



**DELIVERABLE D2.10 – DMP –
DATA MANAGEMENT PLAN
(1st release)**



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Authors (Partner-OU)	Andrea Tarallo, Enrica Nestola, Gregorio Sgrigna, Gianmarco Ingrosso, Ilaria Rosati (CNR-IRET, Lecce)
Reviewed by	Carmela Cornacchia (CNR-IMAA)
Comments	

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1. LIST OF ACRONYMS

DMP: Data Management Plan

EBV: Essential Biodiversity Variables

ECV: Essential Climate Variables

EOV: Essential Ocean Variables

ESFRI: European Strategy Forum on Research Infrastructures

FAIR: Findable, Accessible, Interoperable and Reusable

IADC: Italian Arctic Data Centre

IOOS: Italian Integrated Ocean Observing System

NADC: National Antarctic Data Centre

OU: Operative Unit

DO: Digital Object

RI: Research Infrastructure

VRE: Virtual Research Environment

WP: Work Package

2. INTRODUCTION

The Italian Integrated Environmental Research Infrastructures System (ITINERIS) Project started in November 2022, and it will build the Italian Hub of Research Infrastructures (RIs) in the environmental scientific domain providing access to data and services and supporting the Country to address current and expected environmental challenges. ITINERIS coordinates a network of national nodes from 22 RIs (18 from the environmental domain, 2 from agri-food with strong link with the environment and 2 from the Physical Sciences and Engineering domain, supporting services for the marine domain). The participating RIs are:

- ESFRI Landmarks (Italian nodes): ACTRIS, EMSO, Euro-Argo, ICOS and LifeWatch, (environmental domain) and ANAEE (Health&Food domain);
- ESFRI projects (Italian nodes): DANUBIUS-RI, DiSSCo, e-LTER, (environmental domain), and EMPHASIS and EUIBISBA (Health&Food domain);
- EU RIs: ECORD, EUFAR, Eurofleets, JERICO and SIOS (environmental domain);
- National RIs: ATLAS, CeTRA, Laura Bassi, and SMINO (environmental domain), Geosciences, and LNS (Physical Sciences and Engineering domain) those last as support services to the marine domain.

A specific objective will focus on providing access to facilities, FAIR data and related services connecting the established network of distributed national environmental RI to as wide a user community as possible. Following a user-centric approach and in accordance with the RIs' network technical capability and mission, access to national RIs' facilities services (instrumentation, sites, experimental platforms, etc.) and data and other Digital Objects (e.g. codes, software and any other research outputs that is presented in a digital

form) will be set up. Most of the mature RIs already offer DOs. In addition, facilities will be expanded or newly acquired. The scientific community belonging to the different RI domains will maintain such facilities and use them to produce new DOs. Following the recommendations and technical solutions defined by WP2 for DOs FAIRification, the newly produced DOs will be integrated with the existing ones. A Terminological Service will then be developed in order to annotate the DOs and enhance their discoverability and interoperability. The full set of facilities and DOs will be at full disposal of the users through a user-friendly web interface: the HUB (Figure 1), an integrated access and service portal.

The Hub will provide:

- i) Remote and physical access to the facilities provided by the participating RIs. In this context, the HUB will provide the single and coherent access channel that allow a centralised, harmonised and lean management of the access process: from the collection of access requests; to management, coordination and capture of reviews; to collection and reporting of access metrics and feedback from the users; etc.
- ii) Virtual access to the existing DOs that will be used in the project and the new one generated by the project. To this purpose, the HUB will provide a metadata catalogue containing detailed description of DOs and providing their direct access.

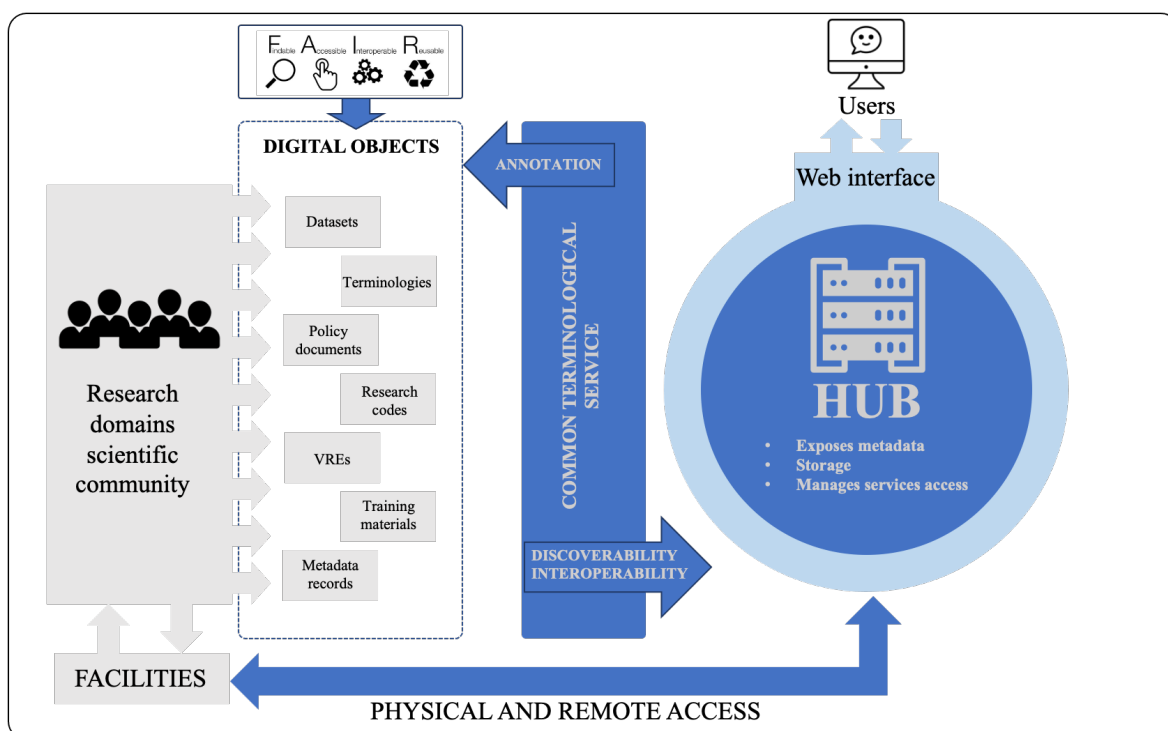


Figure 1. WP2 ITINERIS aims and functionalities. Facilities will be expanded or newly acquired. The scientific community belonging to the different RI domains will maintain such facilities and use them to produce new DOs. The FAIRification process led by WP2, will allow the integration of the newly produced DOs with the existing ones. A Terminological Service will then be developed in order to annotate the DOs and enhance their discoverability and interoperability. The full set of facilities and DOs will be at full disposal of the users through a user-friendly web interface: the HUB. Featured Image: FAIR data principles by SangyaPundir under CC BY-SA 4.0 license

3. PURPOSE OF THIS DOCUMENT

This document is the initial Data Management Plan (DMP), foreseen by the project in Bimester 3 (April 2023). It offers a description of all the DOs - i.e. datasets, codes, software, documents, training materials, etc. - and their relative metadata that will potentially be used, generated and managed along the entire lifecycle of the project (see also sub-chapter 4.A). As outlined by Michener 2015¹, there is a minimal set of necessary information to cover when writing a DMP, as the specificity regarding quality assessment, responsible parties, and ethical, and budgetary considerations. At this stage of the project all the specifications to be considered for the management of the DOs produced in ITINERIS are under development. However, in this first draft, we suggest a series of management strategies to comply with the FAIR principles. In the next release of the DMP we will take into account all progresses made in the meanwhile under the other WPs and related to the specification of DOs management. The management of the already existing resources provided by the RIs is not considered in this document as it is regulated in their service policies. We will only provide specifications related to the harvesting of their metadata.

This work is led by the WP2 and done in close collaboration with all the work packages and the RI representatives of the FAIR IMPLEMENTATION and ACCESS Working Groups.

4. HOW WE DEVELOPED THIS FIRST VERSION OF THE DMP

From the activities foreseen in the project document, we extrapolated the information about the different DOs, existing or potentially produced and managed within the project, from each WP except WP1. Some information has been extrapolated by the WP2 preliminary analysis on the FAIR enabling resources of RIs. A series of management actions are foreseen for each DO.

a. WHY DOs?

The concept of Digital Object is nothing new, being introduced in the early 90's. The commonly accepted definition of Digital Object is: *"a sequence of bits, or a set of sequences of bits, incorporating a work or portion of a work or other information in which a party has rights or interests, or in which there is value, each of the sequences being structured in a way that is interpretable by one or more of the computational facilities, and having as an essential element an associated unique persistent identifier."*²

Schwardmann 2020³ noted that a DO can be seen as the minimal element that can be processed in terms of data management and reuse.

¹ Michener WK (2015) Ten Simple Rules for Creating a Good Data Management Plan. PLoS Comput Biol 11(10): e1004525. <https://doi.org/10.1371/journal.pcbi.1004525>

² <https://www.dona.net/digitalobjectarchitecture>

³ Schwardmann, U., 2020. Digital Objects – FAIR Digital Objects: Which Services Are Required?. Data Science Journal, 19(1), p.15.DOI: <https://doi.org/10.5334/dsj-2020-015>

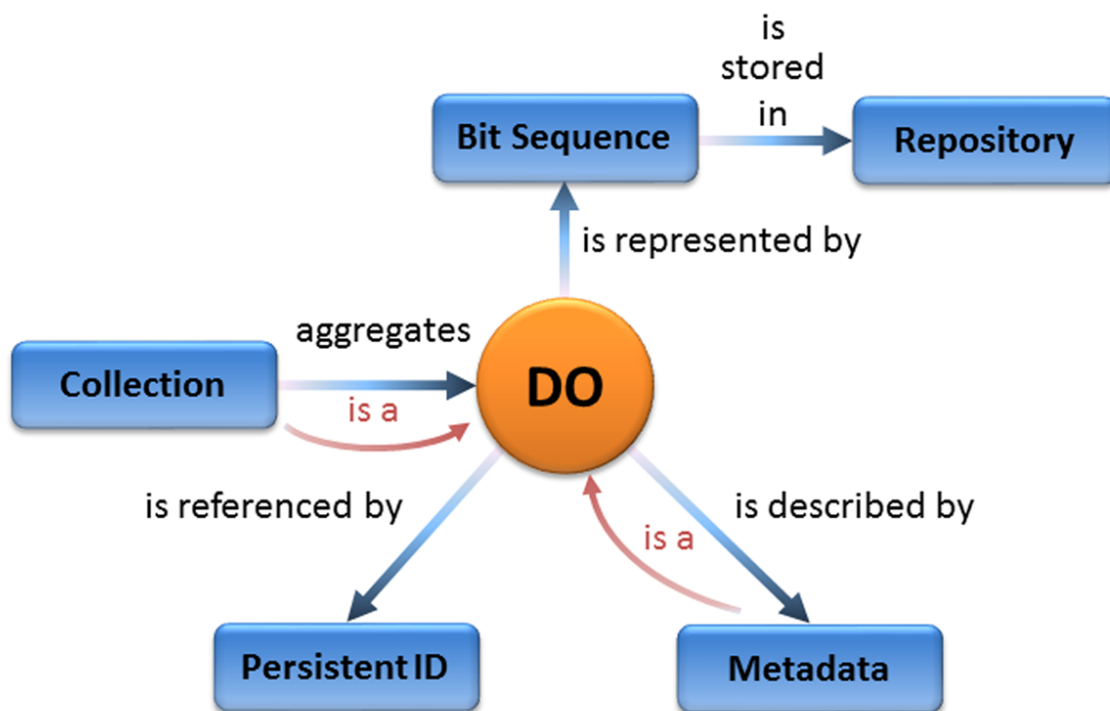


Figure 2. *Digital Object (DO) embedded in a structure of other important data elements and concepts (From Schwardmann 2020).*

Following the abstraction of Schwardmann 2020, a DO can be represented by any digital asset that has a minimal set of associated metadata and can be managed in terms of data management. This may include text documents, datasets, images, geospatial data, videos, audio files, databases, presentations, web pages, software applications, archives, metadata records, and any other product in digital form. For our purposes, in this document we talk about DOs that will be produced during the scientific research project life cycle.

The advantage of the DO is that it offers a framework for the technical implementations of the FAIR principles. Indeed, right after the publication of the FAIR principles, the idea around the Digital Objects evolved to the concept of a FAIR Digital Object (FDO)⁴.

The most common description of an FDO is to see it as a series of four concentric layers (Figure 2). All the layers are necessary to fulfil the minimum requirements in order to make the DOs FAIR. The core layer is the DO itself, i.e. a bit sequence located in a digital memory. The second layer is the Persistent Identifier, that allows the DO to be findable, accessible, and properly cited when utilised. The third layer is represented by the whole set of formats, standards, documentation, and software needed to effectively access and reuse the DO in an interoperable way. The external layer is represented by the metadata that provides all the contextual information, such as the provenance, the authors, the protocols, etc., which enable to discover the DO, but also to reuse it in the right context.

⁴ <https://fairdigitalobjectframework.org/>

The FDO is a still evolving framework⁵, along with its technical implementations. We are closely following the process, and we aspire at organizing the ITINERIS Hub as a FAIR ecosystem in which DOs are managed as FDO. Here we propose to manage all the research products in ITINERIS as DOs with a tendency to become FDOs, i.e. by attaching them a PID, a set of metadata, and the information useful to allow them to be machine actionable. For this reason, the structure of this first DMP release reflects the minimum core of information that composes an FDO.

b. STRUCTURE OF THE DMP

The core of the DMP is the Chapter 5 which has been designed as a simplified version of the Horizon Europe DMP template to comply with the current European guidelines for the development of projects DMP. This structure will also enable a smooth transition to the updated version of this DMP, that will meet the full Horizon Europe requirements.

The chapter begins with the general provisions, where all the management actions that are common to all the DOs potentially managed by the ITINERIS project, are described. The following six sub-chapters regard the management action for the six selected DOs: research data, terminologies, policy documents, research codes and software, training materials, and metadata records. For sake of clarity and, to allow the transformation to a machine-actionable format, all the sub-chapters are organised in six paragraphs:

1. Brief description
2. Provenance
3. Format
4. Size
5. Storage

Only the sub-chapter *B. Research data* is further splitted into the four domains: atmosphere, marine, terrestrial biosphere, and geosphere-landsurface. This is to accommodate the huge differences in the existing or produced data among the RIs belonging to the four domains. A final sub-chapter is dedicated to sensitive data.

This DMP is intended as a live document, and it will be regularly updated whenever needed. In accordance with our commitment in producing FAIR products, we aim at producing a FAIR machine actionable version of the DMP.

5. POTENTIAL DOs MANAGED DURING THE PROJECT

a. GENERAL PROVISIONS

In the following chapter are outlined the general management action which concerns all the DOs.

Community-endorsed interoperability best practices followed

WP2 launched a survey to collect the FAIR-enabling best practices in use among the participating RIs. The analysis of the survey is currently in progress and will serve as the

⁵ <https://fairdigitalobjectframework.org/>

basis to write the deliverable 2.7 “State of the art review of FAIR-enabling best practices”. Aim of the deliverable is to produce a report with an up-to-date analysis of the FAIR implementation practices adopted by the RIs involved in ITINERIS.

The ITINERIS Terminology Service will be developed by WP2 to address terminology-based and semantic interoperability. The service will be built on existing and new FAIR terminologies and services to enhance the data interoperability of National Environmental RIs.

Long term accessibility

The ITINERIS participants will assure the sustainability of the project infrastructures and its products for a period of at least ten years.

Use of persistent identifier(s)

According to the project, all DOs will be identified through a persistent identifier. A common strategy will be discussed and implemented during the advancement of the project and included in the update version of this DMP.

Use of controlled vocabularies

The deliverable 2.11 “Review on the existing terminologies” will identify the relevant terminologies (i.e., controlled vocabularies, thesauri, and ontologies) and terminology services used by ITINERIS partners. The terminologies will be extended, where necessary, and aligned (deliverable 2.12). The terminology will be applied to selected use cases and will serve as guidelines for the developing RIs.

Creating a shared vocabulary among project participants in a large and ambitious project such as ITINERIS, is important for clear communication and effective development of services. It is proposed by WP2 to build a vocabulary of the terms for the access to services and service provision agreed among all the project participants. The vocabulary will be created from the existing terminologies already developed by the RIs, such as the ACTRIS Glossary of terms⁶ and the LifeWatch ERIC Upper Ontology⁷, and will consider the available documents developed by the European Commission that govern the access to RIs⁸.

Application of standard metadata schema

Metadata for all the DOs produced during the project will need to be compiled according to international standards, semantically enabled, and linked to the underlying resource. Considering both the different levels of maturity and the different domain of the RIs involved in ITINERIS, dedicated metadata schema will be used for specific DOs. As previously mentioned, an analysis of the FAIR-enabling best practices in use among the participating RIs is currently in progress. The resulting deliverable 2.7 will outline the metadata standards already established in each community. It will be in the remit of WP2 to suggest the best enabling FAIR practices related to the use of metadata schemas.

⁶ <https://www.actris.eu/documents/actris-glossary>

⁷ <https://ecoportal.lifewatch.eu/ontologies/LUPO?p=summary>

⁸ https://research-and-innovation.ec.europa.eu/partners-networking/access-research-infrastructure/access-european-research-infrastructures_en

International licence

In principle, all the DOs produced by ITINERIS will be licensed under open licences, such as CCBY 4.0 and MIT. Opt outs or different levels of restrictions may apply if well argued (for instance data on protected endangered species, data pertaining national security, etc.; see chapter H. Sensitive data for further details). Metadata will be released under Creative Commons Zero (CC0) licence. Personal data collected during the project will not be released under any circumstance.

b. RESEARCH DATA

Brief description

During the project a considerable amount of research data will be generated by the RIs within the activities undertaken in WPs 4 to 7. Due to the broad diversity of the participating RIs, both in terms of topics that they cover, and in the level of maturity as well, data are described in the next four following paragraphs according to the environmental domains: atmosphere (WP4), marine (WP5), terrestrial biosphere (WP6) and geosphere-landsurface (WP7).

Data format

It is expected that data will be available in a diverse range of formats. FAIR principles discourage the use of proprietary data formats. Open formats will be used to ensure data produced within the project can be integrated with other data and that they can be utilised by applications or workflows for analysis, storage, processing, and long-time usability. Specific data format will be specified during the advancement of the project and included in the update version of this DMP.

Data size

The volume of the research data cannot be estimated at this stage of the project. Single datasets can potentially range from few hundreds of KB to several TB. Specification about data size will be updated during the advancement of the project and included in the update version of this DMP.

i. ATMOSPHERE

Data provenance

WP4 is expected to generate distinct sets of data related to important areas of interest: a) aerosols' nature and origins; b) atmospheric boundary layer height impact on ground-level conditions; c) forest fires emissions investigation. These data products will be produced using high-level observational capacity and instruments.

Types of data

The data that will be managed include:

- *in-situ* and remote sensing measurements of physical and chemical properties;

- laboratory-based measurements that will come mainly from the new data centre and the potentiation of the Italian polar Repositories NADC (National Antarctic Data Centre) and IADC (Italian Arctic Data Centre);
- provision of data from the participating RIs for test case under the Pilot activities.

WP4 have two categories of scientific equipment investment foreseen in the project: one to improve the Italian atmospheric observation system, and a second one to improve the data products accessibility. The OUs will use different kind of instruments to integrate the RIs products. Major items include lidar systems, HATPRO and HALO systems, a tethered balloon, upgraded Tandetron accelerator computer control systems, and many other tools for measuring aerosols, gases, and pollen.

Storage

According to the project, the main aim of WP4 is to establish a national integrated system for the atmospheric observations integrating domain RIs, i.e. the Eco Data Centre Infrastructure at CNR-IMAA. The new data centre will be developed to manage data availability and stream from the other major sources (NADC, IADC, WP4 Pilot services).

ii. MARINE

Data provenance

During the project, there will be data products created using new observations as well as pilot services developed in the e-infrastructures, the Italian Integrated Ocean Observing System (IOOS). The WP5 will also generate and scaling-up existing ocean observing capabilities via integration and harmonisation of observations carried out by the different RIs of the marine domain.

Types of data

The data that will be managed will include several standardised, regular, and long-term marine observations set in the framework of key priority Essential Biodiversity Variables (EBV), Essential Climatic Variables (ECV), and Essential Ocean Variables (EOV) - e.g., temperature, salinity, oxygen, nutrients, currents, chlorophyll, pollutants, macrofauna and plankton abundance, distribution and diversity, omics data, species traits, community composition, ecosystem structure, ecosystem functions, etc.

Storage

Main aim of WP5 is to build the IOOS that will integrate all marine relevant RIs, at national and European level, to guarantee access to Italian facilities, services and marine data.

iii. TERRESTRIAL BIOSPHERE

Data provenance

Both original and existing research data will be produced and managed by the RIs participating in this domain.

Types of data

Data will comprehend mainly historical experimental data, monitoring activities, (meta)data coming from sites, collections, experimental data on behaviour and functional trait in general, remote sensing, carbon fluxes, images and videos, codification of functional traits, DNA and protein sequences, environmental parameters, EBV, ECV, omics data.

Storage

The RIs of the terrestrial biosphere domain will ensure the storage and preservations of the data produced or collected during the project.

iv. GEOSPHERE-LANDSURFACE

Data provenance

Within the WP7, both original research data and existing research data will be managed. Overall, data will be newly collected in three pilot test-sites to complete the already existing dataset. Through the pilot sites (Friuli Venezia Giulia region and Tito and Potenza in the Basilicata region) data integration will be tested, implemented, and optimised by strengthening and updating the IT infrastructures of SMINO, ATLaS, and EUFAR.

Further to this, gathering of existing datasets are expected for both testing innovative approaches, re-evaluate available results and feeding the international Virtual Research Environments.

Types of data

The potential research data collected or produced by geosphere-landsurface domain will include:

- datasets from land geophysical surveys, airborne data, fiber optical strain measurements;
- data generated by scientific ocean drilling;
- geochemical, geophysical, geological, geodetic, and seismological observational data;
- multi-parameter observation of the surface processes (mass movements, subsidence and ground deformation in general).

Storage

The RIs of the geosphere-landsurface domain will ensure the storage and preservations of the data produced or collected during the project.

c. TERMINOLOGIES

Brief description

An initial review on the existing terminologies and terminology services relevant for ITINERIS partners will be the starting point for selecting useful existing terminologies that will be make available through the ITINERIS Terminology Service to address semantic interoperability. As reported in the deliverable 2.11, it should be clarified that from now on within this deliverable and, more in general, within the framework of the WP 2 activities, the terms “terminology” will be replaced by “semantic artefacts” as described in detail below

and in agreement with the international recommendations outlined by the FAIRsFAIR and FAIR-IMPACT projects (Le Franc et al., 2022), by the EOSC Task Force on semantic interoperability (EC, 2021), and by the Metadata for Ontology Description and publication (MOD).

Provenance

Existing semantic artefacts relevant for ITINERIS partners will be used and extended where relevant. New semantic artefacts will be developed to meet the needs of the participating RIs. The ITINERIS Terminology Service will be developed and will include existing and new FAIR semantic artefacts and associated services.

Format

Semantic artefacts are available in different standard models (e.g. RDFs, OWL, SKOS) and open human and machine-readable and -actionable formats, (e.g. OWL/XML, RDF/XML, TTL, JSON, JSON-LD).

Size

The volume of semantic artefacts cannot be estimated at this stage of the project. Single semantic resources are typically within the order of MB.

Storage

The ITINERIS Terminology service will be stored in the Data Centre of LifeWatch Italy and the semantic artefacts created during the project will be stored and exposed in EcoPortal, the LifeWatch ERIC semantic resources repository (<https://ecoportal.lifewatch.eu/>). The long-term sustainability will be guaranteed by the CNR-IRET Unit of Lecce.

d. POLICY DOCUMENTS

Brief description

During the projects, policy, standards procedures and best practices will be developed and agreed among the participating RIs, including:

- policy documents for services access;
- standard procedures published as documentation and/or papers;
- new processing pipelines and services developed within the project, also applied to new data collected from outside the RIs domain.

Provenance

The documents will be generated *ad-hoc* for the project.

Format

Documents will be available in PDF. Whenever possible, they will be available also in machine-readable formats.

Size

The volume of the documents cannot be estimated at this stage of the project. Single files are typically within the range of 100 KB to 10 MB.

Storage

The documents will be published on ZENODO and made available on the ITINERIS HUB as well.

e. RESEARCH CODES AND SOFTWARE

Brief description

A system of Virtual Research Environments (VREs), codes, notebooks and related documentation will be created in order to provide new services where RIs from different disciplinary subdomains contribute, in harmonised ways, to address scientifically and socially relevant issues. These will include, among others, the dynamics of the Critical Zone, aquatic biomass responses to climate change, the carbon cycle monitoring and quantification, and downstream effects of climate and environmental change.

Provenance

The data, information and knowledge generated by the RIs in the different subdomains (atmosphere, marine, terrestrial-biosphere and geosphere) will be used to create the proposed research outputs.

Format

Two types of management softwares for the VREs will be used: TESSERACT with the direct support of LifeWatch ERIC D4Science with the support of CNR ISTI. In any case, a federated and interoperable approach will be ensured and VREs built using D4Science will be proposed for inclusion in LifeWatch ERIC. Research code will be based on Jupyter Notebook to provide the best open standards and web services for interactive computing across all programming languages.

Size

At this time, it is not possible to provide an estimate of the magnitude of the research code and software that will be developed, but our system will be capable of efficiently handling them. However, the ITINERIS e-infrastructure will be designed to adapt and scale accordingly, ensuring efficient management and smooth VRE and model operations even with evolving demands.

Storage

Algorithms and source codes developed for ITINERIS will be published on code hosting platforms (e.g., GitHub.com or GitLab.com) and their release versions will be made citable through open repositories.

f. TRAINING MATERIALS

Brief description

The training materials produced within the project are:

- Digital training objects, as webinars, TEDs, videos and presentations, on the most innovative research areas addressed by the RIs contributing to ITINERIS (targets: RIs scientific and technological staff);
- Digital training objects, as tutorials, videos and presentations, supporting users in taking the highest advantage of the top-level facilities, services and e-services, made available by the RIs contributing to ITINERIS (targets: RIs scientific and technological staff; RIs user community);
- Digital training objects, as webinars, TEDs, videos and presentations, supporting the process of advanced training of the ‘ITINERIS’ PhD students (targets: early career scientists in the field of environmental science);
- Digital training objects supporting the process of advanced training of the 2nd level University Masters selected for applications by the ITINERIS Training Centre (targets: RIs scientific and technological staff and early career scientists in the field of environmental science);
- Digital training objects for the Semantic Training Platform connecting the RIs contributing to ITINERIS as an outcome of the RIs scientific and technological staff training in science communication and citizen engagement in science (targets: RIs scientific and technological staff).

Provenance

Digital training objects will be specifically created within the project context.

Format

Digital training objects will be represented in common and ideally open file formats. This enables others to reuse them as the format is in widespread use and software is available to read the files.

Size

The volume of the whole digital training objects cannot be estimated at this stage of the project. Specification about the size will be updated during the advancement of the project.

Storage

The WP3 will develop a Training Catalogue that will be stored on the Data Centre of LifeWatch Italy, and integrated in the HUB, making accessible all training materials produced within the project.

g. METADATA RECORDS

Brief description

Metadata of all DOs and facilities will be exposed on the ITINERIS HUB catalogue by exploiting the agreed access and harvesting protocols by the ITINERIS RIs network following specifications and international standards.

Provenance

Metadata of existing and new resources will be harvested from the multiple data centres of the sub-domains/RIs.

Format

Metadata will be available in open human and machine-readable formats, such as JSON, XML, RDF.

Size

The volume of the metadata cannot be estimated at this stage of the project. Single files are typically few kBs.

Storage

Metadata will be stored in the multiple data centres of the sub-domains/RIs and made also available on the ITINERIS HUB catalogue. The Catalogue will be designed and developed as the common, comprehensive and discoverable online registry of digital objects and facilities, available as a web-based system allowing discovery and interoperability with other international initiatives.

6. SENSITIVE DATA

Brief description

The main task of WP2 is the realisation of the ITINERIS HUB, an integrated access and service portal that will work as a single-entry point where users could easily discover and access the comprehensive collection of knowledge, data, analytics tool and services provided within ITINERIS, including the Training catalogue developed by WP3. The access to the HUB will require the collection of a minimal set of personal information needed to achieve the purpose of the user interactions with the portal.

In addition, online and in-presence events will be organised. In such cases, the data potentially collected will include:

- Contact information of participants to meetings and workshops, and within surveys of target groups' needs.
- Information gathered by using spreadsheets or surveys.
- Personal data of the participants to the training events.

Access to, and use of, certain research data may include restrictions for reasons of:

- National security: data pertaining to intelligence, military activities, or political decision making may be classified and therefore subject to restricted access.
- Protection of rare, threatened or endangered species: in certain instances, there may be legitimate reasons to restrict access to data on the location of biological resources for the sake of conservation.

In this project data on human subjects will not be collected.

Provenance

The main source of personal data will be the access to the ITINERIS HUB by the users. In addition, online and in-presence events will be organised. In such cases, personal data will potentially be collected.

Data that may include potentially national security information, such as oceanic sound recordings, or protected species observations are collected from monitoring programmes and research purposes.

Format

It is expected that personal data will be stored in an anonymised way on a HUB backend database. Regarding the sensitive research data, they will follow the community accepted format.

Size

The volume of the data cannot be estimated at this stage of the project. Specification about data size will be updated during the advancement of the project.

Use of persistent identifier(s)

Personal data will not be accompanied by any kind of persistent identifier. Regarding the sensitive research data, they will follow the community accepted policy.

Storage

All user's personal information will be stored on a secure server located in Italy, a member of the European Union, and compliant to European Legislation in terms of privacy. Only authorised employees will have access to such data.

Security measures

The time of retention of personal information will be the minimum necessary to fulfil the collection purposes. Appropriate security measures will be put in place to prevent accidentally lost or unauthorised access.

In case of data pertaining to national security or endangered species, anonymisation or confidentiality procedures that ensure a satisfactory level of confidentiality will be put in place.