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Joint European Research Infrastructure network for Coastal Observatory
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DELIVERABLE n° WP and full title	JERICO-S3 D6.1 – WP6 – Draft Data Management Plan
Description	This document summarizes the main principles that will be applied in the data management procedures during the implementation of JERICO-S3
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APPROVALS

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1 Executive Summary

The main data management procedures that will be applied during the implementation of JERICO-S3 are presented in this document which is based on the Horizon 2020 FAIR Data Management Plan template. It provides the framework for the JERICO-S3 data handling from acquisition and processing to dissemination, during and beyond the lifetime of the project. The data that will be collected during the project is summarised, including their origin, their expected size and their relation to the objectives of the project. Furthermore, the JERICO-S3 data FAIRness is extensively described in a separate chapter together with a number of actions for data archiving and long-term maintenance as well as for the interoperability and the re-use of the collected data. Finally, brief information about the necessary allocation of the resources and the rules on the data security is also provided in the document.

2 Introduction to JERICO-S3

The JERICO-S3 project aims at strengthening the European network of coastal observatories providing a powerful and structured European Research Infrastructure dedicated to observe and monitor the complex marine coastal seas and to: (i) provide services for the delivery of high quality environmental data, (ii) access to solutions and facilities as services for researchers and users, (iii) create product prototypes for EU marine core services and users, (iv) support excellence in marine coastal research to better answer societal and policy needs. JERICO-S3 will provide a state-of-the-art, fit-for-purpose and visionary observational Research Infrastructure, expertise, and high-quality data on European coastal and shelf seas, supporting world-class research, high-impact innovation, and a window of European excellence worldwide. It will significantly enhance the current value and relevance of the JERICO-RI, through the implementation of the science and innovation strategy elaborated as part of the JERICO-NEXT project. Major user-driven improvements in the new project will focus on facilitating data and quality control procedures for physical data (WP7), establishing data management and best practices for biological and biogeochemical data generated by new technologies. Data and services, best practices and performance indicators, innovative monitoring strategies will be conducted in collaboration with other European RIs (EuroARGO, EMSO, AQUACOSM, DANUBIUS, ICOS, EMBRC, LIFEWATCH) and international scientific communities, industry and other stakeholders, and aligning strategy with COPERNICUS/ CMEMS, EMODNET and GEO/GEOSS to better understand the complexity of coastal seas.

A thorough data management strategy will support the data flows from the various platforms from the Pilot Super Sites (PSSs) and Integrated Regional Sites (IRSs), and will ensure the FAIR access through an e-JERICO virtual infrastructure to datasets and data products produced under JERICO-S3.

3 Data Summary

This document summarises the main principles that will be applied in the data management procedures during the implementation of JERICO-S3 and it is based on the Horizon 2020 FAIR Data Management Plan template. It provides the framework for the JERICO-S3 data handling from acquisition and processing to dissemination, during and beyond the lifetime of the project. The content of this document includes (a) the data types that will be managed during the project, (b) the standards that will be applied, (c) the actions for data archiving and long-term maintenance, (d) the access policies and (e) the quality standards.

3.1 Purpose of the data collection/generation and its relation to the objectives of the project. Types and formats of data that will be generated/collected

3.1.1 Observation data from platforms

The main objective of the project is to provide a continuous and valuable coastal data flow to stakeholders, coupling of the physical, biogeochemical and biological information. The data management work package (WP6) will enhance the free and open access to data generated by the different platforms in JERICO-S3.
Following the path of its predecessors JERICO & JERICO-NEXT, JERICO-S3 should comply with the common principles that collected observation data sets should be shared in order to become available for uptake and redistribution by the European marine infrastructures:

- EuroGOOS ROOS's and CMEMS In Situ TAC for operational oceanography exchange (NRT)
- SeaDataNet for delayed mode and exchange of validated data sets
- EMODnet, whereby data will provide extra input for EMODnet thematic data products
- Blue-Cloud, which is developing a powerful Virtual Research Environment platform that will be promoted by means of five multi-disciplinary Virtual Lab demonstrators. The Blue-Cloud system will work though access and enabling processing of datasets from the main European marine data infrastructures (EMODnet, SeaDataNet, EurOBIS,...), which underpins the need to JERICO related data to be shared via those channels.

Moreover, JERICO-S3 data sets (both NRT and delayed mode) should also be accessible through the JERICO-RI portal, in order to promote the results of JERICO-S3 activities and progress in establishing a more streamlined data flow.
Aiming to support the creation of the Research Infrastructure for the European coastal seas, JERICO-S3 would manage a diverse and non-homogeneous data framework

which will merge the outputs from the physical, biogeochemical, and biological scientific communities. A brief description of the expected data portfolio can be found hereafter:

Physical Data
Temperature, Salinity, Currents, Sea level, Waves, Air temperature, Air pressure, Wind speed and direction, Rainfall, Radiative fluxes
Biogeochemical Data
Oxygen, Chlorophyll *a*/fluorescence, Nutrients, Inorganic Carbon, Dissolved Organic Matter, Turbidity
Biological Data – Ecosystem
Phytoplankton and zooplankton diversity.

The data description for JERICO-S3 will be under continuous development in order to guaranteea standardised data characterisation with better precision and consistent quality during the lifespan of the project. Data are expected to become available in a variety of formats. However, they will have to comply with the relevant international standards before being released through the European Data Infrastructures (EMODnet, CMEMS, SeaDataNet).

3.1.2 Data products created under JERICO-S3

During the project, there will be data products created using the observation data, e.g. during the scientific work in the PSS's and IRS's, as well as in WP7 in the e-infrastructures. These products will be stored according to international standards as much as possible and published via metadata services and OGC compliant data access services. This will facilitate cross-disciplinary studies which are essential for a comprehensive understanding of coastal environments. Tools used in the data product creations may also be available through the e-infrastructure. Data products will include provenance and uncertainly descriptions so that users understand the potential and limitation of the data.

3.2 Re-use of existing data/Origin of the data

As mentioned in the introduction of this document, JERICO-S3 project aims at strengthening the European network of coastal observatories. Thus, data from existing networks along the European coastline will be used for the JERICO-S3 data portfolio, such as:

- FerryBoxes and Research Vessels
- Underwater Gliders
- Moored buoys
- HF Radars
- Argo profilers
- Surface drifters
- Tide gauges

The above data streams will be complemented by the coordinated activities designed in WP3 (Integrated Regional Sites) and WP4 (Pilot Supersites for innovative coastal monitoring), where multi-disciplinary integrated observations will take place within regions and between regions. JERICO-S3 will provide a number of harmonisation practices for the data originators, but it will strongly rely on the existing data integrators:

- The In-Situ Thematic Assembling Centre (Insitu TAC) component of Copernicus Marine Environment Monitoring Service (CMEMS)
- The SeaDataNet and EMODnet (in particular Physics and Chemistry thematic portals) for the physical and biogeochemical data.
- The EMODnet biology for marine biodiversity (discrete and continuous sampling)

3.3 Expected data size/Data utility

The expected volume of the data that will be collected during the JERICO-S3 activities cannot be estimated. Data size could be varied from a few gigabytes for some providers and networks to a few terabytes for others. Counting at the integrators level, the total volume could be several terabytes, but the existing systems have been set up to efficiently manage such an amount of data.

The challenge for JERICO-S3 is to ensure that data from the different and diverse in-situ observing systems will be accessible and useable by a wider community which includes the international ocean science community and other stakeholders in this field. Following the strategy that has been applied in previous JERICO projects, JERICO-S3 will provide the harmonisation guidelines in order to facilitate the data streaming towards the main European data infrastructures such as Copernicus In Situ TAC, SeaDataNet NODCs, EMODnet, etc. These major integrators are built upon main data management principles that should be met, such as the common quality control for near real time and delayed mode data and the standardisation of mandatory metadata for efficient data exchange; that way more reliable data services will be provided. JERICO-S3 will support the integration of the observations into the existing Network data systems in order to make these observations free, open, accessible for a better use of the outputs (data, products and services) of the European coastal observatories in various domains such as Climate Change, Ocean Health and Operational Services.

4 Generating FAIR Data

4.1 The JERICO legacy and next steps towards FAIRness

During the last fifteen years, a series of standards for data and metadata formats together with exchange protocols have been suggested by international organisations, initiatives and projects like JCOMM, RDA (Research Data Alliance), EuroGOOS, EMODnet, SeaDataNet Copernicus, OGC which have been adapted by the research marine community. During the previous JERICO and JERICO-NEXT projects, a series of documents have been published (available through the IOC Ocean Best Practices System) with data management guidelines that should be followed by the partners for publishing of their data and their efficient upload to the major European Data Banks.
JERICO project:

- Delayed Mode Data Handbook V1
- Near Real Time Mode Real Time Handbook V1
- Delayed Mode Data Handbook V2
- Near Real Time Mode Data Handbook V2

JERICO-NEXT project:

- Report on Data Management Best Practice and Generic Data and Metadata models
- Specifications for a European FerryBox Data Management System
- Recommendation Report 1 for HFR data implementation in European marine data infrastructures
- Recommendation Report 2 on improved common procedures for HFR QC analysis
- Marine biological data: quality control and management practices
- Document describing the biological data

It is evident that the JERICO legacy on data management is rich, ranging from the generic guidelines published during the first JERICO to the more focused and detailed documentation for specific platforms and activities that was produced during the JERICO-NEXT.
The need of developing data management best practices for novel data acquisition methods is widely agreed by the marine observation community. However, it is equally important to keep in mind that it is only by implementing these practices, it can be guaranteed that good quality data which is FAIR will be readily available. All the different phases of data management, whether at the level of the scientist (i.e. data collector) or at the level of the data manager / aggregator, require economic and/or time resources and need to be appropriately funded. However, the lack of appropriate resources continues to be a bottleneck that hampers the publication of data, more specifically interoperable data, after its collection and analysis.
JERICO-S3 should also further optimise the FAIRness of its data flow and data management, as the FAIR concept relates to "Data and services that should be Findable, Accessible, Interoperable, and Re-usable", both for machines and for

people, but with emphasis on machines. Technological advances provide innovative opportunities for new forms of science, which is one of the drivers behind the European Open Science Cloud (EOSC). However, this demands well-described, accessible data that conforms to community standards and best practices.

4.2 Making data findable including provisions of metadata

JERICO-S3 will continue to feed the different European data infrastructures with the relevant coastal data, maintaining and strengthening the operational links with EMODNET and CMEMS (Copernicus Marine Environment Monitoring System) and the connections with the SeaDataNet network, but also to contribute to the development of standards regarding innovative data types, as in the case of novel acquisition methods on biological data. JERICO-S3 should make optimal use of existing infrastructures, standards, services, softwares, best practices and initiatives, to compose its data flow through the use of elements of this data management plan.
In order to support and further enhance the connection with the major European data portals, JERICO-S3 partners should comply with the existing procedures and principles:

- For real time data (NRT/RT mode) the data providers are advised to contact the regional leaders of the seven geographical domains of CMEMS In Situ TAC (Mediterranean (MED), Black Sea (BS), Iberian-Biscay-Irish Sea (IBI), Atlantic North West Shelf (NWS), Baltic Sea (BAL) and Arctic Ocean (ARC) and Global (GLO)) in order to push their data into the ROOSs data centres The relevant QC/QA procedures can be applied either by the provider or by the above regional data centres before being delivered to EMODNET and CMEMS portfolio when it is applicable. Populating the CMEMS In Situ TAC service will ensure that the NRT-RT observation datasets will become available automatically for feeding and calibrating CMEMS forecasting models, for inclusion in various CMEMS data products, and for EMODnet Physics.

- For delayed mode data, it is recommended to deliver the data to the NODCs where they will be further processed and validated before being pushed to SeaDataNet. Populating the SeaDataNet CDI service will ensure that the delayed mode validated observation data timeseries (e.g. monthly /quarterly) will become available automatically for the relevant EMODnet thematic portals (chemistry, physics, biology) as input for their EMODnet data products and services, for inclusion in SeaDataNet data products such as climatologies, and in the overall SeaDataNet CDI data offer.

Furthermore, by populating CMEMS In Situ TAC and SeaDataNet, the observation datasets in their different levels of validation, NRT with automatic validation, and delayed mode with additional manual and scientific validation, will become automatically available for distribution in the Blue-Cloud and as input for the Blue-Cloud Virtual Research Environment (VRE) and its Virtual Labs, where applicable.

The integration of biological data (planktonic and benthic communities) that were collected during extended focused experiments along the European coastline was one of the key objectives of the JERICO-NEXT project. Substantial efforts were made to integrate biological data into the marine observation networks in order to address pelagic and benthic biodiversity questions. These data were obtained with traditional sampling methods but innovative observation techniques and novel sensor data were explored, revealing a significant potential to deliver operational (near real-time) data usable for monitoring purposes. The different datasets were screened and considered with respect to their current conformance with the biodiversity data standard (i.e. DarwinCore when applicable). Data from 18 datasets were made accessible using different approaches: a) through a data access link to a local/ad hoc website; b) through documented archiving in the Nature Scientific Data recommended repository: Marine Data Archive; or, c) through EMODnet Biology by means of full standardisation and integration into the EurOBIS database. Fully standardised data can be checked using automatic quality control procedures developed in the framework of EMODnet Biology (i.e. online QC tool).
Integration of biological data is relatively straightforward for data based on taxonomy and which are collected by traditional sampling methods. However, some methods deployed in JRAPs for measuring the biology component are in an earlier stage of development and present a great variety of new format and variable outputs. Consequently, they were lacking standardisation from data collection (e.g. sensor calibration), to data publication and quality control (e.g. lack of syntactic and/or semantic data standards, data management). Some issues were considerably improved during the JERICO-NEXT project. For instance, a set of controlled vocabularies was developed and put into practice for FCM data, and some of these FCM datasets are now integrated into SDN and published in BODC.. Technical developments were put forward in the EMODnet Biology portal to allow users to search for FCM data. The adoption of new sensor-based biodiversity observations brings further complexities, and additional work on harmonisation of data collection and definition of best data management practices are still needed. This should be a priority in the following phase of the JERICO-RI. Through its direct interaction to wider biodiversity data sharing networks such as OBIS, EMODnet Biology can provide an interface to translate the needs of the observing community for exploration and documentation of data exchange formats for sensor-based biodiversity data.

JERICO-S3 will address the challenge of making the biological data from novel sensors interoperable by defining best practices and development of semantic standards for a limited number of new types of data issued from innovative approaches (e.g imaging data, flow cytometry and multispectrofluorometry).

4.3 Making data (openly) accessible

The JERICO-S3 will continue and enhance the JERICO-NEXT data policy as it is stated in the Recommendation on the free and open access data policy document through a simple and clear statement. The main message of the JERICO-S3 data policy is that data produced within the project is free and unrestricted with no charge for third parties. The project's partners are committed that all the data collected through the JERICO-S3 observing nodes or through any of the project's research activities will be available freely and openly to anyone. JERICO-S3 will identify unnecessary or obsolete barriers towards open access in its data stream and work on the elimination of these obstacles. Furthermore, the access to metadata of each observing node that participates in JERICO-S3 should be free and open without any restrictions. Observing nodes data centres holding facilities shall provide and enable ease data discovery of the host data. Data published by JERICO-S3 observing nodes shall be made freely available through relevant data access tools developed by these nodes. Machine to Machine interface will be encouraged.

Accessible in FAIR does not mean fully open without costs. Specific regulations deviating from this general rule may apply when data is used for e.g. non-scientific or commercial purposes. Separate fees may apply for the reproduction and delivery of data when web-based transfer of data is not possible to cover reproduction costs.

Data that will be collected by the observing nodes contributing to JERICO-S3 or by the foreseen project's research activities shall be made available as soon as possible and without unnecessary delay. All the JERICO-S3 observing nodes and all the project's partners that will be involved in data collection processes, should acknowledge national and international intellectual property rights regulations. Each data infrastructure is responsible for the warranty of copyrights and intellectual property rights which may apply for its data holdings. JERICO-S3 observing nodes will clearly indicate licenses and terms of use for each dataset in the corresponding metadata.

In cases in which data or information provided by JERICO-RI observing components is used in published or unpublished work, attribution for the used resources is required. Data citations shall exclusively use the information provided within the metadata of each data set. To this aim, the final version of the JERICO-S3 Data Management Plan will explore the adoption and adaption of available controlled vocabularies for proper programme citation and acknowledgement. Observing nodes and integrators are in charge to provide the necessary documentation and tools to facilitate data access to users.

4.4 Making data interoperable/Data and Metadata vocabularies standards, best practices methodologies for interoperability

Interoperability is all about metadata and vocabulary standards. As mentioned in the previous paragraphs, this will be achieved during JERICO-S3 via the data streams that exist and the application of their standards as early as possible, meaning all elements should be collected at the source. Furthermore, the JERICO-S3 data products will be also based on the same principles and will be published directly in the JERICO-S3 infrastructure catalogue.

4.5 Increase data re-use

Data and products from JERICO-S3 observing nodes will be integrated in the major existing data integrators infrastructures, promoting, and facilitating their re-use and re-distribution. As mentioned above, the data will be distributed with a minimum set of metadata making possible the traceability of their originator and the feedback on their use. Re-use of non-open free data will not be facilitated by JERICO-S3 as the data cannot be integrated in the identified Integrators (CMEMS, EMODnet, SeaDataNet) and to their linked networks or initiatives. The metadata information of those restricted-access data will be published while their discovery will also be supported through the integration in European and international catalogues.

An important step for optimising the reusability of the data is the improvement of provenance information in the form of traceability and quality assessment. To improve JERICO-S3 data Reusability (and a bit the Findability and Accessibility as well), the adoption of the SeaDataNet Sensor Web Enablement (SWE) software suite is recommended, since the observed data streams will be documented with SWE metadata for sensors and platforms used, for which also dedicated SeaDataNet vocabularies can be applied.

The SeaDataNet SWE software suite will facilitate operators:

- to describe observatories (or networks of observatories) using the SMLE editor
- to operate a local ingestion service with ingestors
    - to receive, decode and check data
    - to use SensorML descriptions of the observatories for data decoding
    - to accept and ingest SWE-based observation data streams
- to receive and store the observations in a local open source database system and in conjunction with the SWE metadata
- to distribute (selections) of observations by means of SOS services
- to retrieve observation data (streams) from the database and using SOS services and to publish these at portals by configuring and customizing the open source Helgoland viewer

This way, data from observing platforms, can be ingested, stored locally, and distributed by SOS for publishing as NRT – RT on the portal of the operator, and at the JERICO-S3 portal, using the Helgoland viewer. A Delayed mode biological data can be submitted to EMODnet Biology or SeaDataNet. JERICO-S3 datasets will become available in the Blue-Cloud and its Virtual Research Environment, whereby it will be arranged and well promoted that JERICO-S3 will contribute to one or more of the VRE Demonstrators. A pilot implementation of the above configuration is proposed to be done in WP7/task 7.5 through the configuration and deployment of the SeaDataNet SWE software suite that will play the role of an operator that manages

several operational observing platforms. Once installed, the deployed platforms and sensors should be described using the SMLE editor, which allows to configure SeaDataNet SWE profiles and to make use of SeaDataNet vocabularies for most metadata elements. Finally, this data stream could be published on a pilot portal while also activities will be undertaken for configuring a JERICO-S3 customised Helgoland viewer

5 Allocation of resources

The cost for enhancing the data FAIRness is managed and supported through enabling or reinforcing the data flows to the main EU infrastructures (to which most data centers are connected). In WP7 (task7.5) a pilot implementation with selected PSS platforms following the SeaDataNet approach is suggested, that it is expected to boost further the FAIRness (and more specific the Reuseability by adding provenance information) of the JERICO-S3 data stream. Additionally, as noted in the previous section, the project covers the networking cost that allows to define common best practices shared and agreed among all the partners.

As far as concerns the cost for the long-term preservation of the data, it is explicitly mentioned in section 3 that JERICO-S3 strategy is to make its data available to the entire marine community through the infrastructures of the major European integrators. Consequently, the resources for long-term preservation of the data are covered by those entities.

6 Data security

Since JERICO-S3 will stream all the data from its observing nodes to the major European data integrators, the issues related to data security are managed at this level, by professional data centres operating for more than fifteen years and apply state-of-the-art security standards on data exchange.

7 Ethical aspects

Whenever the JERICO-S3 project will implement surveys, questionnaires, or collect personal data for any reason (e.g., attendance to organized events), European GDPR law will be used as reference and the user will be informed about the use of personal data. In general, JERICO-S3 will not transfer personal data (e.g., email addresses) to other entities and the only use will be setting up a distribution list to inform users about project progress. Users will be always able to change their consent and ask to be removed from the distribution channel.

8 Other issues

Nothing to report

9 Further support in developing the DMP

Nothing to report

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APPENDIX: ABBREVIATIONS

AQUACOSM: EU network of mesocosms facilities for research on marine and freshwater
CDI: Common Data Index
CMEMS: Copernicus Marine Environment Monitoring Service
DANUBIUS: International Center for Advanced Studies on River-Sea Systems
EMBRC: European Marine Biological Research Center
EMODNet: European Marine Observation and Data Nework
EMSO: European Multidisciplinary Seafloor and water column Observatory ecosystems open for global collaboration.
ERIC: European Research Infrastructure Consortium
EuroARGO: European Contribution to the Argo programme
EuroGOOS: European Global Ocean Observing System
EuroOBIS: European Node of the international Ocean Biodiversity Information System (OBIS)
FAIR: Findable Accessible Interoperable Reusable
FCM: Flow Cytometry
GEO: Group on Earth Observations
GEOSS: Global Earth Observation System of Systems
ICOS: Integrated Carbon Observation System
JCOMM: Joint Technical Commission for Oceanography and Marine Meteorology
JERICO-RI: Jerico Research Infrastructure
LIFEWATCH: European Infrastructure Consortium providing e-Science research facilities
NODC: National Oceanographic Data Center
NRT: Near Real Time
OGC: Open Geospatial Consortium
QC: Quality Control
ROOS: Regional Ocean Observing System
SDN: SeaDataNet
SWE: Sensor Web Enablement