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forschungsdaten management

We offer advise on all aspects of research data management

FAIR and Open Research Data Practices in the Earth Sciences

Dr. Andreas Hübner | University Library

Geo-colloquium | 17 July 2025

The FAIR principles

Source: National Library of Medicine

- 15 principles
- to guide the actions of data publishers, data stewards and researchers

- the ‘FAIR Guiding Principles for scientific data management and stewardship’ were published 2016 in *Scientific Data*. https://doi.org/10.1038/sdata.2016.18

The FAIR principles

To be Findable

F1. (meta)data are assigned a globally unique and eternally persistent identifier.
F2. data are described with rich metadata.
F3. (meta)data are registered or indexed in a searchable resource.
F4. metadata specify the data identifier.

To be Accessible

A1 (meta)data are retrievable by their identifier using a standardized communications protocol.
A1.1 the protocol is open, free, and universally implementable.
A1.2 the protocol allows for an authentication and authorization procedure, where necessary.
A2 metadata are accessible, even when the data are no longer available.

To be Interoperable

I1. (meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation.
I2. (meta)data use vocabularies that follow FAIR principles.
I3. (meta)data include qualified references to other (meta)data.

To be Re-usable

R1. meta(data) have a plurality of accurate and relevant attributes.
R1.1. (meta)data are released with a clear and accessible data usage license.
R1.2. (meta)data are associated with their provenance.
R1.3. (meta)data meet domain-relevant community standards.

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The greatest potential for re-use comes when data are both FAIR and Open

Findable
Accessible
Interoperable
Re-usable

FAIR

+

Open

Data should be as open as possible, as closed as necessary

FAIR and Open Research Data Practices

1. Deposit research outputs (e.g., data, software, physical sample information, etc.) in trustworthy, community-accepted, FAIR-aligned repositories.
2. Describe your data completely.
3. License your data to be as open as possible.
4. Cite data, software, physical samples, and other products created or reused for your research in your publications.
5. Include a data availability statement in your publication to make it clear where the data can be accessed.
6. Develop and implement data management plans.

Supplementary material vs. data repository

Supplementary material of a journal article.

Independent publication in a **data repository**.

Supplementary material vs. data repository

Supplementary material of a journal article.

- has usually no own ID (e.g., DOI), can not be found or cited independently of the article.
- Access to the data may be restricted by the terms of use of the journal.
- Often as PDF with limited re-use options.

Independent publication in a **data repository**.

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- Often as PDF with limited re-use options.

Independent publication in a **data repository**.

- Data set is findable and independently citable.
- Author(s) can decide on open licence.
- Data publication adds to the publication list of authors.
- File formats variable and often better for re-use.

Data, software, physical sample information in repositories

More than
3300
data repositories

https://www.re3data.org/

Data publisher

PANGAEA.
Data Publisher for Earth & Environmental Science

https://www.pangaea.de/

GFZ Data Services

https://dataservices.gfz-potsdam.de/portal/

WDC CLIMATE

https://www.wdc-climate.de

Data tables

Data curation checklist (in Python and R)

helps you to check and resolve some common problems and issues with data tables, before submitting them to a data repository like PANGAEA.

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Data structure

- One cell = one entry
- Columns = Variable/Parameters
- Rows = Single observation
- Single header row
- No mix of numeric values and strings

Data types

- Are data types as expected?

Numeric data

- Columns must contain numbers only
- Fields without data should be left empty

Date formatting

- Date/Time in the ISO-format (UTC)

Convert from degrees to decimal format

- decimal degree, projection WGS84

Spell out abbreviations

Correct species names

Parameter (header) naming

Convert units

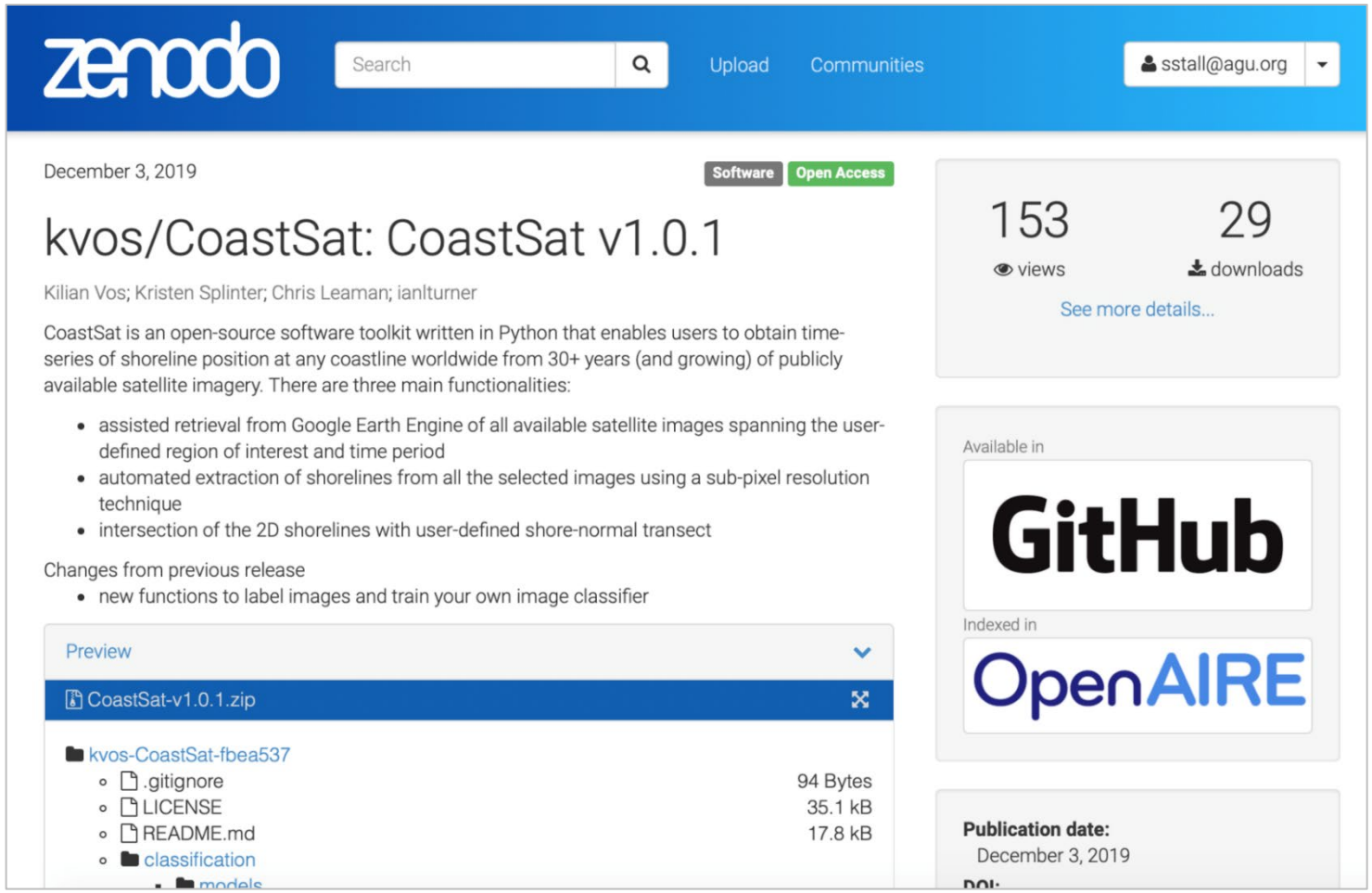
URLs

Events

Software

You can use third-party tools to cite and reference content on GitHub.

https://docs.github.com/en/repositories/archiving-a-github-repository/referencing-and-citing-content



Kilian Vos, Kristen Splinter, Chris Leaman, & ianlturner. (2019, December 3). kvos/CoastSat: CoastSat v1.0.1 (Version v1.0.1). Zenodo. http://doi.org/10.5281/zenodo.3560436

Physical sample information

International Generic
Sample Number (IGSN)

GFZ Data Services offers an IGSN Registration Service.

GFZ Helmholtz Centre Potsdam

IGSN

Physical Sample

Impressum

Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences

General Identifiers

Project:	GEOFERN Expedition 7002
Campaign:	N/A
Type:	Individual Sample
Name:	7002_1_A_002_1_WR_50-52
IGSN:	GFBNO7002EXZ0001 (Open)
Parent IGSN:	GFBNO7002ECAG101
Request:	GEOFERN_5_JG
Request by:	Julia Gravendyck
Purpose:	Palynological Study
Release Date:	N/A

Sampling Location

Latitude:	N/A
Longitude:	N/A
Coordinate System:	N/A
Elevation:	N/A
Location Type:	N/A
Location Name:	N/A
Location Description:	N/A
Country:	Germany
Province:	N/A
County:	N/A
City:	Berlin

Acquisition

Material:	Rock
Rock Classification:	N/A
Collection Method:	
Funding Agency:	
Comments:	N/A
Chief Scientist:	Norden, Ben
Start Date:	2022-01-13
End Date:	2022-01-13

Repositories

Current Repository:	BGR
Current Repository Contact:	Tina.Kollaske@bgr.de
Original Repository:	BGR
Original Repository Contact:	Tina.Kollaske@bgr.de

Sample Family

- 7002_1_A
  - 7002_1_A_001
  - 7002_1_A_002
    - 7002_1_A_002_1_WR_5-6
    - 7002_1_A_002_1_WR_50-52
  - 7002_1_A_003
    - 7002_1_A_003_1_WR_0-2
    - 7002_1_A_003_1_WR_13-16
    - 7002_1_A_003_2_WR_5-10
  - 7002_1_A_004
    - 7002_1_A_004_2_WR_20-22
  - 7002_1_A_005
  - 7002_1_A_006
  - 7002_1_A_007
  - 7002_1_A_008
  - 7002_1_A_009

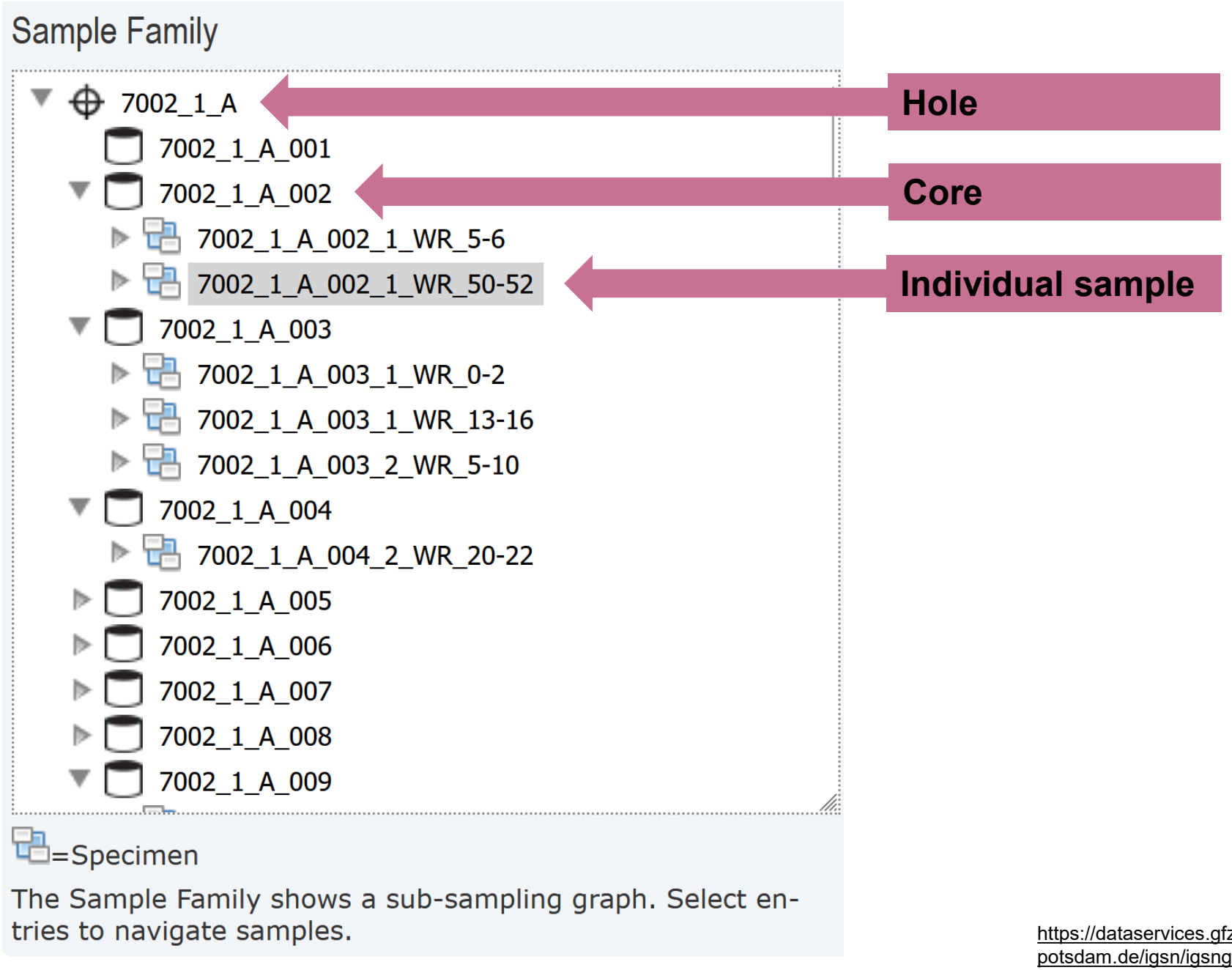
=Specimen

The Sample Family shows a sub-sampling graph. Select entries to navigate samples.

Location Map

Drilling Start/End: 2021-11-15 07:30+01:00 / 2021-12-09 11:30+01:00 *
Latitude: 52.42710 * Longitude: 13.52862 *

https://dataservices.gfz-potsdam.de/igsn/igsngfz/index.php?igsn=GFBNO7002EHG0001



https://dataservices.gfz-potsdam.de/igsn/igsngfz/index.php?igsn=GFBNO7002EHG0001

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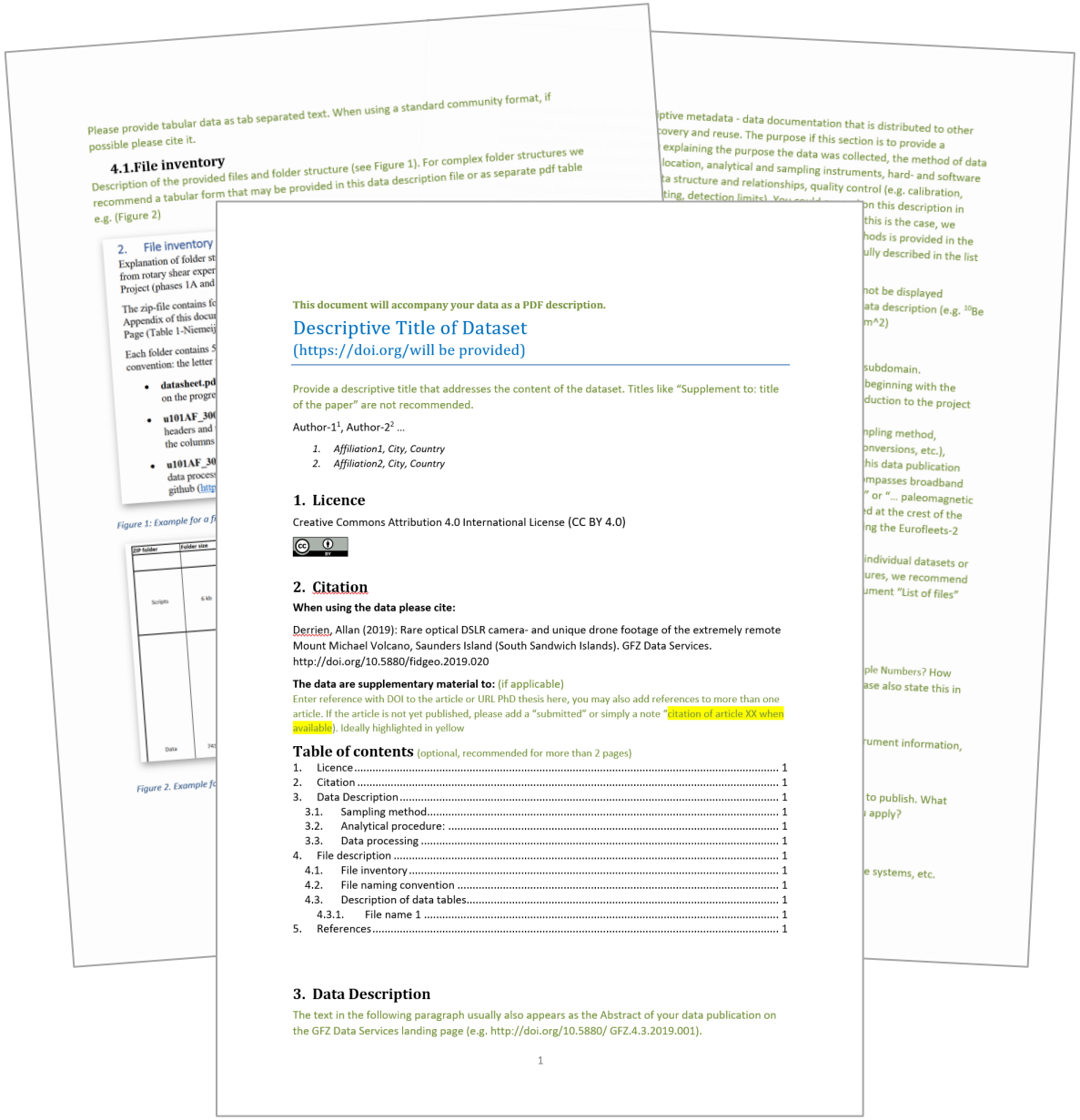
Describe your data completely

Ensuring that data is „independently understandable“ is crucial.

file

link

abstract



Please provide tabular data as tab separated text. When using a standard community format, if possible please cite it.

4.1.File inventory

Description of the provided files and folder structure (see Figure 1). For complex folder structures we recommend a tabular form that may be provided in this data description file or as separate pdf table e.g. (Figure 2)

2. File inventory

Explanation of folder st
from rotary shear exper
Project (phases 1A and

The zip-file contains fo
Appendix of this docu
Page (Table 1-Niemeij

Each folder contains 5
convention: the letter

- **datasheet.pd**
  on the progre
- **u101AF_300**
  headers and
  the columns
- **u101AF_30**
  data process
  github (http

Figure 1: Example for a fi

ZIP folder	Folder size
Scripts	6 kb
Data	742

Figure 2. Example fo

This document will accompany your data as a PDF description.

Descriptive Title of Dataset
(https://doi.org/will be provided)

Provide a descriptive title that addresses the content of the dataset. Titles like "Supplement to: title of the paper" are not recommended.

Author-1[1], Author-2[2] ...

1. *Affiliation1, City, Country*
2. *Affiliation2, City, Country*

1. Licence

Creative Commons Attribution 4.0 International License (CC BY 4.0)

2. Citation

When using the data please cite:

Derrien, Allan (2019): Rare optical DSLR camera- and unique drone footage of the extremely remote Mount Michael Volcano, Saunders Island (South Sandwich Islands). GFZ Data Services. http://doi.org/10.5880/fidgeo.2019.020

The data are supplementary material to: (if applicable)
Enter reference with DOI to the article or URL PhD thesis here, you may also add references to more than one article. If the article is not yet published, please add a "submitted" or simply a note "citation of article XX when available). Ideally highlighted in yellow

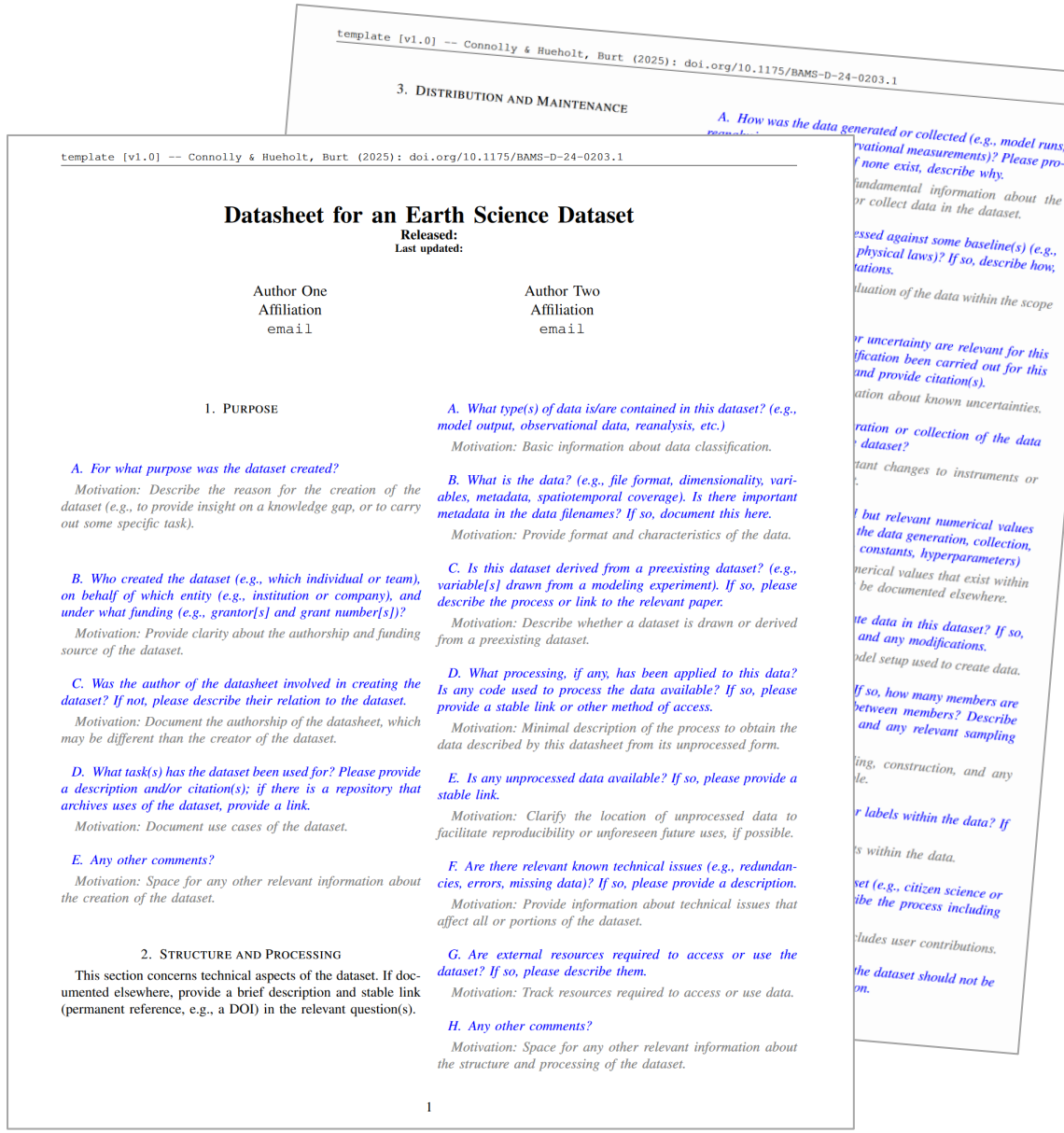
Table of contents (optional, recommended for more than 2 pages)

3. Data Description

The text in the following paragraph usually also appears as the Abstract of your data publication on the GFZ Data Services landing page (e.g. http://doi.org/10.5880/ GFZ.4.3.2019.001).

1

https://gfzpublic.gfz-potsdam.de/pubman/item/item_5007103 (2021)



3. Distribution and Maintenance

A. How was the data generated or collected (e.g., model runs, observational measurements)? Please pro-
If none exist, describe why.
fundamental information about the
or collect data in the dataset.

essed against some baseline(s) (e.g.,
physical laws)? If so, describe how;
tations.
luation of the data within the scope

r uncertainty are relevant for this
ification been carried out for this
and provide citation(s).
ation about known uncertainties.

ration or collection of the data
dataset?
tant changes to instruments or

l but relevant numerical values
the data generation, collection,
constants, hyperparameters)
nerical values that exist within
be documented elsewhere.

te data in this dataset? If so,
and any modifications.
odel setup used to create data.

If so, how many members are
between members? Describe
and any relevant sampling

ling, construction, and any
le.

r labels within the data? If

s within the data.

set (e.g., citizen science or
ibe the process including

cludes user contributions.

the dataset should not be
on.

template [v1.0] -- Connolly & Hueholt, Burt (2025): doi.org/10.1175/BAMS-D-24-0203.1

Datasheet for an Earth Science Dataset

Released:
Last updated:

Author One
Affiliation
email

Author Two
Affiliation
email

1. Purpose

A. For what purpose was the dataset created?
Motivation: Describe the reason for the creation of the dataset (e.g., to provide insight on a knowledge gap, or to carry out some specific task).

B. Who created the dataset (e.g., which individual or team), on behalf of which entity (e.g., institution or company), and under what funding (e.g., grantor[s] and grant number[s])?
Motivation: Provide clarity about the authorship and funding source of the dataset.

C. Was the author of the datasheet involved in creating the dataset? If not, please describe their relation to the dataset.
Motivation: Document the authorship of the datasheet, which may be different than the creator of the dataset.

D. What task(s) has the dataset been used for? Please provide a description and/or citation(s); if there is a repository that archives uses of the dataset, provide a link.
Motivation: Document use cases of the dataset.

E. Any other comments?
Motivation: Space for any other relevant information about the creation of the dataset.

2. Structure and Processing

This section concerns technical aspects of the dataset. If documented elsewhere, provide a brief description and stable link (permanent reference, e.g., a DOI) in the relevant question(s).

A. What type(s) of data is/are contained in this dataset? (e.g., model output, observational data, reanalysis, etc.)
Motivation: Basic information about data classification.

B. What is the data? (e.g., file format, dimensionality, variables, metadata, spatiotemporal coverage). Is there important metadata in the data filenames? If so, document this here.
Motivation: Provide format and characteristics of the data.

C. Is this dataset derived from a preexisting dataset? (e.g., variable[s] drawn from a modeling experiment). If so, please describe the process or link to the relevant paper.
Motivation: Describe whether a dataset is drawn or derived from a preexisting dataset.

D. What processing, if any, has been applied to this data? Is any code used to process the data available? If so, please provide a stable link or other method of access.
Motivation: Minimal description of the process to obtain the data described by this datasheet from its unprocessed form.

E. Is any unprocessed data available? If so, please provide a stable link.
Motivation: Clarify the location of unprocessed data to facilitate reproducibility or unforeseen future uses, if possible.

F. Are there relevant known technical issues (e.g., redundancies, errors, missing data)? If so, please provide a description.
Motivation: Provide information about technical issues that affect all or portions of the dataset.

G. Are external resources required to access or use the dataset? If so, please describe them.
Motivation: Track resources required to access or use data.

H. Any other comments?
Motivation: Space for any other relevant information about the structure and processing of the dataset.

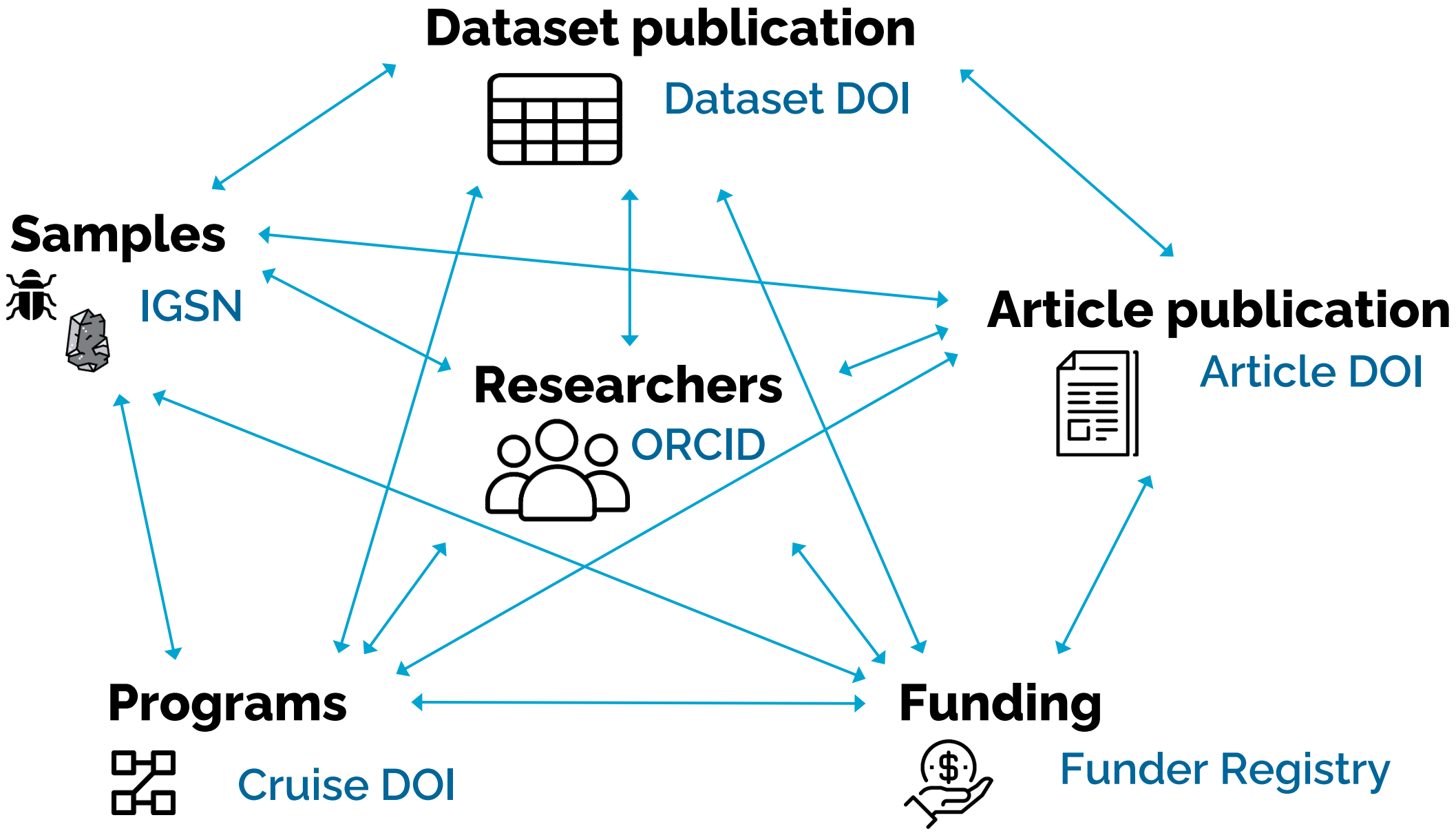
1

Datasheets for Earth Science Datasets (more info in the article Datasheets for Earth Science Datasets, 2025).

Data Journals

Peer-reviewed articles with the description of datasets, data collections, data infrastructures, etc.

No Interpretation!



Adapted from Lehnert et al., 2020, Digital Data Infrastructure for Physical Samples: The IGSN and the Internet of Samples, GeoUtrecht2020 virtual conference

ons made by Freepik, except Funding icon made by Maxim Basinski Premium and esearcher icon made by SBTS2018, all from Flaticon

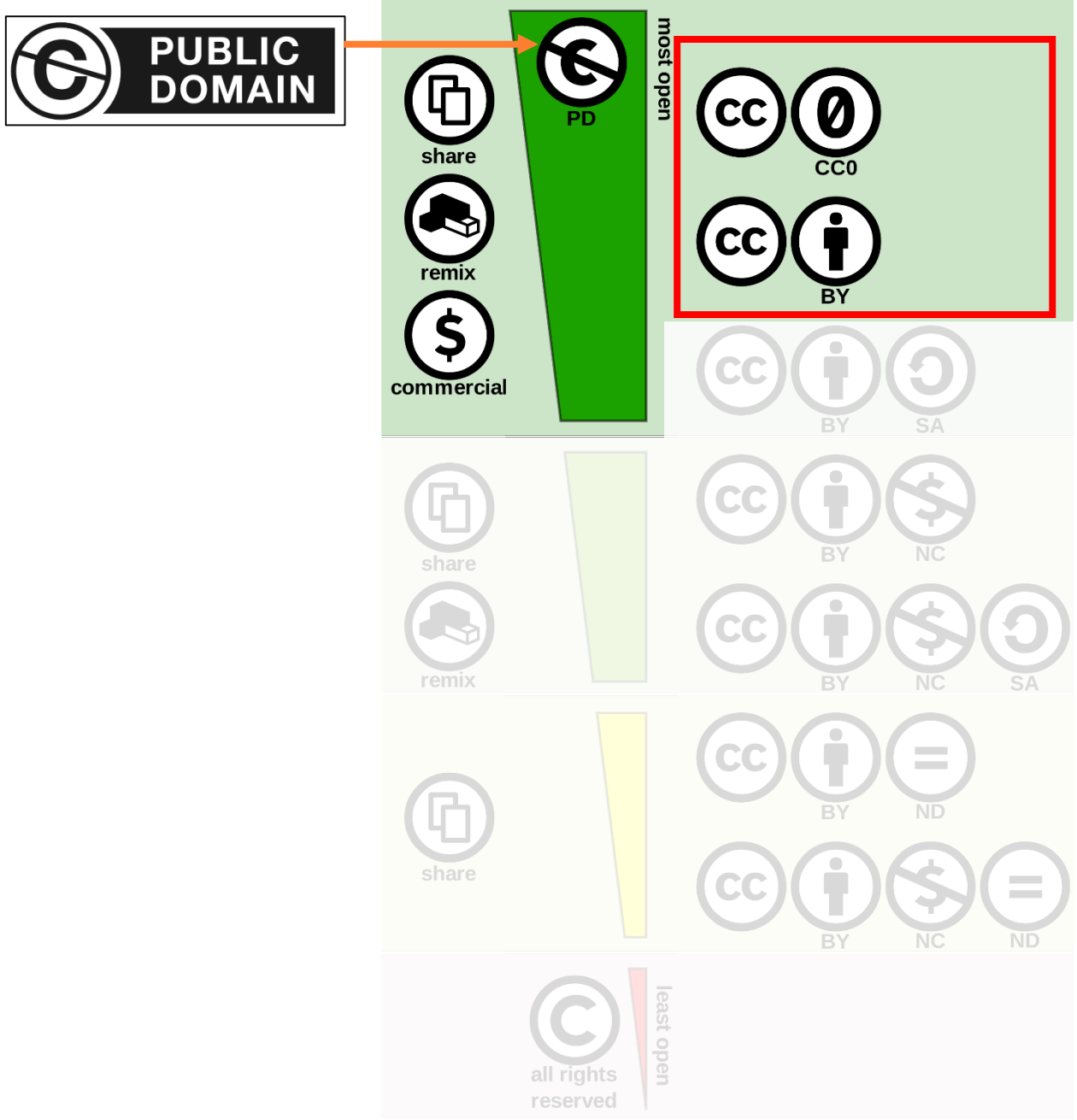
FAIR and Open Research Data Practices

1. Deposit research outputs (e.g., data, software, physical sample information, etc.) in trustworthy, community-accepted, FAIR-aligned repositories.
2. Describe your data completely.
3. License your data to be as open as possible.
4. Cite data, software, physical samples, and other products created or reused for your research in your publications.
5. Include a data availability statement in your publication to make it clear where the data can be accessed.
6. Develop and implement data management plans.

License your data to be as open as possible

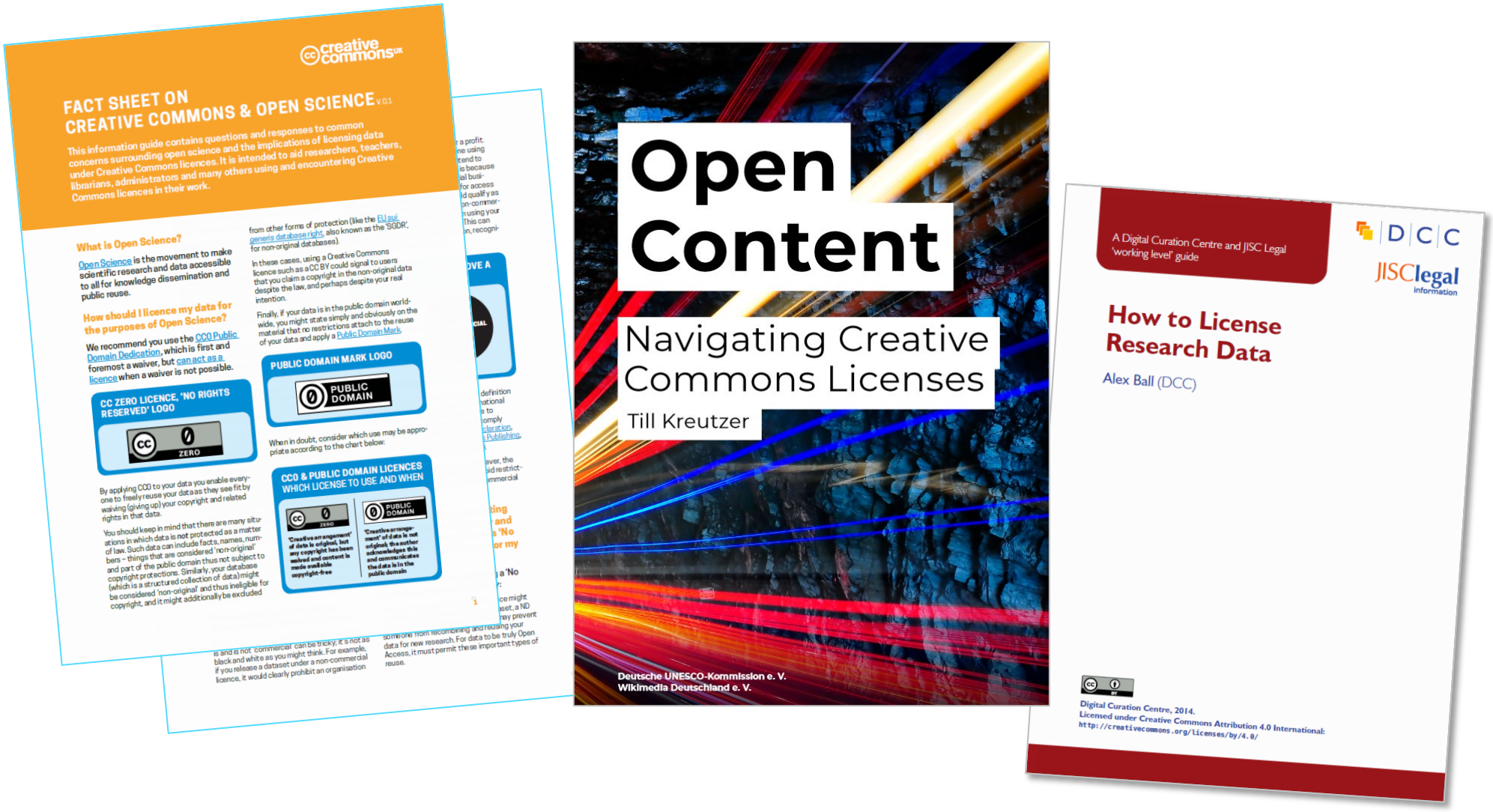
… Freie Universität Berlin therefore recommends granting open licenses for use when data (including their metadata) are published, e.g., **CC0** or **CC BY** [21] for data, **GNU General Public License** [22] or **MIT License** [23] for source code. …

Freie Universität Berlin. 2021. „Research Data Policy of Freie Universität Berlin“. https://doi.org/10.17169/refubium-32141



Use CC0 and simply ask for credit (rather than require attribution), and provide a citation for the dataset that others can copy and paste with ease.

Such requests are consistent with scholarly norms for citing source materials.



Creative Commons UK. (2017). Fact Sheet on Creative Commons & Open Science. Zenodo. 10.5281/zenodo.840651
https://irights.info/wp-content/uploads/2025/01/Open-Content_final_web.pdf
http://www.dcc.ac.uk/sites/default/files/documents/publications/reports/guides/How_To_License_Research_Data.pdf

Types of Open Source Software Licenses

Permissive Licenses

- Allows modification and sharing of the software
- Publishing source code is not required

Benefit: Simple and flexible licenses that are very compatible with other licenses

Copyleft Licenses

- Allows modification and sharing of the software
- Source code must be published
- Derivative works must be licensed under the same license than the original work
- Weak Copyleft: When modified work is incorporated in a larger software, only the derivative work must be licensed under the original license
- Strong Copyleft: Any derived work must be licensed under the original license

Benefit: Licenses ensure that derivative software remains open source

From: Riedel, C. (2024) Licensing Research Data and Software.

https://opensource.org/licenses

OSI Approved Licenses

Open source licenses are licenses that comply with the Open Source Definition – in brief, they allow software to be freely used, modified, and shared. To be approved by the Open Source Initiative (also known as the OSI) a license must go through the Open Source Initiative's license review process.

SEARCH LICENSES ∨

Search for:

Search by keyword, SPDX ID, Steward, etc. | Search

CATEGORIES ∨

INTERNATIONAL | NON-REUSABLE | OTHER/MISCELLANEOUS | POPULAR / STRONG COMMUNITY | REDUNDANT WITH MORE POPULAR | SPECIAL PURPOSE | SUPERSEDED | UNCATEGORIZED | VOLUNTARILY RETIRED

License Name	SPDX ID	Category
1-clause BSD License	BSD-1-Clause	Other/Miscellaneous
Academic Free License v. 3.0	AFL-3.0	Redundant with more popular
Adaptive Public License 1.0	APL-1.0	Other/Miscellaneous

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Data and software citation

Standard data citation

Template
Creator (Publication Year): Title. Publisher. (resourceTypeGeneral). Identifier

Example
Hanigan, Ivan (2012): Monthly drought data for Australia 1890-2008 using the Hutchinson Drought Index. The Australian National University Australian Data Archive. (Dataset) http://doi.org/10.4225/13/50BBFD7E6727A

Standard software citation

Template
Creator (Publication Year): Title. Version No. Publisher. [resourceTypeGeneral]. Identifier.

Example
Xu, C., & Christoffersen, B. (2017). The Functionally-Assembled Terrestrial Ecosystem Simulator Version 1. Los Alamos National Laboratory (LANL), Los Alamos, NM (United States). [Software]. https://doi.org/10.11578/dc.20171025.1962

https://ardc.edu.au/resource/data-and-software-citation/

Data citation

Tectonics

RESEARCH ARTICLE
10.1029/2020TC006425

Key Points:
- Seismic reflection profiles in the

Active Fold-Thrust Belt to Foreland Transi… in Northern Adria, Italy, Tracked by Seism… Reflection Profiles and GPS Offshore Data

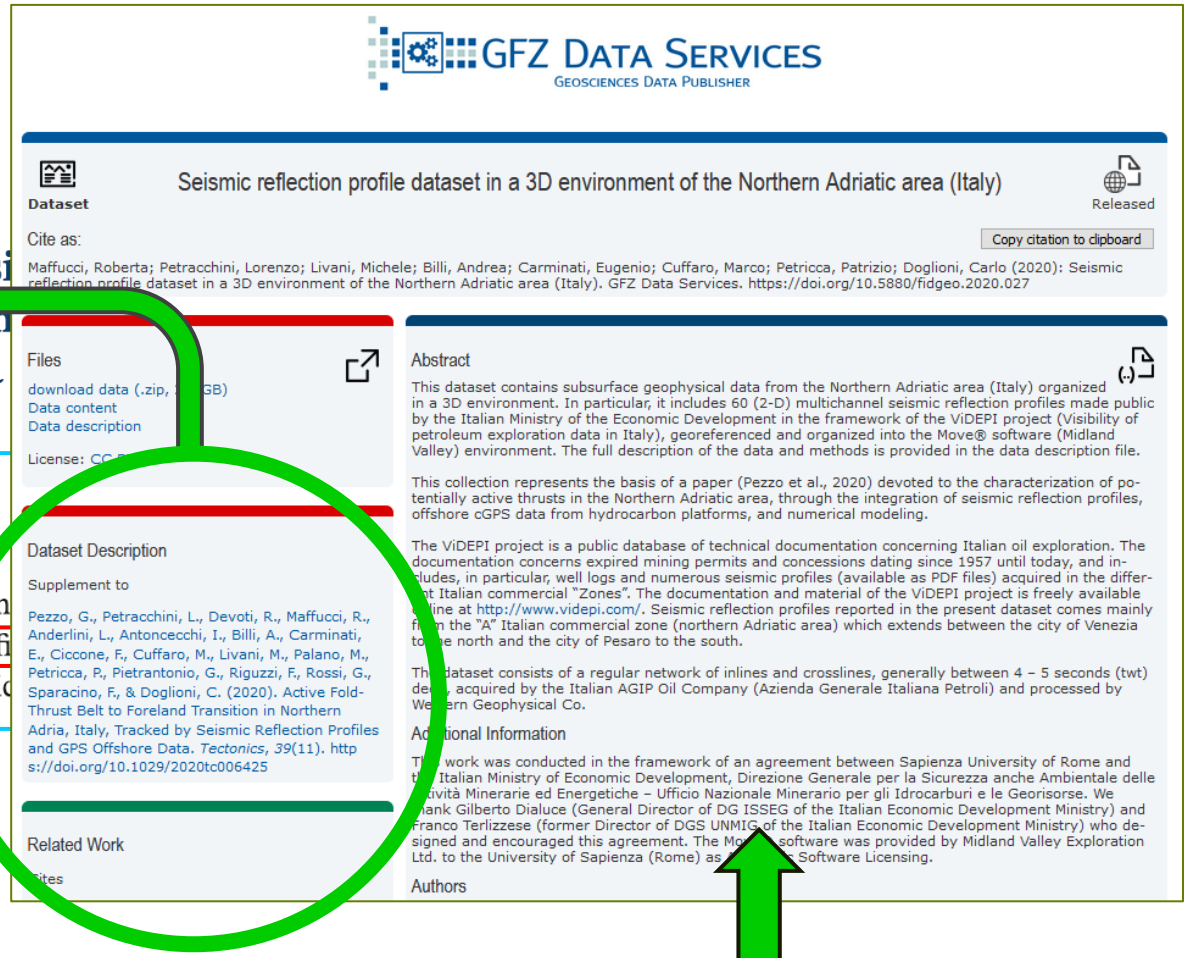
3. Data and Methods

3.1. Seismic Reflection Profiles and Borehole Composite Logs

seismic reflection profiles from the ViDEPI project organized in a 3-D environment b… m… software are available in the GFZ Data Services Repository: http://doi.org/10.58…/fi… Maffucci et al., 2020). Furthermore, we collected seismic profiles, structural geologic…

Data Availability Statement

All data needed to evaluate the conclusions in the paper are present in the paper itself and/or the associated supporting information. All these data are also freely available in external repositories and previous articles. In particular, the geodetic data are available in Palano et al. (2020) (https://doi.pangaea.de/10.1594/PANGAEA.914358). The seismic reflection profiles organized in a 3-D Move® file/project are available in Maffucci et al. (2020) (http://pmd.gfz-potsdam.de/panmetaworks/review/aaf30ce1d97be14e03c64b5a638334ed0c40007bc91f6029b83a149727f47c5f). Supporting figures (Figures S1 and S2) and tables are available online (ftp://ftp.ingv.it/pub/giuseppe.pezzo/TECT_2020TC006425/). In the data repository, we make available the subsurface geophysical data set used to classify the tectonic domains of the studied CGPS stations (i.e., fold-thrust belt, proto-thrust domain, and foreland). The data set is organized into the Move® software (Midland Valley) environment, version 2016.2 and includes 60 public 2-D multichannel seismic reflection profiles deriving from the ViDEPI database (http://www.videpi.com). The dataset and its full description is available on the following link: http://doi.org/10.5880/fidgeo.2020.027 (Maffucci et al., 2020); CGPS data and its full description is available on the following link: https://doi.org/10.1594/PANGAEA.914358 (Palano et al., 2020).



References

Maesano, F. E., Toscani, G., Burrato, P., Mirabella, F., D'Ambrogi, C., & Basili, R. (2… Deriving thrust fault slip rates from geological modeling: Examples from the Marche coastal and offshore contraction belt, North… Apennines, Italy. *Marine and Petroleum Geology*, *42*, 122–134. https://doi.org/10.1016/j.marpetgeo.2012.10.008

Maffucci, R., Petracchini, L., Livani, M., Billi, A., Carminati, E., Cuffaro, M., et al. (2… *Seismic Reflection Profile Dataset in a 3D Environment of the Northern Adriatic Area (Italy)*. GFZ Data Services. https://doi.org/10.5880/fidgeo.2020.027

Malinverno, A., & Ryan, W. B. (1986). Extension in the Tyrrhenian Sea and shortening in the Apennines as result of arc migration driven by sinking of the lithosphere. *Tectonics*, *5*(2), 227–245. https://doi.org/10.1029/TC005i002p00227

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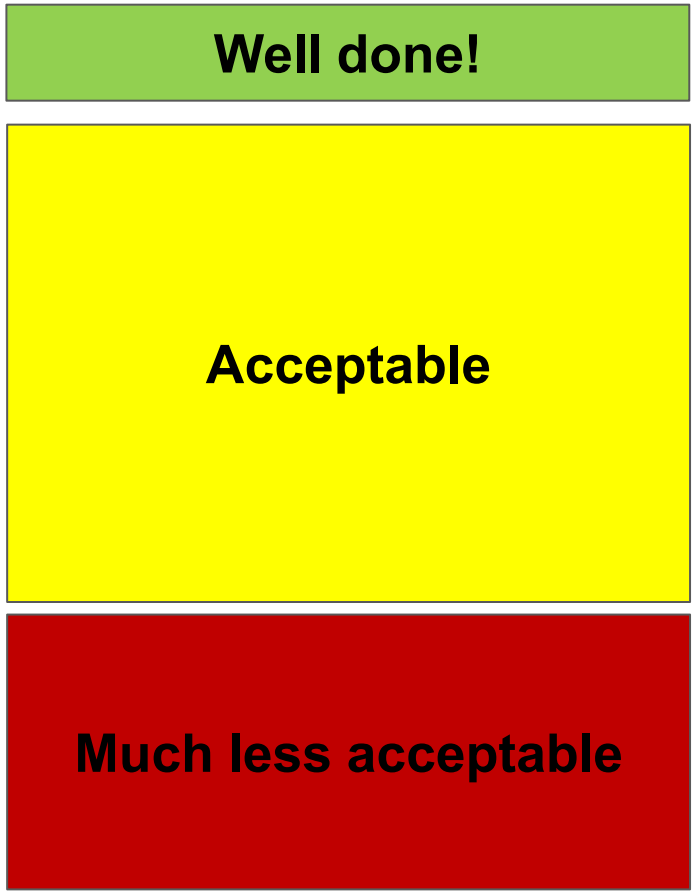
Data Availability Statement

All data needed to evaluate the conclusions in the paper are present in the paper itself and/or the associated supporting information. All these data are also freely available in external repositories and previous articles. In particular, the geodetic data are available in Palano et al. (2020) (https://doi.pangaea.de/10.1594/PANGAEA.914358). The seismic reflection profiles organized in a 3-D Move® file/project are available in Maffucci et al. (2020) (http://pmd.gfz-potsdam.de/panmetaworks/review/aaf30ce1d97be14e03c64b5a638334ed0c40007bc91f6029b83a149727f47c5f). Supporting figures (Figures S1 and S2) and tables are available online (ftp://ftp.ingv.it/pub/giuseppe.pezzo/TECT_2020TC006425/). In the data repository, we make available the subsurface geophysical data set used to classify the tectonic domains of the studied CGPS stations (i.e., fold-thrust belt, proto-thrust domain, and foreland). The data set is organized into the Move® software (Midland Valley) environment, version 2016.2 and includes 60 public 2-D multichannel seismic reflection profiles deriving from the ViDEPI database (http://www.videpi.com). The dataset and its full description is available on the following link: http://doi.org/10.5880/fidgeo.2020.027 (Maffucci et al., 2020); CGPS data and its full description is available on the following link: https://doi.org/10.1594/PANGAEA.914358 (Palano et al., 2020).

https://doi.org/10.1029/2020TC006425

Data availability statement

Availability of data
Data openly available in a public repository that issues datasets with DOIs
Data openly available in a public repository that does not issue DOIs
Data derived from public domain resources
Embargo on data due to commercial restrictions
Data available on request due to privacy/ethical restrictions
Data subject to third party restrictions
Data available on request from the authors
Author elects to not share data
Data available in article supplementary material
Data sharing not applicable



Data availability statement

“We also find an association between articles that include statements that link to data in a repository and up to 25.36% (± 1.07%) higher citation impact on average…”

The citation advantage of linking publications to research data (2020)
https://doi.org/10.1371/journal.pone.0230416

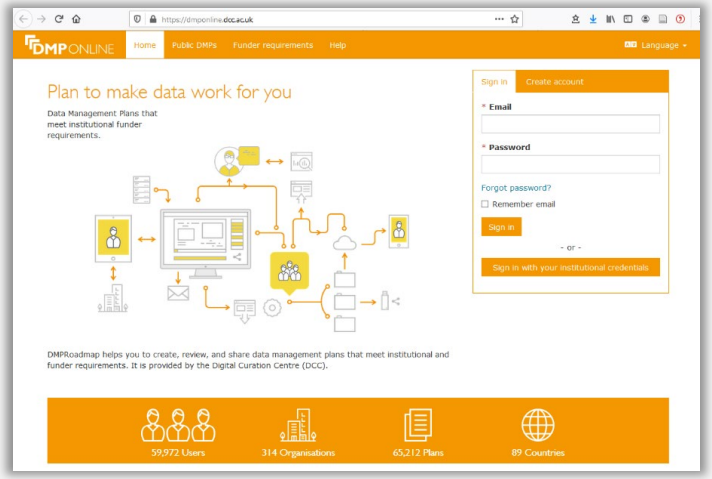
FAIR and Open Research Data Practices

1. Deposit research outputs (e.g., data, software, physical sample information, etc.) in trustworthy, community-accepted, FAIR-aligned repositories.
2. Describe your data completely.
3. License your data to be as open as possible.
4. Cite data, software, physical samples, and other products created or reused for your research in your publications.
5. Include a data availability statement in your publication to make it clear where the data can be accessed.
6. Develop and implement data management plans.

Data management plan

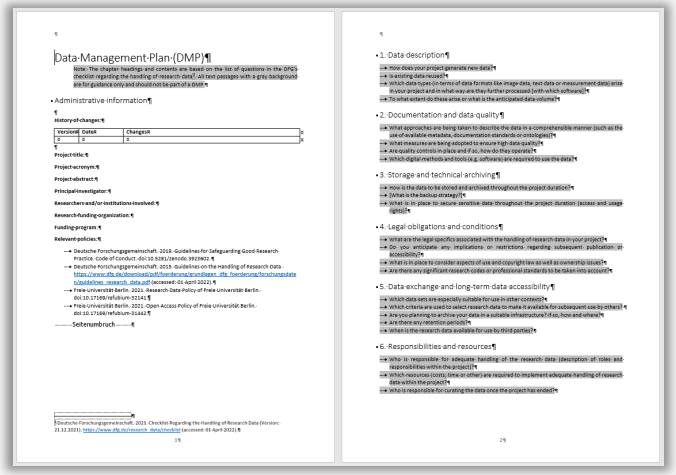
- Structured documentation of all aspects of the research data and the handling of the research data of a project.
- Encompasses the entire course of the project as well as data storage after project completion
- Tool to plan all aspects of research data management at an early stage and/or as a team

Data management plan



[DMPonline]

[TUB-DMP]



[Template] Freie Universität Berlin

Data management plan

FU Resources

- Guide to Data management plans (Link)
- Upcoming: workshop ‘DMP step-by-step’

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NFDI4Earth FAIRness and Openness Commitment

NFDI4Earth

Sign the Commitment at **http://nfdi4earth.de/commit**

NFDI4Earth Consortium. 2024. *NFDI4Earth FAIRness and Openness Commitment (NFDI4EarthDeliverable D4.2.1)*. NFDI4Earth Community on Zenodo. https://doi.org/10.5281/zenodo.10123880.

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We offer advise on all aspects of research data management