Ref. Ares(2025)5793705 - 16/07/2025

LIQUIDICE

Deliverable 6.2 Data Management Plan

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LIQUIDICE: LinkIng and QUantifying the Impacts of climate change on inlanD ICE, snow cover, and permafrost on water resources and society in vulnerable regions.

Funding programme: Horizon Europe
Project Start Date: 01.02.2025
Grant Agreement No.: 101184962
Duration: 48 months

Document information	
Work Package	WP6
Deliverable No.	D6.2
Deliverable title	Data Management Plan
Dissemination level	☒ PU - Public ☐ SEN - Sensitive
Lead Beneficiary	11 – SIOS-KC
Lead Author	ISO Matero
Contributors	1 – IG PAS, 2 – CNR, 3 – GEUS, 4 – NORCE, 5 – DMI, 19 – UCPH
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Due date	31.07.2025

Document history		
Version	1	
Version Date	17.05.2025	
Status	☒ Draft	19.03.2025
	☒WP leader approved	09.05.2025
	☒Coordinator approved	15.05.2025
	☒Executive Board approved	17.05.2025

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Executive summary

This Data Management Plan outlines the policies and practices governing data throughout and beyond the LIQUIDICE project. Data will be collected, processed and stored in accordance with institutional data policies and the FAIR (Findable, Accessible, Interoperable, Reusable) principles. This document provides detailed guidance on practices to follow and adopt for project output, such as a metadata model that ensures proper documentation and discoverability and formats that interoperable and facilitate long-term accessibility. The plan also includes guidance for data quality, security, ethics considerations, embargo periods, access control and confidentiality. In general all research output, including data sets and code, will be shared openly via appropriate repositories unless restricted by ethical or legal constraints.

1. Introduction

As stated in the project grant agreement, LIQUIDICE joins expert cryospheric observers and modellers to i) comprehensively re-assess the past and future century-plus of climate-induced high impact changes to the Greenland ice sheet and permafrost and glaciers in four other climate vulnerable locations across the Alps, Norway, High Mountain Asia and Svalbard; **ii)** develop new, expanded and harmonized data from satellite Earth Observation (EO) and ground stations; iii) use these data to improve and test a hierarchy of ice sheet and glacier models with Earth System Models (ESM); iv) through these steps, yield new process understanding, and ultimately v) inform water resource, hydropower and socio-economic strategies through clear and transparent communication of results and uncertainties. LIQUIDICE aims to pursue collaboration on data dissemination with sister projects CryoSCOPE (EC Grant Agreement No. 101184736) and ICELINK (EC Grant Agreement No. 101184621).

LIQUIDICE is focused on tackling the most critical aspects of terrestrial cryospheric climate change in the chosen regions through more precise quantification of past and future cryospheric changes. The different steps outlined in the previous paragraph will require efficient management, sharing and synthesis of data originating from ground observations, models and remote sensing infrastructure, and as such efficient data management is crucial for the success of the project.

This Data Management Plan (DMP) applies to LIQUIDICE project partners and third parties contributing data for the project. Any natural or legal person or any association of legal and natural persons shall have a right to access the data produced or disseminated as part of this project subject to principles, conditions and exceptions defined in this DMP. Recorded personnel interview data and fieldnotes are an exemption to this and need to be discussed with the partner holding the records directly on a case-by-case basis.

2. Definitions

2.1. Dataset

A variety of data products will be either produced or shared as part of the project, ranging from raw data to processed and aggregated data. Among others, it will contain point data, trajectory data, profile data, time series, and gridded data. The term data product is quite ambiguous, and therefore the term dataset will be used to refer to it in the rest of the document. This can be observational data but also processed observations for a specific purpose. The working definition of a dataset in this context is in line with the INSPIRE directive (Mäkelä, 2007):

"… an identifiable collection of spatial data, i.e. a collection of data that has a reference by name or coordinates to a geographic location or area, and which in addition have a designated start and end time."

A dataset can contain observations (remote or in-situ), derived quantities (from either of these two types of data sources), or forecasts of future and past states of environmental

parameters. Data values can be located at a single point, along a line or transect, in a regular or irregular grid, and be captured or estimated at one or more altitudes/depths.

In addition to environmental and model data, the project will also collect qualitative data generated through interviews, surveys, and workshops involving stakeholders. This may include audio and video recordings, photographs, and written notes.

A dataset can be stored on paper, in files (one or more), or in a database, and is often accompanied by descriptions (metadata) of its content.

2.2. Discovery metadata

Discovery metadata describes the 'who', 'where', and 'when' of the data collection process, how to access data and any potential constraints on the data. It should also link to further information on the data, if relevant. It includes information like titles, keywords, abstracts, geographic locations, dates, and creators. Its primary role is to make resources discoverable in catalogues, repositories, or search engines.

2.3. Use metadata

Use metadata describes the actual content of a dataset and how it is encoded. The purpose is to enable the user to understand the data without any further communication. It describes content of variables using standardised vocabularies, units of variable, encoding of missing values, map projections etc. Examples of use metadata standards are the Climate and Forecast Convention (CF), WMO Binary Universal Form for the Representation of meteorological data (BUFR), and WMO General Regularly distributed Information in Binary form (GRIB).

2.4. Metadata standard

A metadata standard is a set of rules and guidelines that define how metadata should be created, formatted, and exchanged between different systems. Metadata standards provide a common language and structure for metadata, ensuring that different systems can understand and interpret the metadata correctly. By following a metadata standard, developers can ensure that their metadata is consistent and easily consumable by other systems. Examples of discovery metadata standards are ISO-19115, GCMD DIF and Attribute Convention for Data Discovery (ACDD).

2.5. Abbreviations used in this document

ACDD – Attribute Convention for Data Discovery
EO – Earth Observation
ESM – Earth System Model
SSH - Social Sciences and Humanities

3. Data policy

3.1. Open data policy

LIQUIDICE promotes and follows an open data policy, ensuring that data, metadata and research outputs are made publicly available without delay. The work will be done in alignment with FAIR guiding principles for data stewardship (Wilkinson et al., 2016) and EU Open Science Guidelines. Data will be shared through recognized repositories following standardized formatting and with clear licensing terms to maximize reuse. There can be cases where data contain sensitive, proprietary, or legally restricted information due to third-party agreements, in which case access may be restricted. Controlled access mechanisms and appropriate safeguards will be implemented to balance openness with security and compliance in such cases. The datasets and accompanying metadata will be made available as soon as possible, and in any case within 24 months after the completion of LIQUIDICE.

3.2. Licensing

While LIQUIDICE is committed to open data sharing and Open Science and FAIR principles, the data producers will retain control of the contents and ownership of their project outputs. To promote broad accessibility and reuse, open licenses are encouraged to be applied whenever possible. Recommended licenses include Creative Commons Attribution (CC BY 4.0) for datasets, CC0 (Public Domain Dedication) for metadata, and MIT or Apache 2.0 for software. These licenses ensure proper attribution while maximizing the impact of research outputs and enabling collaboration on the datasets. Proprietary, sensitive or confidential data might require other specific licensing practices and those will be determined on a case-by-case basis when necessary.

4. Data/metadata model, formatting and catalogues

4.1. Metadata model

LIQUIDICE aims to primarily rely on documentation of datasets through discovery metadata. The information model to be used is the MET Norway Metadata Format Specification (MMD), which is based on the information model adopted by SIOS for the operation of their central metadata catalogue. The MMD is supported by a vocabulary service (https://vocab.met.no/) that is linked to other vocabulary services, e.g., the NERC Vocabulary Server, the Global Change Master Directory keywords vocabulary, as well linked to relevant international resources, e.g., the WMO Space-based Capabilities (OSCAR/Space) catalogue.

Data producers are required to follow the Attribute Convention for Data Discovery (ACDD) for populating the discovery metadata for their records. The highly recommended fields should all be included and properly formatted for both global and variable attributes. The inclusion of additional fields from the list of recommended and suggested global attributes from the ACDD is encouraged due to them improving reusability of the datasets. The highly recommended fields in ACDD include title, summary, keywords and conventions used. Other fields that should be included in all metadata entries are author, date, dataset description, license, provenance and any discipline-specific metadata fields that are required for understanding the contents of the data (such as spatial resolution).

All metadata shall be provided in machine-readable formats. Used metadata should follow standard naming conventions such as the CF conventions, and we encourage storing the metadata in the dataset (e.g., attributes in NetCDF or Zarr).

4.2. Recommended data formats

The chosen data formats should ensure machine-readability and long-term accessibility. The use of common formats helps facilitate collaboration between disciplines, groups and research domains. We recommend that the LIQUIDICE datasets are published mainly as CF-NetCDF or Zarr for large model output.

4.3. (Meta)data catalogues

There will be no specific portal developed for LIQUIDICE and project outputs will be published in various repositories and data centres that allow for publication of data according to FAIR guiding principles for data management and stewardship (Wilkinson et al., 2016).

5. Data quality policy

The LIQUIDICE project personnel that will be responsible for producing and curating data are highly trained and qualified researchers who are familiar with appropriate practices and adhere to high quality standards. This includes applying suitable methods and data documentation practices that ensure the best possible quality of the data, its dissemination and reproducibility. Researchers are expected to acknowledge everyone contributing to the work and to respect accountability to the general public. Project partners must take all reasonable steps to ensure that their research complies with any relevant regulations and agreements and is as transparent as possible.

6. Data security

LIQUIDICE will implement robust data security measures to ensure the integrity, confidentiality and availability of research data. Data producers are encouraged to publish their data in established repositories that ensure secure and continued availability of their data. Sensitive data that will require restricted access should be published in repositories with secure authentication protocols. Data that contains personal or confidential information should be encrypted and pseudonymized, and only be transferred using secure data transfer methods. The project security measures will be periodically reviewed to address possible emerging risks and to ensure long-term data protection.

7. Policy for research outputs

LIQUIDICE encourages open sharing of all research outputs and recommends that researchers make publicly available outputs such as presentations, newsletters, code and more in addition to their key datasets and peer-reviewed publications. LIQUIDICE and the grant agreement number should be acknowledged in publications.

7.1. Scientific publications

Peer-reviewed scientific publications should be published in open access journals. The project, collaborators and used data should be clearly acknowledged and the persistent identifiers of used datasets should be reported in the research papers. We recommend the following sentence:

"This work was funded by the European Union's Horizon Europe research and innovation programme through the project LIQUIDICE (grant number: 101184962)"

7.2. Scientific code

Unless there is a valid reason not to, code should be shared on open platforms like GitHub. This helps advance open science, enables transparency and allows for verification and replication of findings. Sharing code also helps prevent duplication and provides a foundation for continuing development and fosters collaboration.

7.3. Other publishable results

Other publishable results should be organized under a LIQUIDICE community in the open-access repository ZENODO. Zenodo allows for the publication of various types of outputs, such as presentations, promotional materials and meeting proceedings, and one of the benefits is that this is a good way to receive a persistent identifier for the materials. The publication of any sensitive material, journal articles and datasets should however be done through other repositories.

8. Ethics and GDPR

Partners must carry out their research following ethical principles for research integrity in all parts of data collection, production, storage and sharing. This includes paying attention to non-discrimination, rights to privacy, right to protection of personal data, and the need to ensure the protection of both the environment and human health. The principles of the reliability of quality of research must be followed in design, methodology, analysis and use of resources. All parts of the research work must be transparent and honest. The researchers must also respect their colleagues, society, ecosystem and cultural heritage, and refrain from any research integrity violations as described in the European Code of Conduct for Research Integrity. The team working in Greenland (Kalaallit Nunaat) will follow the guidelines from Greenland's National Research Strategy 2022 — 2030.

LIQUIDICE adopts the following approach to GDPR. All personal data collected as part of the project will be limited to that necessary for the purposes of research and any sensitive data will be anonymized when possible. When personal data is collected, informed consent must be ensured and a record of obtaining proper consent must be maintained.

During the collection of qualitative data (e.g., interviews, questionnaires, workshops), external participants will be informed that sessions may be recorded (audio) and photographs may be taken for scientific purposes. All data will be handled in accordance with ethical standards and GDPR (2016/679). A standard Privacy and Consent Form will be used in each participatory

session to explain how personal data will be processed and to obtain explicit, voluntary consent. The form will also clarify to participants that consent can be withdrawn at any time.

Compliance with GDPR (2016/679) will be ensured, which includes carrying out a periodic data protection impact assessment. Personal information such as name and ORCID about principal investigators and co-authors does not fall under GDPR as it is in the interest of the researchers to be recognized for their contributions.

9. References

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