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Abstract

Background

Within the scope of the Helmholtz Metadata Collaboration, the ADVANCE project – Advanced metadata standards for biodiversity survey and monitoring data: supporting of research and conservation – aimed at supporting rich metadata generation with interoperable metadata standards and semantic artifacts that facilitate data access, integration and reuse across terrestrial, freshwater and marine realms.

New information

To this end, we revised, adapted and expanded existing metadata schemas, vocabularies and thesauri to build a FAIR metadata schema and a metadata entry form built on it for users to provide their metadata instances focused on biodiversity monitoring data. The schema is FAIR because it is both machine-interpretable and follows domain-relevant community standards. This report provides a general overview of the project results and instructions on how to access, re-use and complete the metadata form.

Keywords

Data management, Metadata form, FAIR, biodiversity monitoring

Introduction

In an ever-changing world, field surveys, inventories and monitoring data are essential to predict biodiversity responses to global drivers, such as land use and climate change. This understanding builds the basis to timely conservation management. However, due to funding constraints, biodiversity data are usually collected over short periods of time, hampering analyses of long-term trends and predictions of changes. To overcome this issue, biodiversity researchers rely on the integration of datasets collected by different projects, over distinct temporal and spatial scales (Henry et al. 2008, Lengyel et al. 2018). Since field biodiversity data collected across ecosystems can be highly complex and heterogeneous (Lengyel et al. 2018), the successful integration and reuse of such data depend on how they follow the FAIR guiding principles for scientific data management (i.e., Findability, Accessibility, Interoperability, Reusability; Wilkinson et al. 2016).

The FAIR principles do not impose any specific technological implementations, but provide guidance for improving findability, accessibility, interoperability and reusability of digital assets. As such, interpretations of the FAIR principles are needed to support convergence towards consistent FAIR implementations (Jacobsen et al. 2020). Domain specific communities may, therefore, either choose to reuse existing implementation solutions, to adapt or to create the needed solution, which can be reused again by other communities in the future (Jacobsen et al. 2020). Here, we adopt the FAIR interpretations of the Helmholtz Metadata Collaboration HMC (Buttigieg 2022). Nonetheless, it is important to highlight that the HMC interpretations have been built upon previous interpretations of other groups, such as GO FAIR Foundation (Jacobsen et al. 2020) and Research Data Alliance (FAIR Data Maturity Model Working Group 2020).

The ADVANCE project aimed at developing a FAIR metadata schema for biodiversity monitoring data collected within the scope of the Helmholtz Association. This schema was built upon the most comprehensive metadata catalogue for biodiversity monitoring in Europe, which compiled habitat and biodiversity monitoring schemes across Europe (EuMon: EU-wide monitoring methods and systems of surveillance for species and habitats of community interest; Henry et al. 2008, Lengyel et al. 2008). Metadata on habitat and biodiversity monitoring schemes were collected via a questionnaire containing 43 questions sent to coordinators of monitoring schemes, ministry officials and representatives of other stakeholder groups involved in monitoring in all European countries (Lengyel et al. 2008). It resulted in a metadata catalogue of 650+ monitoring schemes publicly available for more than 15 years (DaEuMon; Henle et al. 2010, Henle 2012). However, due to funding constraints and the need for a new software, this valuable database could not be maintained and, as of today, is out of service. Moreover, the FAIR principles had not been published by the time of its creation, so that the EuMon questionnaire and database are not findable, accessible, interoperable nor reusable.

As such, we revised, adapted and expanded the EuMon questionnaire to build a metadata form which is both machine-readable and follows domain-relevant community standards.

We relied on existing metadata and semantic standards, linked open vocabularies, persistent identifiers, machine-readable formats and other FAIR supporting resources to rebuild the EuMon metadata schema, resulting in the ADVANCE metadata schema and a metadata entry form. This form will replace the former EuMon questionnaire and provide the framework for making the EuMon database again publicly available. Moreover, it contains a field that allows to link the metadata to the actual dataset and can be reused by other communities and adapted to particular project needs.

Project description

Title: ADVANCE project – Advanced metadata standards for biodiversity survey and monitoring data: supporting of research and conservation

Study area description: The project is focused on biodiversity monitoring schemes in Europe

Funding: Helmholtz Initiative and Networking Fund

Web location (URIs)

Homepage: https://www.ufz.de/index.php?de=48268

Repository

Type: CEDAR

Browse URI: https://auth.metadatacenter.org/realms/CEDAR/protocol/openid-connect/auth?client_id=cedar-angular-app&redirect_uri=https%3A%2F%2Fcedar.metadatacenter.org%2F&state=a0eb8837-5cfa-465a-a6d0-7333ebf638d4&response_mode=fragment&response_type=code&scope=openid&nonce=36c44f3c-af7e-46b5-8842-c155aaa424eb

Location: https://cedar.metadatacenter.org/dashboard?folderId=https:%2F%2Frepo.metadatacenter.org%2Ffolders%2F909ec64b-8a57-401a-a98a-812d7af2494b

Usage licence

Usage licence: Creative Commons Public Domain Waiver (CC-Zero)

Implementation

Implements specification

The ADVANCE metadata templateV3

We used the CEDAR Workbench (Musen et al. 2015) to implement the ADVANCE metadata schema as a CEDAR template. CEDAR is a free, open source, online platform that centers on the use of metadata templates that define the elements needed to describe particular types of data. CEDAR templates are represented in JSON, which can achieve machine-interpretability by enriching the expressivity with semantics (JSON-LD). BioPortal, an ontology repository with more than 800 artefacts (Whetzel et al. 2011), is connected with the CEDAR environment, feeding metadata templates and instances with concepts from semantic artefacts. SKOS vocabularies uploaded in BioPortal are used to create controlled lists and autocomplete functions to minimize typos and spelling errors, while safeguarding consistency in term definitions, and to provide semantic interoperability (Musen et al. 2022).

The ADVANCE metadata templateV3 is available online under the CC BY 4.0 license, and can be accessed by creating a CEDAR account. For instructions on how to create a CEDAR account or metadata templates, readers may refer to the CEDAR User Guide. Here, we provide an overview of the features of the ADVANCE metadata schema as well as general instructions on how to complete the form.

The metadata form is human-readable, i.e., it appears as a user-friendly, online questionnaire. Its questions (fields) are grouped into sections (elements) and it includes a *read and understood* check box that provides instructions on how to fill in the form. At the same time, it is also FAIR, as it is built based on a specification that defines for each field the ontological reference in form of object properties that are referred to via persistent identifiers (Suppl. material 1). Moreover, most questions have a help text describing what type of metadata entry (response) is required. Response type can be number, text, URL, email, controlled lists or yes/no. All controlled lists are composed of terms and definitions from the thesauri used by the Integrated European Long-Term Ecosystem, critical zone and socio-ecological Research eLTER community (Suppl. material 2).

For the majority of the questions whose response types are controlled lists, users have the possibility to provide free text entries, in case the required value is not found in the drop-down. This allows new terms to be included in the controlled lists in the next versions of the template. Yet, some questions allow for multiple answers which can be added by using the plus icon.

In the CEDAR environment, the ADVANCE metadata templateV3 is located in the community folders, shared under a folder named *ADVANCE*. After completing all questions, the filled-out form turns into a metadata instance that can be saved and stored in the ADVANCE folder as well as copied to clipboard as JSON-LD (Suppl. material 3) and

RDF formats. If saved in the folder, it will be automatically named *ADVANCE metadata templateV3 metadata*. We recommend to rename it by providing a meaningful title, e.g., the title of the dataset this metadata instance describes. To do so, click the three dots located on the right side of the title and choose *Rename*. An example of a filled-out form (metadata instance) is available under the folder ADVANCE, named as *Amphibian Monitoring in German coal Mines.*

ADVANCE metadata elements and fields

The ADVANCE metadata schema has been revised by marine, freshwater and terrestrial experts from UFZ, AWI; and by biodiversity monitoring experts from the German National Monitoring Centre for Biodiversity (NMZB) and from the National Research Data Infrastructure for Biodiversity (NFDI4Biodiversity). The entry form is composed of 43 questions, divided into 10 sections as described below.

1. SECTION: Read & Understood

This section provides general instructions on how to fill out the ADVANCE metadata templateV3 form

2. SECTION: Monitoring Scheme Identification

In this section users provide information that identifies their monitoring schemes

2.1. Monitoring scheme title

The title by which the monitoring scheme is known should be provided

2.2. Monitoring program title

If the monitoring scheme is part of a larger program (a set of monitoring schemes organized within the same institution), program title should be provided

2.3. Description

A brief summary with the most important details summarizing the data (e.g.: objectives, target group, key aspects, design, methods) should be provided

2.4. Online locator

If data are published, the persistent identifier (e.g.: DOI) of the data should be provided. Otherwise, a link to the data, or to additional information about the data may be provided.

2.5. Keywords

At least three (3) keywords chosen from the drop-down list should be provided

2.5.1. Please, provide suitable keywords if not found in the drop-down list

If keywords are not found, users can type suitable keywords themselves

5

3. SECTION: Contact Information

In this section users provide contact details of organizations and people responsible for monitoring schemes

3.1. Responsible organization

The ROR (Research Organization Registry) identifier of the responsible organization should be provided. Otherwise, the link to the responsible organization website can be given. ROR is a global, community-led registry of open persistent identifiers for research organizations.

3.2. Organization type

The type of organization (e.g., government, NGO, research center) should be chosen from the drop-down list

3.2.1. Please, provide organization type if not found in the drop-down list

Users can type their answer in case it is not found in the drop-down list

3.3. Contact person full name

Users should provide the full name of the person responsible for the data

3.4. Role

The role played by the responsible organization (e.g., owner, contributor)

3.5. E-mail address

E-mail address of the contact person should be provided

3.6. ORCID ID

The ORCID ID of the contact person should be provided. The ORCID (Open Researcher and Contributor) ID is a unique, persistent digital identifier for researchers

4. SECTION: Funding

In this section users declare funding sources of monitoring schemes

4.1. Funding source

Users should provide the type of funding source (e.g., national, regional, private)

4.1.1. Please, provide funding source if not found in the drop-down list

Users can type source of funding if not found in the provided drop-down list

4.2. Funding agency

The ROR ID of the funding agency should be provided

5. SECTION: Intellectual Rights

In this section users declare data accessibility

5.1. Data availability

Users should choose from the drop-down list a statement about the data availability

5.1.1   If data availability is restricted, please describe the conditions under which data might become available

If "under certain conditions" is chosen, then a description on how to access the data should be provided

5.2   License

Creative Commons (CC) license types may be chosen from the drop-down list

5.2.1. If your data are available under other licenses rather than CC, please provide the applicable one

This field allows users to type data access licenses other than CC

6. SECTION: Monitoring Scheme Information

In this section users provide specific information related to the monitoring scheme goals and functioning

6.1. Motivation to launch monitoring scheme

Users can choose their motivation to start the monitoring scheme in the drop-down list (e.g., national law, scientific interest, impact assessment)

Please, provide your motivation if not found in the drop-down list

Users have the possibility to type their motivation other than those provided in the drop-down list

6.2. Scope of monitoring

Users can choose the context of the monitoring scheme (e.g., distribution trend, community structure, physical-chemical environment)

6.2.1. Please, provide the scope of monitoring if not found in the drop-down list

Users can provide scope of monitoring other than those available in the drop-down list

6.3. Biodiversity threats and pressures addressed

A list of biodiversity threats and pressures (e.g., climate change, invasive species, habitat loss and fragmentation) is provided which users can choose from. Definitions can be found at EnvThes

6.3.1. Please, provide threat or pressure addressed if not found in the drop-down list

Users can type other threats or pressures addressed not provided in the list.

6.4. Type of data collected

A list of data types (e.g, presence-absence, count) is provided for users to choose from. Definitions are provided at EnvThes

6.4.1. Please, provide type of data collected if not found in the drop-down list

Users can provide other types of data collected other than those found in the drop-down list

6.5.Training / expert knowledge required to take part in data collection

This is a yes / no question whether training or expert knowledge is required to participate in data collection

6.6.Number of professionals involved

Number of people who have a professional, job-related interest in the monitoring and who get their main salary from monitoring and related activities; professionals will generally have special training or monitoring expertise in their professional capacity

6.7. Number of volunteers involved

Number of people who participate in monitoring in their spare time, not having monitoring as their main income, but who may receive some economic compensation for participating; volunteers may have considerable expertise in monitoring-related fields but generally not related to their profession. In case of uncertainty, please provide an estimated mean number of volunteers involved

6.8. Staff costs

Users provide estimated staff costs (salaries) per year to run monitoring activities. Euro should be used as currency

6.9.Monitoring activities costs

Users provide estimated costs per year to run monitoring activities, except of salaries (e.g., travel, fieldwork, lab work, office work, etc.). Euro should be used as currency

7. SECTION: Temporal Coverage

In this section users provide starting and ending year of data collection

7.1. Start year

The year in which monitoring activities started should be provided

7.2. End year

The year in which monitoring activities finished should be provided. Should be filled only if monitoring activities have already finished or if ending year is planned

8. SECTION: Spatial Coverage

In this section users inform about the spatial coverage of monitoring schemes

8.1. Geographical level

The geographical level to which the monitoring results or conclusions can be applied (e.g., local, national)

8.2. Country

Countries where monitoring activities take place should be provided

8.3. Total area

Area (in km^2) to which results can be extrapolated (e.g., inhabited area of a population, park area for monitoring restricted to a park, country area for national monitoring)

8.4. Altitudinal range

Range of elevation (minimum and maximum values) above sea level of the study site should be provided in meters

8.4.1. Altitude (Min. value)

Minimum altitude in meters

8.4.2. Altitude (Max. value)

Maximum altitude in meters

8.5. Sampling sites located in protected areas

Users can state whether sampling sites are totally, partially or not located in protected areas

8.6. Biogeographical region

Biogeographical and marine regions of Europe can be chosen in the drop-down list. Users can use the Natura 2000 Network Viewer (under "Layers", select "Biogeographical regions") to view the European terrestrial biogeographic regions, and assign the corresponding region to their study areas

8.7. Habitat type

Habitat classifications from different sources are provided in three drop-down lists: the CORINE biotopes, the EUNIS habitat classification and the Habitats Directive Annex I. Users can choose their preferred classification schema

8.7.1. CORINE habitat classification

Users select from this list if they prefer CORINE biotopes for habitat classification

8.7.2. EUNIS habitat classification

Users select from this list if they prefer EUNIS biotopes for habitat classification

8.7.3. Habitats Directive classification

Users select from this list if they prefer Habitat Directive Annex I for habitat classification

8.7.4. Please, provide habitat type and classification scheme if not found in the drop-down lists

Users can use this field to type other preferred habitat classifications (e.g., national classifications)

9. SECTION: Taxonomic Coverage

In this section, users inform about taxonomic coverage of monitoring schemes

9.1. Organism group

Drop-down lists of the most common monitored organisms in Europe are provided below

9.1.1. Birds

9.1.1.1. Please, provide group of birds if not found in the drop-down list

9.1.2. Mammals

9.1.2.1. Please, provide group of mammals if not found in the drop-down list

9.1.3. Other vertebrates

9.1.4. Invertebrates

9.1.4.1. Please, provide group of invertebrates if not found in the drop-down list

9.1.5. Plants

9.1.5.1. Please, provide group of plants if not found in the drop-down list

9.1.6. Other organisms

9.1.7. Please, provide group of organisms if not found in the drop-down list

Users can still type other monitored organisms not available in the provided drop-down lists

9.2. Species of community interest

Species of community interest are listed in appendices of European Directives or under any legal text in Europe (e.g., CITES, CMS). If species of community interest are monitored, users should provide species' scientific names and respective URLs

9.2.1. Species' scientific name

If species of community interest are monitored, users should copy and paste species' scientific names from the GBIF database (e.g., *Lacerta viridis*)

9.2.2. Species URL

If species of community interest are monitored, users should copy and paste species URLs from the GBIF database (e.g., https://www.gbif.org/species/6159273)

10. SECTION: Methods & Sampling Information

In this last section users provide relevant information about the methods used for collecting data

10.1. Experimental design

A list of possible experimental designs (e.g., control treatments, before-after comparison) is provided which users can choose from

10.2. Site selection

Users state how sampling sites have been selected. A drop-down list is provided (e.g., random sampling, convenience)

10.2.1. Please, describe how sites are selected if not found in the drop-down list

Users can still type how sampling sites have been selected

10.3. Number of sampling sites

Users inform the number of sampling sites

10.4. Sampling duration

Users inform about time spent per sampling site during a single visit. Time unit should be added by users (e.g., hours, days)

10.5. Frequency of monitoring

Users inform about the number of visits to a sampling site within a particular period (e.g.: once a month, twice a year)

10.6. Changes in monitoring procedure during monitoring scheme lifetime

This is a yes / no question whether changes in monitoring procedures have taken place during the monitoring scheme's lifetime

10.6.1. If yes, please describe changes

Users describe changes in monitoring procedure

10.7. Field methods

In this last field, users describe methods used to collect data

Conclusion

The ADVANCE project provided a metadata schema for the Biodiversity Monitoring community to allow comprehensive descriptions of biodiversity monitoring schemes across marine, terrestrial and freshwater realms. The schema is implemented as a CEDAR template to provide a human-readable form that can be filled out as is, and also re-used to comply with other projects' needs. Moreover, this metadata schema is machine-interoperable, making use of persistent identifiers, structured vocabularies and ontologies to FAIRify metadata about biodiversity monitoring schemes. Being represented in JSON-LD, the generated metadata instances can be exposed as FAIR data on a Web portal to finally allow semantic faceted search across all monitoring schemas based on their described attributes. This paper provides a detailed specification of the schema, listing all metadata fields with the URIs of the object properties used in the appendix.

Audience

Biodiversity monitoring community

Acknowledgements

Author contributions

AGS and KW wrote and received funding proposal. All authors conceived the study. JM and BM built the entry form. JM wrote the initial manuscript, with all authors subsequently contributing to editing the manuscript.

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Nanopublications

Nanopublication	Creator	Date

Supplementary materials

Suppl. material 1: Appendix 1: All fields of the ADVANCE metadata templateV3 refer to properties from ontologies having a Globally Unique, Persistent, Resolvable Identifier (GUPRI).

Authors: Menger et al
Data type: URI
Download file (38.97 kb)

Suppl. material 2: Appendix 2: All controlled lists of the ADVANCE metadata templateV3 are composed by terms of the thesauri used by the Integrated European Long-Term Ecosystem, critical zone and socio-ecological Research eLTER community

Authors: Menger et al
Data type: URI
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Suppl. material 3: Appendix 3: A JSON Schema of the ADVANCE metadata templateV3

Authors: Menger et al
Data type: JSON-LD code
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