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Rome, February 18th-19th, 2025



Making Digital Objects FAIR and Interoperable Across **Environmental Research Infrastructures:** Insights from the ITINERIS Project

Alexandra Nicoleta Muresan, Cristina Di Muri, Gianmarco Ingrosso, Enrica Nestola, Davide Raho, Gregorio Sgrigna, Andrea Tarallo, Ilaria Rosati

CNR IRET Lecce



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ITalian INtegrated Environmental Research Infrastructures System (ITINERIS)

7 partners

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22 Research Infrastructure

8 Working Packages (89 activities)

39 Operating Units





AIM: provide the Italian Hub of Research Infrastructures in the environmental scientific domain (Atmosphere, Marine, Terrestrial Biosphere and Geosphere Landsurface) and connect it to the user community by providing access to the vast array of physical, remote and virtual services to produce new knowledge.





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Innovation

- ✓ Supports interdisciplinary research and data reuse
- ✓ Facilitates access to environmental data and infrastructures
- ✓ Strengthens Italy's role in environmental research
- ✓ Connects 22 national & European research infrastructures
- ✓ Provides valuable insights for scientific & societal challenges
- ✓ Aligned with the European Open Science Cloud (EOSC)
- ✓ Follows FAIR principles









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Work Package 2: Access to facilities, FAIR data and related services

Task 2.3 - Support the implementation and adoption of FAIR-enabling best practices

Task 2.4 - Interdisciplinary data interoperability

Help to integrate FAIR principles by:

- developing a FAIR-compliant Data Management Plan
- supporting the implementation of FAIR practices
- promoting semantic interoperability





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Principles for scientific data management and stewardship intended to provide guidelines to improve the Findability, Accessibility, Interoperability, and Reusability of digital objects.

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Findable Accessible Interoperable Reusable Source: https://www.nlm.nih.gov/oet/ed/cde/tutorial/02-200.html

A Digital Object (DO) is a machine-independent data structure consisting of one or more elements in digital form that can be parsed by different information systems; the structure helps to enable interoperability among diverse information systems. A digital object is composed of a structured sequence of bits/bytes.

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- 🕆 Metadata
- 🛱 Data

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🕆 Software

Etc.

Protocols

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Main challenges in ITINERIS project

- Heterogeneity: variety of digital objects and standards adopted
- Interoperability & Reusability: achieving consensus on shared standards and solutions is particularly challenging
- Redundancy: need to align with existing standards rather than creating new ones
- Dispersion & Fragmentation: diverse community-specific technologies leads to fragmentation, hindering collaboration and data reuse
- Schema Alignment: efforts required to map and align information across different standards within the same domain
- Metadata Longevity Plans: inconsistent implementation of sustainable plans for metadata management and preservation





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Benefits of FAIR implementation

- Increased visibility and impact of research
- Facilitated data reuse and integration
- Optimised data management
- Collaboration and networking
- Increased trust in science
- Support automation
- Accelerated research and innovation
- Improved quality of research products and analysis



No

FAIR

ONE WAY



FAIR



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FAIR principles adoption in Italian Environmental Research Infrastructures: an overview from the ITINERIS Project (Nestola et al., in preparation)

Analyse the adoption of FAIR principles

Methodology:

- \bigcirc Online survey
- \circ Individual interviews
- $\ensuremath{^{\rm Q}}$ Analysis of available resources

This analysis serves as a **foundation for monitoring future progress in the adoption of FAIR practices by RIs** in the environmental domain and provides **crucial insights for the near-future development of the national Hub** of Italian environmental RIs.





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Findable Persistent Identifiers (PIDs)









Interoperable

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Vocabularies







Atmosphere Marine Biosphere Geosphere Multidomain







A FIP is a formal list of FAIR implementation choices declared by a specific community to fulfil one or more FAIR subprinciples.

- FIPs help track the choices made by Research Infrastructures (RIs) to implement their FAIR strategy
- The convergence of these choices can be assessed using matrices to evaluate how ITINERIS Hub and other RIs are making aligned decisions.





artefacts

& Ilaria Rosati^{1,3}

Semantic Interoperability

scientific data

OPEN





Coverage in topics with text mining on semantic artefacts' titles

Search



Search semantic artefacts available online and in 17 catalogues



Assessing semantic interoperability

Cristina Di Murio^{1,6}, Martina Pulieri^{2,3,6}, Davide Raho¹, Alexandra N. Muresan¹, Andrea Tarallo¹, Jessica Titocci¹, Enrica Nestola¹, Alberto Basset^{1,2,4}, Sabrina Mazzoni^{2,5}

ARTICLE in environmental sciences: variety

of approaches and semantic

Check for updates

F1: identifiers F4: inclusion in catalogues A1: status I1: formality level, language, format **R1: description** R1.1: licence R1.2: version

Management of semantic artefacts available on multiple catalogues with versioning analysis

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Interoperability layers

Technical Interoperability: ability of different information technology systems and software applications to communicate and exchange data and other digital objects (e.g. software, services, workflows, protocols, hardware designs, etc.).

Semantic Interoperability: the ability of computer systems to transmit data with unambiguous, shared meaning. Semantic interoperability is a requirement to enable machine computable logic, inferencing, knowledge discovery, and data federation between information systems.

Organisational Interoperability: the way in which organisations align their business processes, responsibilities and expectations to achieve commonly agreed and mutually beneficial goals.

Legal Interoperability: the ability to combine data and digital objects from multiple sources without conflict between the restrictions imposed by the various licences.



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Check for updates

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scientific data

OPEN Assessing semantic interoperability ARTICLE in environmental sciences: variety of approaches and semantic artefacts

Cristina Di Muri@^{1,6}, Martina Pulieri@^{2,3,6}, Davide Raho¹, Alexandra N. Muresan@¹, Andrea Tarallo¹, Jessica Titocci⁰, Enrica Nestola⁰, Alberto Basset^{1,2,4}, Sabrina Mazzoni^{2,5} & Ilaria Rosati^{1,3} From this analysis, the FAIR semantic artefacts and catalogues were selected for integration into the **Terminology Service**.

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Distribution of the 540 semantic artefacts among ITINERIS domains



Evaluation of key metrics

FAIR sub-principles	Findings
F1: identifiers	18.5% with DOIs
F4: catalogues	5.5% not available in SA catalogues
A1: status	64.6% without status info
<pre>I1: language and format</pre>	8% without standard language and format
R1: description	8.9% without description
R1.1: licence	25% missing licence
R1.2: version	22% missing version info



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For FAIR implementation practices within ITINERIS:

- Publish the Data Management Plan (DMP)
- Support RIs to publish their FIPs
- Re-do the convergence analyses with updated FIPs

To enhance the interoperability within ITINERIS:

- FAIRification of existing semantic artefacts (used and/or managed by ITINERIS RIs) and publication into EcoPortal
- Creation of the ITINERIS vocabulary
- Design and development of a terminology service for data and metadata semantic annotation



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