Preface

The publication of *The FAIR Guiding Principles for Scientific Data Management and Stewardship* addressed a persistent challenge within the research data management community. Although the importance of responsible research data management was widely recognized among data professionals, its objectives and benefits often remained difficult to communicate to researchers, decision-makers, and other stakeholders outside dedicated RDM teams. In particular, data managers frequently encountered uncertainty regarding the value of data documentation, the manner in which such documentation should be structured, and the benefits that systematic data stewardship could provide.

The FAIR Guiding Principles offered a concise and broadly applicable framework through which these objectives could be articulated. By defining four high-level properties—Findability, Accessibility, Interoperability, and Reusability—the principles provided a common vocabulary for describing the intended outcomes of research data management. These overarching objectives were complemented by a set of more specific sub-principles—F1–F4, A1–A2, I1–I3, and R1–R1.3—which describe characteristics and practices intended to support their realization.

The FAIR framework was readily adopted by the RDM community and increasingly informed the development of data infrastructures, services, and research data ecosystems. In many cases, these systems were designed or adapted to satisfy the more detailed FAIR sub-principles. However, the principles were deliberately formulated at a high level and therefore present several limitations for their practical implementation:

1. **FAIR is not a technical standard.** It defines desired properties of digital research objects but does not prescribe a specific technical architecture or implementation.

2. **FAIR provides limited implementation guidance.** The principles do not determine which formats, metadata schemas, software systems, protocols, or technologies should be used.

3. **FAIR depends on community standards.** Effective implementation requires research communities to agree upon relevant standards and to apply them consistently.

4. **FAIRness is incremental.** Digital objects may satisfy individual principles to different degrees and may therefore exhibit varying levels of FAIRness.

5. **Machine actionability remains limited.** The complete and autonomous interpretation and processing of digital objects by machines may rarely be achievable.

6. **Rich metadata alone do not ensure interoperability.** Interoperability additionally requires shared representation languages, controlled vocabularies, semantic alignment, and explicitly defined relationships between digital objects.

7. **FAIR does not imply unrestricted openness.** Data subject to access restrictions may nevertheless be FAIR, provided that their metadata, access conditions, and access procedures are clearly described.

8. **FAIR is not a comprehensive governance framework.** It focuses primarily on the properties of digital research objects and does not encompass all responsibilities of data producers, repositories, research infrastructures, and institutions.

The central implementation challenge may therefore be summarized as follows: the FAIR Guiding Principles define the properties that well-managed digital research objects should exhibit, but they do not themselves provide the shared standards, technical specifications, or coordinated governance required to realize those properties. Their practical effectiveness consequently depends on research communities agreeing upon and consistently applying persistent identifiers, metadata schemas, semantic vocabularies, access protocols, provenance models, licences, and other domain-relevant standards.

The present wiki seeks to address this implementation gap by supporting the coordinated application of FAIR practices across the Helmholtz Association. It provides guidance on the selection and consistent use of relevant standards, technologies, and community practices, with the aim of enabling research data products to attain the highest practicable level of FAIRness.

Introduction

The Character of This Wiki

Welcome to the wiki of Helmholtz Metadata Collaboration (HMC) Hub Earth and Environment! This platform is a permanent work in progress and represents our perspectives as the HMC Hub Earth and Environment and our community. More formal results are derived from here and published on the HMC website, our Hubs website, or in other resources.

The Helmholtz Metadata Collaboration

The HMC promotes the qualitative enrichment of research data by means of metadata – and implements this approach across the whole organization.

HMC develops and implements concepts and technologies for a sustainable handling of research data through high-quality metadata. Its main goal is to make the depth and breadth of research data produced by Helmholtz Centers findable, accessible, interoperable and reusable (FAIR Principles[1)]) for the whole science community. The intention to ensure FAIR data across Helmholtz is also contained in the “Recommendations for Policies of the Helmholtz Centers on Research Data Management”[2)].

Many people and stakeholder groups produce data relevant for research data, information and knowledge systems. In order to create a harmonized interoperable and ultimately **FAIR data space**, practices and processes need to be aligned across our data systems and implemented by these people and stakeholders.

The Content of This Wiki

In this Wiki, the HMC Hub Earth and Environment and its partners will **formulate recommendations** for such aligned practices for the community. We are making concrete suggestions for the implementation and support with practical suggestions for such procedures.

To achieve FAIR data across the various Helmholtz Earth and Environment data infrastructures (DIS), we have developed the **Road-to-FAIR-Strategy**. This strategy describes a number of coordinated efforts. As a first step, the existing DIS and their interfaces are examined to identify best practices that can serve as models. Based on this, different committees work together to develop concrete implementation steps for specific goals. For each agreed-upon building block, concrete recommendations are formulated and documented. These recommendations are developed and presented in this Wiki as a living handbook and will evolve over time as work progresses.

The resulting recommendations are consistently documented using the same guiding questions and a harmonized structure. Two perspectives must therefore be considered: on the one hand, the discussion and agreement on content; on the other, the administrative and technical implementation. Each individual step required for implementation must be examined. The perspectives and roles of the various stakeholders are taken into account to ensure that all influencing factors are considered in detail. In addition, the decision-making processes that lead to established procedures are outlined—both from the bottom up and from the top down.

This provides a foundation for optimizing the procedures concerning the individuals involved, their responsibilities, and the necessary actions. In order for the FAIR approach to be successful, it is essential that identified stakeholders take on specific responsibilities.

Contributions

The contributors to this wiki are

- HMC Hub Earth and Environment
- Working group Arbeitskreis Metadaten
- Working group Arbeitskreis Semantik

Both working groups are formed by the HMC Hub Earth and Environment and the DataHub Earth and Environment.

For questions, comments and suggestions, please write to hmc-hub_ee@geomar.de.

1)
Wilkinson, M. D. et al. The FAIR Guiding Principles for scientific data management and stewardship. Sci. Data 3:160018 doi: 10.1038/sdata.2016.18 (2016).
2)
Empfehlungen für Richtlinien der Helmholtz-Zentren zum Umgang mit Forschungsdaten, 2019, Helmholtz Open Science, https://os.helmholtz.de/open-research-data/forschungsdaten-policies/ doi: doi.org/10.2312/os.helmholtz.002

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