D3.3
See Monitoring Use Case Demonstration Report

Workpackage	**WP 3**	**VRE User Cases**	
Task	3.3	See Monitoring Use Case Demonstration Report	
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Table of contents

Definitions and Acronyms

Acronym	Description
DOI	Digital Object Identifier
DoW	Description of Work
EC	European Commission
EU	European Union
FAIR	Findable, Accessible, Interoperable, Usable Data
GES	Good Environmental Status
IP	Intellectual Property
JRA	Joint Research Activities
MSFD	Marine Strategy Framework Directive
MoM	Minutes of Meeting
OLCI	Ocean and Land Colour Instrument
PID	Persistent Identifier
TBC	To Be Confirmed
VOT	Vehicle Overturning
VRC	Virtual Research Community
VRE	Virtual Research Environment
WFS	Web Feature Services
WMS	Web Map Services
WP	Work Package

Applicable and Reference Documents

Document ID	Document Title
[1]	European Virtual Environment for Research - Earth Science Themes, Grant Agreement N° 674906 – Available on the EVER-EST Alfresco Platform under WP1 Management Folder
[2]	EVER-EST Description Of Work – Available on the EVER-EST Alfresco Platform under WP1 Management Folder
[3]	EVER-EST Consortium Agreement – Available on EVER-EST Alfresco platform under WP1 Management Folder
[4]	European Commission Research and Innovation Participant Portal, http://ec.europa.eu/research/participants/portal/desktop/en/home.html
[5]	EVER-EST Project Web Site, www.ever-est.eu
[6]	D. 3.1.1 Deliverable: EVER-EST VRE Use Case Description and User Needs

[7]	D. 3.2 Deliverable: EVER-EST VRE Validation Plan
[8]	D. 2.5 Deliverable: Report on training activities
[9]	D. 6.2 Deliverable: Report on VRE population and testing
[10]	D. 2.9 Deliverable: Report on dissemination activities
[11]	D. 2.8 Deliverable: Sustainability Development Plan
[12]	D. 3.7 EVER-EST VRE Overall Impact Assessment Report

Abstract

This report describes the validation of the implementation of the Sea Monitoring use case in the VRE developed by the project, against the user requirements captured in AD [6]. The VRE has been assessed for usage to estimate and measure the GES parameters related to biodiversity following the MSDF requirements Analytical methods, protocols and procedures, validated in the VRE, have been demonstrated to monitor the state of biodiversity in a certain area assessing the baseline of biodiversity distribution in space and time.

1 1. Introduction

1.1 Document scope

This report describes the validation of the implementation of the Sea Monitoring use case in the VRE developed by the project, against the user requirements captured in AD [6] according to the EVER-EST VRE Validation Plan defined in [AD7]. The VRE has been assessed for usage to estimate and measure the GES parameters related to biodiversity following the MSDF requirements. Analytical methods, protocols and procedures, validated in the VRE, have been demonstrated to monitor the state of biodiversity in a certain area assessing the baseline of biodiversity distribution in space and time.

1.2 Relations with other EVER-EST work packages

The overall objectives of WP3 are:

- To liaise with the virtual research communities (VRCs) participating in the project and detail typical use cases, starting from and further detailing the ones identified at proposal time and specify the common user requirements arising from the analysis and refinement of VRCs use cases (described in [AD6]);
- To define user requirement validation methodology and success criteria (described in [AD6], [AD7]);
- To validate and assess, against the above mentioned user requirements, the implemented use cases, through the deployed VRE solution (this report);
- To perform and report on the overall assessment, in terms of user uptake and societal benefit, of the overall infrastructure [AD10].

In line with EVER-EST VRE Validation Plan [AD7], Sea Monitoring VRC validation activities have been carried out in strict relation with WP6. During the VRE validation, research objects were generated, user communities trained and dissemination events attended and carried out.

To avoid duplication of input and assure coherency of content among the various document, the relations among WPs deliverables is as follows:

- Verification activities: to verify whether EVER-EST VRE components and systems are compliant to design, well-engineered, error-free and properly integrated is out of the scope of this validation report document and reported in [AD9]. Coordination with the verification activities under WP6 for the specific Sea Monitoring use case testing is reported in [AD9].
- Validation activities: run to validated that the VRE meets the needs of the Sea Monitoring user communities and use case identified [AD6] are reported in this document.
- Population: Sea Monitoring VRC use case scenarios research objects generated during the project are listed in [AD9]
- Training: Sea Monitoring VRC training activities and capacity building events detailed list is provided in [AD8]
- Dissemination: Sea Monitoring VRC dissemination activities and awareness to new user to enlarge new communities capacity adoption detailed list is provided in [AD10]
- Sustainability: Sea Monitoring VRC value proposition statements as derived from VRE validation and usage and inputs to business model is addressed in [AD11]
- User Uptake and Key Performance indicators: Sea Monitoring user uptake assessment has been provided as input for the relevant description in scope of [AD12]

In the frame of WP3 a number of documented validation procedures have been carried out after the deployment of the VRE to evaluate the functionalities of the virtual research environment against the user requirements of

the use case. Particularly Task 3.2 is responsible for assessing the implemented use case in terms of the added value brought to the user community involved. The results of this assessment will be included in the overall VRE assessment conducted in Task 3.6.

2 Sea Monitoring VRC

The community of potential users is wide and heterogeneous, including both scientists and national/international agencies and authorities (e.g. MPA directors, domain experts from regional agencies like ARPA in Italy, the technician working for the Ministry of the Environment) dealing with the adoption of a better way of measuring the quality of the environment.

The scientific community involves multi-disciplinary scientists such as biologists, geologists, oceanographers and GIS experts. The community has the main role of assessing the best criteria and indicators for defining the Good Environmental Status (GES) in their own sub regions, and implementing methods, protocols and tools for monitoring the GES descriptors in the framework of the Marine Strategy Framework Directive (MSFD). A detailed description of the user community is provided in [AD6].

2.1 Sea Monitoring VRC operational scenario

The operational scenario are concerned with the fulfil integration and homogenisation of available data and protocols from different sources (including literature), the discovery of the data and documents related to the MSFD and the sharing of these information among the MSFD community. The Sea monitoring issues can be summarized in: information fragmentation, lack of formalized methodologies, the lack of a unique platform where the MSFD community can work together and with powerful tools. During the project, the EVER-EST VRE has been presented in various dissemination event, demonstrating that the added value to users of the VRE is to support the following general operational objectives:

- Integration and homogenisation of available biodiversity data from different sources including literature:
    - Search for data related to MSFD descriptors and targets and provide links between platforms, easy access and discoveries;
    - Focus on specific key words for descriptor (Biodiversity) and MSFD targets for the discovery of spatial data.
- Design and implementation of a repository for sharing analytical methods, protocols and algorithms and workflows for GES assessment and monitoring (focusing on Biodiversity Descriptor 1, Non-indigenous species Descriptor 2 and Seafloor integrity Descriptor 6);
- Implementation of Research Objects including GES assessment, targets and monitoring protocols to be shared among the use case community.

The EVER-EST solution is a main user web interface to create and share Earth Science ROs, to discover data, to access, to process and visualize services rely on OGC standards (OpenSearch, Web Coverage Service, Web Processing Service, Web Map Service), to manage Research Objects, and finally, to execute remote workflow implemented via Taverna [https://taverna.incubator.apache.org].

Moreover, the VRE provides different user interfaces integrated functionalities such as:

a) collaboration spheres, for the visualization of correlation between similar objects (e.g., users, Research Objects) based on collaborative filtering and versatile keyword content-based recommendations;
b) RoHub, the reference platform for Research Object management supporting the preservation and lifecycle management of scientific investigations, research campaigns and operational processes;
c) Jupyter Notebook, for capturing the whole computation process: developing, documenting, and executing code, as well as communicating the results;
d) Virtual Machine.

Particularly during the value for EVER-EST VRE has been in allowing the Sea monitoring VRC users to:

a) save time in data processing, having more storage space and higher powerful computational capabilities;
b) implement reproducible workflow, with technical assistance in preparing workflows;
c) easily exchange data and processing methodologies among the Sea Monitoring community users;
d) improve and faster communication among researcher;
e) increase the number of publications and it's visibility from public and third parties search engine;
f) organise a scientific workflow in a single digital object, findable and reusable, maintaining attribution through DOI placement;
g) publish grey literature (e.g., project reports, bulletins, etc.) maintaining attribution and citation;
h) ensure long term preservation of research work (data, software, results, interpretations);
i) document scientific work, e.g., encapsulate in a single digital object data and/or results related to a single research as a single scientific result unit;
j) provides a place for storing data coming from oceanographic cruises in real time;
k) provides and environment to remotely access data, software, research results, documentation;
l) re-use, preserve and share among researchers both data and scientific processes.

During the project, the Sea monitoring user had to change his mentality concerning different aspects of the scientific daily life. The most relevant work concerned in:

- Formalize the scientific lifecycle, moving from a conceptual to an executable workflow;
- Spend more time and effort in implementing and orchestrating different codes and scripts in re-executable form. This approach allows the scientists to preserve the methodologies applied, re-use it and save time for further data processing;
- Organize the scientific lifecycle to make it entirely sharable and open to other scientists.

2.2 Sea monitoring VRC service requirements

The following e-collaboration services were included in the Sea Monitoring initial user requirement. However, the Sea Monitoring user communities that have taken advantage of almost all the services offered, few services were not used and perceived as less important while other services were added and more of value as described below. The assessment of the value and usage of the services is summarised below.

E-collaboration services

The service validated and used by the Sea Monitoring communities are:

- Collaboration management: USED. The collaboration sphere has been validated and proved to be a powerful tool providing a significant volume of Research Objects.
- User registration: USED. The service has been used during the validation and population of the VRCs and allows user to request the registration to the VRC of interest and the administrator to approve or reject the account requests.
- Asynchronous mail, message board: USED. The services has been validated and used during the validation and population of the VRE. The service gives the possibility to configure which notifications shall be received by e-mail, allowing the user to be notified for those actions of relevance for its own task.
- Resource sharing: USED. The Seafile cloud service is a very good solution for files sharing, specifically for the Sea Monitoring user communities, this system replaces other clouds solutions previously adopted in a more efficient way (e.g. google drive or we-transfer) and the ISMAR ftp site.

- Audio-visual conferencing and other synchronous services (e.g. chat): PARTIALLY USED. This service has not be fully exploited and integration into the notifications systems has been waived to focus on other services requirements of more relevance for the VRCs.

New services requirement:

One service not originally foreseen but implemented and validated is:

- Working groups: USED. The VRE gives the possibility to create working groups, specifically of value when there is the need to work on the same RO with the same access and sharing rights.

Waived requirements:

- Audio-visual conferencing and other synchronous services (e.g. chat): implementation of a notifications systems.

E-research services

All the e-collaboration service requirement originally identified as needed have been implemented, validated and used by the VRC. The service expected and validated are:

- Knowledge discovery and Research resources discovery: USED. The user can search information and products related to his theme of research using the collaboration spheres and the RO search tool. The user can mine data through the Data Discovery service.
- Research resources management: USED. The resources can be managed using RO paradigm and the Seafile cloud environment.
- Validation and verification: PARTIALLY DEVELOPED. The validation process can be only performed on the RO using the quality check service for each of the research object type. The validation through the automatic quality check is quantitative and not qualitative. The release of DOI for high quality Research Object does not imply that the RO has been peer-reviewed.
- Visualization and interactive services: PARTIALLY DEVELOPED. The visualization of tested data format is allowed by the globe technology. It is not yet possible to visualize WMS and WFS on the globe.
- Workflow management: USED. The workflows can be build or modified in the virtual machine. The VRE performs the execution of the workflows made in Taverna through the Workflow runner and the execution of the WPS through the WPS manager.
- Application management: PARTIALLY USED. The VRC responsible access the VRE as administrators.

The service not expected but implemented and validated are:

- Process building;
- Executable building;
- Executable management.

New recommended services are:

- WMS and WFS visualization

The service not expected but implemented and validated are:

- Data cube: Data Cube technology is the key component of the Digital Earth to allow scientists, to access to historical data as well as future predictions. Geospatial data, including EO products, are consistently

processed to enable Analysis-Ready-Data collections to optimise discovery, access and exploitation by experts for direct use in the marine application domain.
- CoCoNet metadata catalogue: the catalogue was implemented by the Sea community with the aim to connect the CoCoNet database to the VRE through a Open Search service.

E-learning services

As specified in the deliverable D3.1, the Sea monitoring community is normally not involved in educational activities. However, during the project the Sea Monitoring has supported a thesis for a Master in Data Science (See Annex II Reference Paper: Iolanda Maggio et al. 2018. EVER-EST: The platform allowing scientists to cross-fertilize and cross-validated data. IEEE International Geoscience and Remote Sensing Symposium.

The service originally foreseen and validated is:
- Jupyter: PARTIALLY USED. The Jupoter environment provides great potentiality for Python users. The service could be improved adding more specific modules for R users e.g. R packages and modules.

The service not expected but implemented and validated are:

- Take a tour: USED.
- VRE guide: USED.
- Demo: USED.

The new recommended services are additional tutorials:

- Video tutorial (e.g. How create new RO, How discover data)
- Webinar (e.g. Taverna Workbench and Taverna runner)

Digital Information services

All the I services requirement originally identified as needed have been validated by the VRC. Particularly the service used are:
- Annotation: USED.
- Archiving: USED.
- Cataloguing: USED.
- Content management: USED.
- Cross search: USED.
- Data and text mining: USED.
- Data management: USED.
- Information management: USED.
- Information resources discovery: USED.
- Packaging: USED.

The service originally identified but not integrated are:

- Dictionaries and ontologies
- Provenance

There are not recommended new Digital Information services requirements.

Common Services

All the common services requirement originally identified as needed have been validated by the VRC. The service used by the VRC are:

- Accounting: USED.
- Alert and notification: USED.
- Authentication: USED.
- Authorisation: USED.
- Digital Rights Management: USED.
- Messaging: USED.
- Metadata registry: USED.
- Network management: NOT USED BY THE VRC
- Search: USED.
- Security: USED.
- Session management: NOT USED BY THE VRC
- User management: USED.

There are not services originally identified but not implemented.

There are not services not expected but implemented and validated.

There are not recommended new common services requirements.

2.3 Sea monitoring VRC use case selection criteria

During the project the Sea Monitoring VRC has been focalized on three following three MSFD descriptors:

1. D1 - Biological diversity
2. D2 - Non-indigenous species
3. D6 -Seafloor integrity

These descriptors are very interdisciplinary, they require different kind of data from various and heterogeneous repositories and different protocols. These use cases have been optimal for validating the infrastructure and for starting working with Research Objects.

2.4 Sea monitoring VRC use case selection description

The expected use cases implemented and validated are three:

Use Case 1. D1 and D6 for *Posidonia* meadows along the Apulian coast: D1 Biological diversity- Criteria 1.6 Habitat condition – Indicator 1.6.1 Condition of typical species and communities: assessment of biological diversity focusing on habitat perspective considering the *Posidonia oceanica* meadows. The criteria D1.1., D1.4, D1.5, D1.6, D6.1 and D6.2 have been considered. The focus is on the habitat approach producing thematic maps of seagrass communities and their regression from remote sensing data and historical map.

Use Case 2. Deep sea white corals: D1 Biological diversity - Criteria 1.4 Habitat extent – Indicator 1.5 Habitat area:): assessment of biological diversity focusing on habitat perspective. In particular, the habitat extent has been considered and measured along with the distribution and condition found in specific sites of deep sea cold water corals considered by the MSFD as targets for monitoring programs. For this example, the focus is on the habitat approach using habitat suitability model for assessing indicators and criteria.

Use Case 3. D1, D2 for Jellyfish in the Mediterranean Sea: Jellyfish abundance in the Italian water. A crowdsourcing app sponsored by Italian magazine and others different media provides scientific data to study jellyfish. Starting from App sightings DB we elaborated a WF that enable the users to produce map of distribution for each jellyfish species and several others geographically explicit output (shapefile, KML). Wf is reusable and produce updated maps of distribution according with new sightings. In order to evaluate future trend in the evolution of the distribution of these species, we performed an analysis of the density and of the blooms distribution of Non Indigenous Species according with MSFD descriptor 2.1: *"Abundance and state characterisation of non-indigenous species (NIS), in particular invasive species (IAS)"*.

The correlation between environment satellite variables and jellyfish outbreaks was evaluated, highlighting the matches with the environmental variables such as temperature, chlorophyll, nutrients, currents, wind, bathymetry and salinity in order to quantify deterministic and stochastic components of environmental change that lead to outbreaks of Jellyfish.

The user actions of expected use cases have been modified during the implementation of the VRE and the development of the Research Objects. In the Appendix A we describe the user actions updated for each expected use case developed and validated.

2.5 Sea monitoring VRC use cases data needs

Use Case 1. D1 and D6 for *Posidonia* meadows along the Apulian coast: D1 Biological diversity- Criteria 1.6 Habitat condition – Indicator 1.6.1 Condition of typical species and communities.

- Habitat extent and biological related data available through CoCoNet repositories.

Use Case 2. Deep sea white corals: D1 Biological diversity - Criteria 1.4 Habitat extent – Indicator 1.5 Habitat area

- Seafloor bathymetry and reflectivity;
- CWCs occurrences and biological related data available through CoCoNet repository;
- Hydrodynamic condition at bottom, such as current velocities and direction available through CoCoNetand CNR-ISMAR local repository.

Use Case 3: D1, D2 for Jellyfish in the Mediterranean Sea

- Jellyfish occurrences data available through CoCoNet;
- https://podaac.jpl.nasa.gov/dataset/JPL-L4UHfnd-GLOB-MUR
- https://www.aviso.altimetry.fr/en/data/products/sea-surface-height-products/regional/msla-uv-mediterranean-sea.html
  "SEALEVEL_MED_PHY_L4_ugos@4326_0125"
  "SEALEVEL_MED_PHY_L4_vgos@4326_0125"
  - Description: MSLA geostrophic velocities in delayed time product is available since 1993 in the so-called "all sat merged" serie: up-to-date datasets with a maximum of satellites at a given time. MSLA geostrophic velocities in near-real-time product is available during a few months at most, from the latest update of the delayed-time product to today.
  - Geographic coverage: Mediterranean Sea (30.0625°N, 45.9375°N - 354.0625°E, 396.937°E)
  - Copyright: 1993 - ongoing EU Copernicus Marine Service

- Contents: multimission gridded geostrophic velocity anomalies (UV) computed with respect to a twenty-year mean, gridded (1/8°x1/8° on a cartesian grid).
- Types of dataset: Ssalto/Duacs gridded multimission altimeter products.
- Condition of access: The Copernicus Marine and Environment Monitoring Service (CMEMS) has taken over the whole processing and distribution of those products (formerly distributed by Aviso+, no change in the scientific content). Those products can be visualised on the AVISO+ Live Access Server (LAS).
- https://www.aviso.altimetry.fr/en/data/products/sea-surface-height-products/regional/msla-h-mediterranean-sea.html

"SEALEVEL_MED_PHY_L4_adt@4326_0125"

- Description: Types of dataset: Ssalto/Duacs gridded multimission altimeter products. MSLA geostrophic velocities in delayed time product is available since 1993 in the so-called "all sat merged" serie: up-to-date datasets with a maximum of satellites at a given time.
- MSLA geostrophic velocities in near-real-time product is available during a few months at most, from the latest update of the delayed-time product to today.
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- Geographic coverage: Mediterranean Sea (30.0625°N, 45.9375°N - 354.0625°E, 396.937°E)
- Copyright: 1993 - ongoing EU Copernicus Marine Service
- http://orca.science.oregonstate.edu/2160.by.4320.monthly.hdf.vgpm.m.chl.m.sst.php —> vgpm_r2014

"ESACCI-OC-L3S-CHLORA-MONTHLY_4326_05"

"ESACCI-OC-L3S-CHLORA-MONTHLY_4326_005"

- Description: This collection contains version 3.1 datasets produced by the Ocean Colour project of the ESA Climate Change Initiative (CCI). The Ocean Colour CCI is producing long-term multi-sensor time-series of satellite ocean-colour data with a particular focus for use in climate studies.
- Data products being produced include: phytoplankton chlorophyll-a concentration; remote-sensing reflectance at six wavelengths; total absorption and backscattering coefficients; phytoplankton absorption coefficient and absorption coefficients for dissolved and detrital material; and the diffuse attenuation coefficient for downwelling irradiance for light of wavelength 490 nm. Information on uncertainties is also provided.
- This dataset collection refers to the Version 3.1 data products held in the CEDA archive covering the period 1997-2016. Links to the individual datasets that make up this collection are given in the record below.

- http://wiki-measures.eri.ucsb.edu/index.php/GSM

"seawifs_GSMacdm_everest_4326_0083333"

"seawifs_GSMchl_everest_4326_0083333"

"seawifs_GSMbbp_sig_everest_4326_0083333"

- Description: The ocean color products available here were made using Level 3, daily, binned imagery from SeaWiFS, MODIS-Aqua, Meris, and Viirs. The products themselves are 9km if SeaWiFS is involved, 4km otherwise, daily, 8-day and monthly imagery of GSM products, confidence intervals and coverage maps. The products were generated using the Garver-Siegel-Maritorena (GSM) model described in: Maritorena S., D.A. Siegel & A. Peterson. 2002. Optimization of a Semi-Analytical Ocean Color Model for Global Scale Applications. Applied Optics. 41(15): 2705-2714.

2.6 Sea monitoring use case scenario for Research Objects

These ROs are implemented starting from the use cases described in the paragraph 2.4.

RO name	RO Type	Abstract	RO link
1. Posidonia regression along Apulian coast	Process RO	Starting from the historical data on Posidonia oceanica distribution along the Apulian coast (from 1986 to 2006), the RO individuate regression hotspots using a model made in model builder (ArcGIS).	http://sandbox.rohub.org/rodl/ROs/posidonia_regression_along_apulian_coast/
2. CWCs Habitat Suitability Model - Bari Canyon	Workflow RO	Habitat Suitability Model of the Cold Water Corals (CWCs) in the Bari Canyon (Apulia, Italy). In this RO we derive the MSFD indicator 1.5 (Habitat area) to assess the biological diversity descriptor. To do this in deep sea environment, the scientist (user) needs to implement a habitat suitability model.	http://sandbox.rohub.org/rodl/ROs/cwcs_habitat_suitability_model__bari_canyon/
3. Correlation between environment satellite variables and jellyfish outbreaks	Workflow RO	Quantification of deterministic and stochastic components of environmental change that lead to outbreaks of Jellyfish.	http://sandbox.rohub.org/rodl/ROs/correlation_between_environment_variable_satellite_and_jellyfish_outbreaks
4. Jellyfish species distribution along Italian coast	Workflow RO	Starting by sightings from citizen science campaign "Occhio alla medusa"; CNR wants to fully exploit within the EVER-EST initiative the database potential to generate meaningful indicators in MSFD perspective. Descriptor 1 species distribution.	http://sandbox.rohub.org/rodl/ROs/jellyfish_species_distribution_along_italian_coast/

5. Trend in the evolution of non indigenous jellyfish species	Workflow RO	Starting from Jellyfish sightings, we elaborate data to produce explicit geographical information concerning trend about the evolution and distribution of alien species according with MSF directive descriptors 2.1 Abundance and state characterisation of non-indigenous species (NIS), in particular invasive species (IAS).	http://sandbox.rohub.org/rodl/ROs/trend_in_the_evolution_of_non_indigenous__jellyfish_species/

The following ROs are implemented and validated during the project, in addition to the use cases defined a priori in the deliverable D3.1:

6. Digitalization of historical Venice lagoon maps	Data RO	Historical maps comprise a lot of inherent information on natural environmental and anthropogenic changes. They are commonly the most important database for various spatial analyses of the land use as well as historical landscapes, urban development, influences of the economy development, toponyms changes, etc.	http://sandbox.rohub.org/rodl/ROs/historical_maps_venice_lagoon/
7. Multiple and pervasive human impacts in coastal lagoons literature review	Workflow RO	Coastal wetlands are among the most studied, most vulnerable, and economically most important ecosystems on Earth; nevertheless, little attention has been paid, so far, to their sea-floor integrity and the human footprint on their deepest reaches.	http://sandbox.rohub.org/rodl/ROs/multiple_and_pervasive_human_impacts_in_coastal_lagoons_literature_review/
8. Posidonia regression along Apulian coast crossferlilize land monitoring VRC	Process RO	In our study case, starting from historical data of posidonia meadows distribution, we try to individuate regression area and to compare their distribution with the different human activities that can determinate change in the Land/Sea use detecting by WPS developed by Sat Cen VRC.	http://sandbox.rohub.org/rodl/ROs/posidonia_regression_along_apulian_coast_crossferlilize_land_monitoring_VRC/
9. RMS From Bathymetry	Workflow RO	This RO calculates the roughness of the seafloor, as RMS, starting from Multibeam Bathymetry. It was applied with bathymetry files of the Venice Lagoon. It can work with both XYZ txt files and ARCAscii files.	http://sandbox.rohub.org/rodl/ROs/rms_from_bathymetry/

10. RSOBIA southern Adriatic Sea	Process RO	Substrate map obtained through RSOBIA classification of backscatter mosaics	http://sandbox.rohub.org/rodl/ROs/rsobia_southern_adriatic_sea/
11. Statistical analysis on CWCs community structure and environmental variables	Workflow RO	Multivariate analysis of geomorphological factors influencing Cold Water Corals (CWCs) distribution. In addition, the RO performs multivariate analysis to test the influence of species co-occurrence on the distribution of corals.	http://sandbox.rohub.org/rodl/ROs/statistical_analysis_on_cwcs_community_structure_and_environmental_variables/
12. Manage NetCDF in ArcGIS 10.5	Process RO	Spatial tools developed in model builder (ArcGIS 10.5) for managing netCDF files in GIS environment.	http://sandbox.rohub.org/rodl/ROs/manage_netcdf_in_arcgis_105/
13. MSFD literature review	Bibliographic ROs	Bibliographic collection of documents, papers and reports about the MSFD in Europe. Each document is encapsulated in a Bibliographic Research Object.	
14. Human impact in coastal lagoons	Bibliographic ROs	Bibliographic collection about human impact in coastal lagoon ecosystem in the world. Each document is encapsulated in a Bibliographic Research Object.	

2.7 Sea monitoring VRC user actions specification

Sea Monitoring user scenarios and user action specification, further developed from the above use cases, at this stage of the project, are detailed in the Appendix A.

3 EARTH SCIENCE VRE USER REQUIREMENTS

The following requirements applicable to the Sea Monitoring VRC have been validated during the project since the deployment of the VRE during the validation and population phase. VRE infrastructure un-availabilities and SPR were raised to WP6 for operational support, bug fixing and work-around according to the procedure in place for anomaly handling and operation support in WP6. Sub-requirements not implemented and/or validated have been highlighted in red/*italic.*

3.1 EVER-EST infrastructure key objectives

EVER- GEN -010	EVER-EST General Requirement	Mandatory
Requirement	The EVER-EST e-infrastructure shall allow Earth Science data users to: ● Discover, access and process both existing and new heterogeneous Earth Science datasets including the associated information and preserved knowledge held by distributed data centres; ● Share data, models, algorithms, scientific results (including traceability of workflows and processes that would facilitate reproducibility of modelling and simulations) and their own experiences within a community or across communities (including those in other domains beyond Earth Science); ● Capture, annotate and store the workflows, processes and results from their research activities; ● Work together in a real-time environment that facilitates the sharing of expertise, information and data resources overcoming traditional working practices limitations related e.g. to physical meetings or the transfer of large datasets between users; ● Ensure the long-term sustainability and preservation of data, models, workflows, tools and services developed by existing communities of practice that can potentially be re-used in the future by other users either for validation of existing research or for new applications.	
Source	Proposal, SMART Objectives	
Verification Method	Verification Methods: Validation	

EVER-GEN-020	EVER-EST General Requirement	Mandatory
Requirement	EVER-EST e-infrastructure shall enable and facilitate Earth Science Researchers by: ● Supporting the processes of conducting research and the creation and maintenance of collaborations across domains, institutions and countries; ● Be designed to meet user requirements and address usability and accessibility, with appropriate evaluation mechanisms and benchmarks for new service and tool development; ● Be secure and trustworthy – the EVER-EST components should interoperate with federated cross-institutional authentication and authorisation mechanisms;	

	• Be accountable, by providing adequate logging including supporting queries about provenance; • *Be compatible with other widely used and deployed systems, including at least: web, e-mail, instant messaging, SMS, wikis and video-conferencing tools i.e. lightweight desktop applications;* • Allow easy and efficient Earth Science data browsing, query and access from multiple sources, adapting to different standards and services; • Support the creation, sharing and curation of digital content, through ease of authoring, publishing, discovery and access. This implies adoption of appropriate metadata schemas and support for automatic generation of metadata. Resources to be described will include data, publications, computation, experimental or observational facilities and human researchers; • Maximise the processing of the data at EVER-EST VRE.
Source	Proposal
Verification Method	Verification Methods: Validation
note	The VRE has not integrated *other widely used and deployed systems.*

EVER-FUN –030	EVER-EST General Requirement	Mandatory
Requirement	EVER-EST e-infrastructure shall enable and facilitate Earth Science Researchers by • Be based, as far as possible, on loosely coupled, distributed, interoperable services and tools, rather than monolithic applications; • Be extensible with enhanced or new tools (possibly domain-specific) from any developer, through the use of published standards and software development kits, software libraries, etc. It should be as easy as possible to make existing software and services (e.g. e-print repositories, portals and proprietary software) interoperate with the VRE; • Be open source and standards-compliant wherever possible. The licensing of the software should encourage and support improvements to the tools and development of new tools by the community. Intellectual property rights issues need to be investigated and addressed using easy ways to provide attribution identifiers and product licenses; • Support tailoring of the environment by individuals or groups to reflect their domain interests and personal preferences; • Support the delegation of routine tasks to intelligent personal agents where the means to realise these exists, e.g. by incorporation into workflow processes;	
Source	Proposal	
Verification Method	Review of Design	

3.2 EVER-EST services user requirements

3.2.1 EVER-EST common services requirements

EVER-COM-010	User Authentication and Session Management	Mandatory
Requirement	The EVER-EST e-infrastructure shall provide Earth Science data users: • Authentication and Authorisation: have a reliable user authentication and authorization accessing the VRE; • Federation: enable federated identity management; • User management; • Session management and accounting of resources; • Definition of VRE sub-communities (for authorization to access project restricted resources.	
Source	Proposal, VRCs (all)	
Verification Method	Validation	

EVER-COM-020	Research Object, Digital Management, IPR and Citation	Mandatory
Requirement	The EVER-EST e-infrastructure shall: ● Allow scientists to define the terms in which their ROs can be used creating confidence on the RO and establishing etiquette for acknowledgement and citation; ● Allow dissemination of products and research objects in accordance to specific rights/authorization; ● Provide basic access control to the content of the RO, particularly by third parties accessing the RO; ● Implement Authorization and *IPR protection*: need for an authorization mechanism to access data, products or tools, and to maintain IPRs of research results; ● Support Citation of ROs vs. citation of papers. ● Support tools and procedures for license and PID/DOI attribution to data, research products or documents; ● Provide tools for referencing algorithms, products, documents used in each Supersite or study area;	
Source	Proposals, VRC (All)	
Verification Method	Verification Methods: Validation	
note	IPR protection is not implemented yet	

3.2.2 EVER-EST e – collaboration services requirements

EVER-COL-010	Community Building and Peer Reviews	Mandatory
Requirement	The EVER-EST e-infrastructure shall allow Earth Science data users to foster community building by: • Integration, open access and sharing of knowledge, free licensed software tools, open data and scientific products; • Enable dissemination of research objects and products in accordance to specific rights/authorization; • Have an appropriate dissemination interface towards the general public/end-users, including a mechanism to provide feedbacks and share results that could be released on a staged approach for peer review and evaluation purpose; • *Enable VRCs community directory to be linked to external social networking sites (e.g. LinkedIn, Research-Gate) supporting exchange of information.*	
Source	Proposals, VRE (All)	
Verification Method	Verification Methods: Validation	

EVER-COL-020	E-Connect Tools	Mandatory
Requirement	E-infrastructure shall foster collaboration and sharing of scientific results through the adoption of collaboration management tools by either integrating open sources tools or supporting the integration of COTS owned and installed by the same VRC to: • Connect the scientific and the institutional communities allowing exchange of information; • *Support audio-visual webinar/conferencing with audio/video recording functionality and other asynchronous services as instant messenger/chat service and asynchronous mail and message board.* • Showing who is online and where and enable simple click-and-connect functions allowing improved instant communications that could be useful for arranging last minute meetings, clarifications, or other collaborative discussions; • Conduct and present demonstrations using shared data and codes; • *Support space/forum for communities members to post and describe progressions and research status and to support peer-review, separated into themes and/projects to be used by different sub-communities;* • *Capture and archiving of discussions including keyword tagging to relate conversations to specific topics, which are searchable.*	
Source	Proposals, VRE Use Case (All)	
Verification Method	Verification Methods: Validated	
note	• *"Support audio-visual…": partially implemented* • *"Support space/forum for communities…": partially implemented* • *"Capture and archiving…": not implemented yet*	

EVER-COL-030	Content Management Tools	Mandatory
Requirement	The EVER-EST e-infrastructure shall integrate a content management tool: • *For documentation repository with collaboration editing capability for collective document/article writing, including document versioning and provenance metadata capture*; • Assuring secure storage and knowledge management with different level of user accessibility rights • Supporting automatic metadata insertion according to the VRE metadata model for document, records, cataloguing and provenance for long-term preservation. • Providing a central source of information and knowledge management which might include: journal article library of relevant science/technology papers; available skill sets held in each organisation (providing access to additional information/help); *CVs of all EVE-REST collaborators/EU partners providing* information on relevant expertise and sources of help and possibly data, metadata and glossary of terms.	
Source	Proposal, VRE (All)	
Verification Method	Verification Methods: Validated	
note	*not implemented yet*	

EVER-COL-040	Project Management Tools	Highly Desirable
Requirement	*EVER-EST e-infrastructure shall provide project planning and management tools to be used by the VRCs communities that includes presentation and editing of Gantt charts, reporting and recording of minutes and actions.*	
Source	VRE Use Cases (VM, SS)	
Verification Method	Verification Methods: Validated	
Note	not implemented yet, VRCs use as *project planning and management tools ALFRESCO*	

3.2.3 EVER-EST e – research services requirements

EVER-RE-010	Data and Resources Discovery	Mandatory
Requirement	The EVER-EST e-infrastructure shall allow the Earth Science community to: • Retrieve in near real time, and through web services a wide range of satellite and in situ data for the Earth Science community; • *Access EO mission datasets in a rapid and efficient way;* • *Access data using catalogue metadata harvesting tools as well as automatic tools for browsing high volumes of data catalogue;* • *Support the use of semantics and ontologies developed by the VRCs;* • Increase the availability and use of open data and open sources tools	
Source	VRE Use Cases (All)	
Verification Method	Verification Methods: Validated	

note	• *Access EO mission datasets …": partially implemented due to difficulties to find repositories developed as open search* • *"Access data using catalogue…": partially implemented* • *"Support the use of semantics…": partially implemented*

EVER-RE-050	Research Data Generation and Preservation	Mandatory
Requirement	The EVER-EST e-infrastructure shall support preservation and dissemination of Earth Science users generated data set enabling the following functionalities: • Annotation of the data set; • Archiving of the data set; • Cataloguing of the data set; • Cross search of the data set; • Data and test mining; • *Implementation of dictionaries and ontologies defined by the VRCs;* • Information resources discovery; • Packaging; • Data Set Provenance metadata capturing.	
Source	VRE Use Case (SM, All)	
Verification Method	Verification Methods: Inspection, Test, Review of Design	

EVER-RE-060	Application Management	Mandatory
Requirement	The EVER-EST e-infrastructure shall support the following application management functionalities: • Executable building; • Executable management; • Process building; • Application Validation and verification; • Workflow management.	
Source	VRE Use Case (SM, All)	
Verification Method	Verification Methods: Validated	

EVER-RE-70	Workflow Management	Mandatory
Requirement	The EVER-EST e-infrastructure shall allow Earth Science data users to: • Link Research Objects and work-flows/thought-flows together; • Enable documentation of model development e.g. model history; • Facilitate capturing ideas at each stage of model development e.g. ideas/thoughts added to Research Object.	
Source	VRE Use Case (HM)	
Verification Method	Verification Methods: Validated	

EVER-RE-090	Visualisation and Modelling Tool	Mandatory
Requirement	The EVER-EST e-infrastructure shall allow Earth Science data users to: • Deploy and use innovative, interactive and flexible visualisation tools for processing outputs and data;	

	• Browse, query, and analyze processing outputs (normally images or maps in raster/vector format) for interpretation/validation purposes, through a web GIS interface; • Validate processing outputs using the web GIS interface and embedded analysis tools; • Generate, discovery and manage Research Objects through a simple to use, graphical interface, also with geographic tagging capabilities; • Integrated modeling tools as defined by the VRCs use cases.
Source	Proposals, VRE Use Case (All)
Verification Method	Verification Methods: Validated

EVER-RE-100	Research Environment as IaaS	Mandatory
Requirement	The EVER-EST e-infrastructure shall allow Earth Science data users to: • Customize the VRE research environment as an Infrastructure as a Service environment to be used by the communities to integrate tools and product for their specific needs as specified in the relevant use cases.	
Source	VRE Use Case (LM, SS	
Verification Method	Verification Methods: Validated	

EVER-RE-110	Research Object Development Environment	Mandatory
Requirement	The EVER-EST e-infrastructure shall provide Earth Science data users: • Collaborative development on Research Objects; • Case studies re-run with updated datasets, configurations and parameters; • Staged approach to development releases to the operational environment; • Enable partners to interact regardless of their pre-selected operating system platform of use (e.g. Linux and Windows).	
Source	VRE Use Case (HM, All)	
Verification Method	Verification Methods: Validated	

EVER-RE-120	Collaborative Computational Environment	Mandatory
Requirement	The EVER-EST e-infrastructure shall allow Earth Science data users to: • Place workable scripts (R, Python etc.) for the VRCs and others to use, develop, copy and amend as necessary; • Provision of modules of generic model building tools; • Provide access to modules at different levels of complexity (from detailed process models to simple I/O structures); • Modules should be user generated and accessible through a visual library of tools that is easy for other users to pick from; • This facility should include proper code versioning and software archiving where necessary; • Support multiple scripting languages.	
Source	VRE Use Case (LM)	

Verification Method	Verification Methods: Validated

EVER-RE-130	Data Interoperability and Compatibility	Mandatory
Requirement	Data management in EVER-EST should be interoperable with the EPOS framework at European level, and the Common Framework on Earth-Observation Data from USGS and GEO-USA. Compliancy with GEOSS should be provided.	
Source	Proposals	
Verification Method	Verification Methods: Review of Design	

EVER-RE-150	Preservation Requirements	Mandatory
Requirement	EVER-EST infrastructure shall provide the means for Earth Science data sources (either external data providers or VRCs as data generator) to: • Enhance their preservation strategies by facilitating their systematic monitoring of end-user experiences and their requests for system enhancements. • Enhance the data provider data records and relevant knowledge packaging and ingestion in the VRE in accordance with long term preservation best practices defined in D5.1; • Manage the research object life cycle preservation process as defined in D.4.1. • Allow preservation of scientific products and RO generated by the community for the duration of the project and in accordance with EVER-EST sustainability plan expected timeframe • Allow preservation of scientific codes generated by the community for at least for the duration of the project and in accordance with EVER-EST sustainability plan expected timeframe.	
Source	Proposal, D.4.1, D. 5.1 Preservation Requirements	
Verification Method	Verification Methods: Validated	

EVER-RE-160	Research Objects Dissemination	Mandatory
Requirement	The EVER-EST e-infrastructure shall support the following data dissemination needs/ functionalities: • Dissemination of research object as specified in the use case and detailed in EVER-EST Data Management Plan. • Research objects should be disseminated as web services to the community • Metadata should be associated to all data and products generated by the community within the VRC and in capsulated in the dissemination package.	
Source	Data Management Plan, D 4.1, D 5.1. Preservation Requirements	
Verification Method	Verification Methods: Inspection, Demonstration, Test or Review of Design	

3.2.4 EVER-EST e – learning services requirements

EVER-EL-010	E-Learning	Mandatory
Requirement	The EVER-EST e-infrastructure shall support: • The collaboration in the community to foster capacity building of less experienced scientists; • *Tools supporting the organization of online courses (e.g. Massive Open On Line Course);* • Training on the platform usage during dedicated events; • User-driven tutorials; • Walk-throughs of visualisation tools and references for stored code.	
Source	Proposal, VRE Use Case (All)	
Verification Method	Verification Methods: Review of Design	

4 EVER-EST Performances and Operational Requirements success criteria

A major challenge for EVER-EST e-research services integration is to pursue the following performance and operational requirements success criteria :

Success Criteria	Definition	Final Evaluation
Efficiency	There should be immediate, clear advantages for the scientists, either in terms of time required to carry out work, or as actual tasks, which could not be performed outside of the environment. This is the most important requirement, since the VRE is aiming to improve the efficiency of the research work, and an environment, which is perceived as decreasing such efficiency, will not be adopted by scientists	This requirement has been met.
User friendliness	All operations should be intuitive and reflect the researcher's way of working. A steep learning curve may imply refusal to adopt the environment after a few attempts.	Partially met.
Flexibility	Science normally implies the investigation of different lines of thought, sometimes very different. This is why working environments with rigid structures and procedures should be avoided.	Partially met.
Easy integration of new software tools	The environment should provide interactive access to data processing tools (also from COTS), flexibility and simplicity to implement further tools (to maintain the state of the art).	Partially met.

5 Compliance to the Smart Objectives and Key Performance Indicators

SM_OB#2.1	Validate and demonstrate the VRE functionalities within the Sea Monitoring VRC	Results
Measured by	Number of users reached (around 100 researchers); increased number of publications of web map layers of species and habitat distribution in space and time in key areas for biodiversity monitoring; increased number of publications on shared and clear protocols assessing a well-defined methodology for biodiversity monitoring.	15
Achievable	Sea Monitoring community can leverage on a well defined set of data catalogues which will be federated by the EVER-EST VRE and supported by tailored tools for data exploitation and exchange.	Sea Monitoring community has leveraged on various data catalogues (Coconet, federated by the EVER-EST VRE and supported by tailored tools for data exploitation and exchange, particularly of relevance the Data Cube integration.
Relevant	This use case is an example of inter-disciplinary work in terms of disciplines involved, data and software used (biology, chemistry, physics, earth observation).	The selected use cases have embraced various disciplines demonstrating the value and potentiality for cross-fertilisation within different domains
Timely	Each VRC will receive proper training on the VRE functionalities during the first phase of the project. The VRC will be able to use the VRE services starting from M18 and eventually request changes and adaptation.	During the first period of the project, while the VRE functionalities were being implemented, the VRC communities were trained to the create and share Research Object through various training session including hackthlons. The VRC received hands on training to use the VRE services at the final release and deployment of the VRE. A continuos learn and discovery on new functionalities and requirements was put in place significantly improving the value for the Sea Monitoring VRC user of the VRE.

A. Appendix A – Sea Monitoring VRC Use Cases Scenario

Personas

The following personas have been identified:

Personas	Representing group	Description
Federica F.	Scientist (CNR–ISMAR, Bologna)	Expert user. Creates and manage ROs, she works with Francesco and Valentina.
Francesco D.	Scientist (CNR–ISMAR, Bologna)	Expert user. He manages jellyfish App, validates citizen sightings, he elaborates workflow and data need to elaborate MSF descriptor concerning jellyfish. He works with Federica and Valentina.
Ferdinando B.	Scientist (University of Salento)	Expert user. He collaborates with Federica and Francesco to develop Jellyfish App content and evaluates dataset and results.
Valentina G.	Scientist (CNR–ISMAR, Bologna)	Expert user. Database manager. She works with Federica and Francesco.
Fantina M.	Scientist (CNR–ISMAR, Venezia)	Data provider and RO user.
Antonio P.	Scientist (CNR–ISMAR, Venezia)	Data provider and RO user.
Lorenzo A.	Scientist (CNR–ISMAR, Bologna)	Data provider and potential RO user.
CNR	Public agencies	Data provider and potential RO user.
ARPA	Public agencies	Data provider and potential RO user.
EU	Institutional user	Potential RO user. The UE checks the results in terms of MSF descriptors.
Life Watch	European Infrastructure	Data provider and potential RO user.
Pippo	Citizen	Pippo uses the Jellyfish App to inform about the presence of jellyfish and accesses the map of risk (meteo meduse).

User actions

Expected:

Scenarios	Free text description (max 50 words)	Validation
1. Habitat suitability model for CWCs	Federica foglini develops the habitat suitability model for the cold water corals (CWCs) in the Bari canyon.	DONE
2. The Citizen science and jellyfish distribution	A crowdsourcing app sponsored by Italian magazine and others different media provides scientific data to study jellyfish. CNR wants to fully exploit within the EVER-EST initiative the app DB potential to generate meaningful indicators in MSF perspective.	DONE
3. Trend in the evolution of invasive jellyfish distribution	Starting from Jellyfish sightings, we elaborate data to produce explicit geographical information concerning trend about the evolution and distribution of alien species according with MSF directive descriptors.	DONE
4. Habitat suitability model for jellyfish species, study cases *Pelagia noctoiluca* and *Velella velella*	Starting from Jellyfish sightings according with environmental variables we produce suitability model to evaluate habitat extent for *Pelagia noctoiluca* and *Velella velella.*	NOT DONE

New:

Scenarios	Free text description (max 50 words)	Validation
5. Posidonia regression along Apulian coast	Starting from the Historical data on Posidonia oceanica distribution along the Apulian coast, from 1986 to 2006, we elaborate a wf that enable the users to individuate regression hotspot	DONE
6. Correlation between environment satellite variables and jellyfish outbreaks for jellyfish along the italian coast	Assessment of biological diversity focusing on the presence, outbreaks and distribution of indigenous and non-indigenous gelatinous organisms along the Italian seas, highlighting the matches with the environmental variables such as temperature, chlorophyll, nutrients, currents, wind, bathymetry and salinity in order to quantify deterministic and stochastic components of environmental change that lead to outbreaks of Jellyfish.	DONE

7. Jellyfish species distribution along Italian coast The Citizen science and jellyfish distribution	A crowdsourcing app sponsored by Italian magazine and others different media provides scientific data to study jellyfish. CNR wants to fully exploit within the EVER-EST initiative the app DB potential to generate meaningful indicators in MSF perspective. To do this, Starting from App sightings DB we elaborate a WF that enable the users to produce map of distribution for each jellyfish species and several others geographically explicit output (shapefile, KML). Wf is reusable and produce updated maps of distribution according with new sightings.	DONE

Scenario 1: Habitat suitability model for CWCs

Action ID	Action description	Dependencies	Challenge
CNR_CWC_01	Fantina or Lorenzo collect new data (bathymetry or CWC occurrences/absence data) and load them on the ISMAR ftp site	DS_ CNR _01 DS_ CNR _02 DS_ CNR _03 Infra_ CNR_01	DONE (Seafile)
CNR_CWC_02	Valentina updates the CoCoNet database with the new data	GUI_ CNR_01 DS_ CNR _01 DS_ CNR _02 Infra_ CNR _02 DS_ CNR _16 DS_ CNR _17	The action involved the already existing coconet infrastructure
CNR_CWC_03	Federica downloads the bathymetry, the occurrences layer and the absence data layer	Infra_ CNR _01 DS_ CNR _16 DS_ CNR _17	DONE data (discovery on the VRE)
CNR_CWC_04	Federica produces the EGVs	SW_ CNR _01 Algo_ CNR _01 Algo_ CNR _02 Algo_ CNR _03 Algo_ CNR _04 Algo_ CNR _05 Algo_ CNR _06 DS_ CNR _04	DONE (Workflow runner on the VRE)
CNR_CWC_05	Federica carries out a statistical analysis to evaluate which EGVs are relevant for the suitability model	SW_ CNR _02 DS_ CNR _04	DONE (Workflow runner on the VRE)
CNR_CWC_06	Federica choose the EVGs useful for the analysis	HI_ CNR _01 DS_ CNR _04	DONE (data visualizatio

			n on the VRE)
CNR_CWC_07	Federica uses the selected EVGs and the occurrences layer to generate the habitat suitability model	SW_ CNR _03 DS_ CNR _16 DS_ CNR _17 DS_ CNR _04	DONE (Workflow runner on the VRE)
CNR_CWC_08	Federica checks the results	DS_ CNR _05 HI_ CNR _02	DONE (data visualization on the VRE)
CNR_CWC_09	Federica creates the new RO	DS_ CNR _16 DS_ CNR _17 DS_ CNR _04 DS_ CNR_05	DONE (new RO on VRE)
CNR_CWC_10	CNR and EU access the RO	GUI_ CNR_01	DONE (RO discovery on the VRE + working group)

Scenario 2: The Citizen science and jellyfish distribution

Action ID	Action description	Dependencies	Validation
CNR_JFD1.1_01	Citizen provides a new sighting using the App about presence absence and outbreaks of jellyfish along the Italian coasts	Infra_CNR_05	The action involved the already existing app
CNR_JFD1.1_02	Francesco needs to know when new sightings were sent out	GUI_CNR_02	DONE (Asynchronous mail, message board)
CNR_JFD1.1_03	Francesco checks and validates the new data	SW_ CNR_01 DS_CNR_06 HI_CNR_03	DONE (VM)
CNR_JFD1.1_04	Francesco processes the data to produce a daily map of distribution for each species sighted	SW_CNR_01 DS_CNR_06 DS_CNR_09	DONE (Workflow runner on the VRE)

CNR_JFD1.1_05	Francesco processes the data to produce map of distribution for each species to inform Institutional users (D1.1 MSF)	SW_ CNR_01 DS_CNR_10	DONE (Workflow runner on the VRE)
CNR_JFD1.1_06	Francesco sends the new data to Valentina	DS_CNR_09 DS_CNR_10 DS_CNR_06 Infra_ CNR_01	DONE (Seafile or RO)
CNR_JFD1.1_07	Valentina receives results and updates the CoCoNet database with new validated sightings	GUI_CNR_01 Infra_ CNR_01 DS_CNR_06 DS_CNR_09 DS_CNR_10 Infra_ CNR_02 DS_CNR_07	The action involved the already existing coconet infrastructure
CNR_JFD1.1_07	Federica finalizes the results and updates it on Institutional users interface	DS_CNR_10 GUI_CNR_01	DONE (Seafile, VM, Visualization on the globe, RO)

Scenario 3: Trend in the evolution of invasive jellyfish distribution

Action ID	Action description	Dependencies	Validation
CNR_JFD2.1_01	Francesco needs to access jellyfish dataset on CoCoNet DB	DS_ CNR_07 Infra_ CNR_02	DONE (Data discovery on the VRE)
CNR_JFD2.1_02	Francesco and Federica elaborate sightings to produce density raster map for each invasive species for each year	SW_ CNR_01 DS_ CNR_11	DONE (Workflow runner on the VRE)
CNR_JFD2.1_03	Francesco and Federica analyse density rasters and made a quantitative analysis to represent change in time distribution of each alien/invasive species	SW_ CNR_01 DS_ CNR_11 DS_ CNR_12	DONE (Workflow runner on the VRE)

CNR_JFD2.1_04	Valentina receives results and produces the final map (D2.1)	GUI_CNR_01 Infra_ CNR_01 DS_ CNR_11 DS_ CNR_12 Infra_ CNR_02 SW_ CNR_01 DS_ CNR_13	DONE (Seafile, RO live chat)
CNR_JFD2.1_05	Federica finalizes the results and updates it on the Institutional users interface	DS_ CNR_13 GUI_CNR_01	DONE (Seafile, RO)

Dependencies

Datasets/ Products

N°	Name	Source	Volume	Format
DS_CNR_01	Bathymetry		80 MB	Ascii file
DS_CNR_02	CWCs Occurrences		200 KB	.shp, .csv
DS_CNR_04	EVGs for CWCs		250 MB	Rater, Ascii, netCDF
DS_CNR_05	Habitat suitability map		80 MB / 2MB	Ascii file / Image
DS_CNR_06	Jellyfish occurrences		200 KB	.shp, .csv
DS_CNR_07	CoCoNet jellyfish occurrences		200 KB	.shp, .csv
DS_CNR_08	EVGs for jellyfishes		10T	Rater, Ascii, netCDF
DS_CNR_09	Daily map of distribution for each species of jellyfish			
DS_CNR_10	Map of distribution for each species of jellyfish			
DS_CNR_11	Density raster map for each non indigenous species of jellyfish by year			

DS_CNR_12	Time distribution rasters			
DS_CNR_13	Final distribution maps			
DS_CNR_14	*Non indigenoius Jellyfish species* CoCoNet occurrences			
DS_CNR_15	Final statistical correlation analysis between jellyfishes outbreaks and EVGs			
DS_CNR_16	CoCoNet CWCs Occurrences			
DS_CNR_17	CoCoNet bathymetry			

Infrastructures/catalogues

Infrastructure/ Catalogue Name	Infrastructure/ Catalogue Description	Access policy	Com. Protocol	Contacts
Infra_CNR_01	ISMAR ftp site	Password protected		Federica F.
Infra_CNR_02	CoCoNet WebGIS	Data policy acceptance		Valentina G.
Infra_CNR_03	Data cube service online catalogue	Open access		Francesco D. L, MEEO.
Infra_CNR_04	Jellyfish APP	Free		Francesco De Leo

Software requirements

N°	Name	Description	Open source/ IPR	Contacts
SW_CNR_01	ArcGIS	GIS software	IPR	
SW_CNR_02	R		Open	
SW_CNR_03	Maxent	The software is based on the maximum-entropy approach for species habitat modeling. It takes as input a set of layers or environmental variables (such as elevation, precipitation, etc.), as well as a set of georeferenced	Open	

		occurrence locations, and produces a model of the range of the given species		
SW_CNR_04	QGIS	GIS software	Free and open	
SW_CNR_05	ODV	Ocean Data View (ODV) is a desktop software for analysis and visualization of oceanographic, atmospheric and other geo-referenced profile or time-series data	Open	

Algorithms

N°	Name	Description	Sw Used/Code type	Interaction
Algo_CNR_01	Terrain Ruggedness		QGIS	
Algo_CNR_02	Surface Area to Planar Area		ArcGIS	
Algo_CNR_03	Calculate Slope		QGIS	
Algo_CNR_04	Build Fine Scale BPI / Topographic position index		ArcGIS/ QGIS	
Algo_CNR_05	Curvature		QGIS	
Algo_CNR_06	Calculate Statistical Aspect		QGIS	
Algo_CNR_07	Polygon to raster		ArcGIS	
Algo_CNR_08	Diff		ArcGIS	

User stories-actions GUI requirements

Specific GUI Requirement	Free text description/Image
GUI_CNR_01	Update alert
GUI_CNR_02	Sighting alert

Control points

N°	Description	Conditions (YES/NO)	If YES/NO - Go to
HI_CNR_01	Selection of the variables	Yes: the variable is necessary No: the variable is not necessary	Yes: the user inserts the variable in the model No: the user doesn't insert the variable in the model
HI_CNR_02	Validation of the results	Yes: the products are acceptable No: the products are not acceptable	Yes: the user loads the new products in the ROs No: the user rejects the products

B. REFERENCES

An advanced method to make your habitat mapping researches Findable, Accessible, Interoperable, and Re-usable - A Case Study From EVER-EST

1. Foglini et al, 2018. An advanced method to make your researches about Habitat Mapping Findable, Accessible, Iteroperable, and Re-usable - A case study from EVER-EST. Abstract Geohab 2018, May 7 - 11, 2018 Santa Barbara, California.

An advanced method to make your habitat mapping researches Findable, Accessible, Interoperable, and Re-usable - A Case Study From EVER-EST

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One of the main challenge in marine science is to facilitate knowledge building by assisting humans and machines in their discovery of, access to, integration and analysis of task-appropriate scientific data and their associated algorithms and workflows. In general term, our researches should be "FAIR", that is findable, accessible, interoperable and re-usable. These principles precede implementation choices and do not necessarily suggest any specific technology standard, or workflow. Good research data management is not a goal in itself, but rather the key conduit leading to knowledge discovery and innovation, and to subsequent data and knowledge integration and reuse.

The EVER-EST project (http://ever-est.eu/) developed a Virtual Research Environment (VRE) tailored to the needs of and validated by the Earth Science domain. To achieve this, the EVER-EST VRE provides earth scientists with the means to seamlessly manage both the data involved in their computationally intensive disciplines and the scientific methods applied in their observations and modelling, which lead to the specific results that need to be attributable, validated and shared within the community. The EVER-EST VRE offers a framework based on advanced services which are delivered both at the infrastructure and domain-specific level, with the objective of supporting each described phase of the Earth Science Research and Information Lifecycle using Research Objects (http://www.rohub.org/). Research Objects allow to organize and describe resources,

materials and methods of an investigation; to preserve and share research materials with other scientists at discrete milestones of the investigation. Uniquely identified by an URI, pref. as a DOI, Research Object enable full reproducibility and reuse of scientific methods ensuring proper citation.

In particular, ISMAR-CNR provides useful and applicable contributions to the identification and definition of variables indicated by the European Commission in the Marine Strategy Framework Directive (MSFD) to achieve the Good Environment Status (GES). ISMAR-CNR is willing to deliver practical methods, procedures and protocols to support coherent and widely accepted interpretation of the Descriptors 1 (Biodiversity), and 6 (Seafloor integrity).

Here we present how EVER-EST can support the habitat mapping Virtual Research Community, going towards the new role of scientists of 2030, through two case studies: the Cold Water Corals Habitat Suitability Model of the Bari Canyon (South Adriatic Sea) and the new geomorhometric methodologies applied to the lagoon of Venice (Italy).

2. Grande et al, 2018. The EVER-EST Virtual Research environment (VRE): outcomes and solutions for Earth Science. Abstract IMDIS Conference 2018, 5-7 November 201, Barcelona, Spain.

The EVER-EST Virtual Research Environment (VRE): outcomes and solutions for Earth Science

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The EVER-EST project developed a Virtual Research Environment (VRE) to manage the full research lifecycle in Earth Science: from discovery and access of data input, to the coding necessary to extract the information, till to the sharing of methodologies and results.

The logic behind EVER-EST is to put the scientist at the center and to bridge the technological and knowledge gap and barriers for open science, application of EOSC principles and digital innovation. The EVER-EST VRE enables FAIR services to improve findability, accessibility, interoperability and reusability of research data, processes and results in a web environment. EVER-EST ensures to its users the functionalities which are needed to search, access and process Earth Science data: but most importantly it provides services to re-use, preserve and share among researchers both data and scientific processes. This is enabled by the adoption – for the first time in Earth Science – of the Research Object paradigm and related technologies.

The Research Object (RO) aim to account, describe and share everything about the research, including how those things are related. The RO model takes the central point to encapsulate all the resources relevant to the scientific work (data, live code, workflows, results, documents) in a single information unit [http://www.researchobject.org].

The RO model has been adapted to the Earth Science according to the user needs provided by the four different Virtual Research Communities (VRCs) engaged in the EVER-EST project (Land Monitoring, Supersites, Natural Hazard and Sea Monitoring). Nevertheless the four communities use the VRE for different goals (e. g. change detection on land, monitoring, risk assessment, marine habitat mapping), with different data, processes and results, working with the same facilities led to a cross-fertilisation process between VRCs, generating new knowledge.

The CNR-ISMAR represents the Sea Monitoring community and, in this view, developed case studies providing practical methods, procedures and protocols to support coherent and widely accepted interpretation of Good Environmental Status (GES) in the Marine Strategy Framework Directive (MSFD). In this context, we present the Research Objects implemented so far, focusing on methodologies and results related to benthic habitat mapping such as Cold Water Corals habitat suitability models and seafloor roughness extractions using the EVER-EST VRE platform.

The Sea Monitoring portal provides the main user web interface to create and share Earth Science ROs, to discover data, to access, to process and visualize services rely on OGC standards (OpenSearch, Web Coverage Service, Web Processing Service, Web Map Service), to manage Research Objects, and finally, to execute remote workflow implemented via Taverna [https://taverna.incubator.apache.org]. Moreover, the VRE provides different user interfaces such as: *Collaboration spheres*, for the visualization of correlation between similar objects (e.g., users, Research Objects) based on collaborative filtering and versatile keyword content-based recommendations; *RoHub*, the reference platform for Research Object management supporting the preservation and lifecycle management of scientific investigations, research campaigns and operational processes; and *Jupyter Notebook* a web-based application suitable for capturing the whole computation process: developing, documenting, and executing code, as well as communicating the results.

3. De Leo et al, 2018. Analysis Ready Data to support the EVER-EST Vistual Reasearch. Geophysical Research Abstracts Vol. 20, EGU2018-19309, 2018 EGU General Assembly 2018 © Author(s) 2018. CC Attribution 4.0 license.

Analysis Ready Data to support the EVER-EST Virtual Research

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Over recent decades huge amounts of data about our Planet have become available. If this information could be easily discoverable, accessible and properly exploited, preserved and shared, it would potentially represent a wealth of information for a whole spectrum of stakeholders: from scientists and researchers to the highest level of decision and policy makers. By creating a virtual research environment (VRE) using a service oriented architecture (SOA) tailored to the needs of Earth Science (ES) communities, the EVER-EST project provides a range of both generic and domain specific data analysis and management services to support a dynamic approach to collaborative research. EVER-EST provides the means to overcome existing barriers to sharing of Earth Science data and information allowing research teams to discover, access, share and process heterogeneous data, algorithms, results and experiences within and across their communities, including those domains beyond Earth Science.

The main components of the EVER-EST Virtual Research Environment are:

• Presentation Layer, the element that provides the user interfaces and all the technologies that shall guarantee the availability of those services and functions (VRE portal, ROHub, Collaboration Sphere).

• Service Layer that provides both generic VRE services and Earth Science specific services. These components represent the reasoning engine of the e- infrastructure and actually orchestrate and manage the services available to the VRE final users.

Central to the EVEREST approach is the concept of the Research Object (RO), which provides a semantically rich mechanism to aggregate related resources about a scientific investigation so that they can be shared together using a single unique identifier. Although several e-laboratories are incorporating the research object concept in their infrastructure, the EVER-EST VRE is the first infrastructure to leverage the concept of Research Objects and their application in observational rather than experimental disciplines.

• Data Layer that references the data holdings made available to the VRCs: data is linked and proper means are provided, where feasible, to access it from the VRE.

As a default setting, data will not be copied or duplicated, but will continue to reside on the provider's local servers unless it is directly retrieved by the user. The Data Layer relies on interoperable OGC standard services (i.e. OpenSearch, Web Coverage Service) and permits the integration with Big Data services: the integration with EO Data Service (https://eodataservice.org) enables the provision of Analysis Ready Data (ARD) and makes quicker and easier to explore a time series of images stored in multidimensional geospatial datasets.

The EVER-EST e-infrastructure is validated by four virtual research communities (VRC) covering differ- ent multidisciplinary Earth Science domains including: ocean monitoring, natural hazards, land monitoring and risk management (volcanoes and seismicity).

In the framework of the current work the case how an Analysis Ready Data (ARD) service supports the studies "EVALUATE HOW HUMAN ACTIVITIES CAN CAUSE POSIDONIA MEADOWS REGRESSION" and "CROSS-FERTILIZATION BETWEEN JELLYFISH OUTBREAKS & ANOMALIES DETECTION IN THE MEDITERRANEAN SEA" is described.

4. Iolanda Maggio et al. 2018. EVER-EST: The platform allowing scientists to cross-fertilizate and cross-validated data. IEEE International Geoscience and Remote Sensing Symposium

EVER-EST: THE PLATFORM ALLOWING SCIENTISTS TO CROSS-FERTILIZATE AND CROSS-VALIDATE DATA

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ABSTRACT

Over recent decades huge amounts of data about our Planet have become available. If this information could be easily discoverable, accessible and properly exploited, preserved and shared, it would potentially represent a wealth of information for a whole spectrum of stakeholders: from scientists and researchers to the highest level of decision and policy makers. By creating a virtual research environment (VRE) using a service oriented architecture (SOA) tailored to the needs of Earth Science (ES) communities, the EVER-EST project provides a range of both generic and domain specific data analysis and management services to support a dynamic approach to collaborative research. EVER-EST provides the means to overcome existing barriers to sharing of Earth Science data and information allowing research teams to discover, access, share and process heterogeneous data, algorithms, results and experiences within and across their communities, including those domains beyond Earth Science.

Index Terms— Virtual Research Environment, Remote Sensing, Research Object, Cross-fertilization, Data Analysis, Earth Science, Education.