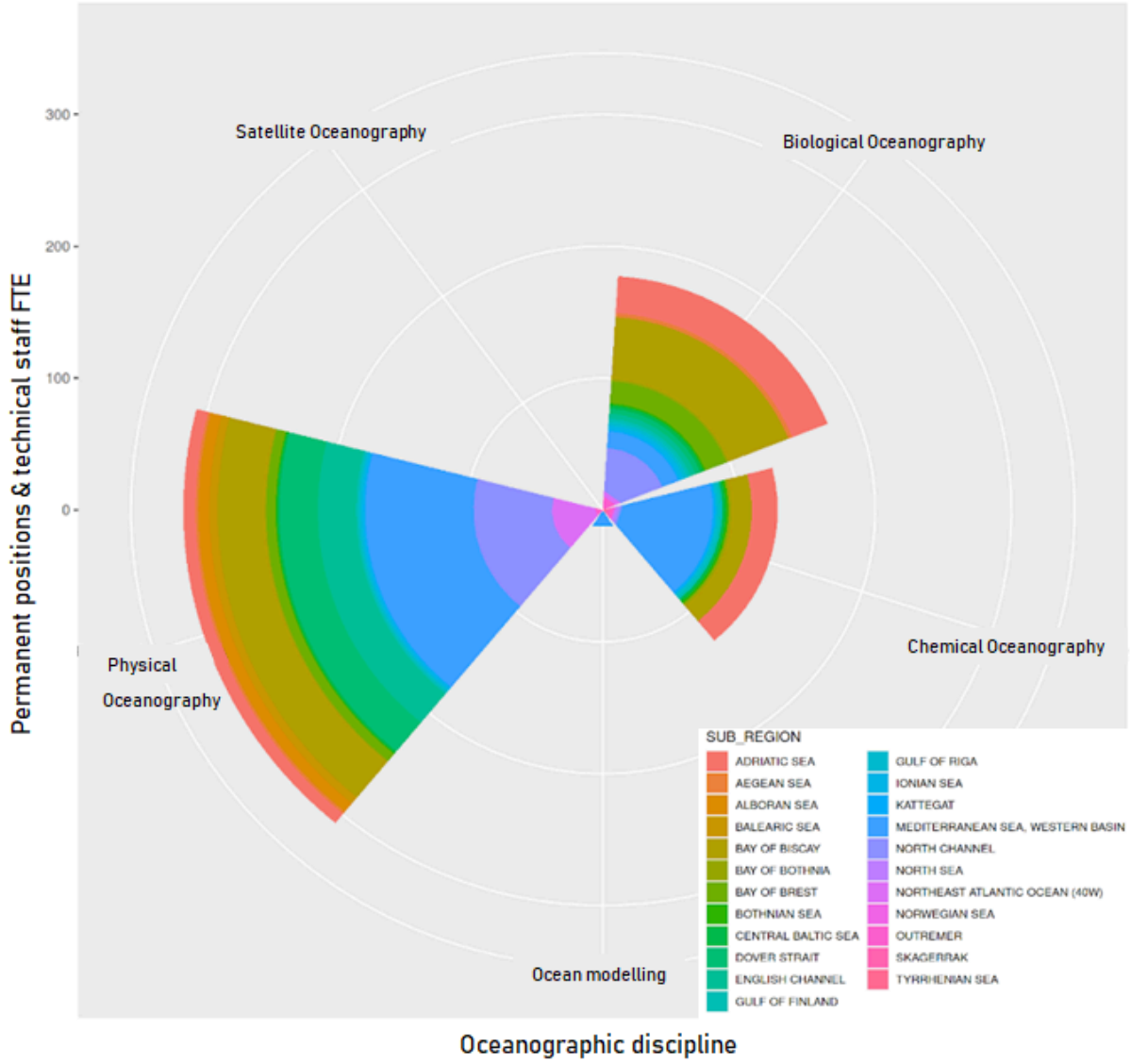

Figure 16: An overview of the Full Time Equivalent (FTE) that can currently be committed to JERICO by the JERICO community/Nations categorised by oceanographic discipline. Chemical, physical and biological oceanography are well presented in the community.

Figure 16 clearly demonstrates that a reasonable number of full-time equivalents (FTE) in chemical, physical and biological oceanography are currently committed to JERICO, which reflects an excellent capacity for sound observations and data acquisition/management, as well as a sound capacity to ensure excellence in coastal observations and state-of-the-art implementations across all disciplines. At the same time, Ocean Modelling and Satellite Oceanography are currently not yet fully committed to JERICO, even though one should keep in mind that those two research fields will be future users/stakeholders of JERICO and its resources.

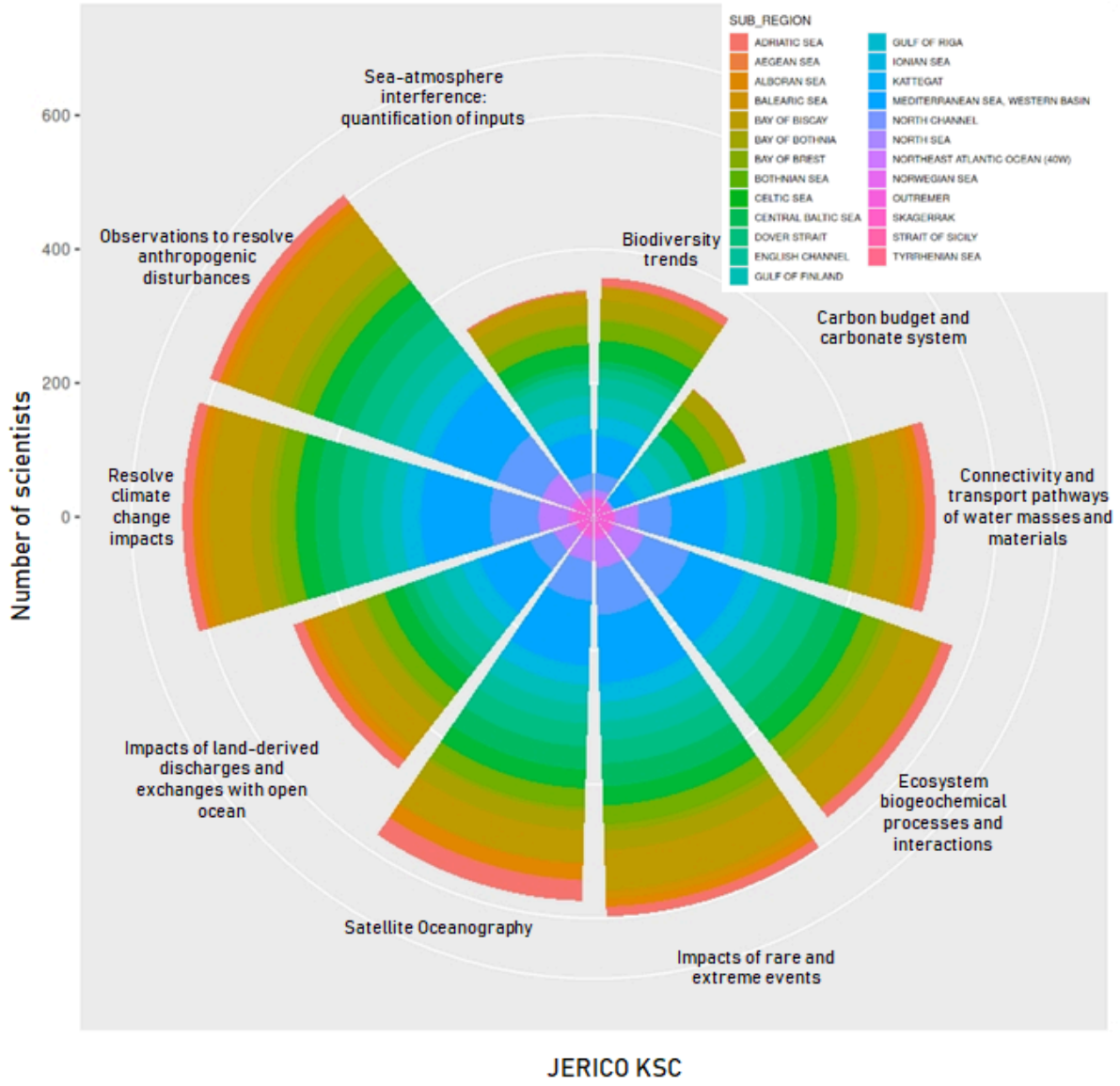

Figure 17: An overview of the number of scientists that can currently be committed to JERICO by the JERICO-community/Nations categorised by their expertise in the Key Scientific Challenges as defined in WP1.

The analysis shown in Figure 17 shows the number of scientists that can currently be committed to JERICO categorised by their expertise in the respective Key Scientific Challenges. A relatively smaller number of scientists within the JERICO community is currently working on KSCs that mainly involve large scale research like *e.g.* the "Sea atmosphere interface: quantification of inputs" or KSCs that will be part of future interfaces with other RIs like *e.g.* Biodiversity trends and the Carbon budget and carbonate systems.

Figure 18 visualises the distribution of expertise per KSC across the sea subregions. The analysis demonstrates that almost all KSCs are addressed, in all sea subregions along the European coastline.

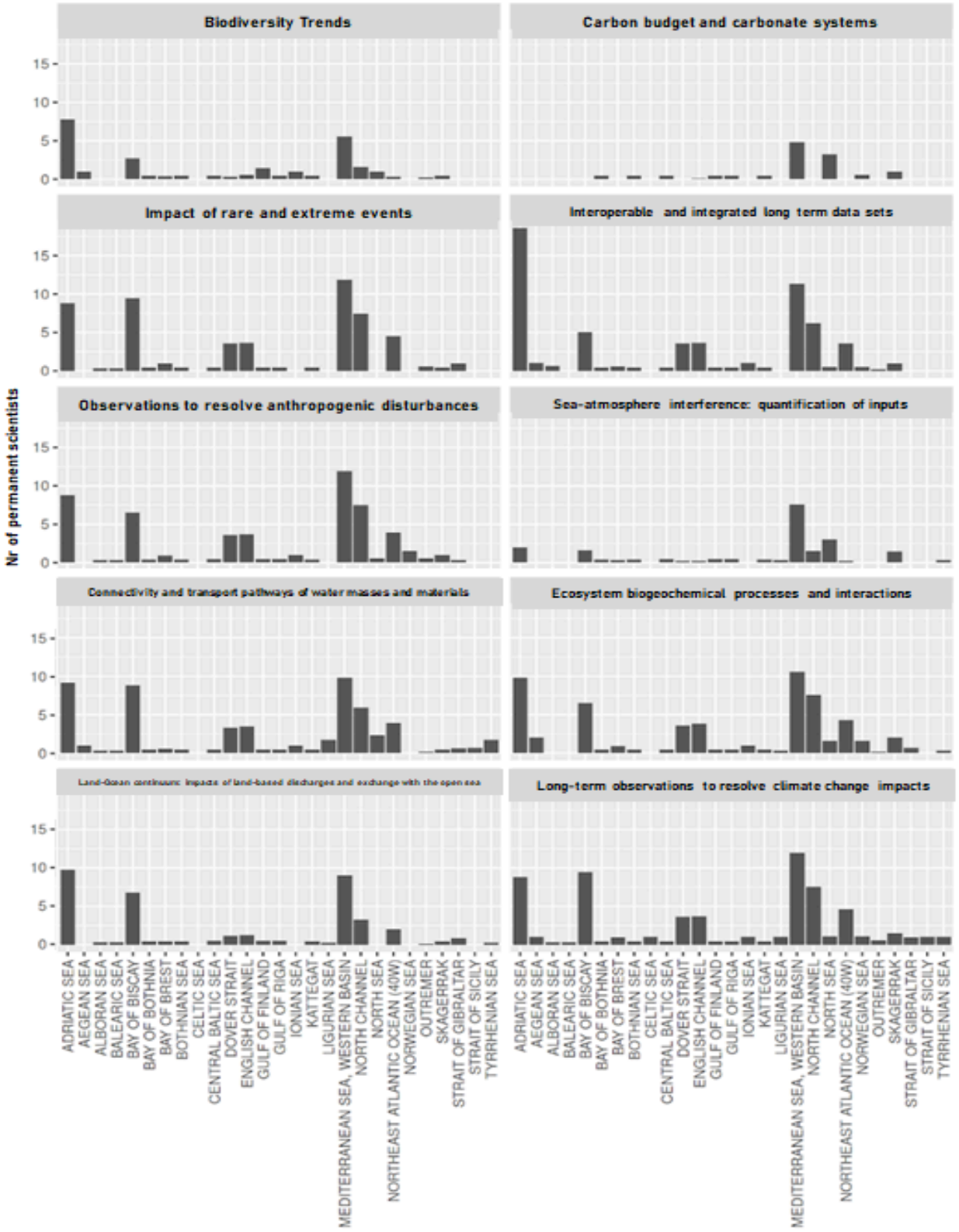

*Figure 18: An overview of the number of **scientists** that can currently be committed to JERICO by the JERICO-community/Nations categorised by their expertise in the Key Scientific Challenges as defined in WP1, as well as per sea subregion.*

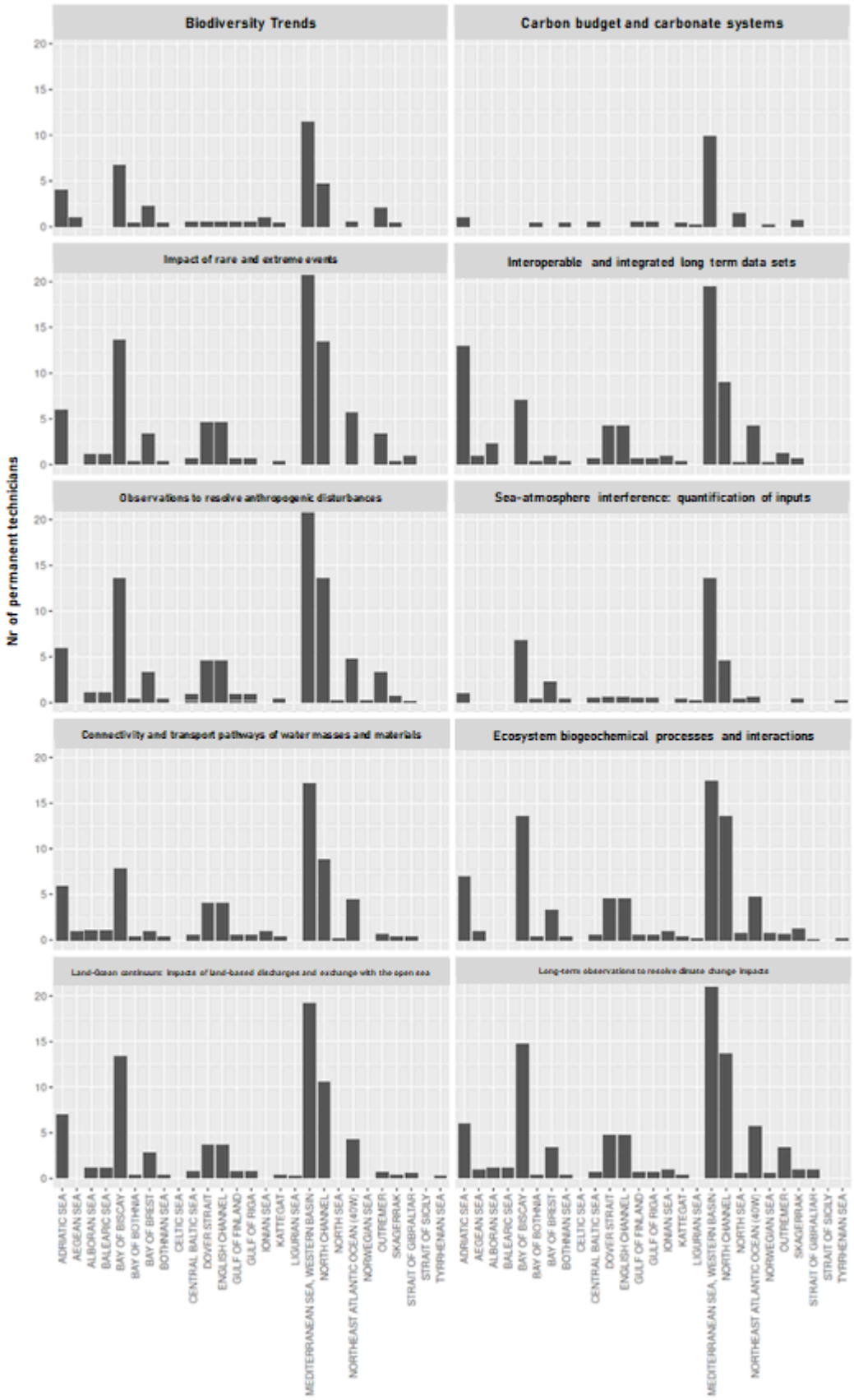

*Figure 19: An overview of the number of FTE of **technical staff** that can currently be committed to JERICO by the JERICO-community/Nations categorised by their expertise in the Key Scientific Challenges as defined in WP1, as well as per sea subregion.*

An important aspect of the technical implementation of a DRI such as JERICO is the need for specialised technical staff able to ensure proper implementation and maintenance. Figure 19 shows the current availability of FTE of technical staff as currently committable to JERICO by KSCs and sea subregion. To demonstrate the capacity of the JERICO community to comprehensively cover the European coastal seas with specific local, regional and pan-European expertise, we evaluated the spatial focus of researchers currently committed to JERICO.

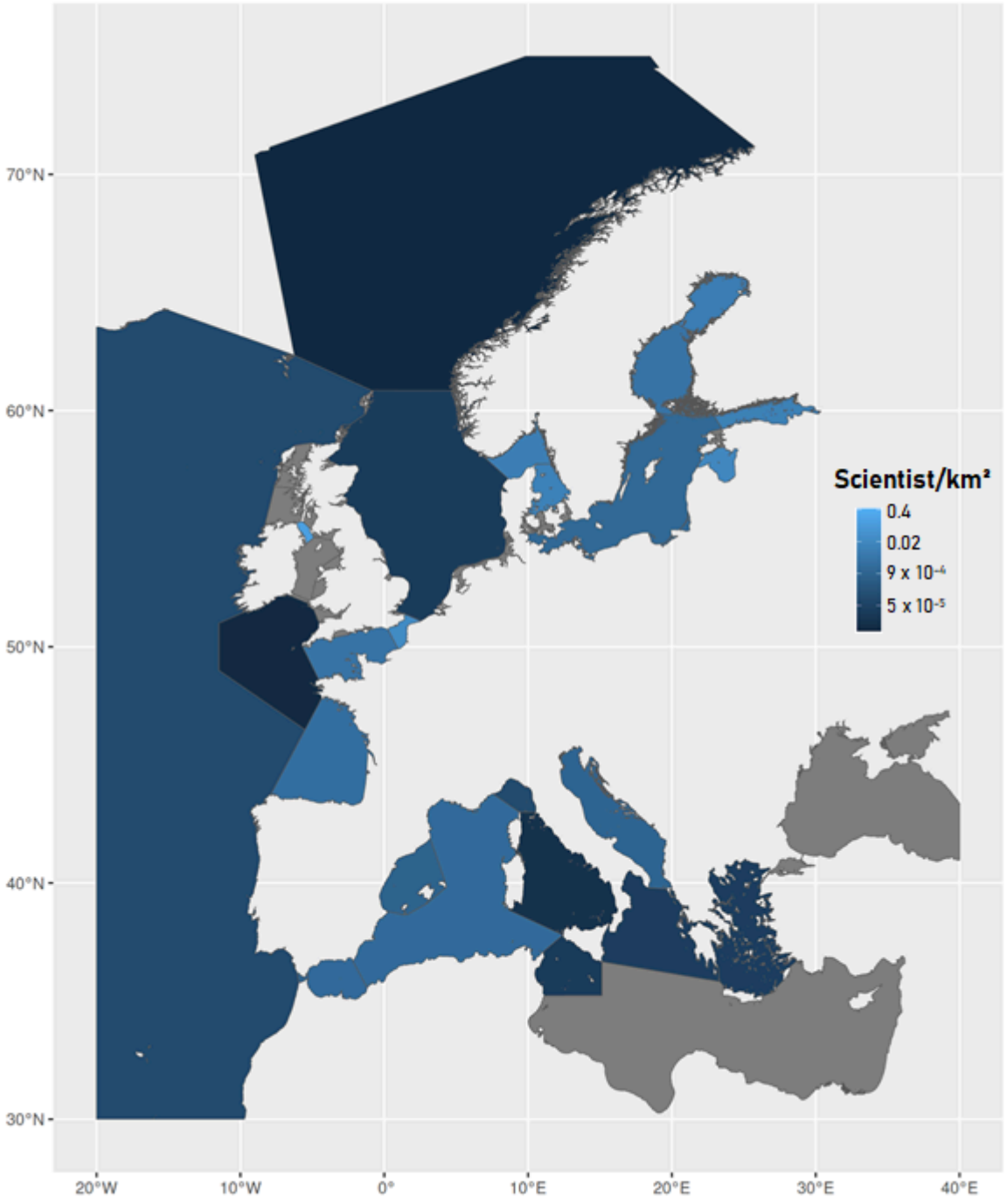

Figure 20: An overview of the number of scientists/km² that can currently be committed to JERICO, by Sea subregion.

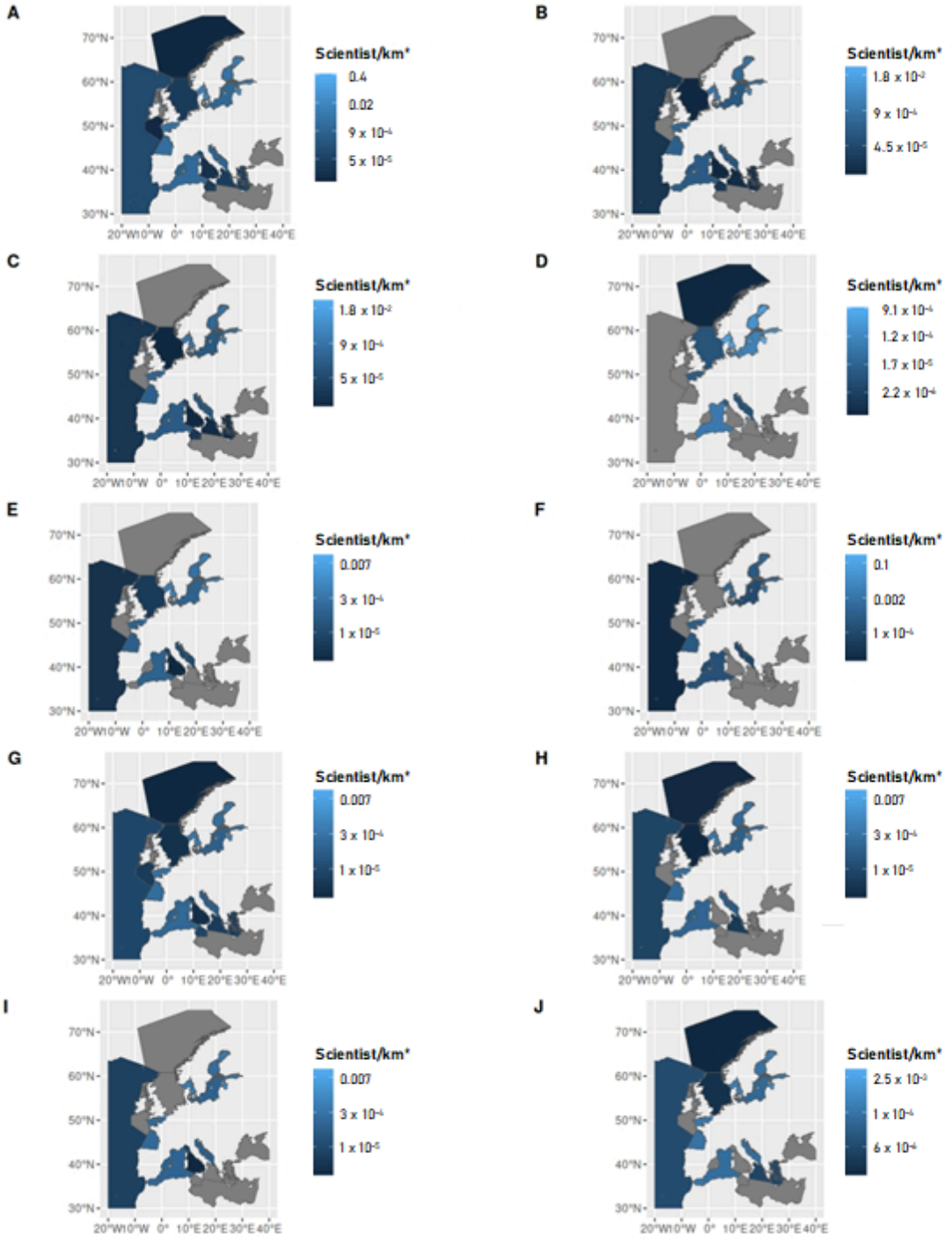

Figure 21: An overview of the number of scientists/km² with research focus on the following Key scientific challenges: A Biodiversity trends, B Connectivity and transport pathways of water masses and materials, C Ecosystem biogeochemical processes and interactions, D Carbon budget and carbonate system, E Sea-atmosphere interference: quantification of inputs, F Impact of rare and extreme events. G Lont term observations to resolve climate change impacts, H Observations to resolve anthropogenic disturbances, I Land-Ocean continuum: Impacts of land based discharges and exchange with the open sea, J Interoperable and integrated long term data sets.

Figure 20 shows an overview of the spatial distribution of regional and local expertise. The figure clearly demonstrates that scientists currently committed to JERICO are specialised on nearly all European coastal sea sub regions.

For a distributed research infrastructure that ventures to reach the required spatial resolution across the entirety of European coastal seas we consider the availability of dedicated scientists with specialised local and regional expertise to be crucial. For several sea regions (grey in Figure 20), we could not map JERICO committed researchers with a research focus on those regions. This indicates that a further enlargement of the JERICO community could be directed towards those geographical areas, possibly during the preparatory phase.

Figure 21 shows the spatial distribution of experts and expertise across European sea subregions that span European coastal marine regions. Once again the data gathered FTE of researchers that can currently be assigned to the JERICO-RI. Through the preparation phase of the JERICO-RI the numbers will still significantly rise as a formalised JERICO-RI entity can be committed to by nations. Directed recruitment of research expertise not yet sufficiently committed per sea subregion as well as dedicated collaborations with existing RI will ensure pan-European coverage across all KSCs.

3.5.3. Risk mitigation strategy

Risk assessment identifies hazards and their potential effects and also identifies potential control measures to offset any negative impact on JERICO. Under the JERICO-DS project, a specific task was dedicated to complete a Financial risk assessment and mitigation strategy for JERICO to ensure that adverse situations are quickly identified, and properly managed.

The Risk Management framework categorises the risks under the following headings: Financial, Organisational, Operational, Technical and Scientific. Certain international standards such as International Organization for Standardization (ISO) 31000:2009 and ISO/International Electrotechnical Commission (IEC) 31010:2009 set out principles, guidelines and techniques for risk assessment and management. The methodology outlined below has been used in a risk assessment for combining marine renewables with other blue economy activities via multi-use of spaces and platforms (Williams et al, 2017).

The methodology used to carry out the risk assessment involves three main steps: 1) Risk event identification; 2) Risk analysis and 3) Risk evaluation.

Risk analysis involves determining the probability of the event occurring and the magnitude of its impacts. A quantitative risk analysis involves estimating practical values for probability (likelihood) and impact being ranked on a numerical scale ranging from 1 to 5, a higher rating signifying a higher likelihood or impact of the risk event occurring. These values are then multiplied to create a single numerical value for the overall risk magnitude.

The Risk Probability refers to the likelihood or frequency of a risk occurring. Probability rank is ranging from highly unlikely to very likely that an event will occur with 3 intermediate levels (Highly unlikely, Unlikely, Possible, Probable, Likely).

The Risk Impact refers to the consequences of the event occurring and is rated on a scale from 1 to 5 assuming a risk event occurs. A single impact may affect a range of different objectives and stakeholders. The impact rank is 1) Insignificant; 2 Minor; 3) Moderate; 4) Serious; 5) Severe. The Risk magnitude is calculated by multiplying probability rating by impact rating as shown in the risk matrix (see Figure 22) below. The risk matrix helps to define risk tolerance and identifies risks that need more attention. In this risk matrix:

· Risk magnitude of 4 or less is low risk (green)
· Risk magnitude of 5 to 14 is a moderate risk (yellow)
· Risk magnitude of over 15 is a high risk (red)

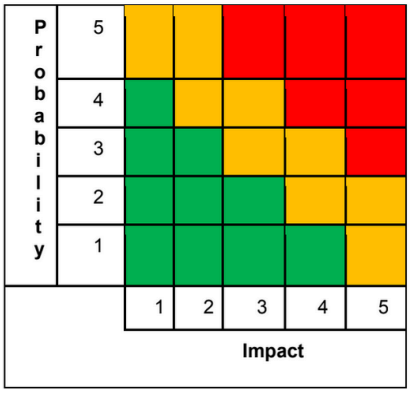

Figure 22: Impact vs Probability risk matrix used in JERICO's risk mitigation strategy.

3.6. RI visibility & societal impact

3.6.1. Communication strategy

The communication of JERICO with the different Users and Stakeholders is of paramount importance. It supports the visibility and interaction which are the bases to ensure the relevance, the fitness-for-purpose, the capacity to improve and the sustainability of JERICO. Communication is indeed at the core of the basic foundations of the RI, which result from the combined efforts of multiple partners in different European nations, each one contributing with a given capacity to the observations of the coastal ocean. An efficient internal communication is key to align these different dynamics around a common goal, and to build a sense of community. The importance of JERICO's communication will increase when stepping forward, with the application to the 2026 ESFRI Roadmap.

In JERICO-S3 deliverable D10.2, an early description of the Communication Plan (CP) of JERICO was outlined. It defined the 5 long-term overarching goals of JERICO's CP, as well as its key objectives:

- Long-term goals
    - Communication of JS3 project activities and results
    - Communication on JRI, it's uses and P&S
    - Support to dissemination and sharing of the project results
    - Support exploitation of project results during & beyond the project lifetime
    - Engagement with project partners, RI stakeholders and end-user groups

- Key objectives
    - Actively engage with communication activities of existing RIs at different levels
    - Improve cooperation and coordination between communication activities of JRI and other RIs
    - Open multilingual dissemination channels at national levels so as to better target JRI key messages
    - Promote JRI P&S amongst external stakeholders and potential end-users, and maintain their interest
    - Promote JRI key activities and outputs
    - Further promote outputs from the DEP (WP10)
    - Establish effective internal communication protocols and guidelines to ensure that all communication and dissemination is delivered in a clear, concise, consistent and timely manner

JERICO-DS deliverable D6.2 presented the design of the Communication Strategy for JERICO. The design builds from the work developed in the JERICO-S3 project and from the more detailed analysis conducted in JERICO-DS.

3.6.2. Impact assessment

Impact assessment of a RI is of crucial importance, for it allows to evaluate objectively the short-, medium- and long-term impacts it might have for society. Given the substantial resources invested into RIs, accountability for its societal and economic impacts is sought after. This is usually done with the use of specific Key Impact Indicators (KIIs), of which several are proposed by the OECD specifically for RIs.

Impact assessment (through KIIs) has to be clearly distinguished from performance assessment (through Key Performance Indicators, KPÏs): the first measures the overall, high-level effect that the RI has on society, while the other measures the effectiveness of the RI's operations (that affect the RI's impact). KPIs of interest for JERICO are treated in section 2.4.1 of the present document.

The impact assessment of JERICO will be conducted with a set of indicators based on OECD work, grouped in 6 impact categories. These indicators are based on the work done by the Organisation for Economic Cooperation and Development (OECD, 2019) to develop a framework to assess the socio-economic impact of research infrastructures and the RI PATHS project (https://ri-paths.eu/ri-pahts-ia-model/). These categories are:

- Scientific and technological excellence
- Technical efficiency (operation)
- Collaboration and Cooperation enhancement (EU and international)
- Socio-economic impact
- Education and training
- Outreach to the public

Further work will be dedicated in JERICO-S3 to fine-tune the set of indicators to be used for JERICO in the different phases of the ESFRI Roadmap, and beyond. However, and as pointed out in JERICO-DS deliverable D4.3, most of the socio-economic benefits of JERICO are not directly quantifiable and may exceed the directly estimated economic added value of the Business Plan (see Table 5).

Table 5 - Areas of non-quantifiable, positive socio-economic impacts of JERICO. Reproduced from JERICO-DS deliverable D4.3.

Improving the efficiency and effectiveness of scientific research: Coastal observatory services support the environmental protection work of public authorities and national, local and regional governments. The data provided by coastal observatories allows bureaucratic authorities to formulate, implement and assess policies for environmental protection with increased effectiveness and with greater confidence that the underlying information is quality-assured and scientifically validated.
Commercial and industrial applications: By improving the management and exploitation of coastal environments for commercial and societal purposes, coastal observation systems meet the needs of end-users by generating information related to societal economic needs and resource requirements. By enhancing the effectiveness of coastal environment marine observatories, the JERICO contributes towards the achievement of more sustainable marine resource exploitation.
Social and producer surpluses: The commercial benefits of coastal marine observation systems stem from the economic value of the data generated by such systems and the effects that such information has on the behaviour of commercially active individuals and organisations.
Supporting environmental protection: Coastal observatory services support the environmental protection work of public authorities and national, local and regional governments. The data provided by coastal observatories allows bureaucratic authorities to formulate, implement and assess policies for environmental protection with increased effectiveness and with greater confidence that the underlying information is quality-assured and scientifically validated.
Understanding and adapting to global climate change: Coastal observation systems can mitigate the socio-economic risks of climate change by improving forecasting of conditions in coastal environments and by assisting in the design of climate-proof coastal infrastructures that prevent coastal flooding and associated property damage. By providing data for climate research and ocean modelling, coastal oceanography can improve climate prediction and monitoring, improve management of environmental change and improve prediction of extreme weather events. Such data can improve guidance for public policymaking on environmental management and climate change adaptation, mitigating the social and environmental costs of climate change.
Responding to public environmental and other public safety hazards: Coastal observatories also improve health and safety in coastal areas by improving the responsiveness and effectiveness of search and rescue services. Particular coastal observatory RIs can monitor conditions in coastal environments in real-time, providing rescuers with information on the location and condition of distressed individuals as well as data on sea currents, sea surface conditions and wind conditions.
Providing secure financial support to the research network: JERICO will provide secure multi-annual funding for scientific research endeavours. National budgetary financing in Europe is invariably revised and allocated on an annual basis, making national funding streams prone to cuts when the fiscal positions of national governments come under strain. Sustained and consolidated long-term funding commitments, whether from participating Member State governments or in the form of EU funding, help to ensure the sustained operation of observatories

and multi-annual research projects that may suffer cuts in their funding streams in the event of an economic crisis or a change in government.

4. Technical Design

4.1. Technical & Technological Design of Operational RI

JERICO-DS WP2 was tasked with the definition of the technical design of JERICO, based on national capacities and vision, and in collaboration with WP1 that defined the Scientific Strategy. This was done through a Technology Outlook, which constituted the basis for a Technology Gap Analysis. In turn, this gap analysis allowed to create a comprehensive Technology Roadmap, also in tight collaboration with WP3 that dealt with the future e-infrastructure of JERICO, ensuring optimal alignment with the physical infrastructure.

The technological design of JERICO has been based initially on an extensive survey sent to nation representatives which allowed for a precise outlook on technical capacities, fine-tuned from the nation's perspective in JERICO-DS deliverable D2.1. Technology design defined 4 crucial technical aspects that will shape JERICO's basic functioning: Strategy - how to coordinate use of technologies and align with existing initiatives, Systems - which technologies are used and how they are implemented , Structure - how technical work and technologies are organised to meet the JERICO aims , and Staff and Skills - what are the human capacities and competencies to be involved.

In JERICO-DS deliverable D2.2, an assessment of current technical capacities was made, through the same questionnaire sent to nation representatives but also using relevant results from JERICO-S3 and past JERICO projects. In particular, current spatial and temporal resolution of JERICO observations were summarised, as well as Technological Readiness Level (TRL) of observation methods for "core variables" in JERICO sites.

The Technology Roadmap of JERICO was built through a collaborative process, involving tight interactions with nation representatives both through questionnaires and workshops. It was exposed in detail in JERICO-DS deliverable D2.3. A list of development proposals together with related activities for the 4 technical aspects previously identified (Strategy, Systems, Structure, Staff and Skills) was submitted to nation representatives for evaluation and ranking, leading to a shortlist. The timeline of activities for Strategy, Structure and Systems proposals can be visualised in Figures 23, 24 and 25 respectively. To monitor the application of these activities and the realisation of the Technological Roadmap, the Nation Committee, other related groups in JERICO-S3, and the ESFRI proposal writing team will interact closely and often.

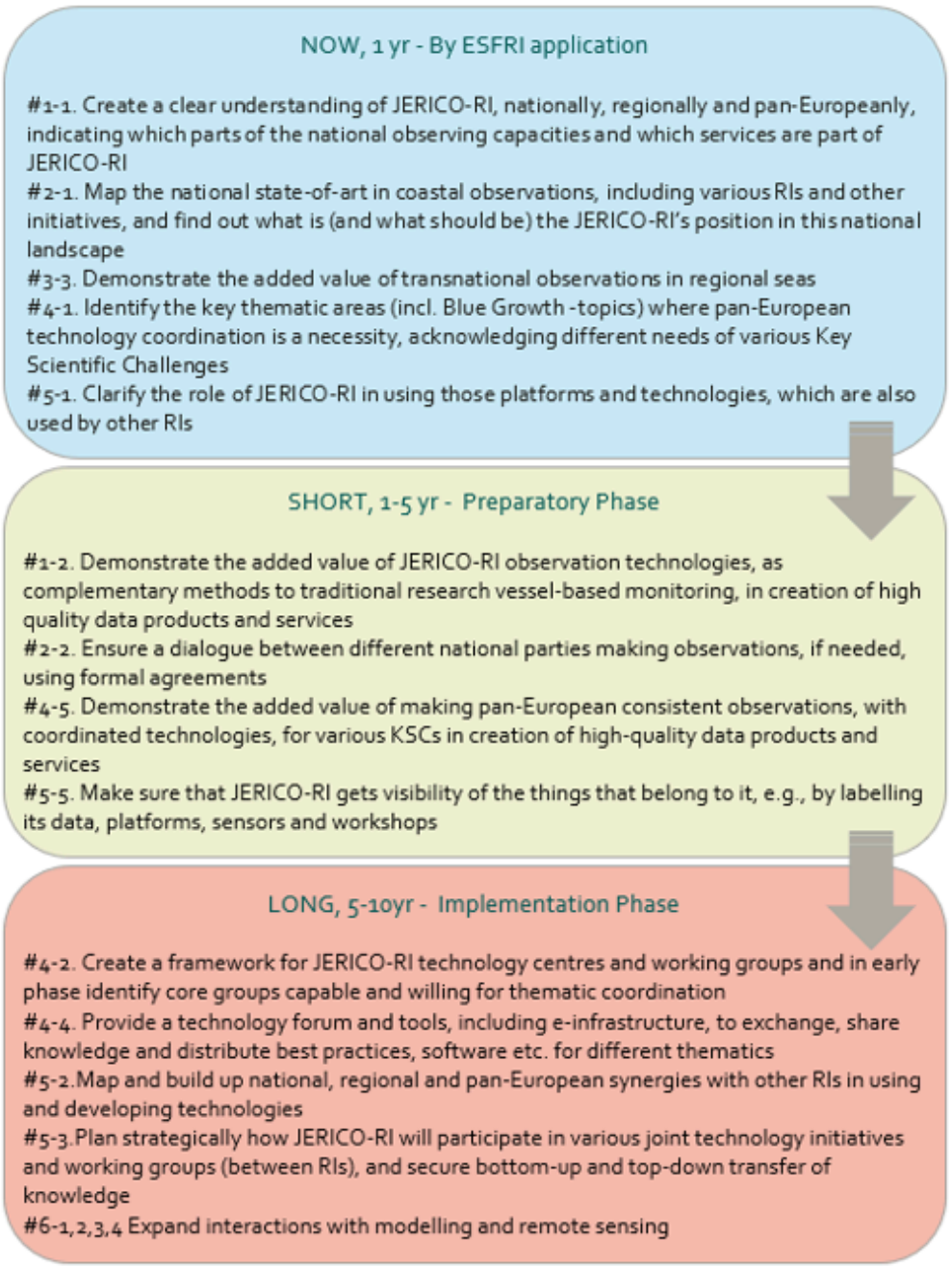

Figure 23: JERICO Technology Roadmap Activities for Strategy Proposals. Reproduced from JERICO-DS D2.3.

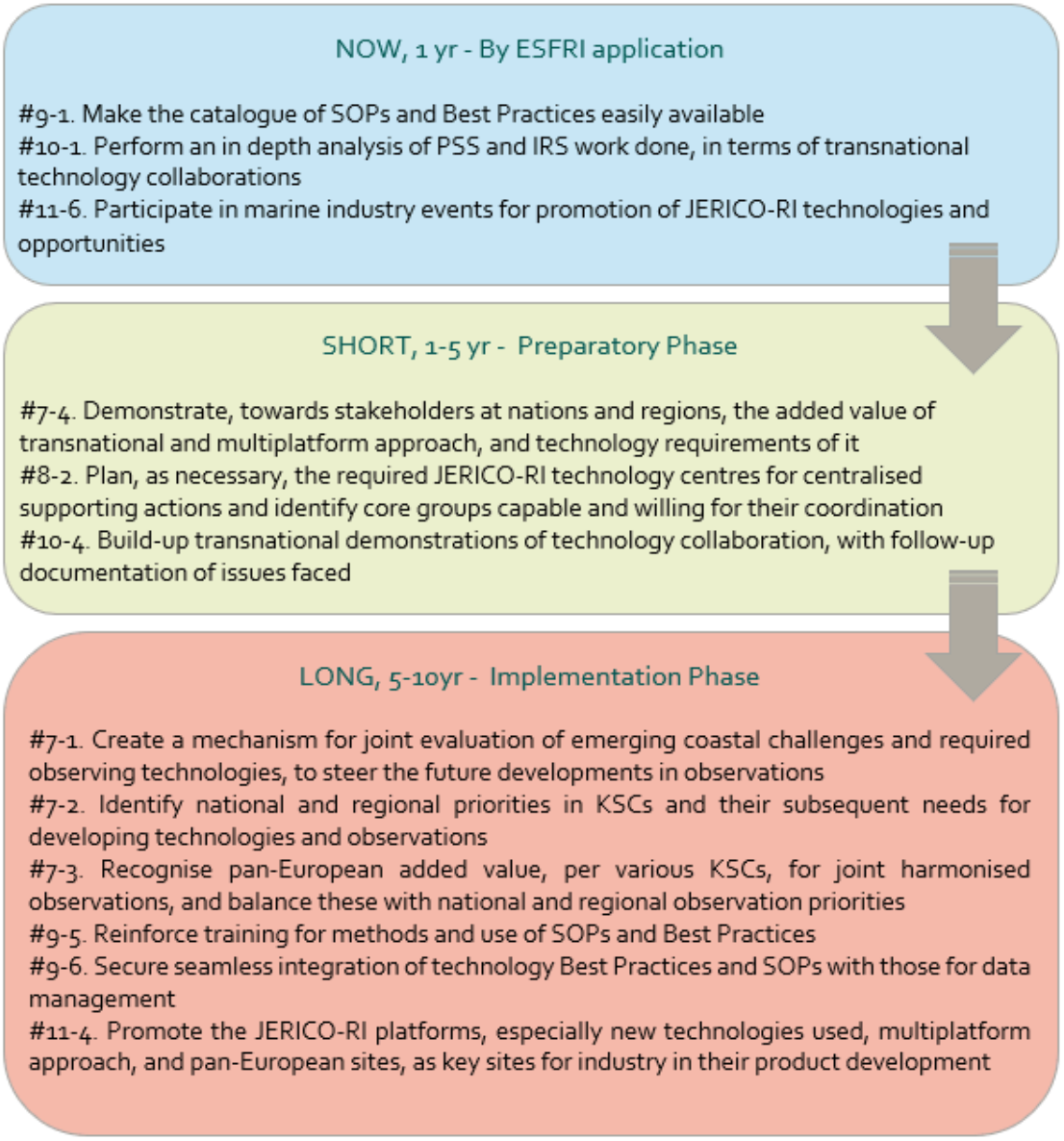

Figure 24: JERICO Technology Roadmap Activities for Structure Proposals. Reproduced from JERICO-DS D2.3

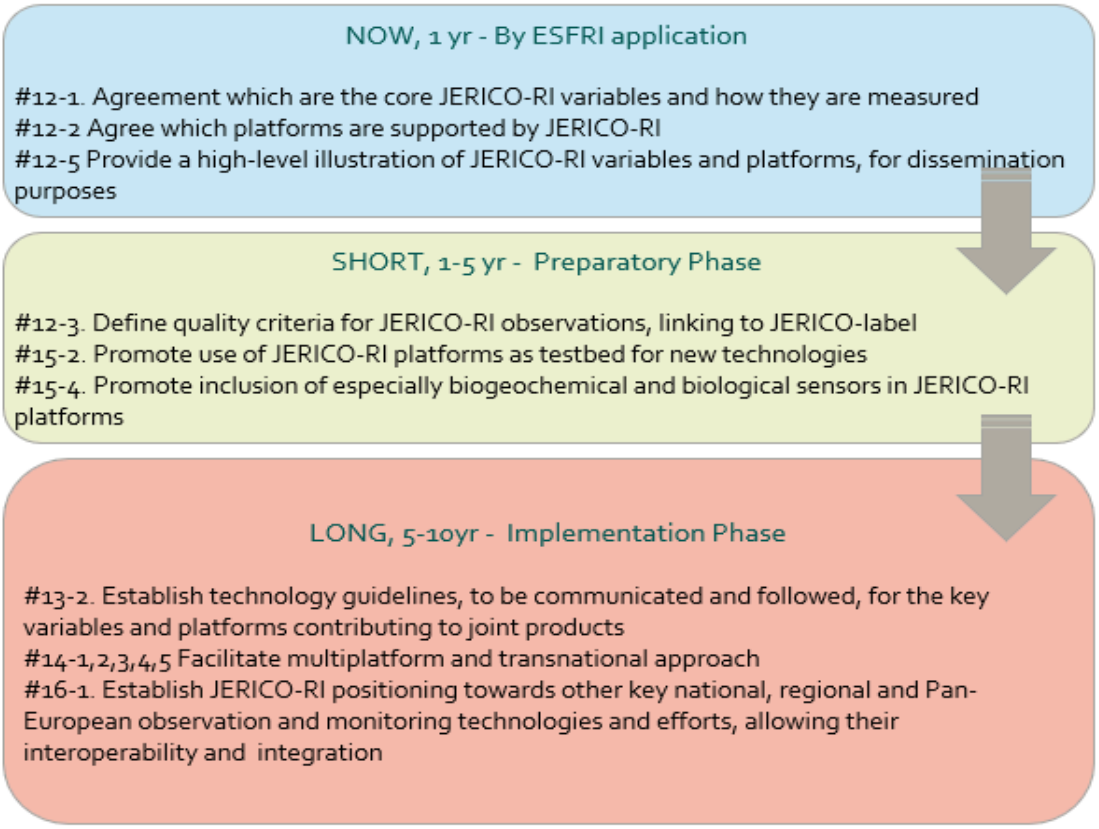

Figure 25: JERICO Technology Roadmap Activities for Systems Proposals. Reproduced from JERICO-DS D2.3.

4.2. Innovative monitoring strategy framework

In JERICO-S3 WP4, a proof of concept and feasibility for JERICO Supersites was provided, with the successful implementation of 5 Pilot Supersites (PSSs). These PSSs demonstrated since then their added value as fully integrated, state-of-the-art multidisciplinary and multiplatform observation capacities for JERICO. They also demonstrate that transnational and trans-institutional integration clearly increases our ability to answer JERICO's KSCs.

As defined in JERICO-S3 deliverable D4.1, a PSS must be able to provide in-situ observations at the desired nested spatiotemporal scales of coastal processes, which in a majority of coastal regions calls for active collaboration between institutions, monitoring programs and industry, as well as seamless feedback from users. A precise list of key requirements for JERICO Supersites was identified in the deliverable:

- 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)
- Transnational and trans-institutional 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

Moreover, JERICO Supersites ought to have the following characteristics, with the support of the RI:

- 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 harmonised 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

For each of the 5 PSS, deliverable D4.1 provided an implementation plan, with specific Actions to be undertaken pertaining to regional contexts, leading to coordinated partnerships and objectives. Having identified expected results, key users, and a dissemination plan, these Actions helped to provide insight on integration gaps and on how PSSs may operate. The ultimate goal is the provision of consistent regional data, services and products, with an optimal structure of communication within and between PSSs.

Ultimately, the distributed observation infrastructure will harbour 3 complementary levels of observatories: Supersites, Advanced observatories and Standard observatories, depending on their capacity to provide observations (as described in JERICO-S3 D4.1, see also Figure 26).

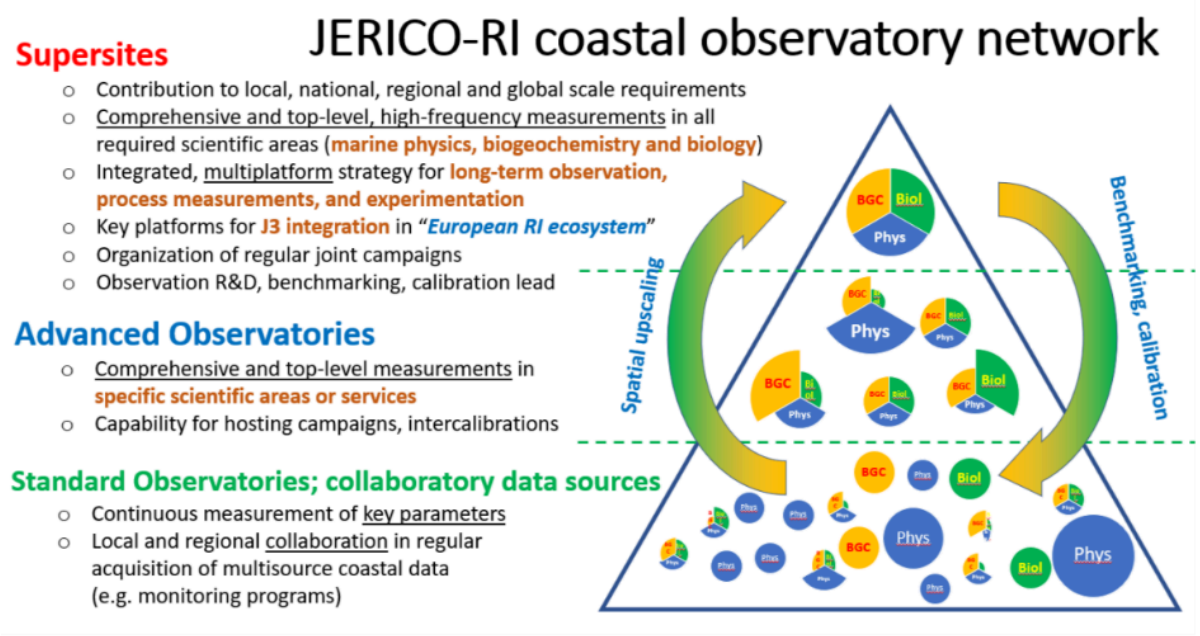

Figure 26: Illustration of JERICO distributed coastal facilities. Supersites enable integrated pan-European observations of complex multidisciplinary research questions. Advanced observatories provide high level integrated observations for specific questions. Standard observatories target more the regional and national questions for some key parameters.Reproduced from JERICO-S3 deliverable D4.1.

4.3. JERICO label, and data management

In order for JERICO to be a reference in terms of coastal marine research, there is a well-established need for an official label that would embody JERICO's drive towards excellent, state-of-the-art and sustainable science and service provision. In the framework of past projects, the JERICO label merely was a set of technical recommendations, whose goal was to harmonise as much as possible existing technologies in place. This has evolved into an ever-updating catalogue of Best Practices that concern all scientific fields intervening in coastal monitoring.

JERICO-DS deliverable D5.2 deals with the updated JERICO Label that will be employed from then on, during the ESFRI Roadmap and beyond. To this end, a JERICO Label Committee (JLC) has been put in place together with the Terms of Reference document that is used by this advisory body. Overall, the deliverable defines the composition of the committee, its role and mission, the guidelines that need to be followed so as to gain the label, the areas of assessment and of responsibility of the Committee, the intended audience and the expected outputs. This advisory body's main task is to maintain a technological watch, in order to keep the JERICO label relevant over time. It also has to address scientific issues related to the decision-making process, in order to maintain an optimal state of governance.

JERICO-CORE benefits from a dedicated Data Management Plan (DMP), outlined in JERICO-DS deliverable D3.4, that covers the management of data products considering the FAIR concept. It provides a DMP for each existing data product, and drawing from that experience, gives a template to follow to create a DMP for future data products. Data flows of advanced products are planned following two potential scenarii, depending on the environment of origin of these products: either the Blue-Cloud Virtual Research Environment (VRE) that is already well-developed (and likely to be used), or the partners' e-infrastructures.

4.4. Technical Design of the e-infrastructure, and its Implementation Roadmap

The need for an e-infrastructure specific to JERICO and its challenges was first recognised in JERICO-NEXT. In the description of work of both JERICO-DS and JERICO-S3 projects, the pilot version of JERICO's e-infrastructure was named e-JERICO, later rebranded.

JERICO-DS deliverable D3.2 covers the Technical Design Study of JERICO-CORE. This was done following the guidelines and recommendations of the ESFRI Roadmap 2021 Strategic Report (*Part 2. Landscape Analysis - Section 1. Data, Computing & Digital Research Infrastructures*). As well, recommended e-infrastructures of major European initiatives were studied in the context of the implementation of JERICO-CORE.

To summarise the envisioned architecture of JERICO-CORE and the complex service landscape surrounding it, Figure 27 was designed.

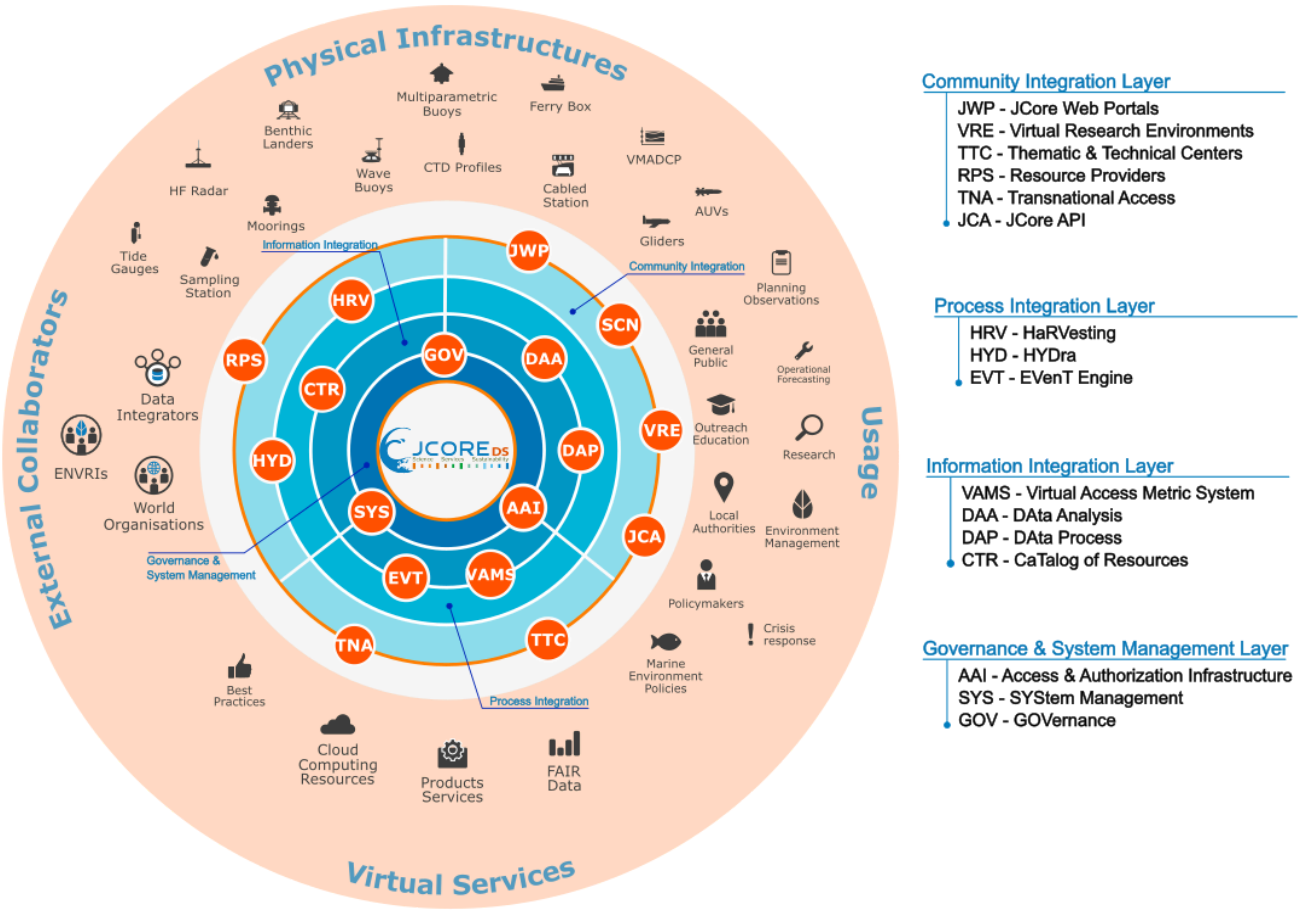

Figure 27: Service architecture landscape view for JERICO-CORE. Reproduced from JERICO-CORE D3.2.

JERICO-DS deliverable D3.2 concluded with a comparison of current main European e-infrastructures: EGI (European Grid Infrastructure), EOSC (European Open Science Cloud), D4Science, EUDAT and Blue-Cloud. This assessment has been based on criteria for the feasibility of the JERICO-CORE project development on the evaluated systems. Due to the technical nature of the evaluation, criteria topics like economic and legal viability were not considered. The scores obtained clearly pointed Blue-Cloud as the best implementation solution for JERICO-CORE. As a result of the analyses done in JERICO-DS deliverable D3.2, a new, advanced Conceptual Design for JERICO-CORE was defined (see Figure 28).

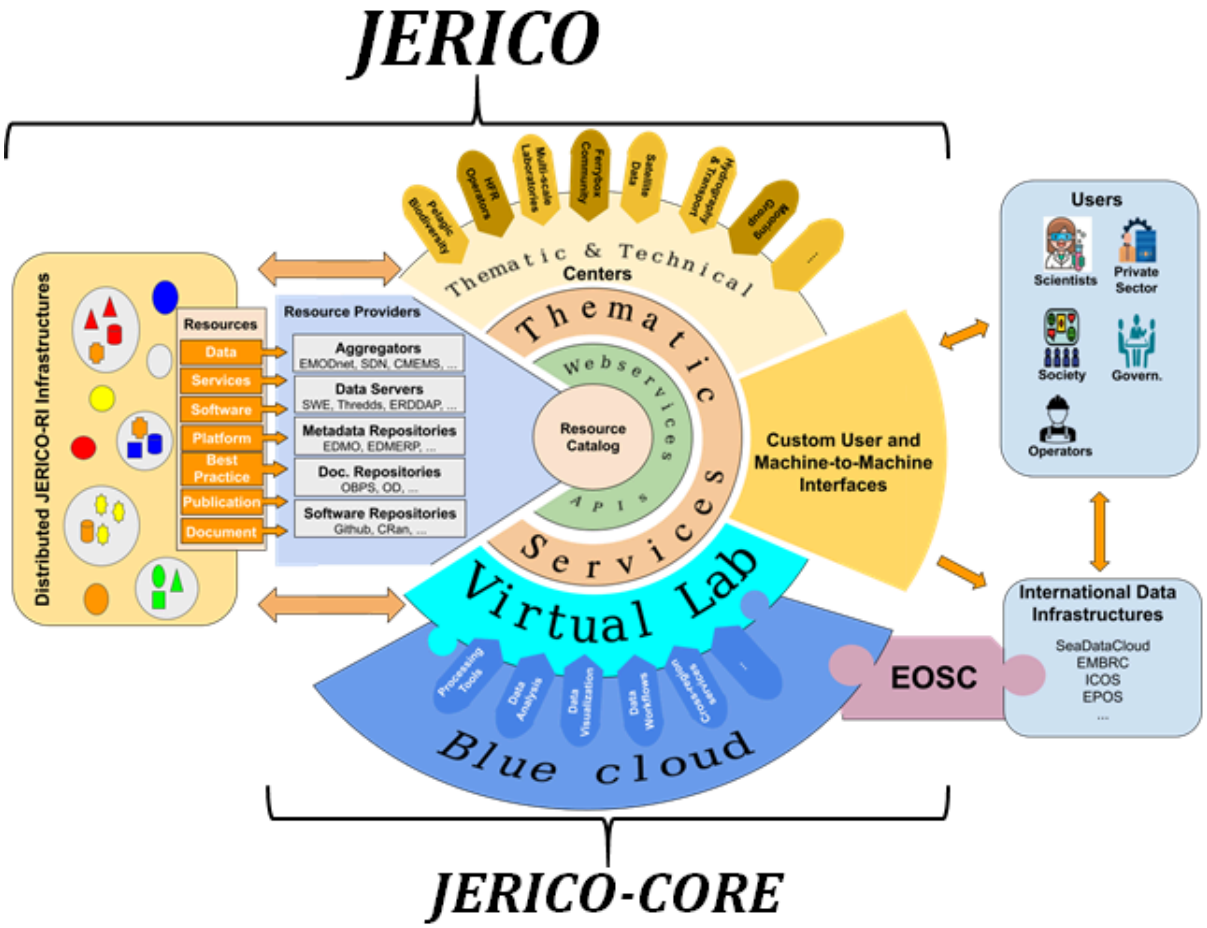

Figure 28: JERICO-CORE final Conceptual Design. Modified from JERICO-CORE D3.2.

JERICO-DS deliverable D3.5 dealt with the Design Phase of JERICO-CORE, and provided a strategic plan for its planned development along the different phases of the ESFRI Roadmap: Design, Implementation, Operation and Closing. This work was done in the context of JERICO-CORE pilot and taking into account its results, in order to design the future JERICO-CORE infrastructure.

In total, 5 working streams pertaining to JERICO-CORE's long-term development were identified by the authors. These 5 working streams will have different roles and responsibilities along the process of implementing the e-JERICO roadmap and will vary depending on the phase of the project:

- **Governance Stream**

  To establish the structures and processes for managing the virtual infrastructure and ensure that all the elements of the development, operation, interoperability and stakeholders involvement are integrated to provide the best framework and services for all JERICO activities.

- **Co-Design & Co-Development Stream**

To set up the strategy and sound environment to guarantee the involvement of JERICO stakeholders in order to deliver the appropriate framework and provide the benefits of such an ecosystem to the entire range of partners considering similarly other inputs from other working streams through the governance stream.

- **Operation Stream**

  To operate the e-infrastructure and establish the structures and processes to collect feedback from users and provide them to the governance stream to make sure that they are considered in future updates of the main JERICO-CORE infrastructure and services.

- **Interoperability Stream**

  To establish and assure standards and support for integration and interoperability with JERICO RIs, other relevant international infrastructures, and information providers. This encompasses European Blue Data Infrastructures (BDI) such as EMODnet, Copernicus Marine Service, SeaDatanet, EuroBis, and other JERICO partners, including infrastructures related to the Digital Twin of the Oceans (EDITO, ILIAD, DITTO).

- **Service Integration Stream**

  To design, deliver, and integrate services from the Thematic and Technical Centers to JERICO-CORE main framework in collaboration with JERICO partners and stakeholders.

With these 5 working streams defined, the implementation roadmap of JERICO-CORE related to the ESFRI Roadmap was described in 6 phases (including the Pilot phase before the ESFRI Roadmap, see Figure 29), along with the broad actions to be undertaken.

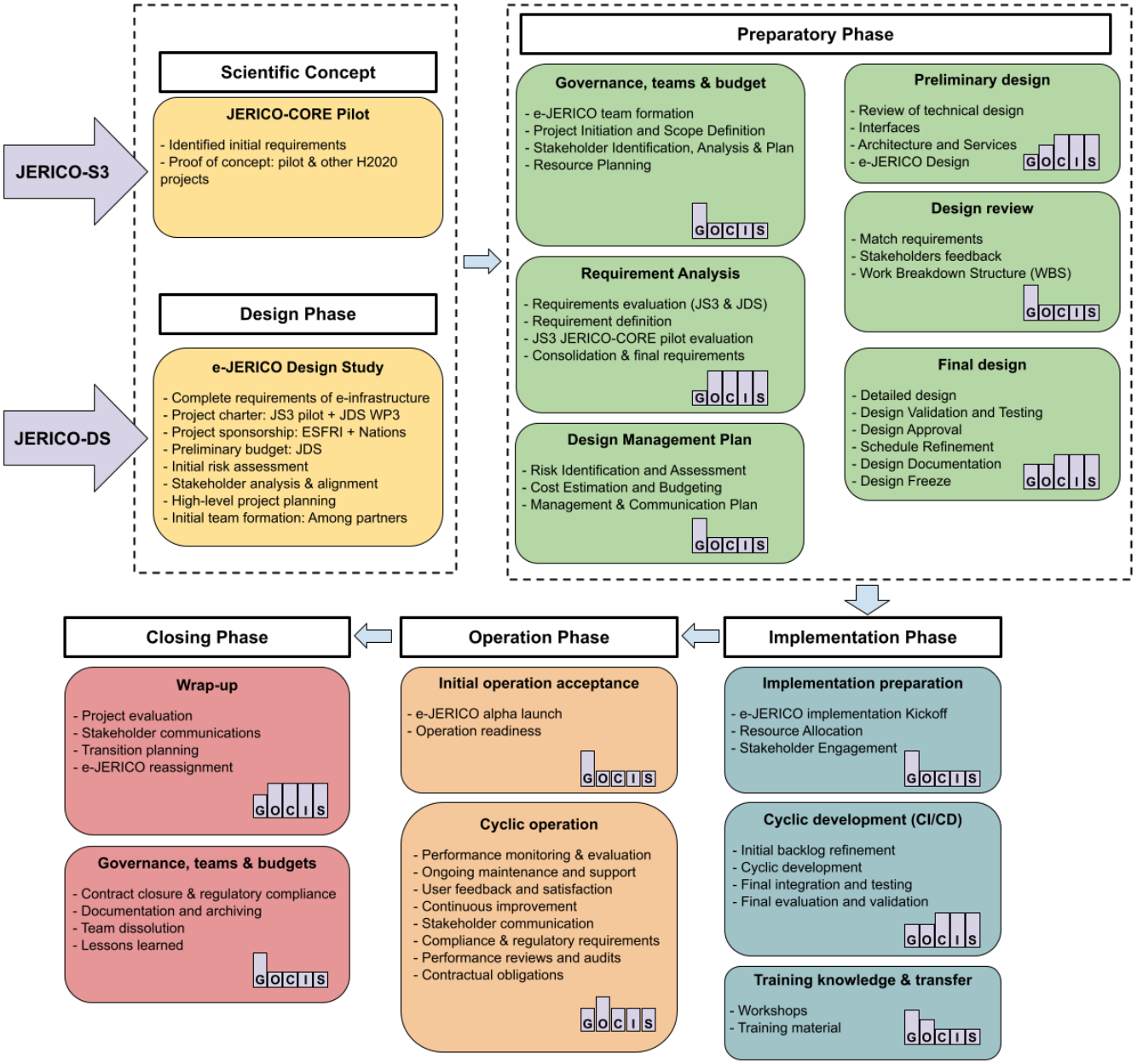

Figure 29: Overview of planned significant achievements throughout JERICO-CORE's development across ESFRI phases, showing the impact of the five working streams. Reproduced from JERICO-DS D3.5.

Additionally, a risk assessment, strategy and mitigation plan was also developed specifically for JERICO-CORE's usage. It is very much linked to the project planning, and to the cost of the chosen components. This risk assessment and mitigation plan represents JERICO's proactive stance in regard to uncertainties concerning its e-infrastructure.

5. Conclusion and next steps

From the previous 2021 ESFRI application (see Figure 30), JERICO now benefits from a significantly improved value proposition. The envisioned DRI will profit from a sustainable development model that takes into account users and stakeholders, potential economic activities and socio-economic impacts. Products and Services already in place provide a demonstrated added value to the scientific community, and the organisation of the coastal observation framework into 3 levels of observatories proved to be a significant step-up from a simple, horizontal observational network. In the future, a TRL-like index to be applied to regional sites, depending on each scientific field covered and assessing the system's maturity, will be implemented.

In particular, relationships with related RIs are better managed, JERICO's business case is deeply expanded upon and improved, and the governance was clarified, simplified and made adaptable in order for JERICO to easily accommodate new members and manage the services provision.

Because of its integrated structure, its scientific and technical framework, its label and its planned socio-economic impacts, it is expected that JERICO becomes a leading reference for holistic coastal research and activities. By filling an obvious gap in the European Environmental RIs landscape, JERICO paves the way to a sharper observation capacity of the global ocean.

Figure 30: Results of the previous JERICO application to the ESFRI Roadmap, and goals for the next ESFRI application.

The next steps for the JERICO project involve finalising the legal status of the organisation. The ERIC status is an option, but may pose significant risks and challenges if national commitment is insufficient, and also takes a significant time to occur. An alternative

considered is the AISBL (or a similar status), temporarily or permanently, which might better support extensive coastal coverage across Europe from the start of operations (see figure 5 p.25). As the commitment process differs substantially between these statuses, with ERIC requiring national commitment and AISBL needing institutional commitment, different in nature and scope, this topic will benefit from more development. This process should be re-evaluated in collaboration with the JERICO National Representatives, through the Nation's Committee still undergoing within JERICO-S3. Securing the commitment of other nations and institutes will be essential to ensure broad support and effective implementation of the project's objectives, and substantial attention and efforts will be dedicated to this topic. However, much of the work described will need to be consolidated during the various phases of the ESFRI Roadmap. The detailed planning of the administrative and financial frameworks of JERICO will be defined during the Preparatory Phase, after securing nation's and/or institution's commitments and defining the governance structure. Initial operations, after securing all partnerships and identifying capacities and needs, will start during the Implementation Phase. The elements hereby presented support the application of JERICO to the ESFRI Roadmap in 2025 as a next logical step.

6. Annexes and references

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