D11.4
Biodiversity and Ecosystem subdomain long-term development and management plan

Work Package	WP11
Lead partner	CMCC
Status	Final
Deliverable type	Report
Dissemination level	Public
Due date	30 April 2023
Submission date	30 June 2023

Deliverable abstract

The ENVRI-FAIR project activities have clearly improved the FAIRness of the data collected by the Ecosystem and Biodiversity RIs and the level of cross-RI collaboration. With a long-term plan, the RIs must have also a trajectory in terms of long-term collaboration, consolidation and management that should be also based on the experience in ENVRI-FAIR.
In this deliverable an analysis of the possible common development paths, complementarities and specific long-term use cases are presented and prepared for a discussion among the RIs' legal entities.

ENVRI-FAIR (www.envri-fair.eu) has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824068

DELIVERY SLIP

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DELIVERY LOG

Issue	Date	Comment	Author
V 1.1	18 June 2023	Sent for review	Dario Papale
V 2.0	24 June 2023	Sent for approval	Dario Papale

DOCUMENT AMENDMENT PROCEDURE

Amendments, comments and suggestions should be sent to the Project Manager at manager@envri-fair.eu.

GLOSSARY

A relevant project glossary is included in Appendix A. The latest version of the master list of the glossary is available at http://doi.org/10.5281/zenodo.4471374.

PROJECT SUMMARY

ENVRI-FAIR is the connection of the ESFRI Cluster of Environmental Research Infrastructures (ENVRI) to the European Open Science Cloud (EOSC). Participating research infrastructures (RI) of the environmental domain cover the subdomains Atmosphere, Marine, Solid Earth and Biodiversity / Ecosystems and thus the Earth system in its full complexity.

The overarching goal is that at the end of the proposed project, all participating RIs have built a set of FAIR data services which enhances the efficiency and productivity of researchers, supports innovation, enables data- and knowledge-based decisions and connects the ENVRI Cluster to the EOSC.

This goal is reached by: (1) well defined community policies and standards on all steps of the data life cycle, aligned with the wider European policies, as well as with international developments; (2) each participating RI will have sustainable, transparent and auditable data services, for each step of data life cycle, compliant to the FAIR principles. (3) the focus of the proposed work is put on the implementation of prototypes for testing pre-production services at each RI; the catalogue of prepared services is defined for each RI independently, depending on the maturity of the involved RIs; (4) the complete set of thematic data services and tools provided by the ENVRI cluster is exposed under the EOSC catalogue of services.

TABLE OF CONTENTS

D11.4 – Biodiversity and Ecosystem subdomain long-term development and management plan

1 Introduction

Terrestrial ecosystems are currently facing multiple forms of anthropogenic stress introduced by e.g. land use change, loss of biodiversity, global warming, eutrophication and the release of new chemical compounds. The resulting loss of ecosystem services provides extremely high risks on societies and threatens food security, health, and many other societal goods worth trillions of €. The way to reduce such anthropogenic stress and keep societies safe from the resulting damage strongly depends on the transfer of scientific knowledge towards politics, private enterprise, and the society at large. Two aspects of environmental science have become important in this situation: the need for comprehensive and sustainable observations and the urgent need to cooperate to understand and integrate all aspects of the Earth System. The Environmental Research Infrastructure cluster (ENVRI), developed in the context of the ESFRI framework, covers all the spatial and functional domains on the Earth System. During the ENVRI-FAIR project and building on the results obtained in previous projects like ENVRIPLUS, the environmental research infrastructures have already achieved a strong alignment.

However, there are also specific areas where the cooperation needs to be improved. Understanding the multiple anthropogenic stress on terrestrial ecosystems is an extremely complex scientific challenge that needs specific cooperation between the involved research infrastructures. Their structural integration towards a 'subdomain cluster of synergies' is pivotal to support the European Green Deal and enable informed environmental decision making at national and European level.

The Biodiversity and Ecosystem subdomain in the context of the ENVRI-FAIR project groups different RIs helps to identify the Research Infrastructures (RIs) that have more potential for strict collaborations and synergies because all acting in the large and heterogeneous context of the biosphere. For its nature, the biosphere includes different spatial domains and for this reason specific RIs could cover or be related to more than one spatial domain, as in the case of ICOS that operates in the Terrestrial, Marine and Atmospheric contexts, or LifeWatch, DANUBIUS-RI, DiSSCo and eLTER that collect measurements and design services across the Terrestrial, Coastal and Marine subdomains, or AnaEE that operates experimental platforms across continental terrestrial and aquatic ecosystems.

A high level of heterogeneity has been identified in the Biodiversity and Ecosystem during the ENVRI-FAIR project: firstly, the RIs have a different level of maturity, with ICOS, LifeWatch and AnaEE Landmark Infrastructures with an established ERIC, and eLTER, DiSSCo and DANUBIUS-RI still in the ESFRI Project status and all at a different level of readiness and development. In addition, and more importantly, all the RIs observe, analyse, and provide services related to different points of view and components of the Biodiversity and Ecosystem subdomain. ICOS in its Ecosystem components observes greenhouse gas exchanges, meteorological parameters and ecological status in about 100 stations in Europe that are coordinated by an Ecosystem Thematic Centre responsible also for the protocol's development, quality evaluation and data processing. The 62 AnaEE platforms simulate the impacts of global change drivers on terrestrial and aquatic ecosystems in open-air or enclosed facilities, and provide modelling and advanced biological, physical, and chemical analyses for a deeper insight into ecosystem processes. LifeWatch, as an eScience Infrastructure, provides tools and services supporting harmonisation and interoperability of biodiversity and ecosystem data and their analysis and modelling in virtual research environments. eLTER collects standardised data on terrestrial, freshwater and transitional water ecosystem functions, structure, and long-term trends in response to environmental and anthropogenic pressures in about 500 sites and platforms. The Distributed System of Scientific Collections (DiSSCo) brings 175 museums, botanical gardens, and natural science collections-holding Universities across 23 countries. DiSSCo is working towards mobilising the full potential of natural history collections by bringing them together in a distributed, interoperable European research infrastructure. The 10 Supersites and the 4 thematic Nodes of DANUBIUS-RI focus on studying and understanding processes in freshwater - coastal - marine continua. A significant focus is on transitional environments at the river-sea interface (deltas, estuaries, lagoons). DANUBIUS-RI components provide data and specialised services, in terms of Observations, Analysis, Modelling and Impact on River-Sea systems. SIOS, that in its ecosystem component comprises various heterogeneous type of platforms for observation of arctic ecosystems and biotopes from reindeer population monitoring to ecosystem

resilience, terrestrial but also in marine environment: anthropogenic pollutants effect on functional capability, reproductive behavioural change in bird colonies, alteration predative strategy, marine food chain comprehensive model.

The need for a long-term strategy

This high level of heterogeneity must be seen as richness, because the complexity of the terrestrial biosphere, the direct impact on human life quality and the number of relationships between biotic and abiotic factors require a multi-disciplinary approach that these RIs can cover. The data and services accessible through the RIs involved in the Biodiversity and Ecosystem subdomain can offer a unique set of information for improving our understanding, detecting, tracking, and monitoring the role of and the effects on the terrestrial biosphere (and links to the other subdomains) in the context of human induced environmental pressures such as climate change and pollution, and to support decisions on adaptation and mitigation actions.

A coherent and synergic development of the RIs clearly requires a high level of collaboration among the participating RIs, with the development of integrated coordination actions and services that can offer the maximum level consistency and accessibility of cross-RIs data and services, and the needed robustness of the Biodiversity and Ecosystem subdomain in order to ensure the needed long-term stability and highest possible level of complementarity.

The long-term strategy will have to consider generic actions for synergic and complementary development and coordination (described in Sections 2) but also a number of specific and focussed use cases, that have been already shown as successful to identify gaps and needs and to develop new services in the context of ENVRI-FAIR (Task 11.3).

It is important to remark and clarify that this deliverable analyse the main aspect to consider for a long-term strategy, suggesting possible practical actions and listing examples of high priority actions, however the decision on the long-term development and management plan across RIs is uniquely in the hands of the legal entities representing the RIs.

2 Coordination, development, and synergies

A long-term coordination of the Environmental RIs participating in the ENVRI community is already ongoing, through different MoU and the BEERI. However, in order to address the specific needs, gaps and coherent development of the Biodiversity and Ecosystem subdomain RIs, a specific level of coordination is needed, that can be focussed on improving and developing specific needs that characterise the participating RIs. This subdomain level coordination will then ensure the needed link and exchange with the other environmental RIs (e.g., in the BEERI) to ensure the overall ENVRI coherent development.

- Three main aspects have been identified as major needs for the long-term strategy:
- A higher level of coordination among the RI legal entities
- A framework to continuously analyse the complementarity of the RIs and guide a synergic development

The identification, definition, construction, and regulation of common and shared cross-RIs specific services.

These have been identified as important needs by the WP11 RIs, that will need to be addressed and implemented in the near future in order to ensure the needed coordination and development at subdomain level. A project proposal has been submitted under the Horizon Europe framework to specifically develop these aspects.

2.1 Coordination among RI legal entities

The coordination at administrative and operational level could comprise different aspects, such clarification on complementarities in the general scientific objectives, the analysis of common challenges and issues faced in the RI operations (political, financial, practical), the identification of possible synergies and development strategies for cross-RIs services and common scientific user facilitation (See point 2.3) and organise a continuous dialogue between the governmental bodies.
RI legal entities could also cooperate in the development of common, shared or coordinated tools (e.g. communication, training, human resources and gender issues) in order to highlight the level of inter-connection among RIs. The principal aim of such coordination is not the possible financial impact (the number of financial resources saved is estimated to be rather low) but the increase in the efficiency and impact toward users, stakeholders and other RIs.
Finally, the role of a strong and continuous coordination should not be underestimated in supporting emerging RIs under construction, thanks to the experience gained in the ERICs and Head Offices establishment, in particular for the subdomain specific aspects (e.g., large heterogeneity of measured quantities, large network of stations and facilities).

2.2 Complementarity and synergic development

Although the Biodiversity and Ecosystem subdomain RIs involved in WP11 are characterised by different scientific objectives and approaches, they share a consistent number of target users, audiences and challenges in defining the best possible design and development strategy. A coordinated continuous analysis of the needs and best possible complementary development, where overlaps are minimised, should be a common aim, achieved through a long-term coordination.
For example, it would be strategically important and of high impact toward the users to ensure that the maximum possible number of Essential Climate Variables (ECV, Bojinski et al. 2014), Essential Biodiversity Variables (EBV, Pereira et al. 2013), and Essential Ecosystem State Variables (EESV, Balvanera et al. 2022) are monitored by the ensemble of Biodiversity and Ecosystem RIs.
For the RIs that include a network of monitoring and observation sites such as ICOS, eLTER, DANUBIUS-RI, SIOS and partially AnaEE, it is also important to carefully understand, evaluate and quantify the advantages and disadvantages (from both resources and scientific perspectives) of physical co-location. There is already a large degree of physical co-location in the observation sites across RIs, e.g. INAR in Finland, but a tool and framework to find the optimal compromise between the reduction of financial needs obtained by co-location and the increase of representativeness (in its broad ecological meaning, covering spatial, climate, vegetation, anthropogenic pressure etc.) that is instead maximised without co-location.
The complementarity and synergic development and operation can work only if all the data and services are made findable, accessible, interoperable, and reusable to the cross-RI user community in a consistent

and integrated way and if the inclusion of new variables is coordinated. This must include a clear analysis and unambiguous description of the different variables and parameters collected by the participating RIs, including site documentation (already started in the Use cases in the context of ENVRI-FAIR) and the development and long-term maintenance plan of domain specific vocabularies and a common semantic model.

2.3 Common and shared cross-RI services

The type of measurements, analysis, services, and facilities that characterise the Biodiversity and Ecosystem subdomain RIs is highly heterogeneous. However, there are common parameters and tools that more than one RI is measuring/developing/using. During their development and construction, each RI invested in many core technical, methodological, and infrastructural commitments. One of the long-term objectives of the subdomain should be to evaluate and organise a synergic cross-RIs set of services and common developments.

This would lead to a double benefit: on one side it will avoid duplication and inefficiency in the use of resources and on the other side it would dramatically increase the data interoperability level and facilitate the use of data across RIs. In addition to strengthen the overall cross-RIs collaboration, common shared services could also increase the level of robustness if a cross-RIs overlap of competences is built, with people from different RIs able to use and maintain the common services.

The list of potential common and shared services could be long and more importantly it will evolve in time, thanks to new RIs developing in ERIC and also due to the natural development of the existing RIs in order to provide answers to new questions and new user communities. For this reason, it is important to organise a continuous dialogue and coordination on these specific aspects that can help the design, development, implementation and management of common services and tools.

In the WP11 activities, discussions, and exchanges, a first list of examples of common and shared services has been identified, based mainly on the current core competences of the more developed Biodiversity and Ecosystem subdomain RIs and the potential interest by other RIs:

1) A Greenhouse Gases (GHG) fluxes product chain: the collection of measurements of GHG fluxes using chambers and the Eddy Covariance technique and their quality filtering and processing are key activities in ICOS, where the ICOS Ecosystem Thematic Centre is responsible for the protocols' definition and centralised processing, following international standards developed in the context of FLUXNET. A common service, mainly shared with eLTER and AnaEE and potentially with other RIs such DANUBIUS-RI, could cover the full (meta)data pipeline from acquisition to final product, ensuring a coherent and strong presence of Europe in the FLUXNET global network.
2) Taxonomic data mapping service: all the ecosystem RIs deal with species, either as main variable collected (e.g., their presence in a certain ecosystem) or as metadata connected to other measurements (e.g., biomass, ecological functions, nutrients content, specimen in a collection etc.). The use of the same taxonomy (name of the species) is a key aspect to ensure consistency and interoperability and it has been the focus of a specific Use Case in Task 11.3. DiSSCo and LifeWatch, also thanks to the close links and collaboration with Catalogue of Life and the Global Biodiversity Information Facility (GBIF), can further develop a taxonomic and nomenclature checklist and tools that all the RIs could use to verify, curate and update species names, ensuring both internal consistency and full interoperability.
3) Site level Remote Sensing characterisation service: the acquisition, processing and distribution of high spatial resolution remotely sensed data using airborne and UAV sensors, that can be optimised to target specific site needs (type of measurement, time of acquisition, area covered etc.) are a highly valuable product for the upscaling of ecosystem measurements, analysis of the representativeness and homogeneity and link to the satellite RS data. AnaEE has tools and competences to organise a cross-RI airborne/UAV RS data acquisition, also thanks to established collaborations with the European Facility for Airborne Research (EUFAR - www.eufar.net). A possible shared service could be organised for this type of data acquisition and processing, that requires large investments for the equipment and specific competences for the data acquisition and processing.
4) Ecosystem vegetation parameters chain: there is a large set of ecosystem parameters that are collected in the Biodiversity and Ecosystem subdomain (in particular in ICOS, eLTER, AnaEE, DANUBIUS-RI and SIOS), ranging from vegetation parameters such species and structure,

biomass, Leaf Area Index (LAI), the Fraction of Absorbed PAR (FAPAR) and the phenological stage, to the vegetation and soil chemical characteristics and the natural and anthropogenic ecosystem import and export of carbon and other nutrients/elements. The different RIs have developed protocols and processing tools (in particular the most developed such ICOS and AnaEE) that required iterations with experts also outside the RIs. These services are for this reason good candidates to be part of the common and shared tools.

5) Modelling platforms and Virtual Research Environments: one of the natural analysis and synthesis of the data collected by the Biodiversity and Ecosystem subdomain RIs will be through the use of modelling platforms, virtual laboratories, and virtual research environments. These are a core element of the LifeWatch competences and for this reason the development of a common service, directly linked to the other Biodiversity and Ecosystem subdomain RIs, with the aim to maximise visibility, exploitation, use and synthesis of cross-RIs data could be a valuable common service. Moreover, DANUBIUS-RI with its Modelling Node, has competences on the deterministic modelling applied to the river-sea continuum. Collaborations to use the DANUBIUS-RI modelling outcomes and services within the Biodiversity and Ecosystem subdomain is certainly possible in synergy with the LifeWatch modelling platforms and VREs.

Clearly the development of common and shared services can be effective and robust in the long-term only if sustained by the different RIs with a clear share of responsibilities and roles. This is something that can be obtained through specific Service Level Agreement that will regulate all the aspects on development, maintenance and use that are critical for to ensure a long-term strategy.

3 Further development of long-term Use Cases

The definition, planning and development of the Use Cases in the context of the WP11 of ENVRI-FAIR have been a cornerstone of the FAIRness evaluation. Through the common activities performed by the Biodiversity and Ecosystem RIs to build 1) a common Site documentation system, 2) a common Soil Water Content metadata discovery system and 3) the analysis of the issues and gaps for a common species names system, the RIs not only increased their FAIRness but also could quantify the effort needed to reach a minimum level of cross-RI compatibility/collaboration and demonstrate feasibility and advantages.
Defining practical Use Cases, where the development of features is performed with a clear user community as target (that could be the RIs themselves), helps to have clear targets and to have a direct and tangible evaluation of the results by the users.

For this reason, in the medium to long timeframe it is suggested to continue with few focused Use Cases to support the development of the general synergic development and co-development described in Section 2. The three Use Cases selected in WP11 are not completed and it is worth to continue the effort and bring them to the next level. The taxonomic tool has been identified as one of the possible common shared services organised and offered by one RI (Section 2, point 2) while both the site registry and the (meta)data provision from a single interface are two key development elements for the medium-long-term, with additional three identified as emerging interest and priority.

3.1 Common site registry

The development of a common site registry with the key metadata needed to fully discover the Biodiversity and Ecosystem subdomain network and services is a key element to move toward a stronger collaboration. The system has been developed in ENVRI-FAIR and tested positively. However, in order to make it operational and useful for standard users it is necessary to further refine the workflow of collecting and exposing metadata, agree on maintenance and distribution and, more importantly, obtain the commitment of the different RIs to keep the information synchronised in near real time.

3.2 Beyond SWC: (meta)data FAIRness

The SWC use cases had the original aim, focusing on a single variable, to make metadata and data across RIs discoverable and accessible through a single interface. The activities demonstrated that the objective was too challenging and for this reason only metadata related to SWC measurements collected in 10 sites per infrastructures could be managed. Nevertheless, it has been extremely useful to identify the main issues and gaps, develop solutions, estimate the resources and time needed and define possible final products.

In order to ensure its full development, it would be important to define a specific Use Case to continue to develop also after the ENVRI-FAIR project, with the aims to 1) complete the SWC demonstrator extending to all the sites participating to each RI and providing also the access to the data, 2) extend it to all the other common variables, starting from the meteorological and basic ecosystem characteristics, 3) define the users access methods, that should range from a pure machine to machine to a basic graphical interface in order to satisfy the needs of different user communities.

3.3 Remote sensing Calibration and Validation

A network of terrestrial ecosystem sites that are part of environmental RIs represents a great potential as an in-situ component for Remote Sensing Calibration and Validation (CalVal) activities. The long-term perspective, the high level of standardisation and FAIRness, the open and fast access to the data, are all characteristics of the RIs that are crucial for the CalVal communities. Analysing the requirements set by the Committee on Earth Observation and Satellites Land Products Validation (CEOS LPV) and Fiducial Reference Measurements (FRM) it is clear that timely high-quality data with a long-term perspective are key characteristics requested for a CalVal network. However, adaptation of measurement and processing protocols and inclusion of new additional variables to the ones already collected would be needed in order to fulfil the needs. Defining a Use Case on this would allow start and maintain an open discussion among all the Biodiversity and Ecosystem RIs with in-situ measurements network and all the reference actors in the context of the CalVal activities (e.g., ESA, Copernicus), for an RIs contribution to the

current and forthcoming remote sensing missions (e.g. Sentinel constellation, FLEX, CHIME) calibration and validation activities.

3.4 Support to Nature Based Solutions

Nature Based Solutions (NBS) for biodiversity conservation, for mitigation of poor air quality and to contrast climate change are an important set of activities where the Biodiversity and Ecosystem subdomain RIs can contribute, providing methods, observations and tools that could be used in the planning, realisation, and verification of the NBS. In particular, AnaEE with the applied experimental and modelling knowledge under future scenarios, ICOS and eLTER with the network of observational sites and LifeWatch, with the Virtual Research Environments and knowledge to integrate data and tools from different sources could work on a long-term Use Case to develop this service, starting with specific application cases (e.g. biodiversity conservation and/or carbon farming) and then evaluating, together with the users, the best development strategy.

3.5 Subdomain International collaborations

In general, the cluster of ENVRI RIs have already developed partnership, MoU, collaborations and discussions with other similar networks, initiatives, and infrastructures in other continents. The international collaboration is at the basis of the success of the RIs because of the global scale of the scientific questions that want to be answered. The heterogeneity in the environmental RIs with their four subdomains led to RI specific discussions and collaborations that however could be organised at the level of subdomains. In the Biodiversity and Ecosystem context there are few examples, like the GERI (Global Ecosystem Research Infrastructure) where ICOS and eLTER signed an agreement with the Chinese Ecosystem Research Network (CERN, China), the National Ecological Observatory Network (NEON, USA), the South African Environmental Observation Network (SAEON, South Africa) and the Terrestrial Ecosystem Research Network (TERN, Australia) for common activities and development. There are however other possible cross-RI international collaborations that could be proposed as long-term Use Cases, for example on the participation to FLUXNET, where in addition to ICOS also eLTER, DANUBIUS-RI, SIOS and partially AnaEE could contribute to a discussion with all the other regional networks. In fact, also Use Cases listed above (site documentation, (meta)data availability, CalVal and NBS) could be also extended to international partners in order to increase the level of impact.

4 Conclusions

The ENVRI-FAIR project allowed an unprecedented co-development of the Biodiversity and Ecosystem subdomain RIs, increasing their level of FAIRness and developing Use Cases that increased the level of knowledge on limits, solutions, and strength. It would be important to build on this increased knowledge and level of development, organising a long-term development plan for all the RIs of the subdomain. Three main synergic and complementary development contexts have been identified, together with five possible long-term Use Cases that should ensure a practical and constant link and exchange across the RIs of the subdomain. The proposals are summarised in Table 1 together with the list of RIs potentially involved.

It is important to note that this is not a programmatic document because decisions on collaborations, development and synergies are defined by the legal entities representing the single RIs. However, this document aims to be a starting point and a basis for discussion that we hope could lead to a more and more coherent development of the Biodiversity and Ecosystem subdomain.

Table 1. Long-term development and synergy activities proposed and RIs potentially involved. In bold the RIs that could lead the process or are already acting, in parenthesis the RIs where the involvement should be verified.

	Long-term development action	RIs potentially involved
Coordination Development Synergies	Coordination among RI legal entities	ALL
	Complementarity and synergic development	ALL
	Common and shared cross-RI services: GHG fluxes	**ICOS**, eLTER, DANUBIUS-RI, SIOS, (AnaEE)
	Common and shared cross-RI services: Taxonomic tool	**DiSSCo**, **LifeWatch**, ICOS, eLTER, AnaEE
	Common and shared cross-RI services: Site level Remote Sensing	**AnaEE, DANUBIUS-RI**, ICOS, eLTER
	Common and shared cross-RI services Ecosystem vegetation parameters	**ICOS**, **eLTER**, AnaEE, (DANUBIUS-RI), (SIOS)
	Common and shared cross-RI services Modelling platform	**LifeWatch, DANUBIUS-RI**, ALL, (DiSSCo)
Long-term Use Cases	Common site registry	**eLTER**, ICOS, AnaEE, DANUBIUS-RI, SIOS
	Beyond SWC: (meta)data FAIRness	ALL (except DiSSCo)
	Remote sensing Calibration and Validation	**ICOS**, **eLTER**, DANUBIUS-RI, (AnaEE), (SIOS)
	Support to Nature Based Solutions	**AnaEE**, ICOS, eLTER
	Subdomain International collaborations	ALL

5 References

Balvanera P. et al. (2022) Essential ecosystem service variables for monitoring progress towards sustainability. Current Opinion in Environmental Sustainability, 54, 101152, doi: 10.1016/j.cosust.2022.101152

Bojinski S. et al. (2014) The Concept of Essential Climate Variables in Support of Climate Research, Applications, and Policy. Bulletin of the American Meteorological Society, 95-9, 1431:1443, doi: 10.1175/BAMS-D-13-00047.1

Pereira H.M. et al. (2013) Essential Biodiversity Variables. Science, 339-6117, 277:278, doi: 10.1126/science.1229931

6 Appendix A: Glossary and terminology

The following is the list of acronyms and terms that could have been used in this deliverable:

AAAI	Authentication, Authorisation and Accounting Infrastructure
AAI	Authentication and Authorisation Infrastructure
AnaEE	Analysis and Experimentation on Ecosystems
API	Application Programming Interface
CalVal	Remote Sensing Calibration and Validation
CC0	Creative Commons – Not rights reserved
CC-BY-NC 4.0	Creative Commons attribution non-commercial license
CC-PDM	Creative Commons - Public Domain Mark
CEOS LPV	Committee on Earth Observation and Satellites Land Products Validation
CF	Climate and Forecast (semantics for NetCDF)
Ckan	Comprehensive Knowledge Archive Network. It is an open-Source data portal platform
CMD	Common layer of core metadata
CoL	Catalogue of Life
CSW	Catalogue Service for the Web
DANUBIUS-RI	International Centre for Advanced Studies on River-Sea Systems
DAP	Data Access Point
DataCite	A leading global non-profit organisation that provides persistent identifiers (DOIs) for research data and other research outputs
DCAT	Data Catalogue Vocabulary
DEIMS-SDR	Dynamic Ecological Information Management System - Site and dataset registry
DIF	Directory Interchange Format (National Aeronautics and Space Administration)
DiSSCo	Distributed System of Scientific Collections
DMP	Data Management Plan
DOI	Digital Object Identifier
EcoPortal	The LifeWatch ERIC comprehensive repository of ecological ontologies
eduGAIN	EDUcation Global Authentication INfrastructure
eLTER	Long-Term Ecosystem Research in Europe
eLTER PLUS	H2020 project on eLTER Advanced Community Project
eLTER PPP	eLTER Preparatory Phase Project (H2020 project)
EML	Ecological Metadata Language
ENVRI	Environment research infrastructures
ENVRI-Hub	A federated machine-to-machine interface to access environmental data and services provided by the contributing ENVRIs

EnvThes	Environmental Thesaurus
EOSC	European Open Science Cloud
EPOS	European Plate Observing System
ERIC	European Research Infrastructure Consortium
ESA	European Space Agency
FAIR	Findable Accessible Interoperable Reusable
FAPAR	Fraction of the Photosynthetically Active Radiation absorbed by the vegetation
FLUXNET	The global network of eddy covariance sites
FRM	Fiducial Reference Measurements (linked to Remote Sensing calibration and validation activities)
GBIF	Global Biodiversity Information Facility
GEDE-RDA	Group of European Data Experts in RDA
GeoNetwork	A catalogue application to manage spatially referenced resources
GEOSS	Global Earth Observation System of Systems
GHG	Greenhouse Gases
GUI	Graphical User Interface
I-ADOPT (RDA)	InteroperAble Descriptions of Observable Property Terminology (it is a RDA Working Group)
ICOS	Integrated Carbon Observation System
IM	Identity Management
ISMN	International Soil Moisture Network
ISO	International Organisation for Standardisation
LAI	Leaf Area Index
LDAP	Lightweight Directory Access Protocol
LifeBlock	LifeWatch. ERIC blockchain-based technology platform)
LifeWatch	LifeWatch European Research Infrastructure Consortium
LOM	Learning Object Metadata
Metacat	Metacat: Data Preservation and Discovery System
NetCDF	Network Common Data Format.
OAUTH	Open Authorisation (standard)
ODC-PDDL	Open Data Commons Public Domain Dedication and License
OntoPortal	Repository code for semantic content from any domain
OpenID	Open standard authentication protocol (it allows for signing into multiple websites with a unique account)
ORCID	Open Researcher and Contributor ID
OSI	Open-Source Initiative
OWL	Web Ontology Language
PAR	Photosynthetically Active Radiation
PID	Persistent Identifier
pyCSW	An OGC CSW (Open Geospatial Consortium Catalogue Service for the Web) implementation written in Python
QC	Quality Control
RDA	Research Data Alliance
RDF	Resource Description Framework
REST	REpresentational State Transfer
RI	Research Infrastructure
SDMS	SIOS Data Management System
SEISM	SoftwarE for InfraStructure administration (France)
SESS	State of Environmental Science in Svalbard

SIOS	Svalbard Integrated Arctic Earth Observing System
SPARQL	SPARQL Protocol and RDF Query Language
SPDX	Software Package Data Exchange
SDI	Site Documentation Interoperability
SLA	Service Level Agreement
SNI	Species scientific Names Identification
SWC	Soil Water Content
TF	Task Force
UAV	Unmanned Airborne Vehicles
UC	Use Case
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
USGS	United States Geological Survey
VRE	Virtual Research Environment
WIGOS	WMO Integrated Global Observing System
WMS	Web Map service
WP	Work Package