







NFDI4Earth

Milestone MS3.2.2

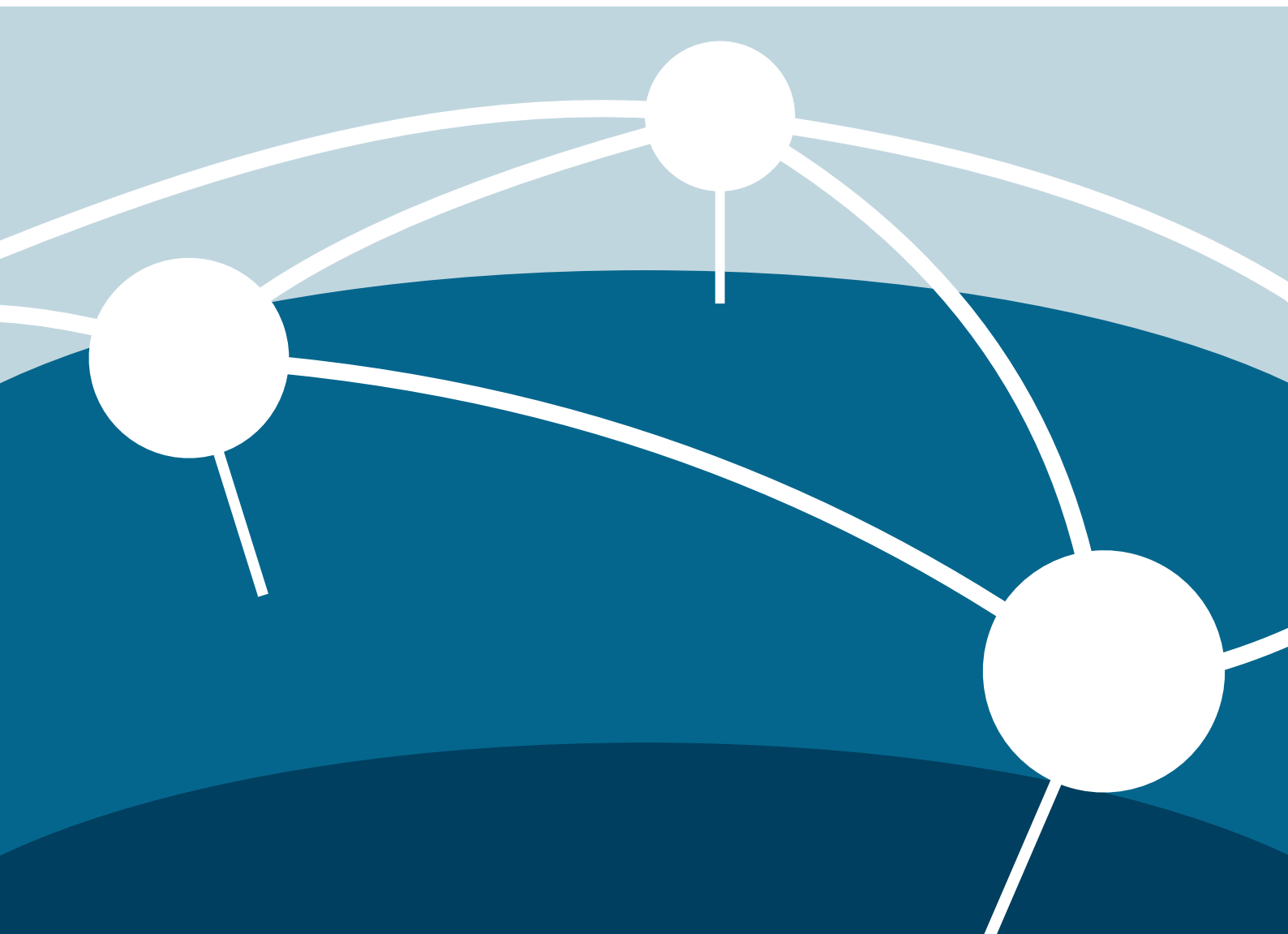
NFDI4Earth Label Status Report

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2025-10

DOI: [10.5281/zenodo.17856067](https://doi.org/10.5281/zenodo.17856067)

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Citation

Robert Brylka, Jonas Grieb, Ronny Gey, Claudia Müller, Stephan Frickenhaus, Claus Weiland. 2025. *NFDI4Earth Label Status Report (NFDI4Earth Milestone MS3.2.2) (NFDI4Earth Deliverable MS3.2.2)*. NFDI4Earth Community on Zenodo. <https://doi.org/10.5281/zenodo.17856067>

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Acknowledgement

This work has been funded by the German Research Foundation (DFG) through the project NFDI4Earth (DFG project no. 460036893, <https://www.nfdi4earth.de/>) within the German National Research Data Infrastructure (NFDI, <https://www.nfdi.de/>).

Executive summary

The NFDI4Earth Label is being developed as a tool to support the harmonization of data infrastructures in the Earth System Sciences (ESS) towards a FAIR ecosystem of services within NFDI4Earth. The Label primarily focuses on assessing the technical interoperability and trustworthiness of repositories. This milestone builds on the [first Status Report on the NFDI4Earth Label](#), which introduced the overall concept, motivation, and theoretical background. The present document focuses on the current release version, summarizing the practical implementation and community feedback, and outlining the next steps for further development.

Contributions

Based on CRediT Contributor Roles, see <https://credit.niso.org/>.

RB: Writing – original draft, Software

JG: Writing – review & editing, Software

RG: Writing – review & editing

CM: Writing – review & editing

SF: Writing – review & editing

CW: Writing – review & editing

Abbreviations

API – Application Programming Interface

CTS – CoreTrustSeal

DCAT – Data Catalog Vocabulary

DIF – Directory Interchange Format

DOI – Digital Object Identifier

ESS – Earth System Sciences

FAIR – Findable, Accessible, Interoperable, Reusable

FTP – File Transfer Protocol

F-UJI – FAIRsFAIR F-UJI Automated FAIR Data Assessment Tool

Handle – Handle System (Persistent Identifier System)

ISO 19115 – International Standard for Geographic Information Metadata

JSON – JavaScript Object Notation

NetCDF – Network Common Data Form

OAI-PMH – Open Archives Initiative Protocol for Metadata Harvesting

OGC CSW – Open Geospatial Consortium Catalogue Service for the Web

OPeNDAP – Open-source Project for a Network Data Access Protocol

ORCID – Open Researcher and Contributor ID

PID – Persistent Identifier

REST – Representational State Transfer

SOAP – Simple Object Access Protocol

SPARQL – SPARQL Protocol and RDF Query Language

SWORD – Simple Web-service Offering Repository Deposit

URL – Uniform Resource Locator

URN – Uniform Resource Name

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1. Executive Summary

The NFDI4Earth Label is being developed as a tool to support the harmonization of data infrastructures in the Earth System Sciences (ESS) towards a FAIR ecosystem of services within NFDI4Earth. The Label primarily focuses on assessing the technical interoperability and trustworthiness of repositories.

Interoperability is evaluated through a workflow that relies on information retrievable from the re3data¹ registry of data repositories, while the trustworthiness of repositories is assessed using a questionnaire-based self-assessment. In addition, an optional automated FAIRness assessment using the F-UJI² tool extends the concept by evaluating interoperability at the dataset level. All assessments are based on a set of metrics that were defined through an iterative process within the ESS community.

This milestone builds on the first Status Report on the NFDI4Earth Label (Grieb et al., 2023), which introduced the overall concept, motivation, and theoretical background of the Label. The present document focuses on the current release version, summarizing the practical implementation and community feedback, and outlining the next steps for further development, including the implementation, testing, and refinement of the current workflow.

2. Introduction

Harmonizing research data infrastructures within the Earth System Sciences (ESS) is one of the key goals of NFDI4Earth, the German National Research Data Infrastructure for the ESS (Bernard et al., 2021). To support this process, the NFDI4Earth Label is being developed as a framework for assessing the FAIRness of participating research data infrastructures, referring to the principles of Findability, Accessibility, Interoperability, and Reusability (Wilkinson et al., 2016). The Label primarily focuses on the technical interoperability and organizational trustworthiness of repositories and introduces a structured yet lightweight evaluation process that complements existing certification schemes (Grieb et al., 2023).

The conceptual foundation of the Label builds upon prior work on FAIRness assessment tools such as F-UJI, FAIRassist³, and FAIR-Checker⁴, which translate the abstract FAIR principles into measurable indicators for individual datasets. In contrast, the NFDI4Earth Label moves beyond

¹ re3data.org - Registry of Research Data Repositories. <https://doi.org/10.17616/R3D> last accessed: 2023-12-19

² Devaraju, Anusuriya and Huber, Robert (2021) "An automated solution for measuring the progress toward FAIR research data" *Patterns* 2(11). <https://doi.org/10.1016/j.patter.2021.100370>

³ <https://fairassist.org/>

⁴ <https://fair-checker.france-bioinformatique.fr/>

the dataset level, focusing on repositories as active components within a larger network of interoperable services. Similar approaches have recently been proposed (d'Aquin et al., 2023), emphasizing the importance of governance, trust, and community engagement in repository evaluation. These ideas are reflected in the Label's design through its self-assessment component, which complements the automated technical checks.

The NFDI4Earth Label serves dual purposes: it offers researchers and data users a clear indicator for identifying interoperable and trustworthy repositories, while simultaneously providing repository operators with structured feedback and practical recommendations to strengthen interoperability and sustainability. In this way, the Label serves as both a quality mark and a mechanism for continuous improvement, contributing to the broader harmonization of ESS data infrastructures towards a coherent NFDI4Earth data ecosystem.

The current stage of development represents the first operational release of the Label framework. It has been implemented and tested within the NFDI4Earth infrastructure, where initial evaluations demonstrated its technical feasibility and usability. Designed as an iterative, community-driven process, the Label continuously evolves based on feedback from pilot assessments and workshops, which are systematically analysed and integrated to refine the framework, broaden its applicability, and align it more closely with community needs. In this way, the NFDI4Earth Label develops dynamically as both a practical tool and a collaborative effort toward a harmonized, FAIR-oriented ESS data ecosystem.

3. Current Release State and Application Workflow

The current release of the NFDI4Earth Label represents the first operational version of the assessment framework. It defines the components, data sources, and evaluation logic required to determine the interoperability and trustworthiness of repositories within the ESS. The implementation reflects the results of previous development phases (Grieb et al., 2023) and community feedback, serving as the basis for testing and further refinement.

3.1. Assessment Framework

The assessment procedure is implemented as part of the established OneStop4All⁵ service within NFDI4Earth. User authentication is handled through the NFDI Authentication and Authorization Infrastructure, provided by the IAM4NFDI⁶ project, and ORCID⁷, ensuring secure,

⁵ <https://onestop4all.nfdi4earth.de/>

⁶ <https://iam.services.base4nfdi.de/>

⁷ <https://orcid.org/>

standards-based, and reliable identification of repository representatives. As a prerequisite, each participating repository must be registered in the re3data registry of data repositories and classified as relevant to NFDI4Earth.

The workflow integrates three assessment components, each addressing a distinct aspect of FAIR-aligned repository quality:

1. re3data-based automated assessment (mandatory)

This component retrieves and analyses metadata directly from the repository's re3data record. The extracted information is evaluated against a set of predefined criteria, with particular focus on metadata standards, API availability, and the use of persistent identifiers (for a complete list of metrics, see Appendix, [Table 1](#)).

2. Self-assessment (mandatory)

This component captures additional information not available through re3data, such as governance, sustainability, and institutional trustworthiness. The data are collected via a structured online form and contribute to the qualitative dimension of the overall evaluation (for a complete list of metrics, see Appendix, [Table 2](#)).

3. F-UJI-based automated assessment (optional)

To estimate the FAIRness of data holdings at the dataset level, a subset of records is analysed using the F-UJI tool. The resulting metrics provide insight into metadata completeness and standard compliance (for a complete list of metrics, see Appendix, [Table 3](#)).

The information obtained from the re3data record and the self-assessment form serves as input for the Label evaluation, which is conducted according to a defined set of metrics. The assessment result consists of individual numeric scores for each component. Where criteria are not fulfilled, detailed recommendations are generated to guide improvements in subsequent iterations.

At the current stage, the F-UJI-based assessment remains optional, as it depends on the availability of an OAI-PMH⁸ endpoint, which is not yet consistently implemented across all repositories.

3.2. Label Award and Public Representation

The Label assessment follows an iterative process, allowing repositories to refine their entries and resubmit updated information as needed. Once all assessment components accurately

⁸ <https://www.openarchives.org/pmh/>



Figure 1: NFDI4Earth Label Badge

represent the repository's capabilities and the required thresholds are met, the NFDI4Earth Label is awarded.

The awarded Label is visualized as a digital badge confirming the successful assessment. The badge, along with repository information, is publicly displayed in the *Explore awarded repositories*⁹ section of the OneStop4All portal.

Repositories are encouraged to include the Label badge on their own webpages. For this purpose, an HTML code snippet is provided for direct integration into the repository's website. Along with the HTML code for the badge icon, a verification link is provided that directs users to the official list of awarded repositories on the OneStop4All portal, serving as a verification mechanism for the displayed badge.

3.3. Alignment with the CoreTrustSeal

Repositories already certified with the CoreTrustSeal¹⁰ (CTS) are considered to comply with all criteria covered by the self-assessment component of the NFDI4Earth Label. Consequently, representatives of CTS-certified repositories are exempt from completing the self-assessment form.

This alignment reflects the shared objectives and overlapping standards between CTS and the NFDI4Earth Label framework, while reducing redundant effort for certified repositories.

4. Report on the second workshop on September 23, 2025

On September 23, 2025, the NFDI4Earth Label team, in collaboration with the NFDI4Earth FAIRness and Openness Commitment initiative, hosted the workshop *Label and Commitment – Joint efforts towards FAIR and Open services and practices* together as part of ongoing efforts to promote FAIR and Open services. The workshop aimed to present the current state of development of the NFDI4Earth Label, discussed first ideas regarding its concept and implementation, and collected feedback from the community.

⁹ <https://onestop4all.nfdi4earth.de/label/explore/>

¹⁰ <https://www.coretrustseal.org/>

The NFDI4Earth Label team presented the progress achieved so far on behalf of the Label initiative. This included a live demonstration of the assessment procedure, showcasing how repositories can perform and interpret the assessment within the current evaluation framework.

The 90-minute session also featured an experience report from a repository representative who had already completed the assessment. The presentation provided valuable insights into the usability, clarity of the criteria, and practical challenges encountered during the process.

In the ensuing discussion, various concerns, suggestions, and ideas were voiced. The main topics were:

- **Meaning of the Label**

The discussion was initiated by the question of whether requiring a publicly accessible API as a mandatory condition for the Label is reasonable. A few participants expressed concerns, noting that government-run repositories are subject to legal restrictions that currently prevent them from offering public APIs.

It became clear that these concerns were based on a misunderstanding of the Label's intent. The Label is intended to confirm fundamental FAIR practices rather than determine inclusion or exclusion from the NFDI4Earth community. The requirement for a standard API reflects the FAIR principle A1, which states that data should be accessible through a standardized communication protocol.

In a constructive exchange, the idea emerged to voluntarily disclose unmet criteria, showing that a repository can still demonstrate strong FAIR practices even if certain features, such as a public API, are missing due to legal or institutional constraints.

- **Peer Review for the self-assessment**

A suggestion was made to introduce a peer review mechanism for the self-assessment part of the label process. The idea is that repositories already awarded the Label could be invited to review new applicants once.

Such an approach could enhance trust and transparency within the process, encouraging active community participation. By involving experienced repository representatives, the review could promote a common understanding of the criteria and provide constructive feedback to applicants.

At the same time, the additional effort required might discourage participation, as the process would become more time-consuming.

- **Handling of Evaluation Information**

The question was raised whether greater transparency would be beneficial. Although the overall procedure has been communicated, the detailed results are not currently available to the public. Publishing all partial evaluation results could further strengthen openness and trust in the label process.

It was discussed whether repository representatives could be encouraged to voluntarily publish their results. Although the information is not sensitive, some may be reluctant to disclose incomplete assessments. It was therefore suggested to develop a balanced and transparent way of presenting results that highlights strengths and clearly indicates where criteria are only partially met.

- **Visual Design of the Label**

Another point raised during the discussion concerned the visual appearance of the Label. One participant suggested that the current design might be too generic and could therefore resemble common "GitHub-style" badges, making it less distinctive. However, several voices from the audience supported the simplicity of the current design, emphasizing its clarity and neutrality.

It was proposed to consider multiple design variants of the Label, allowing the appropriate version to be chosen depending on the context of presentation or placement. The more elaborate variant should include the NFDI4Earth logo to connect the Label to the initiative visually.

- **Support for non restful APIs**

During the discussion on the requirement for a publicly accessible API, SPARQL endpoints and FAIR Signposting were mentioned as alternative interfaces. SPARQL endpoints provide standardized, machine-actionable access to structured, linked data and are recognized as equivalent within the Label assessment. An update to the documentation is planned to make this explicitly clear. FAIR Signposting, however, does not constitute an API or a direct alternative to a search and harvesting endpoint. It offers a lightweight mechanism for exposing machine-readable links between data, metadata, and identifiers and will be considered in future developments as a complementary method to enhance metadata accessibility and discoverability.

These ideas will serve as the basis for further discussion in upcoming internal Label meetings, where a decision will be made on whether and how to implement them.

5. Outlook

The presented report reflects the current state of implementation of the NFDI4Earth Label, as consolidated by the discussions with the community and ongoing work within the Label team. Since the release of the current version, several repositories have successfully completed the evaluation process and obtained the Label. The experiences gathered from these first implementations have provided valuable feedback on the usability and clarity of the assessment workflow. This feedback is continuously analysed and integrated into the ongoing refinement of the framework to ensure that the NFDI4Earth Label remains both technically robust and user-oriented.

Community feedback, particularly from the workshop on September 23, 2025, has been instrumental in identifying strengths and areas for improvement. The collected input is being analysed and will guide the next iteration of the framework, ensuring that the Label continues to evolve in close alignment with the needs of repository providers.

Therefore, future work will focus on enhancing the automation of the evaluation steps, improving user guidance, and exploring new ways to present assessment results more transparently, thereby strengthening both the usability and the overall trust in the NFDI4Earth Label process.

References

- Bernard, L., Braesicke, P., Bertelmann, R., Frickenhaus, S., Götde, H., Keßler, C., Lorenz, S., Mahecha, M., Marschall, H., Hezel, D., Nagel, W. E., Reichstein, M., Sester, M., Thiemann, H., Weiland, C., Wytzisk-Arens, A., & NFDI Consortium Earth System Sciences. (2021). NFDI Consortium Earth System Sciences - Proposal 2020 revised (Revision 1 from 2021-10-01). Zenodo. <https://doi.org/10.5281/zenodo.5718944>
- d'Aquin, M., Kirstein, F., Oliveira, D., et al. (2023). FAIREST: A framework for assessing research repositories. *Data Intelligence*, 5(1), 202–241. https://doi.org/10.1162/dint_a_00159
- Gaignard, A., Rosnet, T., De Lamotte, F., Lefort, V., & Devignes, M.-D. (2023). FAIR-Checker: Supporting digital resource findability and reuse with Knowledge Graphs and Semantic Web standards. *Journal of Biomedical Semantics*, 14(1), 7. <https://doi.org/10.1186/s13326-023-00289-5>
- Grieb, J., Weiland, C., Gey, R., Stocker, M., Degbelo, A., Henzen, C., & Thießen, F. (2023). First draft of resource information types (protocols, vocabularies, metadata schemes) in use in NFDI4Earth (NFDI4Earth Deliverable D3.2.1) (1.0). Zenodo. <https://doi.org/10.5281/zenodo.8344901>

Grieb, J., Schäfer, T., Frickenhaus, S., Gey, R., & Weiland, C. (2024). NFDI4Earth Label Status Report (NFDI4Earth Milestone MS3.2.1). NFDI4Earth Community on Zenodo. <https://doi.org/10.5281/zenodo.13711420>

Wilkinson, Mark D., et al. (2016). The FAIR Guiding Principles for scientific data management and stewardship. Scientific Data, 3.1 (2016): 1-9. <https://doi.org/10.1038/sdata.2016.18>

A. NFDI4Earth Label Metrics

The following tables list the evaluation criteria across the three assessment components. (Release date: July 17, 2025.)

A.1. Table 1: re3data Assessment

The re3data component is based on metadata automatically retrieved via the [re3data API](#) using the repository's unique identifier. Each criterion is evaluated based on the presence of specific metadata elements. A criterion is considered fulfilled if at least one of the accepted standards listed in the table is present in the re3data record.

N4E metric	Guideline	Considered Standards	Related FAIR principle
n4e:assignsUniqueIds	Supports ID system with unique IDs	URL , URN , DOI , Handle	F1
n4e:assignsPersistentIds	Supports ID system with persistent IDs	DOI , Handle	F1
n4e:providesAnyAPI	Provides an API to access metadata	FTP , NetCDF , OAI-PMH , OGC CSW , OPeNDAP , REST , SOAP , SPARQL , SWORD	A1
n4e:providesHarvestAPI	Provided API supports harvesting	NetCDF , OAI-PMH , OGC CSW	A1
n4e:supportsCrossDomainStandard	Supports at least one of (by us considered) cross-domain metadata standards	Dublin Core , schema.org , DataCite , DCAT	F4
n4e:supportsSpecificESSStandard	Supports an ESS-specific metadata standard	ISO 19115 , DIF , Darwin Core	R1.3

A.2. Table 2: Self-Assessment

The Self-Assessment component consists of a structured form to be completed by repository representatives and covers aspects such as sustainability, user support and data maintenance.

Each item is evaluated individually and scored as either fulfilled or not fulfilled. The submitted answers - including the attached explanations and references - are reviewed and can be supplemented with follow-up questions for clarification if necessary.

N4E metric	SAF Field	Guideline	Corresponding CTS criteria
n4e:hasBackupStrategy	Backup Strategy	The repository should have a backup strategy.	R14
n4e:hasArchivingStrategy	Archiving Strategy	The repository should have a long-term preservation strategy in place.	R09
n4e:hasFundingStatement	Funding	The repository should have a funding statement, mission statement or some other self description that allows users to understand the purpose of the repository, which institution runs it, and how it is funded. The mentioned information should be made clear to repository users on the repository website.	R05
n4e:hasCuration	Curation	The repository should have data curation. The degree of curation should be made clear to repository users on the repository website.	R08/R10
n4e:hasUserSupport	User Support	The repository should have some form of user support. The options for user support should be made clear to repository users on the repository website.	R06

A.3. Table 3: F-UJI Assessment

The F-UJI tool evaluates the FAIRness of individual datasets rather than entire repositories. For this reason, a fixed number of datasets is randomly sampled from the repository and assessed using the F-UJI tool. To derive the final F-UJI assessment result, each metric is evaluated across all sampled datasets. The metric is marked as fulfilled if more than 50% of the sampled datasets meet the corresponding condition.

N4E metric	Guideline	F-UJI Metric
n4e:hasDescriptiveMetadata	Metadata of records stored in the repository should include descriptive core elements.	FsF-F2-01M
n4e:metadataIncludesIdentifier	Metadata of records stored in the repository should include the identifier of the data it describes.	FsF-F3-01M
n4e:metadataLinks	Metadata of records stored in the repository should include links between the data and its related entities.	FsF-I3-01M
n4e:includesLicense	Metadata of records stored in the repository should include license information under which data can be reused.	FsF-R1.1-01M
n4e:includesProvenance	Metadata of records stored in the repository should include provenance information about data creation or generation.	FsF-R1.2-01M
n4e:metadataRepresentation	Metadata of records stored in the repository should be represented using a formal knowledge representation language.	FsF-I1-01M

N4E metric	Guideline	F-UJI Metric
n4e:specifiesContent	Metadata of records stored in the repository should specify the content of the data: the type of the object and technical properties like file format, size, and names.	FsF-R1-01MD