CrossEU

D6.2 – Data Management Plan (Version 2)

WP6 - Task 6.1

May 2025

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Executive Summary

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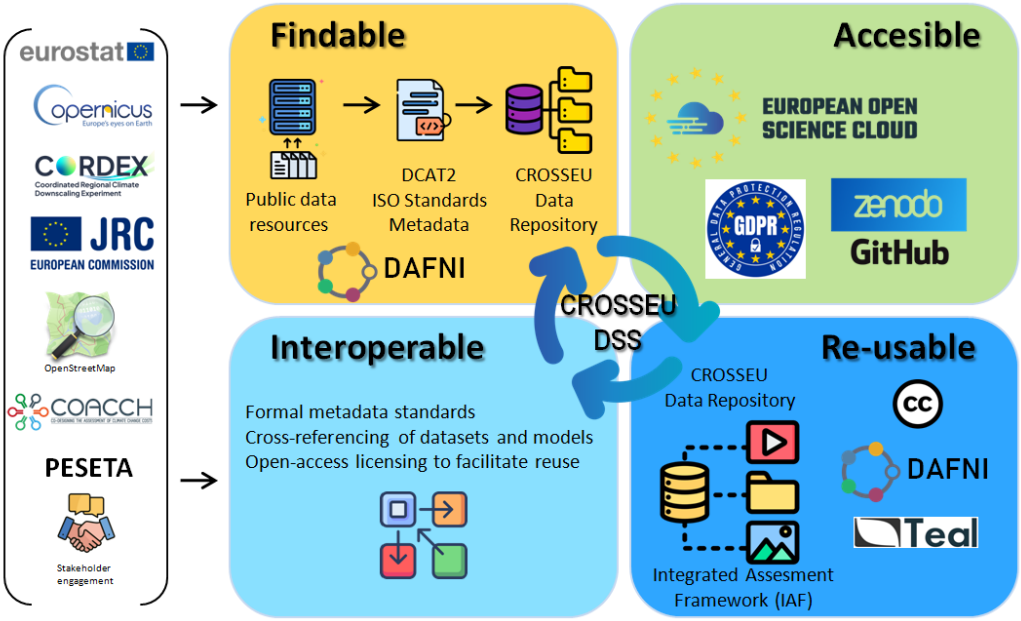
This new version of the Data Management Plan (DMP) provides an updated description of the data handling including data collection, its organisation, curation, storage, and provision for its access, preservation, security, quality assurance, allocation of persistent identifiers, metadata, licensing, rules, and procedures for sharing and deletion of data, both during and after the CROSSEU project. It aims to explain the data utilised and its connection to the project's Work Packages (WP), as well as how the data generated by the project will be accessible to various communities.



Keywords

Impact data, biogeophysical risks, socio-economic risks, climate change, risk modelling, decision-support system, case studies, DAFNI platform, TEAL

Abbreviations and acronyms

Abbreviations	Description
BGP	Biogeophysical
CA	Consortium Agreement
CC	Climate Change
CC0	Creative Commons Public Domain Dedication
CCH	Climate Change Hotspot
CGE	Computable General Equilibrium model
CLIMADA	CLImate ADAptation
CMIP	Coupled Model Intercomparison Project
COACCH	Co-designing the Assessment of Climate Change Costs project

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CSA	Case study area
D	Deliverable
DAFNI	Data and Analysis Framework for National Infrastructure
DMP	Data Management Plan
DOI	Digital Object Identifier
DSS	Decision Support System
EEA	European Environmental Agency
EOSC	European Open Science Cloud
EPIC	Environmental Policy Integrated Climate model
FAIR	'Findability', 'Accessibility', 'Interoperability' and 'Reusability'
GA	Grant Agreement
GDPR	General Data Protection and Regulation
HDR	Harmonised Data Repository
HPC	High Performance Computing
IAF	Integrated Assessment Framework
IAM	Integrated Assessment Modelling
IIASA	Institute for Applied System Analysis
IPR	Intellectual Property Rights
NUTS3	Nomenclature Units for Territorial Statistics 3
PI	Principal Investigator
RCP	Representative Concentration Pathways
SE	Socio-economic
SNOW-17	Snow Accumulation and Ablation model
SSP	Shared Socio-economic Pathways
STL	Storyline
TESSA	Toolkit for Ecosystem Service Site-based Assessment
WP	Working package
WBGT	Wet Bulb Globe Temperature

Summary of changes

Version 2 of the CROSSEU DMP (D6.2) reflects significant progress since Version 1 (March 2024), enhancing alignment with FAIR ('Findability', 'Accessibility', 'Interoperability' and

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'Reusability') principles, refining metadata standards, and strengthening legal and ethical safeguards for data sharing. Key updates include:

- Metadata and Structure: A robust metadata framework was introduced to improve dataset discoverability and standardisation within the Harmonised Data Repository (HDR).
- Interoperability and Licensing: Open licenses (e.g., CC0, CC BY-NC-ND) and preferred data formats (e.g., XML, NetCDF) are now more clearly assigned, improving cross-model and decision-support system (DSS) integration.
- Expanded Data Scope: New sections and an annex detail how existing and new datasets support case studies and macroeconomic analyses, linking data use to thematic and geographic contexts.
- Ethical Compliance: General Data protection and Regulation (GDPR) provisions are strengthened, with clearer guidance on consent, anonymisation, and stakeholder engagement.
- Platform Integration: Harmonised Data Repository (HDR) integration with the Data & Analytics For National Infrastructure (DAFNI) platform and TEAL interface is outlined, including reuse protocols for post-project data access.
- Roles and Responsibilities: Cross-work package coordination is reinforced, especially for work packages WP2 and WP3, to support interdisciplinary data workflows.

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Introduction

CROSSEU is a project funded by the European Union that aims to build a climate-sensitive framework, including a ready-to-use DSS and technical recommendations. This framework will help investment decisions, adaptation and mitigation decisions and policies.

To tackle all the specific objectives the project has set, CROSSEU was divided into six work packages. WP6 is dedicated to project management. Task 6.1 is dedicated to administrative, legal and financial management and reporting to EC and includes the elaboration and update of the Data Management Plan (DMP). As a living document, this data management plan will be maintained and updated throughout the CROSSEU project's lifecycle, with changes and revisions made as necessary to reflect evolving project needs and address any emerging issues.

1. DMP objectives and updates

The second version of the DMP for the CROSSEU project builds upon the foundational data management framework for updating data contents re-used and generated within the project, in line to the original project proposal and Grant Agreement (GA). It expands on the types of datasets involved and details the data-sharing strategies that will be adopted throughout the project's implementation period.

1.1. Objectives

The primary aims of DMP v0.2 are to:

- Outline the datasets that have been re-used and those that have been generated within the project until M17.
- Describe how the CROSSEU consortium will ensure that data is findable, accessible, interoperable, and reusable (FAIR), and explain the measures for data curation and long-term preservation.
- Ensure active engagement with stakeholders during and after the project's lifecycle.
- Detail the approach to managing personal data collected during stakeholder engagement activities, including the principles and safeguards adopted to ensure compliance with the General Data Protection Regulation (GDPR).

1.2. Updates

The DMP is a dynamic, evolving document that is continuously updated to reflect the status of data being generated or utilized throughout the CROSSEU project. A final update will be released as Deliverable D6.3 – Data Management Plan, Version 3 in Month 35 (M35), and will be made publicly available. DMP v0.3 will provide a comprehensive account of all data-related activities conducted over the course of the project, including the processes of data collection, storage, assessment, and post-project exploitation.

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2. Data summary

Within the CROSSEU project, a dataset is defined as any structured collection of data originating from single or multiple sources, including newly generated data produced over the course of the project. These datasets are integral to the project's activities and are used for analytical, validation, dissemination, communication, reusability, and demonstration purposes.

The CROSSEU consortium leverages a broad spectrum of existing data sources, particularly in the domains of climatology and socio-economics, at both the European scale and the more focused Case Study Area (CSA) level. These datasets serve as essential inputs for project analyses and scenario development. Throughout the project's duration, the consortium actively evaluates and integrates new, high-quality datasets as they become available, ensuring alignment with the evolving assessment methodologies.

Data sources utilized by CROSSEU, whether provided by consortium members or third parties, must comply with predefined standards, constraints, and access conditions. These include Intellectual Property Rights (IPR) and legal limitations as outlined in the CROSSEU Consortium Agreement (CA). This agreement, already endorsed by all partners, establishes the framework for data sharing and may be updated as necessary throughout the project lifecycle.

A core objective of data management in CROSSEU is the creation of **the CROSSEU harmonised data repository (HDR)** — a comprehensive and harmonized database that integrates a wide range of data types. This will include: (i) In situ observations, (ii) Reanalysis datasets, (iii) Remote sensing data, (iv) Model outputs (BGP and SE as described in the deliverable D1.2 - Leveraging bio-geo-physical data outputs to enhance social value for climate adaptation. Interim Report), produced by the project or sourced from platforms such as EUROSTAT, COPERNICUS, national inventories, and relevant past or ongoing EU research initiatives (e.g., the COACCH Data Repository) and (v) Impact data from CSA level.

This repository combines both re-used data (existing, ready-to-use, and publicly available datasets) and newly generated data (outputs from CROSSEU modelling and vulnerability and risk analyses) to feed the proposed solution of the project — the CROSSEU DSS —, supported by two powerful operational tools DAFNI and TEAL (Fig. 1). The overall data resources support multiple project goals, including:

- Socio-economic risk assessments in CSAs, informed by event-based storylines (STLs) and climate change hotspots (CCHs) under diverse sectoral and cross-sectoral conditions and scenarios (WP2).
- Upscaling of local findings to broader European contexts.
- The DSS will feature an advanced TEAL visualization tool (WP3), enabling stakeholders and policymakers to better assess and respond to socio-economic climate risks.

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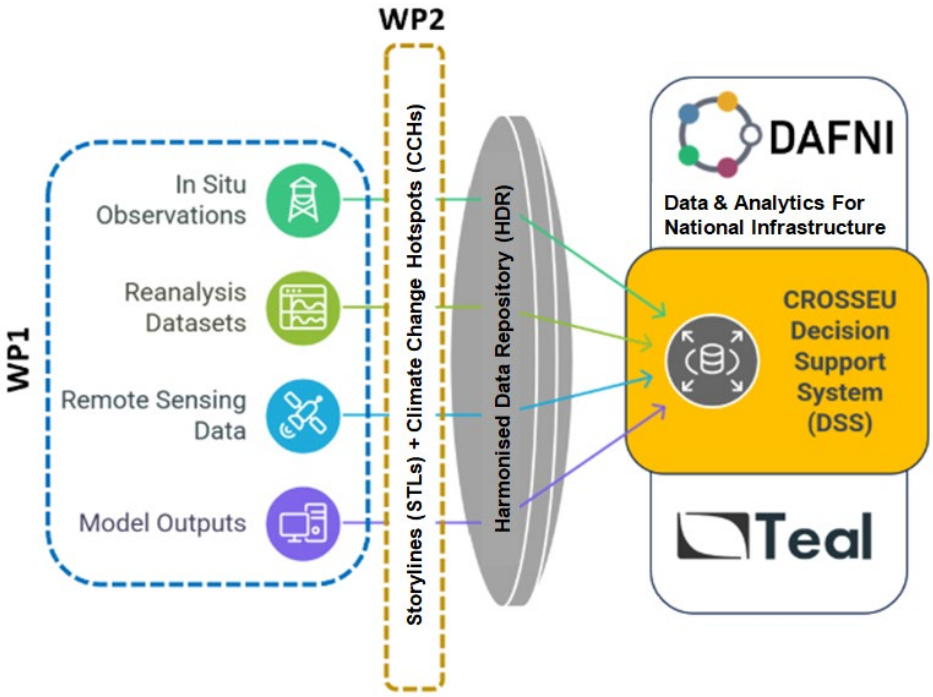

Figure 1. Data flow and integration in the CROSSEU DSS

2.1. Types and formats of data generated and re-used in the CROSSEU project

The CROSSEU project adopts a pragmatic and resource-efficient approach to data use to effectively meet its research objectives and proposed policy-oriented goals. A significant share of the data inputs required for analysis and implementation is sourced by the project's consortium members and from engaged stakeholders, from various existing datasets. Additionally, publicly available data licensed for reuse is incorporated where relevant and applicable.

The consortium developed new datasets tailored to the project's and stakeholder needs. These data resulted through dedicated modelling procedures as outlined in Deliverable D1.1 (The co-design and operationalisation of the CROSSEU methodology) and the interim Deliverable D1.2 under WP1, while ensuring consistency with the co-developed scientific and operational design.

The project relies on the integration of diverse datasets and associated metadata, originating from a broad spectrum of disciplines and technical domains. These include:

- Direct measurements (e.g., in situ environmental observations),
- Simulation outputs from models spanning various scales,
- Earth observation products obtained via remote sensing.

The thematic scope of data integration covers several interconnected areas of expertise:

- Socio-economics (SE), including both macro- and micro-scale models, valuation methodologies, and policy impact simulations;
- Climate science, using future scenarios and the assessment of various climate hazards and socio-economic risks driven by climate change;

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- Environmental and land system modelling, focused on biogeophysical (BGP) dynamics, ecosystem interactions, and land use transformations;
- Data harmonisation and systems engineering, enabling the development of interoperable databases for cross-sectoral and cross-regional analysis;
- Risk assessment, aimed at understanding the complex socio-economic risks as reflected by the environmental, economic, and societal vulnerabilities.

An essential element of the CROSSEU methodology is the integration of scientific modelling with participatory processes, ensuring that both quantitative insights and qualitative knowledge contribute to evidence-based decision-making. This integrated approach is systematically applied across all CSAs of the project, including storyline-driven contexts and climate change hotspot regions, to deliver meaningful outputs for a range of climate-sensitive sectors such as health, energy, agriculture, finance, migration, and biodiversity management.

This initial release of the DMP outlined the types of data reused and generated within the project, offering a preliminary overview of their sources, formats, and intended uses. Subsequent version of the DMP provides updated and expanded descriptions as new datasets become available for the 8 case studies of the project and as the integrated modelling outputs and stakeholder engagement activities progressed.

2.1.1. Re-used data from available resources

To build a robust evidence base for assessing socio-economic and climate-related risks across Europe, the CROSSEU project leverages a diverse and extensive set of existing datasets collected from publicly available sources, international research programs, and institutional partners. This strategy aimed to ensure an efficient use of data resources, scientific interoperability, and consistency across all case studies and climate change hotspot regions identified in the project.

The initial data survey conducted under WP1 identified over 50 core datasets re-used within CROSSEU, spanning environmental, socio-economic, and geospatial domains. These datasets come from authoritative and well-established resources such as Copernicus, EUROSTAT, IIASA, PESETA, and OpenStreetMap, and served as critical inputs for climate hazard (i.e., heat, drought, storm, flood, snow) analysis, socio-economic vulnerability assessment (for various components i.e., sensitivity, adaptative capacity), impact evaluations/modelling and risk level estimations (Fig. 2).
Key examples of re-used datasets include:

- **Climate and environmental data** from Copernicus services, such as land cover (e.g., CORINE2018), tree cover density, soil moisture indices, vegetation indices (e.g., normalised difference vegetation index, leaf area index) and land surface temperature composites.
- **Climate projection (scenario) data** from the Coupled Model Intercomparison Projects Phase 5 (CMIP5) and Phase 6 (CMIP6), including downscaled EURO-CORDEX datasets, support analyses of future climate conditions and their impacts across the project's key hazard categories: heat, drought, storm, flood, and snow.

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- **Socio-economic and demographic data** from EUROSTAT, including population distribution, health, education, poverty levels, and employment, as well as historical and scenario-based on the gross domestic product and population data from IIASA.
- **Geospatial data** integrating data referring to the spatial distribution of different elements at risk (e.g., road and rail networks, buildings, tourist infrastructure elements), obtained from OpenStreetMap, national inventories, and pan-European spatial datasets.
- **Impact records** from national or European statistics and research programs and initiatives, such as daily water level data on the Danube, death counts disaggregated by cause and region avalanches fatalities.
- **Various data derived through stakeholder engagement activities** (e.g. data related to storyline event location, impact data).

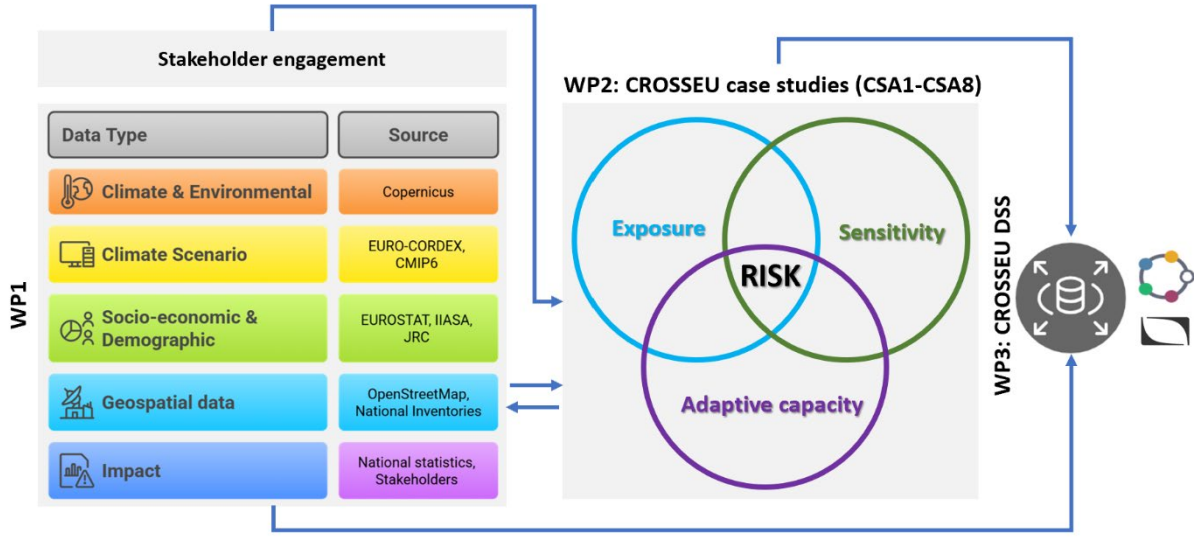

Figure 2. Types and sources of re-used data and their connection to case study level risk evaluations (WP2) and DSS (WP3).

These datasets are stored internally via UEA's HPC (as described in the deliverable D1.2) and further, they will be linked via metadata into the CROSSEU HDR hosted on the DAFNI platform as described in Deliverable 1.6 (CROSSEU IAF-Harmonized Data Repository, version 1). The HDR acts as both a physical and virtual repository that feeds the CROSSEU DSS, linking to remotely hosted datasets and supporting token-based, policy-driven access protocols.

A key advantage of CROSSEU's approach to data re-use is that it enables comparative analyses across sectors, regions, and spatial scales, thereby enhancing the project's ability to generate policy-relevant and actionable insights for a wide range of domains, including health, infrastructure, agriculture, finance, and energy. By leveraging both open-access datasets and data contributions from project partners, CROSSEU ensures a rich and diverse data foundation that supports integrated, cross-sectoral assessments. As the project progresses, additional datasets will be continuously identified, assessed, and incorporated into the HDR, in alignment with the FAIR data principles. This process will be guided by robust standards of data provenance, licensing transparency, and metadata quality, ensuring the integrity and long-term usability of all datasets within the CROSSEU framework.

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2.1.2. New data generated by the project

The CROSSEU project is generating a diverse set of new datasets through the implementation of climate and socio-economic modelling frameworks, tailored specifically to support the assessment of the socio-economic risks of climate change of the selected case studies across Europe. These new datasets are instrumental in underpinning the analytical capabilities of the DSS, ensuring that policy-relevant insights are rooted in up-to-date and context-specific evidence to support stakeholders in the decision-making for a more efficient risk management.

New data generated within the CROSSEU project is primarily the result of activities carried out in WP1 and WP2. In WP1, the BGP and socio-economic (SE) modelling activities are conducted to capture the complex interactions between climate hazards, economic systems, and social vulnerabilities. These outputs are subsequently integrated in WP2 into tailored socio-economic vulnerability and risk assessment frameworks, which are applied across the project's eight case studies to support context-specific analysis and decision-making. Key outputs include:

- **Enhanced integrated assessment modelling (IAM)**. This is a core modelling strand that involves an updated version of the PAGE2020 model, recalibrated to incorporate the latest CMIP6/AR6 climate data. This version includes improved damage and adaptation modules, building insights from CROSSEU as well as earlier EU-funded projects (e.g., PESETA IV, COACCH). The model extends its resolution to cover four distinct EU regions (Central and Eastern, Northern, Southern, and Western Europe), enabling regionally differentiated impact assessments.
- **Climate–socio-economic scenario framework**. CROSSEU develops a modelling framework that links climate scenarios with socio-economic narratives, generating datasets that capture plausible futures of risk exposure, adaptive capacity, and systemic vulnerability at both national and sub-national levels.
- **Updated macroeconomic and econometric models.** The project integrates refined Computable General Equilibrium (CGE) modelling, particularly the ENGAGE model developed by UCL, to assess macro-level responses to climate shocks and adaptation policies across multiple sectors.
- **Sector-specific impact estimations.** Several new datasets are being created using specialized models for estimating climate impacts on some target sectors (Table 1).

Table 1. Models employed in the CROSSEU CSAs for sector-specific estimations

CSAs	Models employed (partners involved)	Purpose of use / Justification of alternative models	References
CSA1 (Heat)	Multivariate meta-regression model (CZU)	The multivariate meta-regression modelling framework was used (instead of CLIMADA) because it was developed specifically for	Gasparrini et al. 2012; Vicedo-Cabrera et al. 2019

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		modelling the impacts of temperature variability and climate change on human health	
CSA2 (Drought)	Environmental Policy Integrated Climate model - EPIC (BOKU, MeteoRo)	Simulation of soil productivity and yield losses in agriculture	Williams 1995
CSA3 (Storm)	Flood Damage Cost Model (DTU)	Evaluation of the economic costs of hydrological hazards under different scenarios	https://github.com/Skadesokonomi
CSA5 (Snow)	Snow accumulation and Ablation Model - SNOW-17 (MeteoRo)	Estimation of snow avalanche hazard conditions (i.e., rain-on-snow) / The SNOW-17 model was selected over SNOWPACK due to its greater suitability for large-scale, climate-driven assessments of rain-on-snow events and related snowmelt dynamics relevant to snow avalanche hazard analysis	Anderson 2006
CSA6 (Cross-sectoral multi-hazard risks)	Toolkit for Ecosystem Service Site-based Assessment - TESSA (UB)	Evaluation of climate change impacts on ecosystem services and natural capital	Peh et al. 2013
CSA8 (Spillover)	Subnational-ENGAGE model	Assessment of the economy-wide implications of climate-induced impacts on agricultural outputs and labour productivity across Europe and globally, using a dynamic, multi-sectoral, and multi-regional Computable General Equilibrium (CGE) framework.	Calzadilla et al. (forthcoming)

All new data generated in the project will be integrated into the HDR hosted by the DAFNI platform. They represent a critical asset in all case studies of the project, especially for the sectoral and cross-sectoral risk analyses and identification of adaptation options.

2.1.2.1. CSA datasets

As part of its commitment to delivering robust, context-specific climate risk assessments, the CROSSEU project is generating a diverse suite of new datasets tailored to the needs of its case studies. These datasets are developed through the integration of high-resolution climate modelling, sector-specific impact simulations, and co-designed socio-economic scenarios. All data production and use follow a harmonised protocol established in WP1

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(further details are outlined in the interim Deliverable D1.2), which guides data selection, preparation, and application across case studies, ensuring scientific consistency, comparability, and methodological coherence throughout the project.

Each case study builds upon a shared foundation of climate data, predominantly derived from CORDEX-EU CMIP5 model ensembles at 0.11° resolution. Several CSAs employ customised datasets, including:

- CSA3: High-resolution (1 km) projections from DMI's Klimaatlas.
- CSA4: Convection-permitting CORDEX-CPM data at 2.5–3.0 km resolution.
- CSA7 and CS8: Global-scale CMIP6-based datasets at coarser resolution.

Standardised climate time slices are used across the project: 1971–2000 (baseline), 2011–2040 (near-present), 2041–2070 (mid-century), and 2071–2100 (end-of-century). Most case studies use these 30-year intervals with multi-model ensembles (≥5 members) to capture both climate variability and model uncertainty. CSA1 and CSA4 use 10-year time slices due to either research focus or technical limitations of the source datasets.

Scenario modelling is aligned with two representative concentration pathways (RCP), namely RCP4.5 and RCP8.5, enabling exploration of both moderate and high-emission futures. These scenarios are mapped to socio-economic trajectories using the shared socio-economic pathways SSP1 and SSP5, with additional combinations such as SSP1–RCP2.6 and SSP3–RCP7.0 used selectively (e.g., CSA3) to highlight the combined influence of climate and socio-economic dynamics. CSA1 employs demographic scenarios EUROPOP2019, providing population and mortality projections at the NUTS3 level, to consider the role of population aging in heat-related mortality estimates.

To ensure interoperability with land-based data layers, land cover harmonisation is also pursued across case studies. Where relevant, WP1 provides or supports the generation of land cover datasets aligned with SSP-specific projections, particularly in areas where land use change has a significant role in shaping future risks.

The case study datasets serve multiple project objectives:

- Supporting BGP and SE modelling.
- Enabling integrated and sectoral risk assessments.
- Facilitating downscaling to NUTS3 for regional planning and modelling (e.g., in the ENGAGE CGE model).
- Contributing to the CROSSEU HDR and DSS.

As part of WP1's support to WP2, tailored climate datasets are produced for each case study, for the analysis of the key hazards (heat, drought, storm, floods, snow). For example: (i) CSA3 and CSA4 already integrate 1 km and 3 km resolution datasets, respectively, and (ii) CSA5 and CSA6 include variables like snowfall water equivalent, wind speed, and soil moisture to address specific regional vulnerabilities. In parallel, each case study generates new sectoral datasets to support decision-making in domains such as agriculture, health, infrastructure, and ecosystem services:

- CSA1: Heat-related mortality estimates using multivariate meta-regressions.

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- CSA2: Agricultural yield impacts via EPIC.
- CSA3: Flood damage cost estimations from DTU's economic model.
- CSA5: Potential snow avalanche hazard conditions estimated with Snow-17 (i.e., rain-on-snow conditions).
- CSA6: Ecosystem service assessments using TESSA model.

Each CSA also contributes to developing co-designed scenarios that combine SSPs and RCPs, ensuring that socio-economic risk indicators and adaptation metrics reflect both scientific modelling and stakeholder input. This participatory element grounds the scenario analyses in real-world conditions and enhances their policy relevance.

Together, these datasets constitute a critical foundation for the CROSSEU project's analytical and advisory outputs. They reflect the project's emphasis on scientific rigour, cross-sectoral insight, and stakeholder engagement, enabling the development of tailored resilience strategies across Europe's diverse regions.

2.1.2.2. Datasets for macroeconomic (econometric) analyses

In addition to the CSA specific data, further indicators have been created to support the econometric modelling in the task T1.3. This part of CROSSEU aims to explore the effects of climate extremes on income inequality and to do so, climate hazards need to be linked to economic data on a global level. Based on the ERA5 core datasets, frequency and severity of selected climate extremes – such as heatwaves, tropical nights, extreme rainfall days – were determined on national levels. All generated data relating to this task will be available on the CROSSEU HDR and integrated into the DSS once harmonisation and modelling have been finalised. More detailed information on all relevant data and harmonisation processes are provided in interim deliverable D1.3 (Data on the sectoral impacts of selected mitigation and adaptation strategies at European level).

The task T1.3 focuses on the macroeconomic modelling of climate impacts through two main approaches. First, the UEA team develops and estimates an econometric model designed to identify the economic drivers of income inequality at the global level. The econometrically estimated coefficients are then used to update the Poverty module of ENGAGE - the CGE model developed by UCL that underpins our WP1 macroeconomic analysis. The UCL team then runs the CGE model to update computational estimates of gross domestic product damages. This integration enables the CGE model to account for the interaction between climate change impacts and income inequality using the most current available data. Moreover, the UEA team also develops and applies econometric models to estimate the effects of extreme weather events on income distribution and inequality, using global economic (supplied by the World Bank) and climate (supplied by Tyndall) data. Our current models account for four key types of extreme weather events: heatwaves, cold waves, icing days, and hot days. Future iterations will expand the scope to include other events such as droughts, floods, and possibly more. The results of the econometric modelling will be used to compare against and validate the outputs of the CGE model.

2.1.2.3. Datasets for macroeconomic analyses

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The macroeconomic analyses (CSA8) aim to assess climate change impacts on agricultural labour productivity by applying the Hyatt et al 2012) methodology to compute the wet bulb globe temperature (WBGT) from projected climate data. Monthly gridded projections of temperature and precipitation at NUTS2 level under RCP4.5–SSP2 and RCP8.5–SSP5 are used to derive relative humidity and vapor pressure. These are input into the WBGT formula to estimate regional heat stress impacts.

The resulting WBGT values inform damage functions linking heat exposure to reduced labour productivity, following Roson and Satori (2016). These impacts, along with projected crop yield changes, are introduced into the Subnational-ENGAGE CGE model to quantify socio-economic risks at regional scale, including shifts in production, consumption, trade, GDP, and welfare. Outputs of these analyses support CSA8 and WP2 by revealing regional and transboundary vulnerabilities and adaptation needs.

Macroeconomic modelling results are integrated into the CROSSEU HDR and DSS, enabling scenario-based analysis and stakeholder engagement. The structuring of all employed variables is annotated with standardised metadata to ensure consistency and interoperability across work packages. Each dataset will include:

- Emissions scenarios: RCP4.5-SSP2, RCP8.5-SSP5;
- Climate simulation: Ensemble mean;
- Frequency: Annual;
- Units: Million € and % change from baseline;
- Spatial resolution: NUTS2;
- Temporal coverage: Baseline to mid-century (e.g., 2030, 2050);

This harmonised structure ensures that the CGE outputs are fully compatible with other datasets in the repository and can be effectively leveraged within the CROSSEU DSS for scenario analysis, policy evaluation, and stakeholder engagement.

2.1.3. Data derived through stakeholder engagement

Activities in the CROSSEU project places strong emphasis on the integration of data and insights derived from its communication and dissemination activities. These activities not only support the visibility of the project but also generate valuable information that contributes to shaping its scientific, operational, and policy outputs. The data collected from engagement efforts, particularly through co-design sessions, feedback loops, stakeholder surveys, and use case workshops, serve as a dynamic and evolving input stream into both the project's DSS and the broader data infrastructure.

The first round of stakeholder engagement has already yielded a range of qualitative and quantitative data types, including user expectations, accessibility preferences, and sector-specific priorities. For instance, during initial workshops for case studies such as CSA1 and CSA5, detailed feedback was collected on how public health officials, emergency responders, and civil protection agencies interpret and apply climate data in operational decision-making. This information has been instrumental in defining user requirements for the visualisation functionalities and analytical tools embedded in the DSS.

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Moreover, stakeholder surveys have been used to capture data on existing gaps in access to climate information, preferred formats for data downloads (e.g., CSV, GIS-compatible files), and the desired types of visualisations (e.g., maps, time series, and scenario-based comparisons). These structured responses inform both the technical development of the DSS interface, and the metadata attributes of outputs intended for broader dissemination. All these user requirements are included in Deliverable 3.1 (Inventory of user requirements and support system processing workflow and functionalities).

As the project progresses, future engagement rounds and beta-testing of the DSS will generate new feedback data and user interaction logs, which will be systematically harvested, analysed, and fed back into the iterative refinement of project tools. These evolving datasets from communication and dissemination activities will therefore remain a key component of the CROSSEU data ecosystem, contributing both to the relevance and the usability of the project's scientific outputs. Some relevant examples of data derived from stakeholder activities in CROSSEU are presented hereafter.

- **User requirements and preferences** – e.g., survey responses on preferred data formats (e.g., *.CSV, *.GeoTIFF), feedback forms from stakeholder workshops detailing usability expectations for the DSS, ranked preferences for visualisation types (e.g., time series, impact maps, climate storylines).
- **Sector-specific priorities and decision contexts** – e.g., sectoral data gaps, such as missing socio-economic indicators for different sectors, adaptation preferences.
- **Perceived risks and vulnerabilities** – e.g., workshop-collected insights on prominent climate-related hazards under climate change, narrative inputs from stakeholders describing past climate-related events and institutional responses.
- **Scenario co-design and validation** – e.g., preferred socio-economic trajectories, weights of adaptation measures (e.g., through pairwise comparison or scoring), validation of climate storylines based on local knowledge and policy realities.
- **Engagement and usage metrics** – e.g., interaction logs from the DSS testing (this could be most viewed indicators, number of downloads or maps accessed, charts generated from Teal). Also to include user feedback on the DSS.
- **Recorded testimonials or quotes** from local actors expressing information needs or experiences.

2.2. Data formats

The data formats used in the CROSSEU project remain consistent with those outlined in the previous version of the DMP. The types of data generated, collected, and processed throughout the project will include, but are not limited to, the following formats:

- Tabular data stored in widely accessible ASCII formats such as *.txt and *.csv files;
- Gridded or array-based data in formats commonly used for scientific datasets, including *.NetCDF and *.HDF;
- Geospatial data, comprising vector formats (e.g., ESRI shapefiles, geodatabases) and raster formats (e.g., *.GeoTIFF);

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- Survey data, including structured questionnaires and associated quantitative datasets;
- Multimedia content, such as audio files (*.mp3), video files (*.mp4), and images (*.jpg, *.png);
- Model scripts and data harmonisation tools, developed using open-source programming languages (e.g., Python, R), maintained with version control systems (e.g., Git), and hosted in trusted repositories (e.g., GitHub, Zenodo);
- Project documentation and communication materials, including reports, deliverables, presentations, and textual documents in formats such as *.txt, *.pdf, *.docx, .pptx, as well as compressed file archives (*.zip, *.rar).

2.3. Data curation and storage

The CROSSEU project generates a diverse array of data types across its multiple case studies and work packages, including observational datasets, simulation outputs, socio-economic indicators, modelling scripts, and stakeholder co-developed outputs. These datasets are curated and managed according to EU standards on data quality, security, and privacy, in line with GDPR compliance and FAIR data principles.

The core data infrastructure for the project is built around the DAFNI, which provides robust, scalable capabilities for data storage, model execution, and workflow integration. DAFNI is used to host the CROSSEU Integrated Assessment Framework (IAF), which supports data uploading, workflow orchestration, and version-controlled modelling. Data curated in the CROSSEU HDR will be stored within this platform for the duration of the project, enabling advanced simulations, analysis, and decision-making. While DAFNI serves as the primary repository for curated data, certain datasets, due to their size, sensitivity, or other constraints, are hosted externally. Models that require these external datasets will be processed externally only, and their results are uploaded to DAFNI for further use and visualization. Metadata is employed to link results to these external data sources and models, ensuring traceability and accessibility. For sensitive datasets, results are pre-processed (such as de-anonymization) before being uploaded to DAFNI. If sensitivity persists, data is stored with strict security measures, limiting access to authorized users only, as per the existing security provisions in DAFNI.

Data management within DAFNI (Fig. 3) includes:

- Structured data ingestion pipelines;
- Integration of internal datasets with external sources via metadata references;
- Workflow support for model chaining;
- Workflow storage using containerised environments (e.g., Docker);
- Visualisation outputs through Teal - a web-based front-end interface integrated into the DAFNI system – including interoperability with data sources using DuckDB.

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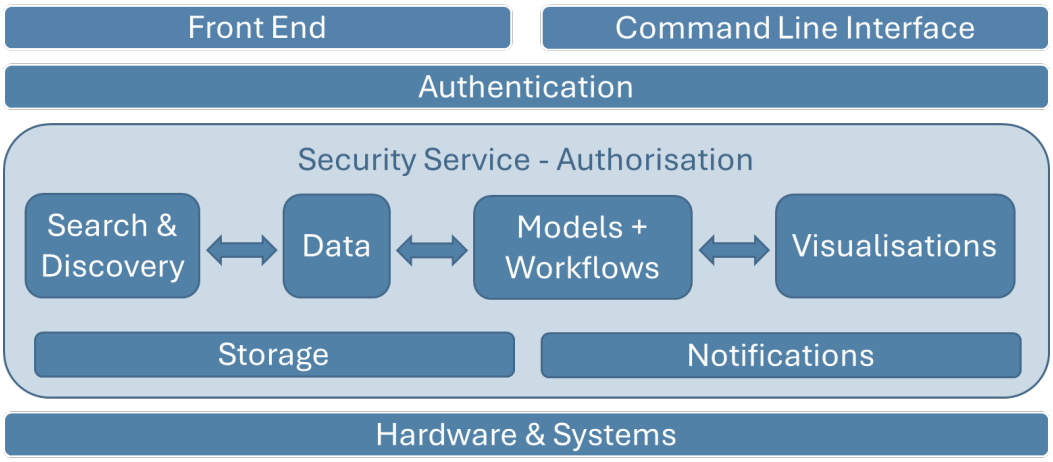

Figure 3. DAFNI core architecture.

As detailed in Deliverable 3.1, this technical configuration allows seamless access to data, real-time visualisation, and the ability to generate customised outputs from pre-processed and harmonised data streams. The Teal tool (Fig. 4) serves as the main interface for stakeholders, offering intuitive visualisation and downloading features. All datasets used or produced in CROSSEU, including gridded climate data, maps, model outputs, and socio-economic indicators, will be available in accessible formats (e.g., *.CSV, *.NetCDF, *.GeoTIFF, *.PNG, *.JPG).

In addition to DAFNI, trusted open-access repositories such as Zenodo will be used to ensure long-term preservation and citation of key project outputs, including scripts, codes, documentation, and metadata. Project-generated content (e.g., reports, presentations, images, multimedia) will be managed and shared via the consortium's dedicated Microsoft Teams SharePoint space, which ensures secure access across project partners.

The estimated data volumes include:

- Up to 50 TB for observational and simulation datasets hosted on DAFNI;
- Approximately 500 GB for project management data and multimedia, curated in SharePoint.

Each WP and local partner (including the CSA leads) will contribute data to the CROSSEU HDR, which will serve as the central hub for data exchange and research continuity. Metadata standards, access control policies, and naming conventions are enforced to maintain data integrity and enable consistent reuse across the consortium.

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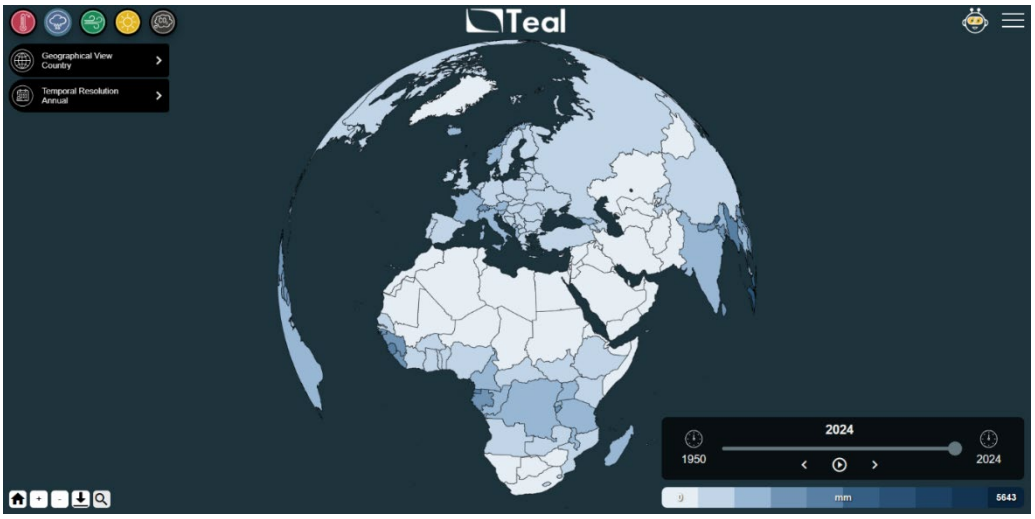

Figure 4. Teal - public version at https://tealtool.earth/

Long-term preservation of key datasets and models is planned for at least 10 years post-project completion, in compliance with Horizon Europe and institutional archiving policies. According to the CA, post-project access to DAFNI will be maintained for retrieving results, subject to the availability of the platform under the discretion of UKRI.

2.4. Roles and responsibilities

Data management within the CROSSEU project follows a structured, collaborative framework to ensure high standards of data integrity, privacy, accessibility, and reusability. Roles and responsibilities are clearly delineated to address the collection, processing, storage, sharing, and long-term preservation of project data, in full compliance with GDPR, IPR protection, and Horizon Europe open access requirements.

The CROSSEU CA defines the legal framework for data handling and sets binding obligations for all partners. It stipulates that, when necessary, parties must enter supplementary data processing, data sharing, or joint controller agreements prior to exchanging sensitive or personal data. For all data transfers outside the EU/EEA, partners are required to demonstrate compliance with EU data protection regulations and to implement adequate safeguards ensuring equivalency with GDPR standards.

To ensure ethical and legal handling of data, a core interdisciplinary team, coordinated by the Project Coordinator (MeteoRo), oversees the implementation of data protection, FAIR principles, and the secure curation of research outputs. This team includes experts from MeteoRo (RO), UEA (UK), UKRI (UK), UCL (UK), DTU (DK), and WEMC (UK). Their role encompasses data quality assurance, compliance with national and EU-level regulations, and support for harmonised data flows across case studies and stakeholder activities.

The technical backbone for data curation and storage is provided by the CROSSEU IAF, which operates through the DAFNI platform. UKRI leads the technical implementation of the CROSSEU HDR, as outlined in Deliverable D1.6. The HDR enables secure storage, metadata documentation (based on DCAT2 and GeoJSON-LD standards), version control, and controlled access through federated authentication protocols. Data owners retain full

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oversight over their contributions, and policy-based access ensures accountability, logging, and reproducibility.

Each WP lead holds direct responsibility for ensuring that data generated within their scope adheres to the project's DMP guidelines. They ensure data is uploaded to the HDR or relevant third-party repositories with appropriate metadata and licensing. In case of operational challenges or inconsistencies, WP leads are expected to coordinate with the Project Coordinator to resolve them in a timely and compliant manner.

The Principal Investigators (PI) of each partner institution are accountable for ensuring that all team members are familiar with and follow the DMP and CA stipulations. This includes the appropriate use and citation of shared datasets, the management of background and foreground IPR, and the adherence to security protocols when handling sensitive or proprietary information.

The communication, dissemination, and exploitation tasks, led by the LGI/WEMC team under WP5, are responsible for ensuring that data products, visualisations, and project outcomes are disseminated openly and in alignment with the Exploitation Strategy (D5.3) and the Communication and Dissemination Plan (D5.2). This includes maintaining the visual identity of the project, facilitating access to public data outputs through platforms such as Teal and Zenodo, and ensuring that dissemination is aligned with open science and stakeholder engagement objectives.

Lastly, project stakeholders and external partners engaged in co-design and DSS testing will be given access to project results through controlled interfaces, primarily via the Teal visualisation platform. They are expected to respect access protocols and provide feedback that can support system refinement and knowledge co-production throughout the project lifecycle.

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3. FAIR data

The research data managed within the CROSSEU project will follow the 'Findability', 'Accessibility', 'Interoperability' and 'Reusability' principles, EU standards and regulations[1].

3.1. Making data findable, including provisions of metadata

To ensure that data generated, collected, and re-used within the CROSSEU project is findable and usable by all intended stakeholders, the project adheres to the FAIR principles. All research data will be accompanied by comprehensive and structured metadata, enabling efficient discovery, access, and reuse across various scientific and decision-making domains.

The CROSSEU HDR, hosted on the DAFNI platform, supports this process through a robust metadata management system. The metadata schema, (detailed in D1.6), complies with DCAT2 and integrates additional components from ISO standards, GeoJSON-LD, and DCAT-AP, promoting semantic interoperability and machine-readability.

Each dataset will receive a persistent and unique identifier (typically a DOI), ensuring traceability and long-term access. Metadata creation is mandatory at the point of upload and includes:

- Descriptive elements: Title, abstract, authorship, thematic tags, and timestamps;
- Legal and licensing information: Usage rights, license type, and access restrictions;
- Provenance: Source data references, model lineage, and processing history;
- Spatial and temporal coverage: Geographic scope and temporal resolution;
- File-level details: Format (e.g., *.NetCDF, *.GeoTIFF), size, and technical schema.

All metadata records are stored in a centralised, version-controlled catalogue and are openly accessible unless restricted by legal or ethical conditions. Advanced search capabilities in the HDR allow users to locate datasets using multiple criteria (e.g., author, date, theme). Version management ensures that past versions are archived and retrievable. This approach ensures that CROSSEU data products are technically discoverable, contextually documented, and fully citable, supporting reproducibility, transparency, and multi-sectoral policy application.

3.2. Making data openly accessible

The CROSSEU project is committed to ensuring that all research data (re-used and newly generated) are made openly accessible, in line with the principles of open science, the European Open Science Cloud (EOSC) guidelines, and the FAIR data principles. Data will be curated, harmonised, and made publicly available through the CROSSEU HDR, hosted on the DAFNI platform, as well as through trusted open-access repositories such as Zenodo.

The repository will include a wide range of project outputs: observational and modelled datasets, derived indicators, processing scripts, visualisation tools, documentation, and

[1] https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/revised-charter-access-research-infrastructures-foster-open-science-innovation-and-research-security-2024-11-27_en

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stakeholder-facing materials. These resources will be discoverable and citable through persistent identifiers (e.g., DOIs), ensuring long-term accessibility and traceability. Metadata will be provided for all datasets using interoperable formats (e.g., DCAT2, GeoJSON-LD), and will be indexed and searchable via standardised protocols, supporting both human and machine retrieval.

The DAFNI platform enables real-time access to curated datasets and supports the operational use of the IAF and CROSSEU DSS. Through these platforms, users can run modelling workflows, download pre-processed outputs, and interact with data visualisations. Inputs and outputs from the DSS, particularly those used for climate change hotspot analysis and sectoral risk assessments (WP2) will be made openly available where legally and ethically permissible.

Access restrictions will apply only in cases where data are subject to confidentiality, third-party licensing, or GDPR-related limitations. In such cases, the data will be made available through controlled access arrangements, with authentication and authorisation required in accordance with agreements established with the original data providers. All data access and usage will be governed by the CA, which includes stipulations regarding data protection responsibilities and outlines the procedures for concluding separate data-sharing or joint controller agreements where necessary.

To support transparency and knowledge dissemination, until M17, the project produced a series of public deliverables to further facilitate data accessibility and usability, including – D1.1 (The co-design and operationalisation of the CROSSEU methodology), D1.4 (CROSSEU IAF and DAFNI functionalities), D1.6 (CROSSEU IAF – Harmonised data repository), D2.1 (Assessment methodology for CCHs and STLs) and D3.1 (Inventory of user requirements and support system processing workflow and functionalities).

In addition to open data dissemination, project management-related documentation (including reports, minutes, financial summaries, and partner contacts) are stored in the CROSSEU Microsoft Teams SharePoint, with open internal access for all project partners. These internal documents will not be shared externally unless explicitly permitted, and only under the following conditions: (i) no confidential or personal data are disclosed, (ii) permission is granted by the data owners, and (iii) such sharing does not conflict with the project's IPR or GDPR obligations.

As stated in the CA, all partners are responsible for upholding data protection obligations under applicable legislation, including Regulation (EU) 2016/679 (GDPR). Where necessary, partners will establish specific data processing, data sharing, or joint controller agreements to ensure legal compliance in all collaborative data activities.

Finally, the Project Coordinator (MeteoRo), in coordination with data-related leads (UKRI, WEMC, UEA), will oversee the implementation and continuous update of the DMP throughout the project lifecycle. This includes preparing for post-project data reuse, enabling long-term accessibility of high-value datasets, and addressing new data opportunities that may emerge beyond the project's end.

3.3. Making data interoperable

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To ensure full interoperability, the CROSSEU project adheres to widely recognized standards for data formatting and metadata documentation, fostering seamless integration across various systems, applications, and disciplines. All datasets—whether newly generated or re-used—are prepared using standard, open, and machine-readable formats such as *.CSV, *.NetCDF, *.GeoTIFF, and *.SHP, aligned with the specific needs of the scientific and user communities engaged in climate risk research. When proprietary formats are necessary, their specifications and conversion tools will be explicitly provided to ensure usability.

Interoperability is further supported by adopting a harmonised metadata standard based on the DCAT2 specification and ISO-compliant extensions. This ensures alignment with the EOSC, the FAIR data principles, and broader linked data frameworks. The metadata schema accommodates general and domain-specific elements, enabling meaningful integration and reuse of data across sectors such as agriculture, forestry, transport, and tourism.

The CROSSEU IAF and its HDR, hosted on the DAFNI platform, enable this interoperability by supporting a flexible metadata structure. It includes six thematic sections: dataset-level descriptors, provenance, legal use conditions, temporal and spatial coverage, and file-level attributes. Metadata is recorded at the point of upload and supports version tracking, semantic annotation, and standard vocabularies (e.g., ISO 19115, INSPIRE, GeoNames).

All CROSSEU datasets and workflows hosted in the HDR or linked through external trusted repositories (e.g., JASMIN, CEDA, Zenodo) are provided with persistent identifiers (DOIs) and licenses, ensuring traceability and legal clarity. Formal vocabularies, such as GeoJSON-LD and schema.org, are integrated to support structured geospatial and thematic search across platforms.

Interoperability in CROSSEU is reinforced by:

- Formal metadata standards that ensure consistent understanding of data properties.
- Cross-referencing of datasets and models, allowing workflows within the IAF to integrate sectoral simulations efficiently.
- Open-access licensing to facilitate reuse, except in cases of legal, ethical, or commercial restrictions.

Ultimately, the approach to data interoperability in CROSSEU supports reproducible research, collaborative modelling, and policy-relevant impact assessment across diverse climate risk scenarios and stakeholder domains.

3.4. Increase data re-use

The CROSSEU project is committed to maximising the reuse of all openly available data and research outputs in alignment with the FAIR principles and Horizon Europe open science guidelines. Data will be made available under clearly defined open licenses, enabling legal reuse, redistribution, and integration into future research and applications.

Where appropriate, datasets will be licensed under Creative Commons Public Domain Dedication (CC0) or Creative Commons Attribution – Non Commercial – No Derivatives 4.0 (CC BY-NC-ND 4.0). For software and scripts shared via repositories such as Zenodo or GitHub, additional licenses such as the GNU General Public License v2 may be applied. Licensing terms will be transparently included in each dataset's metadata.

CROSSEU ensures data reusability through:

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- Rigorous documentation protocols in the HDR to maintain consistency and version control;
- Compliance with domain standards relevant to forestry, climate, and geospatial analysis (e.g., ISO 19115, INSPIRE);
- Accessible interfaces (e.g., DAFNI, Teal) for downloading, visualising, and tracking datasets.

For data subject to confidentiality, privacy (GDPR), or intellectual property constraints, appropriate embargo periods or controlled access mechanisms are implemented. Embargoes will not exceed three years from the date of data collection. Such datasets will remain accessible internally via secure authentication systems governed by the Consortium Agreement. In addition to datasets, CROSSEU will ensure the open availability of modelling scripts, policy-relevant outputs, and peer-reviewed publications, facilitating broad reuse across research, policy, and practice communities.

3.5. Other research outputs

In addition to primary research data, the CROSSEU project generates a variety of complementary outputs essential to supporting modelling efforts and enhancing the robustness of risk and vulnerability assessments across its case studies. These include model codes, data harmonisation scripts, post-processing routines, data visualisation tools, and tailored input datasets used to validate and optimise hazard and risk models. All supporting scripts and model codes developed within the CROSSEU project will be made openly available through trusted public repositories such as GitHub and GitLab, and where applicable, mirrored in long-term preservation platforms such as Zenodo. These outputs will be carefully documented, version-controlled, and released under appropriate open-source licenses to ensure reusability and transparency, in line with the FAIR principles and project's commitment to open science.

Additional examples of such research outputs are particularly important in case studies that require secondary or supporting datasets to enhance the quality and accuracy of core analyses. This is notably the case in CSA5 (snow), where the assessment of snow avalanche hazard relies on terrain susceptibility datasets. These datasets are derived from a combination of topographic variables—including elevation, slope, curvature, and aspect—and land cover characteristics, such as tree cover density. To ensure their robustness, these datasets are validated against the spatial distribution of documented avalanche events, sourced from both European and national inventories. By integrating this terrain-based susceptibility data, the snow hazard analysis gains a more nuanced understanding of localised avalanche dynamics. These secondary datasets are therefore essential for improving the reliability of hazard assessments, and they serve as critical inputs in risk modelling and adaptation scenario development, particularly in complex mountain environments where exposure and vulnerability are strongly influenced by terrain features. These secondary datasets in CSA5 serve as critical support layers for the snow avalanche hazard assessment in the target mountain regions (European Alps and Carpathian Mountains) and further, contribute to the overall reliability of exposure, vulnerability and risk evaluations and adaptation planning.

Access to these research outputs will primarily serve project partners involved in modelling tasks (notably in WP1–WP3), including the co-development of the DSS, but will also be

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extended to external stakeholders as part of broader dissemination and exploitation activities. Metadata associated with these outputs will adhere to the standards defined for the CROSSEU HDR, ensuring discoverability, provenance tracking, and integration with the DAFNI-based IAF.

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4. Allocation of resources

The effective coordination and management of data-related responsibilities in CROSSEU is overseen by WP6, led by MeteoRo. WP6 ensures efficient collaboration across partners, supports the delivery of scientific outputs at high quality, and manages compliance with data protection regulations, including GDPR and intellectual property rights (IPR). This includes monitoring adherence to the data management provisions set out in this updated DMP and facilitating alignment with FAIR data principles and open science best practices.

Within the project, each WP lead is responsible for ensuring that data produced, used, or shared under their WP complies with the data governance procedures defined in the DMP. Principal Investigators (PIs) from all consortium partner institutions are accountable for ensuring that their teams understand and apply these data protocols throughout the project. They also support WP6 by addressing any emerging data-related issues and ensuring the secure handling and ethical use of sensitive data.

Data contributors and curators from WP1, WP2 and WP3, who are actively involved in developing the CROSSEU HDR and the DSS, have the main responsibility for ensuring that their datasets comply with the project's metadata standards, licensing terms, and quality assurance procedures. They must also observe GDPR-compliant processing when personal or sensitive information is involved.

No additional financial costs are expected for project partners beyond their institutional data management routines. However, the long-term preservation and potential migration of data assets after the project's end will be evaluated and resourced during the project's final phase. Curation and documentation efforts, particularly those supporting future reproducibility and stakeholder reuse of project results, are incorporated into WP6 planning.

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5. Data security

The CROSSEU consortium recognises that the datasets collected, generated, and shared throughout the project may include sensitive, confidential, or restricted information, whether related to stakeholder inputs, geospatial risk layers, or project management data. The consortium is committed to implementing robust data security protocols that ensure the integrity, confidentiality, and availability of all data, in compliance with EU data protection legislation, including the GDPR.

Data managed within the project is stored primarily through the CROSSEU HDR, hosted on the DAFNI platform. This platform provides secure, scalable infrastructure designed for sensitive research data handling (see D1.4 and D1.6). More specifically, DAFNI ensures:

- Secure user authentication and role-based access control, managed through federated identity systems;
- Data encryption at rest and during transfer, preventing unauthorised access and interception;
- Version-controlled storage and logging mechanisms, which maintain audit trails for all data uploads and revisions;
- Regular system backups and a disaster recovery framework, supporting resilience and long-term data preservation.
- Data hosted on external repositories (e.g., Zenodo, GitHub) will follow the same security principles, using open-access licensing only when datasets have been reviewed and confirmed to be free of personal or restricted-use content.

At the organisational level, all CROSSEU partners are instructed to consult their institutional IT and data protection officers to apply appropriate safeguards when storing or processing project-related data locally. This includes the use of password-protected systems, secure cloud environments, encrypted communications, and antivirus protections. Where sensitive data is involved (i.e., stakeholder contact lists, unpublished scenarios, or datasets flagged under data-sharing agreements), additional layers of security are applied. These include: restricted access groups within Teams SharePoint or DAFNI workspaces, data access request forms for third-party usage, and signed data-sharing or joint controller agreements where required by the CA.

Overall, the CROSSEU project's approach to data security combines technical infrastructure, institutional protocols, and regulatory compliance to safeguard all forms of research and project management data throughout the lifecycle of the project and beyond. The storage of data reflects its sensitivity, with appropriate levels of storage security and measures that guarantee the security of sensitive information, such as regular monitoring for security threats and implementing strong access control.

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6. Ethical aspects and GDPR compliance

The CROSSEU project upholds the highest standards of ethical research and full compliance with the GDPR (Regulation (EU) 2016/679), embedding these principles across all phases, especially in stakeholder engagement, data collection, and public communication.

Stakeholder activities (e.g. surveys, interviews, workshops) involve non-sensitive personal data. Each partner is responsible for national-level data protection compliance and securing ethical approvals where needed.

Before any data collection, participants receive:

- Information sheets detailing the data use;
- Informed consent forms, signed before participation;
- Clear withdrawal rights at any time.

A standardised consent protocol is applied across relevant work packages. Collected data are securely stored, anonymised or aggregated for analysis and publication, and only accessible to authorised partners. Face-to-face interviews follow institutional ethics procedures, with opt-in options for future contact.

CROSSEU uses LinkedIn and Twitter/X (@CROSSEU) for dissemination, sharing only anonymised or aggregated content, without any personal or confidential data. Partners are expected to maintain transparency and discretion online.

Each partner ensures ethical data handling within their organisation, following internal, national, and EU rules. Data relevance and compliance are reviewed continuously, with updates reflected in future DMP versions.

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7. Other issues

No other issues are foreseen at this stage.

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CROSSEU Partners

Meteo Romania	WORLD METEOROLOGICAL ORGANIZATION	UNIVERSITÀ DEGLI STUDI DI PADOVA | TESAF
K&I Conoscenza e Innovazione	Helmholtz-Zentrum hereon	LGI sustainable innovation
EDF	BOKU	DTU
UNIVERSITY OF BUCHAREST	CZU	UEA University of East Anglia | NORWICH BUSINESS SCHOOL
UCL	WEMC World Energy & Meteorology Council	UKRI UK Research and Innovation

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