

FAIR Supporting Resource (FSR) Description Article

Advancements in EcoPortal: Enhancing functionalities for the ecological domain semantic artefacts repository

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Abstract. EcoPortal is a repository for ecology-specific semantic artefacts. It recently underwent significant updates to improve its functionalities and FAIRness. This document outlines the features of the new release, along with a Semantic Interoperability Profile.

Keywords: Research infrastructure (<https://kos.lifewatch.eu/ontologies/LUPO#ResearchInfrastructure>), e-infrastructure (<https://kos.lifewatch.eu/ontologies/LUPO#Einfrastructure>), semantic model (<https://w3id.org/fair/fip/latest/Semantic-model>), registry (<https://w3id.org/fair/fip/terms/Registry>), Semantic Interoperability Profile (<https://w3id.org/fair/fip/terms/Semantic-Interoperability-Profile>)

1. Context

In the last decade, ecological research groups have contributed to the development of numerous semantic artefacts (SAs) [13], including glossaries, controlled and structured vocabularies, and ontologies, to increase data discovery,

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Table 1

Summary of the EcoPortal 3.0 semantic implementation profile	
SIP Wizard questions	FAIR enabling resources
Data registry	EcoPortal
Data model	SKOS
	UMLS
	OBO
Metadata schema	MOD 2.0
Metadata registry	EcoPortal
Web API	RESTful API
Metadata editor	EcoPortal
Validation service	O'FAIRe
FAIR representation service	VocBench
Crosswalk editor	EcoPortal
	VocBench
Provenance model	MOD 2.0
Provenance tracking service	BioPortal ontology metrics
Ontology	MOD 2.0
Semantic artefact editor	VocBench

integration and interoperability [11]. To support the scientific community working in the ecological domain, LifeWatch ERIC [2], in collaboration with its Italian distributed centre LifeWatch Italy, has developed and maintains EcoPortal [14], a repository for domain-specific SAs. The aim is to boost data interoperability and reuse by providing a centralised gateway for reliable resources that can be used to harmonise and annotate data produced by the scientific community.

Thanks to national funding associated with LifeWatch Italy (i.e., PON-IR “LifeWatchPLUS” project) and international funding awarded to CNR and LifeWatch ERIC (e.g., FAIR-IMPACT), a new version of EcoPortal has recently been released. The purpose is to increase its degree of adherence to the FAIR Principles [23] and of the resources hosted therein.

We took advantage of the recently developed Semantic Interoperability Profile (SIP) questionnaire [5,15] to provide an updated picture of the FAIR enabling functionalities we implemented in EcoPortal 3.0. The EcoPortal SIP is available at [19] and is summarised in Table 1.

2. Description

EcoPortal serves primarily as a repository for SAs in the ecological domain, supporting a diverse community of stakeholders including researchers, vocabulary managers, data managers, data scientists, and ontology developers. Its purpose is to support and facilitate the creation, management, mapping, and alignment of FAIR SAs.

Initially developed as an instance of the OntoPortal [12] (see also Sect. 2.2), EcoPortal has undergone numerous advancements since its launch in 2019, improving the provenance aspects of OntoPortal [9], and integrating a connector to VocBench [20,22], which provides a web-based, multilingual, collaborative space for the editing and development of SAs. The main improvements introduced in the last release are: *i.* the update of VocBench, *ii.* new features to support SKOS visualisation and management, *iii.* the adoption of the Metadata for Ontology Description and publication Ver 2.0 (MOD 2.0) [10], and *iv.* the integration of the Ontology FAIRness Evaluation (O'FAIRe) tool [1].

As outlined in the subsequent sections, the new release not only increased the FAIRness of the repository and of its SAs, but it increased its capacity to involve the scientific community by providing collaborative tools to improve and develop new SAs.

2.1. FAIR supporting resource type

EcoPortal is a repository for SAs, mainly OWL ontologies and SKOS thesauri. Other representation models supported by EcoPortal are OBO [8] and UMLS-RRF [3], developed for the biomedical domain and come inherently with the original BioPortal code [9].

As a SAs repository, it offers both SA-focused services (i.e. automatic mapping generation by built-in algorithm and mapping upload; O'FAIRe tool) and ontology-based services (i.e., annotator, recommender) to foster the creation of FAIRer data [9].

Users can create or edit SAs using the VocBench instance connected to EcoPortal. A link to VocBench is available on the EcoPortal homepage. Users can access to VocBench and create SAs. Thanks to the connection with EcoPortal, the SAs created on VocBench can be published directly to EcoPortal. In addition, VocBench can be used as an editor for metadata and crosswalks. VocBench can produce crosswalks by doing a SPARQL query on declared mappings (in tabular format), or by using VocBench reporting system to produce a custom-format file.

By taking advantage of MOD 2.0, and the integration with O'FAIRe, EcoPortal supports a validation service for metadata fields.

The EcoPortal nanopublication as FAIR Supporting Resource is available at [6].

2.2. Contributing community

EcoPortal was developed through the reuse and customisation of the OntoPortal technology [9,12]. EcoPortal is a member of the OntoPortal Alliance, and as such it contributes to the overarching mission of improving the OntoPortal technology in a shared contribution with the other OntoPortal instances. These improvements are then onboarded by the different instances, including EcoPortal.

The maintenance and management of EcoPortal and its integrated functionalities is a joint responsibility between LifeWatch ERIC and LifeWatch Italy. Specifically, LifeWatch Italy takes primary responsibility for the development and mobilisation of SAs concerning national initiatives e.g. [17], while LifeWatch ERIC oversees those related to international projects.

2.3. How EcoPortal supports FAIR

In the following section we present the advancements of EcoPortal 3.0 emphasizing how they support each FAIR Principle (FP: F1, F2, F3, F4, A1, A1.1, A1.2, A2, I1, I2, I3, R1, R1.1, R1.2, R1.3) following [23] and the GO FAIR Foundation interpretations [7]. LifeWatch ERIC is a member of DataCite [4] and it can provide Digital Object Identifiers (DOI) to SAs metadata that do not have one (FP F1). EcoPortal assigns a DOI only upon verification and validation of the SA (see also Sect. 2.4 for the use of O'FAIRe for SA validation). The DOI is connected to its digital location (e.g. the URL) where all the details about the resource are available (FP F3 and A1) [12]. To adhere to the FAIR Principles effectively, SAs require rich, structured, and interoperable metadata, which is also a crucial condition for machine-actionability [10]. With the adoption of the MOD 2.0 as the new EcoPortal metadata schema, publishers are encouraged to provide rich metadata to describe their SAs (FP F2 and R1.3). MOD 2.0 was introduced in 2020. It is an extension of the Data Catalog Vocabulary ver. 2.0 (DCAT2), an RDF vocabulary designed to facilitate interoperability between data catalogues published on the Web (FP I1 and I2). MOD 2.0 serves not only as a metadata schema and ontology, but also functions as a provenance model due to its inclusion of specific metadata fields dedicated to describing the origin and history of SAs (FP R1.2).

The protocol utilized for retrieving SAs and associated metadata is HTTP URIs, which is open, free, universally implementable, and supports authentication and viewing restriction. SPARQL (accessible over HTTPS) serves as an alternative access mechanism for retrieving metadata, further enhancing accessibility (FP A1.1).

An authentication/authorisation protocol is in place for users that wish to update (meta)data. Additionally, EcoPortal added the ability to graphically administrate groups and categories of SAs. Providers, editors and validators can work, with different levels of authorisation, in VocBench, a collaborative environment, to develop or update SAs (FP A1.2).

In EcoPortal there are different types of licences (e.g. CC-BY, GNU, MIT, etc.) that can be used to indicate the reusability of the SA (FP R1.1). Users may upload SAs in any format. EcoPortal provides the download in RDF/XML and CSV, other than in the original format in which the SAs was uploaded, for instance Turtle, OWL/XML, etc.

Metadata are available as JSON, JSON-LD, N-triple, and RDF/XML file formats. Moreover, with an integrated transformer, JSON metadata can be exported with the DataCite format (FP R1.3).

2.4. Features of EcoPortal

EcoPortal has inherited some basic functionalities from the OntoPortal technology: browsing, searching, publishing, annotating, mapping, and receiving recommendations for semantic resources [9]. The EcoPortal homepage presents two search bars, one for SAs, and the other to search for concepts within SAs. Statistical information summarising the EcoPortal contents are shown as well (e.g. number of SAs, classes, users, etc.). EcoPortal integrates the O'FAIRe tool [1], a web service that automatically assesses the level of FAIRness of SAs answering 61 questions thanks to the integration with the catalogue extended metadata ontology. The tool then assigns a global FAIR score with some basic statistics to the SAs, which is shown in real time in a graphical way to the user (Fig. 1). The integration of the O'FAIRe tool within EcoPortal enhances metadata description performed by SA providers, giving the opportunity to improve their FAIRness. In addition, O'FAIRe facilitates the validation of SAs by providing a general overview of their strengths and weaknesses in terms of FAIRness. Such overview can support validators' decision, including that of providing DOIs to the SAs providers that request them, ultimately improving the FAIRness of the resources included in EcoPortal.

Furthermore, EcoPortal's latest update introduces enhanced features to better support the management of SKOS artefacts, including Schemes, Collections, and SKOS-XL Labels. The updated user interface seamlessly allows users to visualize these objects, ensuring full compliance with SKOS standards.

2.5. Limitations of EcoPortal

Following a thorough analysis of EcoPortal, informed by user feedback and requirements, several critical issues have surfaced. Foremost among these is the lack of support for multilingualism. While EcoPortal hosts resources containing content in multiple languages, it does not adequately support and display this content within its interface.

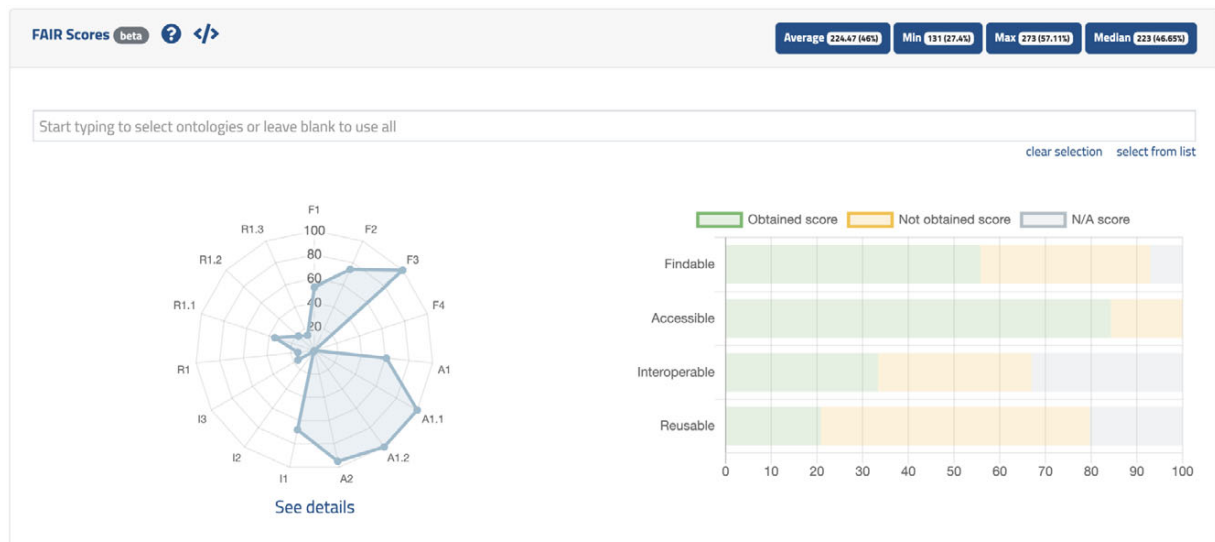


Fig. 1. FAIR graphical assessment obtained by O'FAIRe of the SAs present in EcoPortal (last access 06.03.2024).

Another concern is the absence of an edit history for SAs. Non-expert users find it challenging to interpret the DIFF files generated by the catalogue, highlighting the need for a graphical representation of the edit history.

Furthermore, EcoPortal lacks a SPARQL query editor and viewer, with the SPARQL endpoint being restricted to read-only access for security reasons. Lastly, a significant limitation reported by creators of SAs utilizing EcoPortal's VocBench installation is the absence of a system for URI dereferencing to EcoPortal. This limitation necessitates the use of alternative platforms for this purpose such as ShowVoc [18], currently in use solely for content negotiation of SAs concepts created by LifeWatch ERIC and LifeWatch Italy.

Management-wise, some EcoPortal features rely on local installation of an external tool, e.g. VocBench, or web services consumed by EcoPortal, such as O'FAIRE. Issues or limitations in these may impact their full usability.

Addressing these limitations requires ongoing efforts in refining EcoPortal's features. However, continual enhancements are contingent upon project fundings, resulting in variations in the pace of progress over time.

2.6. Planned improvements

As an integral part of a vast community, EcoPortal continuously receives significant feedback, which is meticulously collected and assessed. This feedback serves as a crucial foundation for designing new releases, implementing enhancements, and improving the overall system.

In the upcoming months, several new features are scheduled for release. These include the new documentation publication, the implementation of a URI dereferencing system to EcoPortal, the creation of a multilingual interface, and the establishment of a content federation among the different various instances within the OntoPortal alliance consortium.

As explained above (Sect. 2.1), users have the option to create or edit SAs using the VocBench instance connected to EcoPortal. While this integration is highly convenient, we currently face an incomplete compatibility between the metadata generated on VocBench and MOD 2.0 in EcoPortal. We are planning to enhance this feature by aligning the changes in the metadata schema.

2.7. Example application

Users utilize EcoPortal to create, edit, access and share domain-specific SAs, such as thesauri and ontologies. Currently it hosts 28 SAs (18 in SKOS, 9 in OWL, 1 in UMLS). Researchers and data managers leverage EcoPortal to harmonise and integrate heterogeneous data, enabling comprehensive analysis and synthesis of ecological information. This integration is particularly evident in the LifeWatch Italy Data Portal and Metadata Catalogue. When (meta)data are published within these platforms, the managers assure that those are annotated and described, when possible, with SAs enlisted in EcoPortal. For instance, the Phytoplankton Traits Thesaurus [16] is used to annotate several datasets in the LifeWatch Italy Data Portal. The thesaurus has been developed and published by LifeWatch Italy [17], by involving a wide community of scientific experts which worked together with the editors and developers. The SA is currently under revision by LifeWatch Italy to enhance FAIRness and expand its application, by exploiting all the new EcoPortal features. Furthermore, SAs stored in EcoPortal are used to implement the semantic model which forms the basis for the LifeWatch Italy Semantic Platform. LifeWatch ERIC Upper Ontology [21] is one example of an ontology that has been integrated in the LifeWatch Italy Semantic Platform. It defines the core set of LifeWatch ERIC elements (Actors, Services and Infrastructure) and describes their high-level arrangement.

3. Conclusion

Through enhancements facilitated by national and international projects, as well as the continuous support of LifeWatch ERIC, EcoPortal has evolved to offer a range of digital solutions aimed at promoting (meta)data interoperability and reuse. The recent updates further enhance its FAIRness and utility, along with that one of the SAs deposited therein, facilitating the application of FAIR Principles within the ecological research domain.

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Conflict of interest

The authors have no conflict of interest to report.

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