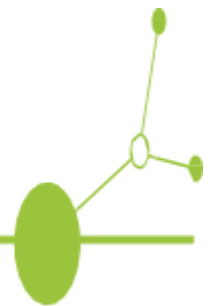


Climate_CRICES PROJECT

D.1.4.1 – Climate_CRICES Strategy

FROM DATA TO DECISION: LESSONS FOR A
ROADMAP TOWARDS CLIMATE CHANGE
ADAPTATION



Version 1

10 2025

Partner responsible: Institute for Ecological and Urban Development (IOER)
Main Author(s): Maralda Drosky, Tamara Avellan, Eric Neuber, Marco Neubert
Delivery Date: 31.05.2025

DISCLAIMER

The information and views set out in this deliverable are those of the authors and do not necessarily reflect the official opinion of the European Union. Neither the European Union institutions and bodies nor any person acting on their behalf may be held responsible for the use which may be made of the following information.

DOCUMENT SHEET

Project Acronym	Climate_CRICES
Full title	Increasing Climate Change Resilience in Central Europe
Grant Agreement number	CE0200728
Coordinator	Veneto Region
Website	https://www.interreg-central.eu/projects/climate_crices/

Deliverable number	D.1.4.1
Deliverable name	Climate_CRICES Strategy
Lead Beneficiary	IOER
WP	1
Activity title	Development of the CRICES Strategy supported by a data-driven tool to integrate climate change management plans
Type	Report
Dissemination level	public
Delivery date	31.05.2025
Main Author	Maralda Drosky, Tamara Avellan, Eric Neuber, Marco Neubert
DOI	https://doi.org/10.5281/zenodo.15656638

EXECUTIVE SUMMARY

Climate change represents one of the most complex and systemic challenges facing Europe today, impacting natural ecosystems, built environments, economies, and societies. The Climate_CRICES Strategy addresses this challenge by exploring how regional and local authorities can use data—quantitative, qualitative, and spatial—to understand, plan, and monitor climate resilience. It provides a shared framework for strengthening data-driven climate adaptation governance, aligning regional approaches with the European Union’s 2021 Strategy on Adaptation to Climate Change, the European Climate Law, and the EU Mission on Adaptation to Climate Change.

Chapter 1 defines the strategic role of data as both a foundation and a driver of resilience planning. Climate_CRICES identifies data not only as a technical asset but as a governance instrument capable of linking climate impacts, adaptation indicators, and policy responses in a coherent framework. The approach is based on a “data value chain” that transforms raw datasets into actionable insights through structured processes of collection, integration, validation, and valorization. Interoperability, transparency, and accessibility are recognized as essential principles that allow climate data to inform decision-making across different administrative and territorial levels.

The Strategy distinguishes between observed, projected, and impact data, combining climate, hydrological, environmental, socio-economic, and spatial dimensions to capture the complexity of climate impacts. These datasets support risk and vulnerability assessments, help identify priority sectors and territories, and enable measurable indicators for tracking adaptation progress. Data governance extends beyond technical management, involving clear institutional roles, coordination among data custodians and end users, and integration of open-data standards (INSPIRE, FAIR, Copernicus, Eurostat). Climate_CRICES contributes by designing a prototype Regional Climate Data Dashboard, demonstrating how heterogeneous datasets can be harmonized into a transparent, metadata-based platform accessible to both public authorities and citizens. By promoting a culture of data sharing and collaborative validation, the project reinforces the co-production of knowledge in line with EU priorities for open governance and evidence-based policymaking.

Chapter 2 situates this approach within the European Union’s broader policy framework. The EU Strategy on Adaptation to Climate Change, the European Climate Law, and the Governance Regulation of the Energy Union define a coherent architecture for climate resilience based on knowledge, coordination, and monitoring. The European Environment Agency’s Climate-ADAPT platform and the Adaptation Support Tool (AST) operationalize these principles. Climate-ADAPT acts as the central EU repository for adaptation knowledge, hosting more than 4,000 resources, while the AST provides a six-phase iterative process that guides public authorities through preparation, risk assessment, option selection, implementation, and evaluation. Complementary instruments such as the Urban Adaptation Support Tool (UAST) and the European Climate Data Explorer further support local and regional adaptation planning.

The Climate_CRICES Strategy builds upon and extends this framework, integrating it into regional and cross-border contexts through an impact-indicator-measure logic that complements the EU’s risk-based approach. This model emphasizes transparency, stakeholder participation, and the conversion of data into actionable measures. A comparative analysis between the EU frameworks (AST, SECAP, Mission on Adaptation) and the Climate_CRICES approach highlights strong alignment with EU principles but also demonstrates the added value of a metadata-first

integration model, a cross-border regional perspective, and a dashboard-based monitoring system that allows comparability across territories. The Strategy thus translates abstract EU guidance into a concrete and replicable workflow for regional and local authorities.

The Strategy concludes with a roadmap that translates the EU adaptation cycle into a time-based operational model for public authorities. In the short term (1–2 years), governance frameworks and vulnerability assessments are established; in the medium term (3–5 years), integrated data platforms and shared indicators are developed; and in the long term (5–10 years), institutionalized monitoring and policy mainstreaming ensure that climate resilience becomes embedded in planning and investment systems. This roadmap exemplifies how data availability, interoperability, and governance can progressively strengthen regional adaptive capacity—transforming fragmented datasets into a coherent evidence base that supports strategic decisions, funding alignment, and the design of climate-resilient policies.

Additionally, according to the “core actions” planned for the short/medium term, this document provides an overview of the process that was followed in Climate_CRICES, reflect on it and derive respective lessons-learned, to then suggest a revised strategy for future implementation. This document has three main parts. First, it describes the dashboard development process in the Climate_CRICES project, from a predefined roadmap to data collection, policy analysis, and co-creation workshops with regional stakeholders. Second, it reflects on lessons learned throughout this journey, identifying what worked, what didn't, and where user engagement and design processes could be improved. Third, it introduces a revised roadmap – a more flexible, inclusive approach that builds on the project's experience and is offered as a model for others. Section 5 provides an outlook about future developments of the dashboard within the project's lifetime, and beyond.

From Implementation to Insight

At the outset, the project followed a structured, expert-led roadmap to define user requirements and identify relevant datasets across regions. However, as the process evolved, the need for early and continuous stakeholder engagement became clear. The team adapted its approach through iterative design cycles, incorporating insights from eight regional co-creation workshops and a comparative review of 31 existing climate platforms.

A working dashboard prototype was eventually developed, featuring clear visualizations, multilingual support, and a metadata framework that linked fragmented datasets to 16 regional adaptation strategies. Some ambitions – such as full interoperability and real-time updates – were scaled back due to technical constraints, but prioritizing transparency and usability helped build trust with stakeholders.

Key Lessons Learned

Several key insights emerged from the dashboard development process:

- Start with impacts, not just data: Aligning the dashboard to actual adaptation goals ensured it was relevant and actionable.
- Design iteratively, not linearly: Flexibility allowed the project to adapt to new stakeholder needs and data realities.
- Transparency builds credibility: Openly communicating data limitations helped maintain trust even when technical features were limited.
- Co-creation improves integration: Reference to a shared glossary and developing a shared metadata framework with users enabled comparability across borders and sectors.

A Revised Roadmap for the Future

The third section of the document presents a revised Climate_CRICES roadmap – the so-called Climate_CRICES strategy –, reflecting the project’s commitment to co-production. It emphasizes an impact-first, user-centred approach, supported by flexible methods, transparent data practices, and tools that prioritize accessibility. This new roadmap is designed to be replicable and adaptable – enabling other regions or institutions to either build on the Climate_CRICES dashboard or design similar tools based on their own data and policy needs.

In short, the Climate_CRICES project demonstrates that climate adaptation is not just a technical challenge – it is a social and institutional one. Effective solutions require not only robust information but also inclusive processes that enable diverse actors to access, understand, and use information meaningfully.

Contents

EXECUTIVE SUMMARY.....	4
LIST OF FIGURES.....	9
Climate_CRICES GLOSSARY.....	10
Introduction and Objectives.....	17
1. The Strategic Role of Data for Climate Resilience.....	17
1.0 Users' Needs and Stakeholders' Contribution to Climate Data and Adaptation Planning.....	17
1.1 The Central Role of Data in Climate Forecasting and Adaptation.....	18
1.2 Data Types, Availability and Valorization for Public Authorities.....	20
1.3 Lessons from Data-Based Climate Projection Platforms.....	22
2. The EU Framework for Climate Adaptation Planning and the Central Role of Data.....	22
2.1 Context and Reference Framework.....	22
2.2 The EU-Guided Process for Developing Climate Adaptation Plans.....	23
2.3 Data in the EU Adaptation Framework: Types, Standards, Analysis and Valorisation.....	23
2.4 Comparative Insight: Climate_CRICES Strategic Perspective and EU Policy Guidance.....	24
2.5 Roadmap for Regional Authorities.....	25
2.6 Conclusions.....	25
Original Climate_CRICES Roadmap.....	26
Preliminary Analysis.....	28
1 Climate Change Impacts and Indicators Analysis.....	40
2 Information system and data pre-analysis.....	40
3+4 Co-Creation of Knowledge.....	41
O1 Dashboard Requirements.....	49
5 Dashboard architecture and functionalities.....	52
Data Collection and Dashboard Development.....	54
6 Data Repository Conceptualization.....	55
O2 Data Repository.....	57
7 Promoting trust through continuous stakeholder engagement.....	59
8 Bridging data gaps.....	62
Dashboard Deployment.....	63

9	Data repository.....	63
O3	Dashboard.....	64
10	Launch and presentation of the dashboard.....	65
	References.....	70

LIST OF FIGURES

Figure 1: Overview of the 'original' roadmap adopted in the Climate_CRICES project (© Eric Neuber @ IOER)	16
Figure 2: Summarized overview of lessons learned	23
Figure 3: Revised ,idealised' roadmap for the dashboard co-creation process based on the original roadmap applied and their lessons learned. (© Eric Neuber @ IOER)	27
Figure 4: Preliminary Analysis of the revised ,idealised' roadmap for the dashboard co-creation process (© Eric Neuber @ IOER)	28
Figure 5: Elements that are relevant for successful climate services (CS) for adaptation (redrawn from table 2 of Boon et al. 2024)	31
Figure 6: Ideal co-production process for climate services development that ensures long-term use of information, source: https://weadapt.org/tandem/	31
Figure 7: Steps undertaken in Climate_CRICES for stakeholder co-creation workshops	33
Figure 8: Data Collection and Dashboard Development of the revised ,idealised' roadmap for the dashboard co-creation process (© Eric Neuber @ IOER)	43
Figure 9: Entities metadata structure of the Climate_CRICES project (© Eric Neuber @ IOER)	47
Figure 10: Dashboard Deployment of the revised ,idealised' roadmap for the dashboard co-creation process (© Eric Neuber @ IOER)	52
Figure 11: View of the dashboard landing page	53

LIST OF TABLES

Table 1: Overview of stakeholder groups relevant for the dashboard development	32
--	----

Climate_CRICES GLOSSARY

Effective interdisciplinary collaboration on climate risk and adaptation requires a shared understanding of core concepts. Within the Climate_CRICES project, a common glossary has been developed to ensure clarity, reduce misinterpretation, and promote coherence across scientific, technical, and policy domains.

This dynamic reference focuses on essential terms related to hazards, exposure, vulnerability, and risk. It draws from authoritative sources while reflecting the integrated, interdisciplinary nature of the project.

By standardizing terminology, the glossary enhances the consistency and transparency of climate adaptation processes, supports informed decision-making, and bridges conceptual divides. The terms presented here form a foundational linguistic framework for Climate_CRICES and underscore a central principle: terminology matters.

Term	Definition	Source
<p>Adaptation Strategy / Plan</p>	<p>The terms might be used interchangeably, but developing a climate change adaptation strategy or plan involves different processes.</p> <ul style="list-style-type: none"> • A strategy serves as an overarching element in the early stages of policy formulation, which is key to implementation. It's a flexible, medium- to long-term, non-binding document that outlines your organisation's vision, adaptation objectives, processes and recommendations for enhancing adaptive capacity in your area. • A plan is developed subsequently, focusing on practical execution of the strategy. It outlines the adaptation actions prioritised for the short term (e.g. 5 years), along with the resources allocated and the designated actors. It requires broad involvement from the community and other stakeholders, which may pose challenges for adoption, compared to the strategy. <p>Some local or regional authorities may develop these as a single document.</p>	<p>https://climate-adapt.eea.europa.eu/en/mision/knowledge-and-data/regional-adaptation-support-tool/step-5-implementing-adaptation/step-5-1-1</p>

B iodiversity	Biodiversity or biological diversity means the variability among living organisms from all sources including, among other things, terrestrial, marine and other aquatic <i>ecosystems</i> , and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (UN, 1992).	https://apps.ipcc.ch/glossary/
C apacity	The combination of all the strengths, attributes and resources available within an organization, community or society to manage and reduce <i>disaster risks</i> and strengthen <i>resilience</i> .	https://www.undrr.org/drr-glossary/terminology#R
D ashboard	A dashboard is a visual display of important information and key performance indicators (KPIs) that can be captured at a glance. It uses diagrams, graphs and tables to present data in a clear and understandable way. Dashboards are interactive and allow users to gain deeper insights into the data by using filters and drill-down functions. They are a key tool for monitoring and decision-making as they present complex data in an easy-to-understand form, helping to quickly recognise trends and problems.	https://www.haufe-x360.de/blog/erp-wissen/dashboard
Disaster Risk	The potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of <i>hazard</i> , <i>exposure</i> , <i>vulnerability</i> and <i>capacity</i> .	https://www.undrr.org/drr-glossary/terminology#R
Drought	An exceptional period of water shortage for existing <i>ecosystems</i> and the human population (due to low rainfall, high temperature and/or wind).	https://apps.ipcc.ch/glossary/
Meteorological drought	A period with an abnormal precipitation deficit.	https://apps.ipcc.ch/glossary/
Agricultural and ecological drought	Depending on the affected <i>biome</i> : a period with abnormal <i>soil moisture</i> deficit, which results from combined shortage of precipitation and excess <i>evapotranspiration</i> , and during the growing season impinges on crop production or <i>ecosystem</i> function in general.	https://apps.ipcc.ch/glossary/

Hydrological drought	A period with large <i>runoff</i> and water deficits in rivers, lakes and reservoirs.	https://apps.ipcc.ch/glossary/
Mega-drought	A very lengthy and pervasive drought, lasting much longer than normal, usually a decade or more.	https://apps.ipcc.ch/glossary/
E cosystem	<p>A functional unit consisting of living organisms, their non-living environment and the interactions within and between them. The components included in a given ecosystem and its spatial boundaries depend on the purpose for which the ecosystem is defined: in some cases they are relatively sharp, while in others they are diffuse. Ecosystem boundaries can change over time.</p> <p>Ecosystems are nested within other ecosystems, and their scale can range from very small to the entire biosphere. In the current era, most ecosystems either contain people as key organisms or are influenced by the effects of human activities in their environment.</p>	https://apps.ipcc.ch/glossary/
Exposure	The situation of people, infrastructure, housing, production capacities and other tangible human assets located in <i>hazard</i> -prone areas.	https://www.undrr.org/drr-glossary/terminology#R
F lood	<p>The overflowing of the normal confines of a stream or other water body, or the accumulation of water over areas that are not normally submerged. Floods can be caused by unusually heavy rain, for example, during storms and cyclones. Floods include river (fluvial) floods, flash floods, urban floods, rain (pluvial) floods, sewer floods, coastal floods, and glacial lake outburst floods (GLOFs).</p>	https://apps.ipcc.ch/glossary/
Coastal Flood	Coastal flooding is most frequently the result of storm surges and high winds coinciding with high tides. The surge itself is the result of the raising of sea levels due to low atmospheric pressure. In particular configurations, such as major estuaries or confined sea areas, the piling up of water is amplified by a combination of the shallowing of the seabed and retarding of return flow (WMO, 2011).	https://www.preventionweb.net/drr-glossary/hips

Flash Flood	A flash flood is a flood of short duration with a relatively high peak discharge in which the time interval between the observable causative event and the flood is less than four to six hours (WMO, 2006).	https://www.preventionweb.net/drr-glossary/hips
Fluvial Flood/ River Flood	A fluvial flood is a rise, usually brief, in the water level of a stream or water body to a peak from which the water level recedes at a slower rate (WMO, 2012).	https://www.preventionweb.net/drr-glossary/hips
Pluvial Flood/ Rain Flood	The accumulation of water over areas that are not normally submerged and not necessarily in the vicinity of water bodies caused by heavy rainfall.	Internal definition
H azard	A process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation.	https://www.undrr.org/drr-glossary/terminology#R
Heatwave	A heatwave is a marked warming of the air, or the invasion of very warm air, over a large area; it usually lasts from a few days to a few weeks (WMO, 1992). Alternative definition: A heatwave is a marked unusual period of hot weather over a region persisting for at least two consecutive days during the hot period of the year based on local climatological conditions, with thermal conditions recorded above given thresholds (WMO, 2020).	https://www.preventionweb.net/drr-glossary/hips
	A period of abnormally hot weather, often defined with reference to a relative temperature threshold, lasting from two days to months.	https://apps.ipcc.ch/glossary/
	Specific thresholds within the Climate_CRICES project: Heatwaves are defined here as periods of at least 3 consecutive days during summer (June to August) with a maximum apparent temperature and a minimum air temperature equals or exceeds 30 °C.	Internal definition

<p>Heavy Precipitation Event</p>	<p>An extreme/heavy precipitation event is an event that is of very high magnitude with a very rare occurrence at a particular place. Types of extreme precipitation may vary depending on its duration, hourly, daily or multi-days (e.g., 5 days), though all of them qualitatively represent high magnitude. The intensity of such events may be defined with block maxima approach such as annual maxima or with peak over threshold approach, such as rainfall above 95th or 99th percentile at a particular space.</p>	<p>https://apps.ipcc.ch/glossary/</p>
<p>Impact</p>	<p>The consequences of realized <i>risks</i> on natural and human systems, where risks result from the interactions of climate-related <i>hazards</i> (including extreme weather/climate events), <i>exposure</i>, and <i>vulnerability</i>. Impacts generally refer to effects on lives, livelihoods, health and well-being, <i>ecosystems</i> and species, economic, social and cultural assets, services (including ecosystem services), and infrastructure. Impacts may be referred to as consequences or outcomes and can be adverse or beneficial.</p>	<p>https://apps.ipcc.ch/glossary/</p>
<p>Indicator</p>	<p>Indicators are observable and measurable characteristics that can be used to simplify information to help understand the state of a concept or phenomenon, and/or to monitor it over time to show changes or progress towards achieving a specific change.</p>	<p>(Gill et al., 2022)</p>
<p>Impact Indicator</p>	<p>Impact indicators describe the effects of climate change.</p>	<p>(Umweltbundesamt, 2023)</p>
<p>Response Indicator</p>	<p>Response indicators describe adaptation measures or activities and conditions that support the adaptation process.</p>	<p>(Umweltbundesamt, 2023)</p>
<p>Measure</p>	<p>In the context of the Climate_CRICES project measure refers to the specific interventions for mitigation and adaptation that are specified in the analysed policies.</p>	<p>Internal definition</p>

Metadata	Information describing the characteristics of data including, for example, structural metadata describing data structures (e.g., data format, syntax, and semantics) and descriptive metadata describing data contents (e.g., information security labels).	https://csrc.nist.gov/glossary/term/metadata
P olicy	In the context of the Climate_CRICES project policy refers to the analysed climate change adaptation strategies of the pilot regions. These are documents managing the expected <i>impacts</i> of climate change, grounded on <i>projections</i> and expected impacts of climate change.	Internal definition
Projection	A potential future evolution of a quantity or set of quantities, often computed with the aid of a model. Unlike predictions, projections are conditional on assumptions concerning, for example, future socio- economic and technological developments that may or may not be realised.	https://apps.ipcc.ch/glossary/
R eceptor	An individual, a community, assets or systems that are impacted by <i>hazards</i> . For example: The topic impacts on <i>biodiversity</i> within the Climate_CRICES project refers to the specific impacts on the receptor <i>ecosystems</i> , having an influence on the diversity within species, between species and of ecosystems.	Internal definition based on <i>vulnerability</i> definition
Resilience	The ability of a system, community or society exposed to <i>hazards</i> to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through <i>risk management</i> .	https://www.undrr.org/drr-glossary/terminology#R
Response	Actions taken directly before, during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected.	https://www.undrr.org/drr-glossary/terminology#R
Risk	<i>See Disaster Risk</i>	

<p>Risk Management</p>	<p>Plans, actions, strategies or <i>policies</i> to reduce the likelihood and/or magnitude of adverse potential consequences, based on assessed or perceived <i>risks</i>.</p>	<p>https://apps.ipcc.ch/glossary/</p>
<p>Vulnerability</p>	<p>The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the <i>impacts</i> of <i>hazards</i>.</p>	<p>https://www.undrr.org/drr-glossary/terminology#R</p>

Introduction and Objectives

The Climate_CRICES project aims to increase climate change resilience in Central Europe by supporting regional authorities in climate adaptation with a data-driven dashboard. The project focuses on the topics of (1) heat and drought, (2) flooding, and (3) the impacts of climate change on biodiversity. The partners adopted a pre-defined roadmap, referred to in this document as the 'original' Climate_CRICES roadmap, to assess the user requirements and define the specifications of a dashboard capable of visualizing integrated and compiled multi-scale climate change adaptation data.

In this deliverable, we first shortly present this roadmap ([Original Climate_CRICES Roadmap](#)), and then evaluate its usefulness and derive respective lessons learned ([Lessons learnt](#)). Lastly, we describe an ideal roadmap for future use, referring to it as the 'revised' Climate_CRICES roadmap, the so-called Climate_CRICES Strategy ([Climate_CRICES Strategy](#)). Finally, we offer an outlook for the future use and implementation of the strategy and its main product, the dashboard (From Prototype to Practice).

We expect that regions and authorities interested in the benefits of integrating, compiling, and visualizing multi-scale data for adaptation planning will gain a clear understanding of the road mapping process and how to use the dashboard. This is supported by providing here a well-defined roadmap along with ready-to-reuse results (e.g. indicators and impact lists, glossary or metadata structure), lessons learned, and specific recommendations. The approach can then be used to develop a similar, new product or to possibly integrate their own or additional data into the Climate_CRICES dashboard.

1. The Strategic Role of Data for Climate Resilience

1.0 Users' Needs and Stakeholders' Contribution to Climate Data and Adaptation Planning

Climate_CRICES is designed around a fundamental premise: effective climate adaptation depends not only on high-quality science but also on the governance ecosystem that produces, interprets, shares, and applies data. Deliverables D.1.2.1 (Stakeholder Engagement Report) and D.1.2.2 (Stakeholder data utilization SWOT analysis) provide the empirical foundation for this premise. They document how users currently access data, which barriers they face, and how they can co-create content and functions for the Climate_CRICES dashboard.

Between February and March 2025, eight local co-creation workshops were organized across partner territories with a total of 99 external stakeholders (in addition to 37 organizers). The events combined in-person and online formats and followed a harmonized agenda to ensure comparability of outputs. Stakeholders represented regional and local authorities responsible for adaptation strategies, river-basin managers, environmental protection agencies, civil protection services, utilities, agricultural and business associations, NGOs, universities and research institutes, and data-portal operators. This breadth reflects the multi-sectoral nature of climate impacts and the corresponding need to align data practices across policy domains.

Across all regional workshops, participants articulated **four recurring needs for climate data tools**: accessible and user-friendly interfaces, context-relevant indicators at appropriate territorial scales, transparent and traceable metadata, and sustained capacity and governance beyond project lifetimes.

These needs translate directly into design and maintenance requirements for the Climate_CRICES Dashboard. Thematic discussions revealed specific priorities for each area: under Heat & Drought, thermal-stress indicators for vulnerable groups, soil-moisture anomalies, and energy demand for cooling were highlighted; for Flooding, stakeholders emphasized metrics on intense rainfall, sediment and erosion processes, and the integration of pluvial and fluvial risks; while for Biodiversity, attention centred on habitat connectivity, invasive species monitoring, aquatic temperature profiles, and early-warning systems for fires and pests. Persistent data governance issues emerged, including fragmented institutional responsibilities, low interoperability between data providers, and challenges in translating high-quality datasets into actionable local planning. Additional barriers concerned licensing restrictions, incomplete time series, and discontinuous funding for local portals. The SWOT analysis confirmed both the strong scientific and institutional foundations across regions and the opportunities presented by EU programmes and adaptation mandates, while warning of weaknesses such as limited municipal capacities and project-based dependencies. Importantly, stakeholders contributed beyond consultation by sharing local datasets, validating indicators, and testing prototypes—an approach that strengthened co-production, user ownership, and the long-term sustainability of the Climate_CRICES data ecosystem.

Implications for the Strategy. The stakeholder evidence justifies three strategic choices: (1) a metadata-first integration model that lets diverse datasets remain in place while enabling transparent comparison; (2) an impact-first narrative that starts from policy goals and traces back to indicators and datasets; (3) a capacity-building track that runs in parallel to technical work, ensuring that administrations can absorb the tools and that knowledge is retained in institutions.

Roadmap for engagement. Climate_CRICES will continue stakeholder engagement through focused clinics on (i) indicator interpretation for planners, (ii) dashboard use in monitoring and reporting cycles, and (iii) data stewardship (licensing, updates, and responsibilities). These clinics will be aligned with forthcoming local workshops and with the testing of the final dashboard release to cement adoption and feedback loops.

1.1 The Central Role of Data in Climate Forecasting and Adaptation

Climate data form the backbone of modern climate-change forecasting, enabling public authorities, scientists, and planners to anticipate risks, assess vulnerabilities, and design effective adaptation strategies. In Climate_CRICES, data are not an end in themselves but the means to connect scientific models, public users, and territorial realities.

At the European level, the EU Strategy on Adaptation to Climate Change (2021) emphasizes open, interoperable, high-quality data. The Copernicus Climate Change Service (C3S) and the European Climate Data Explorer provide free indicators and projections. Complementary initiatives—the European Green Deal, the Climate and Health Observatory, and the Mission on Adaptation—further promote integration and capacity.

For the partnership, integrating these datasets serves three objectives: improve understanding of local phenomena by connecting observations with pan-European models; transform scientific information into practical tools for administrations; and enhance cross-regional comparability and transparency in adaptation strategies.

To ground the strategic use of data in real policy contexts, Climate_CRICES partners analysed climate adaptation policies and related planning tools across Italy, Austria, Germany, Hungary, Poland, Croatia, and Czech Republic (Deliverable D.1.1.1). The analysis covers national, regional, municipal and transboundary documents and compares their treatment of the three Climate_CRICES impact domains (Heat & Drought; Flooding; Biodiversity).

Below is a synthesis of the policies reviewed (ref. D.1.1.1 §2.7 and §2.8), including the current status and the climate-change impacts primarily addressed (Table 1). This grid supports the Strategy's impact-first approach by linking the policy landscape to the data and indicators required for implementation and monitoring.

Table 1: Overview of the current status of different climate change adaptation strategies in the different regions.

Policy / Territory	Status	Climate-Change Impacts Focused
Veneto (IT) – SRACC	To be approved by Regional Council (2024)	Heat & Drought; Flooding; Biodiversity
Piedmont (IT) – SRCC	In implementation (2022)	Heat & Drought; Biodiversity
Turin (IT) – Climate Resilience Plan	Under implementation (2020)	Heat & Drought; Flooding
Zagreb (HR) – SECAP	Under update (2019)	Heat & Drought; Flooding; Biodiversity
Lower Silesia (PL) – APCNLWV (Climate Neutrality Action Plan)	Framework completed – action plan under development (2024)	Primarily mitigation; adaptation emphasis on water security (Heat & Drought)
Lower Silesia (PL) – DPW (Water Policy)	Under development (2024)	Flooding (river/pluvial); water-related Heat & Drought
Odra River Basin (PL) – PGW (Water Management Plan)	Under implementation (2022)	Heat & Drought; Flooding
Central Danube (HU) – CDPA Operational Programme	Under implementation (2021)	Heat & Drought; Biodiversity
Bács-Kiskun County (HU) – Climate Strategy	Under implementation (2021)	Heat & Drought; Biodiversity
Tolna County (HU) – Climate Strategy	Under implementation (2021)	Heat & Drought; Flooding; Biodiversity

Note:
Impact
focus

Saxony (DE) – EKP (Energy & Climate Programme)	Under implementation (2021)	Heat & Drought; Flooding; Biodiversity
Germany (DE) – DAS (National Adaptation Strategy)	Under implementation (2024)	Heat & Drought; Flooding; Biodiversity
Saxony (DE) – Saxonian Adaptation Strategy	Under development (2027)	Heat & Drought; Flooding; Biodiversity
Austria (AT) – NAS (National Adaptation Strategy)	Under implementation (updated 2024)	Heat & Drought; Flooding; Biodiversity
Liberecký Region (CZ) – Climate Adaptation Action Plan	Under implementation (2021)	Heat & Drought; Flooding; Biodiversity
Hrádek nad Nisou (CZ) – Adaptation Strategy	Legacy / To be updated (2015)	Flooding
Lusatian Neisse (PL–DE–CZ) – Sub-basin Plan (WFD/Floods)	Under implementation (2021–2027)	Heat & Drought; Flooding

categories follow the Climate_CRICES domains. Where a plan is primarily mitigation-led (e.g., climate neutrality frameworks), the adaptation scope is indicated. For river-basin documents under the Water Framework and Floods Directives, the focus is predominantly on Flooding with relevant heat/drought interactions.

1.2 Data Types, Availability and Valorization for Public Authorities

Deliverable D.1.3.2 provides a systematic picture of the current data landscape supporting adaptation across partner regions. By May 2025, partners catalogued 223 regional datasets and 64 European/global sources relevant to the Climate_CRICES domains—Heat & Drought, Flooding, Biodiversity. Each dataset was described with metadata covering origin, spatial/temporal resolution, methodology, update cycle, licence, and policy relevance, creating a common foundation for transparent comparison.

Data typologies. (i) Meteorological: temperature, precipitation, humidity, wind, radiation, derived indices (SPEI, SPI, CDD, HDD, heatwave duration). (ii) Hydrological: river discharge, groundwater levels, soil moisture, flood extents, pluvial intensity-duration-frequency curves, snow cover, evapotranspiration. (iii) Land cover and use: CORINE Land Cover, land-use/land-cover change, urban fabric, green infrastructure. (iv) Biodiversity and ecosystems: Natura 2000, habitat condition, species occurrence, phenology, vegetation productivity, forest fires. (v) Socio-economic and exposure: population density, age structure, deprivation indices, critical infrastructure, economic losses (EM-DAT).

Coverage and quality. While many meteorological and hydrological variables are well covered, biodiversity and socio-economic vulnerability indicators are uneven. Several partners reported

modelled rather than observed soil-moisture series, fragmented groundwater data, and limited availability of habitat quality metrics. Flood-risk information is often siloed in national services and published with differing baselines and return periods, hampering cross-border comparability.

Indicators and gaps. The partnership consolidated 24 impacts and 44 indicators. Examples of misalignments include: Common Bird Index—high relevance but poor availability; Potential Hail Index—recognized need but scarce data; vegetation productivity and Climatic Impact Indicators—important for ecosystem change yet underrepresented in policies and datasets; duration of soil-moisture droughts—relevant everywhere but present in few plans; daily max flow—relevant but inconsistently monitored in strategic documents.

European/global sources. To mitigate regional gaps and ensure a baseline for all territories, partners selected 64 EU/global sources, including Copernicus (31 datasets), EURO-CORDEX (13), EEA (forests, fragmentation), Eurostat (bird and butterfly indices), NASA (hail risk), EDO (drought), EFAS (flood awareness), WISE (freshwater), EM-DAT (disasters), and the European Severe Weather Database. These sources offer standardized methods, broad coverage, and long time series. However, their spatial resolution may be coarser than national datasets and requires careful interpretation.

Metadata-first integration. Full technical harmonization is beyond project scope and, in many cases, not feasible due to incompatible methods. Climate_CRICES therefore adopts a metadata-based integration layer that enables comparability without forcing uniformity. The common data model—co-designed by CSI Piemonte with all partners—links entities (impact → indicator → objective → measure) and exposes for each dataset the assumptions, scales, and update cycles. This makes differences visible and actionable instead of hiding them.

Glossary and classification. A shared glossary stabilizes terminology across languages and institutions; common classifications align impacts, risks, and indicators for Heat & Drought, Flooding, and Biodiversity. This structure underpins the dashboard's navigation and the filters used to query information by theme, territory, or policy objective.

Valorization pathways. Data become strategic assets when connected to the policy cycle: risk assessment, priority setting, planning, implementation, monitoring, and reporting. Climate_CRICES implements five pathways: (1) discoverability—metadata catalogue and search by entity; (2) interpretability—context panels explaining indicator meaning, caveats, and thresholds; (3) comparability—views that place one territory alongside another; (4) traceability—links from measures back to indicators and datasets; (5) re-use—export functions for tables and graphics to feed statutory documents and public communications.

Use-cases. (Heat & Drought) Municipal heat-health action plans can combine CDD trends with population age structure and health-facility locations to prioritise cooling shelters and urban greening. (Flooding) Basin authorities can compare EFAS pluvial alerts with local IDF curves and land-use change to target nature-based solutions for peak attenuation. (Biodiversity) Regional planners can use habitat connectivity indices and land-take statistics to steer mitigation hierarchies and restoration programmes.

Cross-border comparability. The dashboard reveals where partners use different metrics for similar risks (e.g., distinct drought indices or flood return periods) and flags where policy coverage lags behind data availability. By visualising gaps, the tool promotes dialogue with data providers and encourages inclusion of neglected indicators (e.g., soil-moisture drought duration, vegetation productivity) in future plan revisions.

Sustainability and updates. Datasets will continue to evolve; governance arrangements must define who updates what, when, and under which licence. The Strategy proposes a light stewardship model: (i) partners maintain their metadata records and signal changes; (ii) a coordination node validates

additions and resolves classification issues; (iii) release notes track updates for transparency. Training modules will support staff turnover and institutional learning.

1.3 Lessons from Data-Based Climate Projection Platforms

Benchmarking of 31 platforms (D.1.3.1; D.1.3.3) shows that successful systems pair authoritative data with human-centred design and a clear link to policy. Practices to emulate include: plain-language indicator pages; transparent documentation of methods and uncertainties; stable identifiers and APIs; and export functions for integration in local reports. ReKIS and ClimRisk.cz illustrate regional tailoring; NAGiS and Italy's national portals show strong policy alignment; C3S exemplifies open standards and traceability. Weaknesses observed elsewhere—limited multilingual support, fragmented biodiversity layers, and scarce ties to concrete measures—have been explicitly addressed in Climate_CRICES through co-creation and the entities model.

2. The EU Framework for Climate Adaptation Planning and the Central Role of Data

2.1 Context and Reference Framework

Climate adaptation planning within the European Union is framed by a complex but coherent governance architecture designed to help Member States and regions prepare for and respond to the increasing risks posed by climate change. The main reference policy documents are the EU Strategy on Adaptation to Climate Change (COM(2021)82), the European Climate Law (Regulation (EU) 2021/1119), and the Governance Regulation of the Energy Union (Regulation (EU) 2018/1999). These set the strategic, legal, and procedural foundation for climate resilience across the Union.

At the operational level, two cornerstones support the implementation of adaptation policies: the European Climate-ADAPT Platform and the EEA Adaptation Support Tool (AST).

Climate-ADAPT, managed jointly by the European Environment Agency (EEA) and the European Commission (DG CLIMA), is the central knowledge platform for adaptation in Europe. It provides access to more than 4,000 references, including national and regional adaptation strategies, case studies, datasets, and methodological tools. The platform enables users to explore risks and impacts by sector, country, or hazard type and is visited by more than 1.5 million users annually. It also acts as the dissemination and coordination hub for the EU Mission on Adaptation to Climate Change, linking policy, research, and practice.

The Adaptation Support Tool (AST), hosted within Climate-ADAPT, offers a detailed, step-by-step guide for developing and implementing adaptation strategies and action plans. It proposes an iterative six-phase process that can be scaled to national, regional, or local levels. The AST ensures methodological consistency across Europe by recommending practical approaches to risk assessment, option appraisal, and monitoring. It is complemented by the Urban Adaptation Support Tool (UAST), tailored for cities and local governments, and by the European Climate Data Explorer, which provides climate projections and impact indicators derived from the Copernicus Climate Change Service (C3S).

Together, these instruments foster a shared European methodology: adaptation should be data-informed, inclusive, and cyclical, integrating risk assessment, policy design, and monitoring in continuous feedback loops.

2.2 The EU-Guided Process for Developing Climate Adaptation Plans

The European Commission does not impose a single, legally binding procedure for local adaptation planning but encourages authorities to follow a structured, evidence-based process aligned with the Adaptation Support Tool (AST) and the Covenant of Mayors' Sustainable Energy and Climate Action Plan (SECAP) methodology. Both instruments promote iterative learning, participatory governance, and the integration of adaptation measures into broader development frameworks such as regional spatial plans, biodiversity strategies, or disaster-risk management systems.

This process is intended to ensure that adaptation is systematic rather than reactive: authorities are encouraged to start from scientific evidence and vulnerability assessments, translate findings into policy objectives, co-design measures with stakeholders, and review progress periodically. The process emphasises multi-level coordination between local, regional, and national authorities, as well as the use of harmonised indicators for monitoring.

Following this logic, the EU recommends that public authorities develop their adaptation plans through six iterative phases, each feeding the next in a continuous policy cycle:

1. Preparation and Governance Setup – securing political commitment, defining geographic and thematic scope, establishing cross-departmental working groups, and identifying stakeholders and data custodians.
2. Risk and Vulnerability Assessment – analysing observed trends and projected hazards, exposure, and vulnerability, using climate data, socio-economic datasets, and sectoral information.
3. Identification of Adaptation Options – co-designing a portfolio of measures (nature-based, infrastructural, regulatory, and behavioural) that address prioritised risks.
4. Assessment and Prioritisation – evaluating measures against cost-benefit, feasibility, co-benefits, and alignment with existing strategies and funding frameworks.
5. Implementation and Mainstreaming – integrating selected measures into urban, sectoral, and financial planning, and ensuring compliance with the “climate-proofing” principles of EU funding instruments.
6. Monitoring, Evaluation and Learning – defining indicators, collecting data for progress assessment, and updating the plan in iterative cycles of review.

2.3 Data in the EU Adaptation Framework: Types, Standards, Analysis and Valorisation

Within the EU adaptation governance system, data are both the foundation and the integrator of planning processes. EU guidance distinguishes between four main categories of datasets: Climate and Meteorological Data, Hydrological and Environmental Data, Land-Use and Biodiversity Data, and Socio-economic and Exposure Data.

Quality and interoperability standards are ensured through the INSPIRE Directive, the Copernicus Data Policy, and the FAIR principles. Each dataset should include metadata specifying temporal coverage, resolution, uncertainty, licence, and methodological assumptions.

Data analysis proceeds through successive scales: detection of climate signals; projection of future scenarios; impact assessment through hazard-exposure-vulnerability interactions; indicator development; and valuation of socio-economic and ecological impacts.

Data valorisation means embedding information into the adaptation policy cycle—supporting diagnosis, design, implementation, and evaluation. EU instruments such as C3S, Climate-ADAPT, and the Mission Implementation Platform (MIP4Adapt) provide the infrastructure for this translation from data to decision-making.

2.4 Comparative Insight: Climate_CRICES Strategic Perspective and EU Policy Guidance

Before comparing, it is important to note that the EU framework sets out guidance, not uniform rules. Its purpose is to foster comparability and capacity-building across diverse national contexts. Climate_CRICES operationalizes these principles at the regional level, demonstrating how European guidance can be translated into practice through cross-border data integration, stakeholder engagement, and shared governance structures.

The following table highlights the main points of convergence and innovation between the EU methodological frameworks and the Climate_CRICES approach.

Table 2.1: Comparative insight between EU frameworks and the Climate_CRICES approach

Aspect	EU Framework (AST / SECAP / Mission)	Climate_CRICES Approach
Starting point	Hazard and vulnerability assessment	Impact-first logic linking impacts → indicators → policies
Integration model	Harmonized datasets (INSPIRE)	Metadata-first model ensuring transparency and comparability
Stakeholder involvement	Recommended at each phase	Institutionalized through co-creation workshops
Data typology	Generic categories	Expanded typologies covering Heat & Drought, Flooding, Biodiversity
Governance focus	National and urban	Regional cross-border perspective (Central Europe)
Valorization	Monitoring and evaluation cycles	Dashboard for traceability, exportability, and multi-regional benchmarking

As shown, Climate_CRICES expands the EU's strategic vision by adding a transnational, impact-driven, and co-creative dimension, translating abstract guidance into an operational and replicable model for regional authorities.

2.5 Roadmap for Regional Authorities

The following roadmap provides a synthesis of short-, medium-, and long-term actions that regional authorities can undertake to align their adaptation planning with EU standards and the Climate_CRICES methodology. It outlines how data collection, indicator definition, and intervention design can evolve progressively through a continuous learning cycle.

Table 2.2: Roadmap for regional authorities towards data-driven adaptation planning

Time Horizon	Core Actions	Climate Impacts to Analyse	Key Indicators to Define	Adaptation Measures to Elaborate
Short Term (1–2 years)	Establish governance framework; map data custodians; compile existing datasets; perform preliminary risk and vulnerability assessment.	Heatwaves, pluvial floods, drought frequency.	CDD, SPI/SPEI, daily max flow, population exposure, land-use change.	Early-warning systems, heat-health action plans, drainage maintenance, data-sharing agreements.
Medium Term (3–5 years)	Develop/adopt integrated data platform; adopt shared metadata and glossary; co-create indicators with stakeholders; align with SECAP or regional climate strategies.	River floods, groundwater depletion, habitat fragmentation, soil-moisture anomalies.	Return period of floods, groundwater trend indices, connectivity metrics, soil-moisture duration.	Nature-based solutions, urban greening, water-retention zones, biodiversity corridors.
Long Term (5–10 years)	Institutionalize monitoring and evaluation; integrate adaptation into spatial and sectoral planning; ensure interoperability with Copernicus/EEA systems; periodic plan update.	Compound impacts (heat–drought–biodiversity loss interactions).	Composite resilience indices, ecosystem health indicators, adaptive capacity metrics.	Structural flood defenses, landscape restoration, cross-border management frameworks, climate-resilient infrastructure investments.

2.6 Conclusions

The European framework for adaptation planning provides a clear, flexible, and data-driven methodology that regional and local authorities can adapt to their specific contexts. Climate-ADAPT and the Adaptation Support Tool remain the essential entry points for technical guidance and policy alignment, while instruments like the Mission on Adaptation and Copernicus ensure continuity between science, governance, and practice.

The Climate_CRICES experience demonstrates that these European principles can be successfully translated into operational tools when coupled with transparent metadata, user co-creation, and regional cooperation. The roadmap outlined above bridges the gap between data availability and decision-making, guiding public administrations toward integrated, evidence-based adaptation strategies that strengthen climate resilience across Central Europe and beyond.

Original Climate_CRICES Roadmap

In the frame of the above mentioned roadmap, looking at the short/medium term core actions and in line with the Project's objectives, as part of the Climate_CRICES project, a series of coordinated steps were undertaken to lay the foundation for a data-driven dashboard aimed at supporting regional climate adaptation in Central Europe (see Figure 1). The process began with a broad, partner-led data collection effort to understand the availability and relevance of climate-related data in each region. This informed a transregional analysis of climate change impacts and associated indicators, supported by international sources such as IPCC and EU adaptation strategies.

These initial findings enabled the creation of a shared [Climate_CRICES Glossary](#) and an “entities metadata structure” (further details in section [O2 Data Repository and Figure 9](#)) to ensure consistency and comparability across the project and regions. Subsequent steps involved refining the impacts and indicators for the pilot regions through detailed policy analysis, which also revealed data gaps and the need for standardised classification methods. User requirements were then collected through co-creation workshops with regional stakeholders, which also served to review and improve a first demo version of the dashboard. A prototype dashboard was ultimately launched, featuring core functionalities such as policy comparison and data visualization.

The results of these efforts include revised, regionally tailored impact and indicator lists, an expanded metadata structure, a consolidated set of user requirements, and a working dashboard prototype. Further details on methods, findings, and lessons learned can be found in the respective sections of this deliverable.

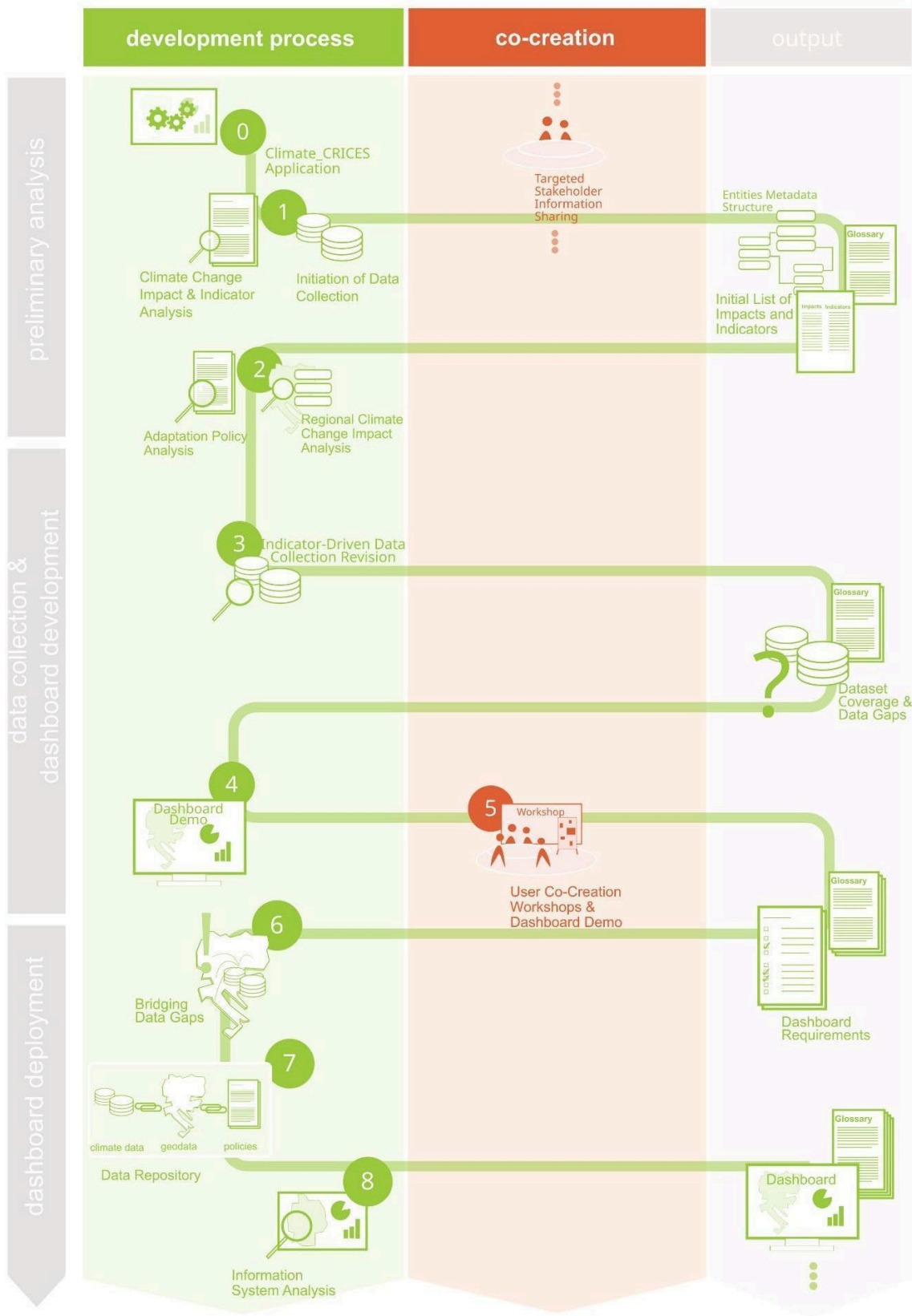


Figure 1: Overview of the 'original' roadmap adopted in the Climate_CRICES project (© Eric Neuber @ IOER)

Preliminary Analysis

This initial analysis served the purpose of getting an overview of the main climate change issues, in terms of impacts affecting the regions, indicators that can and are being used to describe these impacts, policy documents that are available, being designed or implemented, as well as the understanding the users and their potential needs of the Climate_CRICES dashboard. This analysis revealed that in addition to data collection, this being on the one hand impacts, indicators and their descriptions in policy documents, and on the other hand the sources for the indicator values, structures and terms needed to be agreed upon. Thus, a glossary of terms and an entities metadata structure were created.

The first step was a **climate change impacts and indicators analysis for Central Europe ①**. The process was led by three working groups, one for each of the three project topics: (1) heat and drought, (2) flooding, and (3) impact on biodiversity. This was done using well-known and easily available information from international data sources – Intergovernmental Panel on Climate Change (IPCC) assessment reports, the EU Strategy on Adaptation to Climate Change, supporting European Environmental Agency (EEA) publications, existing national adaptation strategies – creating initial lists of impacts and indicators relevant for Central Europe. This process is described in detail in Deliverable D.1.3.2.

In parallel, a non-prescriptive approach towards **data collection ①** was applied by all partners to get an overview of regionally available datasets to be integrated into the dashboard (see also Deliverable D.1.3.2). This was mainly based on the partner's regional knowledge and using national or regional data provision platforms or portals. Each partner collected datasets based on their own understanding of relevance, but harmonized according to characteristics (such as coordinate system, availability of projections, data format, license). An entities metadata structure was created to harmonize and structure the data and information collected. The structure facilitated the collection of impacts and indicators in a structured way. The approach is described in detail in the [Data Repository Conceptualization](#).

Based on the initial lists of impacts and indicators, a glossary was initiated to support cohesive data collection of impact indicators, enhance project communication, and ensure consistency throughout the project. The glossary is a living document, continually developed further in the Climate_CRICES project, and includes all important terms regarding the incorporated hydroclimatic hazards, risk determinants, adaptation processes, classification, and general dashboard-related terms. A condensed current version at the writing of this deliverable is included here as a prefixed chapter.

While no structured co-creation process for user engagement was conducted until the co-creation workshops, selected one-on-one meetings happened in some of the pilot regions. These meetings primarily aimed to inform key stakeholders about the project and its goals and to gain a first understanding of the user landscape and its needs.

Some of the steps in the Climate_CRICES project were pre-determined either by the **project application ①** or the composition of the consortium and are therefore not part of this original Climate_CRICES roadmap. This is especially true for designing the process during the application


phase, which was based on preliminary knowledge about policies, impacts, indicators, existing data and data platforms, as well as stakeholder needs. Nevertheless, these steps are described for completeness and replicability in the [Climate_CRICES Strategy](#) forming the Section C of this document.

Generated outputs:

- Initial list of impacts and indicators → full description of methods and findings in [Climate Change Impacts and Indicators Analysis](#), Deliverable 1.1.1 (Impacts) and Deliverable 1.3.2 (Indicators)
- A glossary of terms ([Climate_CRICES GLOSSARY](#))
- An entities metadata structure → full description of methods and findings in [Data repository](#) and Deliverable 1.3.2

Data Collection and Dashboard Development

This second phase intended to advance data collection to a degree that an initial dashboard could be developed for stakeholder validation and further refinement. The focus was on collecting more detailed national and regional information and gaining a better understanding of how the policies addressed climate change impacts (heat and drought, flooding, and impacts on biodiversity) and the corresponding indicator categories. It also included looking for further nationally and regionally available data sources that underpinned the indicator values.

The **Policy Analysis**  involved two partial steps: (1) the regional climate change impacts analysis and (2) the analysis of regional climate change adaptation policies (see Deliverable D.1.1.1 for more detail on the process and results). The regional climate change impacts analysis aimed at refining the initial impact and indicator lists from the preliminary analysis that used large scale information to the smaller scale of the project's pilot regions, making them more meaningful and tailored to user needs. This process began by comparing impacts and indicators mentioned in the policies (16 in total were assessed) with the initial lists. Overall, the initial list of impacts aligned well with relevant impacts in the regions. As a result of this analysis, only three additional impacts were identified and added to the list.

Similarly, this analysis was conducted regarding indicator relevancy in the pilot regions, coverage in adaptation policies, and data availability of indicator values. The analysis showed large gaps in policy coverage and especially in indicator data coverage. Based on the policy analysis, additional indicators and regionally relevant core indicators were collected. Core indicators were defined as those that are or may become mandatory in regional and local adaptation strategies and are thus of significant importance for future use of the dashboard by regional stakeholders (see Deliverable D.1.3.2 for more detail on the process and results).

Policies were furthermore analysed based on their objectives, measures, and actions for climate change adaptation. These elements were interlinked with one another and with the respective impacts. The entities metadata structure was further developed to include adaptation objectives,

measures, and actions. Based on this analysis, a common classification was developed to categorise the information within entities and support findability and comparability in the dashboard.

The initial lists of datasets were systematically updated with a focus on the indicators list and emerging data gaps (③ **indicator-based data collection revision**). Data coverage and availability for further use differed greatly across the Climate_CRICES pilot regions (see also Deliverable D.1.3.2). To bridge these **data gaps** ⑥, the original approach of harmonizing existing datasets across regional boundaries needed to be supplemented by using transboundary datasets, such as those from the Copernicus services (overcoming data gaps is described in detail in [Bridging data gaps](#)).

At this stage of the project, a first demo version of the dashboard ④ based on these first lists, metadata structure and policy data, was put into operation and reviewed by the partners. This version served as a basis for discussing dashboard requirements based on user profiles from the professions within the consortium, and gathering suggestions for enhancement. In parallel a stakeholder engagement process was launched to prepare for the stakeholder co-creation workshops. Here, partners reached out to their associated partners and further stakeholders relevant for the dashboard implementation process, following the stakeholder engagement handbook (generalised process shown in [3+4 Co-Creation of Knowledge](#), and also addressed in Deliverables D.1.2.1 and D.1.2.2).

The **stakeholder co-creation workshops** ⑤ were held to assess the stakeholders' capacity to engage with climate change and adaptation data and to present the current state of the project and dashboard. Stakeholders were asked in a systematic manner about their needs beyond what had been already implemented (more information in Deliverables D.1.2.1 and D.1.2.2). Additional dashboard requirements identified during these workshops were reviewed by the technical partner.

Generated outputs:

- Data set coverage & data gaps: Revised lists of impacts and indicators → full description of methods and findings in [Climate Change Impacts and Indicators Analysis/Deliverables D.1.1.1 and D.1.3.2](#) and [Bridging data gaps/Deliverable D.1.3.2](#)
- An entities metadata structure → full description of methods and findings in [Data repository](#) and Deliverable D.1.3.2
- A glossary of terms ([Climate_CRICES GLOSSARY](#))
- A dashboard demo presented at stakeholder co-creation workshops (see an image of the landing page in [O3 Dashboard](#))

Dashboard Deployment

This last phase largely deals with integrating user requirements from the workshops with the functionalities of the chosen IT infrastructure.

The **Data Repository** ⑦ integrates the preceding steps in the development process. It brings together harmonized policy information using a consistent metadata structure and establishes clear connections between climate impacts, related indicators, and their treatment within policy documents. In addition, it outlines the integration of indicator datasets and their links to both impacts and relevant policy content.

As part of the preparation of this deliverable, an **analysis of existing information systems** ⁸ was carried out (see Deliverable D.1.3.1). This analysis provided a comprehensive overview of regional and European data portals, assessing their strengths and limitations. From this review, further technical and functional requirements for the dashboard were identified, and best practices from existing platforms served as inspiration for the design of additional features.

The dashboard prototype was launched at the end of Work Package 1 of Climate_CRICES. At this stage, the dashboard already displayed the structured entities for all analysed policy documents, a regional Cooling Degree Days (CDD) dataset, and pan-European dataset for mean temperature. While not all targeted datasets had yet been integrated, core functionalities – such as policy comparison, filtering of policy content (objectives, measures, impacts), and data visualization – could already be demonstrated.

Next steps will involve a thorough review of the entity tables, further classification and data collection, testing of the prototype, and refinement of dashboard functionalities. Ultimately, the goal is to fully populate the platform with relevant datasets to support local and regional authorities in advancing their climate adaptation planning and decision-making.

Generated outputs:

- Dashboard user requirements collected across all 8 pilot regions and consortium members → full description of methods and findings in [O1 Dashboard Requirements/ Deliverable D.1.3.3](#)
- Dashboard prototype launched (see [O3 Dashboard](#)) full description of methods and findings in Deliverables D.1.3.3 and D.1.4.2
- A (revised) glossary of terms ([Climate_CRICES GLOSSARY](#))

Lessons learnt

This section presents a reflection on the roadmap presented above and is part of an ongoing process of iterative learning and refinement. Throughout the process, valuable lessons have emerged from each activity undertaken, offering important insights for both the development of the dashboard and the design of similar tools in the future (Figure 2). The next section summarizes key lessons learned across the project, while more detailed findings can be found in the related deliverables.

Climate Adaptation Strategies in Central Europe

In the Climate_CRICES project an in-depth cross-analysis of regional climate adaptation strategies in Central Europe – under implementation, currently in revisions, or still under the development – revealed a mixed picture: while some regions are advancing with comprehensive frameworks and structured monitoring, others still struggle with fragmented data, limited indicator use, and under-addressed climate risks. The analysis focused particularly on how well regions integrate climate impacts into policy and whether those are supported by relevant indicators and data.

The process showed clear signs of **innovation**, especially in regions like **Austria and Veneto**, which have implemented strong institutional frameworks and participatory monitoring systems. These regions link climate impacts directly to adaptation measures and provide robust indicators to evaluate progress. **Heat and flooding risks** were generally better covered, reflecting widespread concern and political urgency. However, persistent **shortcomings** emerged in several areas. Notably, **biodiversity and phenological risks** are often acknowledged but lack corresponding measures, especially in regions like Hungary, Poland, and parts of Germany. The lack of adequate or up-to-date **regional data** further undermines precise impact assessment and the ability to define and monitor progress with suitable indicators.

The review also underscored the importance of **stakeholder involvement**. Where stakeholders were integrated into planning and monitoring processes, indicator systems were more context-sensitive and actionable. Conversely, regions with limited stakeholder participation often produced declarative strategies with weak follow-up mechanisms. To support future improvements, the study emphasized the need for **standardized monitoring frameworks**, better data integration, and stronger alignment between risk identification and implementation.

Platform and data availability and usefulness

In the Climate_CRICES project, addressing the **challenge of fragmented data sources** across Central Europe was central to the project's aim of supporting cross-border climate adaptation. Data diversity – ranging from regional to global scales – posed significant barriers due to differing assumptions, resolutions, and methodologies. While full technical integration of datasets was beyond the project's scope, the team embraced an approach rooted in transparency and structured comparability rather than forced harmonisation.

The consortium developed a **shared methodology and metadata framework** to describe each dataset's origin, scope, and policy relevance. This enabled users to understand the context and limitations of each source without requiring standardization. Regional datasets, while highly relevant, were often inconsistent or incomplete.

As part of the Climate_CRICES project, a **comparative analysis was conducted of 31 climate information platforms** operating at regional, national, and international levels. The goal was to assess how well these platforms support regional climate adaptation planning – particularly in multi-level governance settings like Central Europe – and to extract actionable insights for the development of the Climate_CRICES dashboard. The analysis reviewed strengths, limitations, and structural gaps in the design and functionality of existing tools, focusing on accessibility, usability, policy relevance, and data integration.

Several platforms emerged as best-practice examples, offering clear, user-friendly interfaces, high-resolution municipal-level data, and policy-aligned functionalities. Tools such as *Klimatickazmena.cz* and the World Bank's *Climate Change Knowledge Portal* were praised for their intuitive design and accessibility for both experts and non-specialists. Others, like *ReKIS* (Germany) and *ClimRisk.cz* (Czech Republic), showcased the benefits of providing localized data and indicators, while portals aligned with national strategies – such as Italy's *Adaptation Portal* and Hungary's *NAGiS* – demonstrated the added value of clear policy linkages. Additionally, platforms that allowed for flexible data export, like *Copernicus* and *EURO-CORDEX*, supported both quick insights and in-depth analysis, appealing to a diverse user base.

Despite these strengths, the analysis revealed **several systemic weaknesses**. Many platforms face interoperability challenges, lack transparent metadata, and are difficult to use without technical training. Some require registration, are only available in local languages, or fail to document modelling assumptions and uncertainties – issues that are especially problematic in cross-border or multi-sectoral contexts. Gaps were also identified in real-time data availability, multilingual access, and thematic integration, particularly concerning biodiversity and ecosystem services.

The Climate_CRICES project **does not seek to replace existing systems** or create full technical integration. Instead, its dashboard will act as a facilitation and synthesis tool. By highlighting data gaps, visualizing fragmented landscapes, and improving user access and comparability, it supports regional actors in navigating the complex data environment around climate adaptation. The added value lies in fostering transparency, supporting policy linkages, and making diverse datasets more meaningful for both technical and non-technical users.

Dashboard development

The development of the Climate_CRICES **dashboard** was driven by a strong emphasis on policy relevance, usability, and transparency. Unlike many platforms that begin by compiling as much data as possible, Climate_CRICES took an impact-first approach: starting from the structure and content of regional adaptation strategies in Central Europe and then identifying supporting datasets. This

ensured that the **dashboard aligned directly with strategic needs**, making it more useful for decision-makers.

A key success factor was the creation of a **shared metadata framework** that linked fragmented datasets to specific impacts, indicators, and subsequently policies and their objectives and corresponding measures. Rather than attempting to technically integrate incompatible data, the project used metadata to clarify assumptions and support meaningful cross-border comparisons. This enabled functional interoperability even in the absence of fully harmonized inputs. However, some ambitions, such as dynamic mapping, or real-time updates, had to be scaled back due to data or technical limitations. Importantly, these constraints were not hidden – transparent communication and alternative solutions helped manage expectations while maintaining trust.

Ultimately, the dashboard stands as a **scalable and policy-aligned prototype** that consolidates the project's earlier work. It offers both structure and flexibility, fostering cooperation and strategic planning across Central Europe, and laying the groundwork for future improvements beyond the project's lifetime.

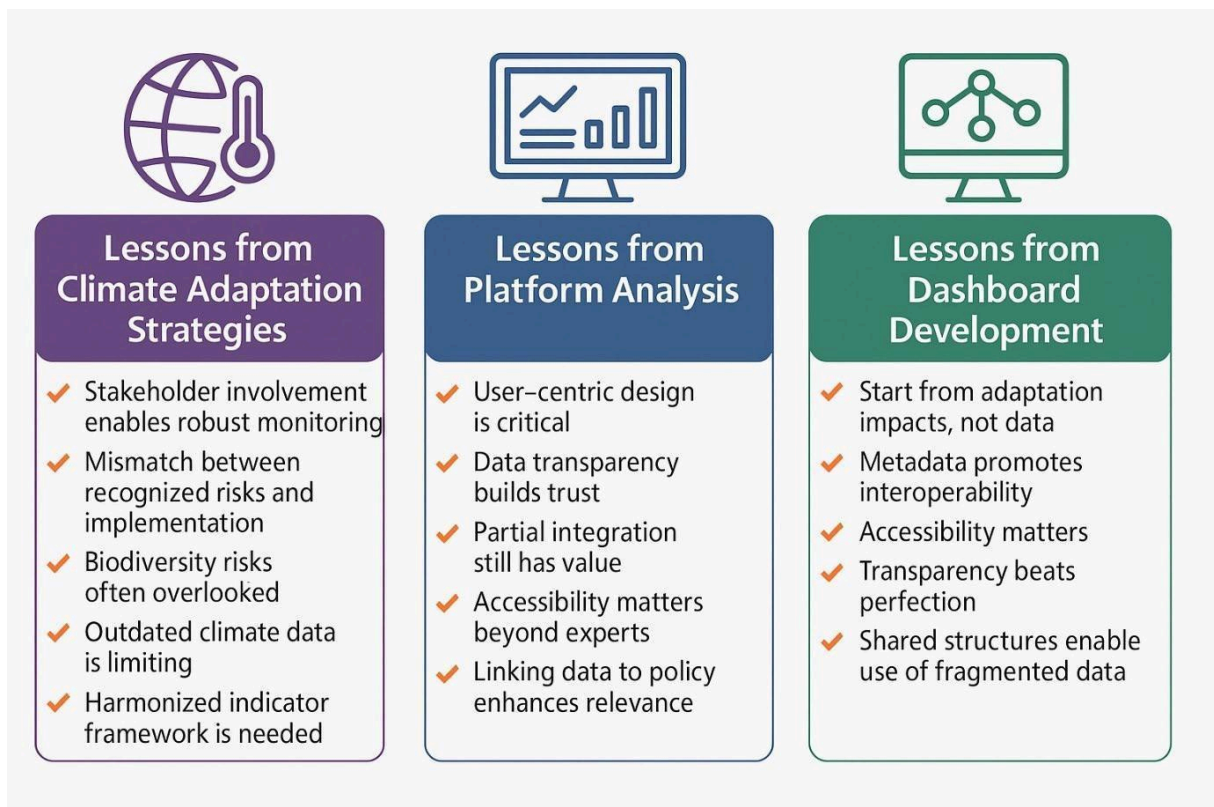


Figure 2: Summarized overview of lessons learned

In sum, the Climate_CRICES project provides both a replicable model and a strategic foundation for more inclusive, data-driven climate adaptation. It shows that building resilience is not only about having the right information, but also about investing in the people, systems, and institutions needed to use that information effectively. However, it also showed some key gaps in terms of inclusiveness and effective integration of user needs.

Moving forward – the importance of co-creation

The Climate_CRICES project brought together regional authorities, researchers, and civil society actors to collaboratively advance climate change adaptation planning across Central Europe. Through a **series of eight regional workshops** – each grounded in a shared methodological framework but adapted to local contexts – the project aimed to improve stakeholder engagement, identify data needs, and support the development of actionable, evidence-based strategies. These workshops not only fostered cross-sectoral dialogue but also served as a means for presenting practical tools, such as the envisioned climate data dashboard.

The workshops revealed a number of **shared challenges and opportunities**. While there was strong enthusiasm for collaboration and a clear recognition of the importance of reliable data, significant disparities emerged between stakeholder groups. Academic institutions and NGOs were generally well-prepared to engage with technical content, whereas smaller municipalities often struggled with limited capacity and resources. Nevertheless, the flexible workshop design – which combined predefined themes with space for local priorities – helped to ensure that discussions were both coherent and contextually relevant.

One of the most valuable components of the process was the use of **SWOT analysis** (Strengths, Weaknesses, Opportunities, Threats), which captured region-specific insights and allowed for the identification of broader trends. For example, participants consistently pointed to fragmented data systems, unclear institutional responsibilities, and limited funding mechanisms as barriers to effective adaptation. On the other hand, opportunities such as digital data tools, improved training, and cross-sector partnerships were widely acknowledged as promising avenues for progress.

Importantly, the project also emphasized the need to go beyond meteorological data, integrating biodiversity metrics, and ecosystem services into planning frameworks. This more holistic approach to adaptation was well received by stakeholders, who noted that broader data integration is essential for developing sustainable and inclusive strategies.

Co-production of knowledge is a critical step in the development of effective climate adaptation measures and plans that help diverse stakeholders in the implementation of these (Jacob et al., 2025). In more general terms, climate services refer to: *“a complex combination of data, processes, products, actors, sources of knowledge, delivery modes, and organisations, that ensure climate knowledge is not only scientifically robust, but also ‘fit for purpose’ in a particular decision-making context”* (ibid). Co-production is needed for services to be fit-for-purpose, meaning that they are useful for the respective user communities, government entities, city officials, and other decision-makers. These groups, however, do not have the knowledge or capacities to fully understand and grasp the complexity of climate information, climate change impacts, or the effects of adaptation strategies on mitigation. ‘Climate service providers’, entities such as National Hydrological and Hydrological services, specialized research institutes and boundary organisations need to work together with users, their capacities, needs and constraints to find a way in which climate information can be conveyed and used in a manner that is appropriate but also relevant (Jacob et al. 2025). In line, with the literature, the lessons learned section above highlighted the following three elements clearly:

1. Early and Continuous User Engagement Is Crucial

One of the most important lessons from the Climate_CRICES process is the necessity of engaging end-users—especially regional and local stakeholders, users as well as providers—from the earliest possible stage. The initial roadmap was primarily expert-driven, and only later validated through co-creation workshops. This delayed integration of user needs limited the project’s ability to align data, indicators, and dashboard features with practical, on-the-ground adaptation requirements. Future processes should build in structured co-creation from the start, enabling more tailored outcomes and fostering stronger user ownership.

2. Iterative Design Over Rigid Roadmaps

The original linear roadmap was insufficient to accommodate the evolving understanding of regional data realities, policy contexts, and stakeholder needs. The process has to be adapted iteratively, especially after the user workshops and dashboard prototyping revealed gaps and new requirements. This highlights the importance of flexibility and iterative learning in the development of adaptation tools, allowing for real-time adjustments based on user feedback and regional constraints.

3. Integrated Structures Require Shared Understanding

Establishing a shared metadata structure, glossary, and classification system was essential to integrate multi-scale, cross-regional data and policy content. However, aligning on terminology and structure took significant effort and time—effort that could have been better streamlined with earlier stakeholder involvement. A common language and data framework must be co-developed early with users to ensure meaningful integration and usability of dashboard content across different regions and administrative levels.

Climate_CRICES Strategy

Based on the above lessons learned, we present in this section an **idealised strategic roadmap** (Figure 3). This roadmap should allow defining the added value of integrated, compiled, and visualized multi-scalar data for a region's climate change adaptation and possibly integrating own or further data into the Climate_CRICES dashboard or to create a similar product. We hope that the process presented here can serve as an inspiration for others to implement a similar process, or to expand on what was achieved in Climate_CRICES. The following subsections provide an overview of an idealised process using methodologies and key insights from the Climate_CRICES results as examples that can be applied and used further. Examples of what was done in Climate_CRICES can be found in green sections, and boxes for the co-creation workshops in red.

The Climate_CRICES project focused on three topics of climate change impacts: heat and drought, flooding, and the impact of climate change on biodiversity. Thus, as a first step, the **scope** of any new project has to be determined. This includes not just a geographic scope, but also the description of the impact scope. Many other climate change effects not addressed in Climate_CRICES are also relevant for regional climate adaptation and could be included in future projects.

Similarly, to the original roadmap, the strategic process starts with the **preliminary analysis** of climate change impacts and indicators for the geographic scope, e.g., Central Europe. The glossary, which is displayed as a prefix of this document, can be reused and refined to reflect the new project scope. In contrast to the original roadmap, two elements should be integrated right at the beginning of the project: Stakeholder Engagement that includes both users and data providers, and the Information System and Data Pre-Analysis. These two elements are critical for selecting and defining the tools, meeting user and provider requirements, and determining the added value of integrated, compiled, and visualized multi-scalar data.

It is followed by the presentation of the necessary **data collection and dashboard development** that allows bringing the requirements of the dashboard users and the data providers of the dashboard together. This facilitates a better understanding of data gaps to design and implement climate change adaptation strategies and may also allow defining strategy to overcome these. A shared workshop between data users and providers fosters trust building for sustained collaborations across these entities also post-project.

Finally, the **dashboard deployment** that integrates climate change data on impacts, their indicators and the related policies that describe climate change adaptation strategies is wrapped up by launching the dashboard to the broader public. Understanding how to sustain the dashboard use and expand and upscale this, is presented in the section entitled: From Prototype to Practice

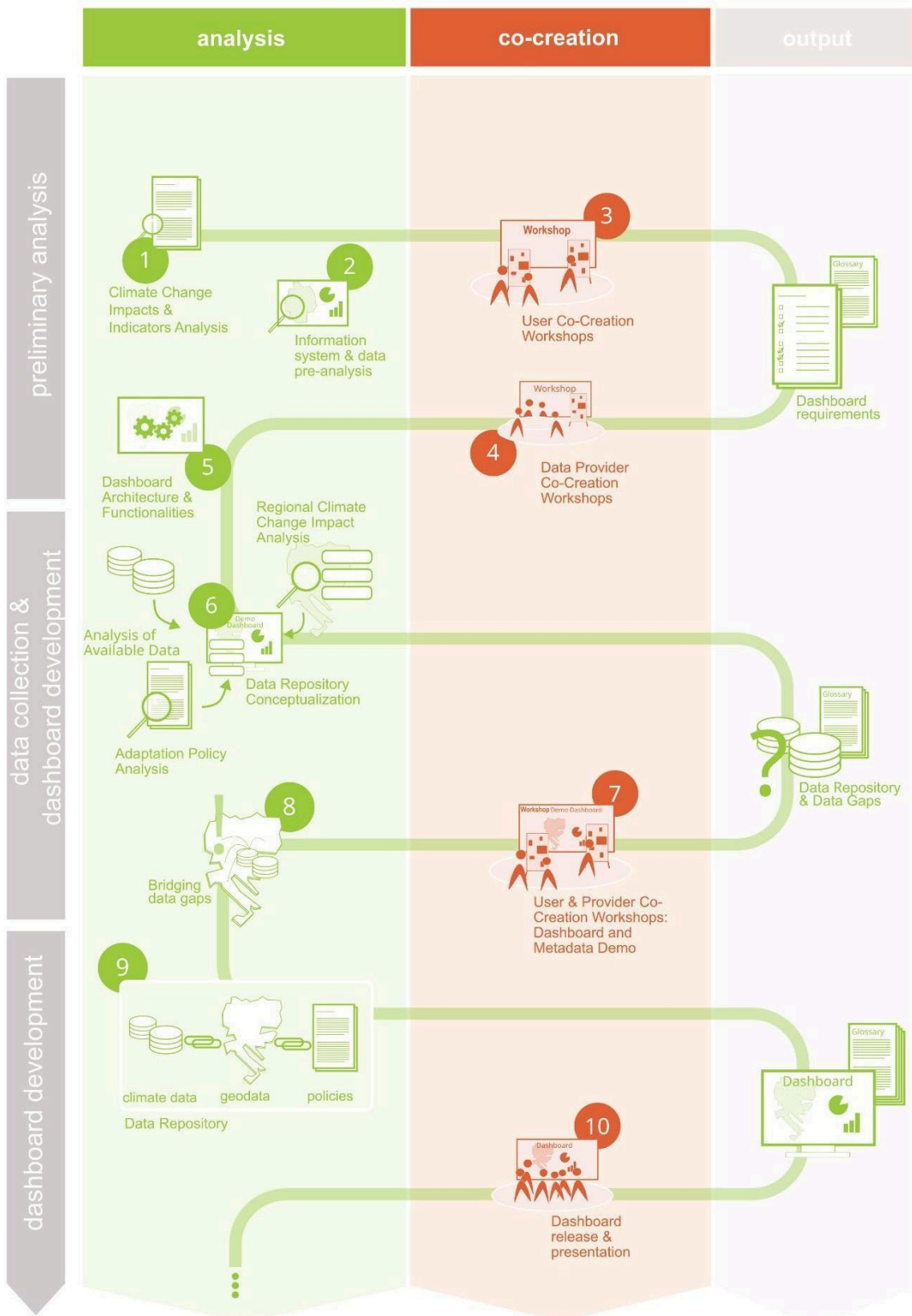


Figure 3: Revised 'idealised' roadmap for the dashboard co-creation process based on the original roadmap applied and their lessons learned. (© Eric Neuber @ IOER)

Preliminary Analysis

This section presents the **foundational process** for defining the technical and stakeholder-informed requirements for an adaptation dashboard (see Figure 4). It outlines how project partners identified key climate impacts and indicators, analysed existing climate information systems, and conducted an initial assessment of available datasets. The section then highlights how these preparatory analyses, alongside structured co-creation workshops with users and data providers, inform the strategy for dashboard development. It details both methodological steps and expected outputs, such as interoperability criteria, user-specific functionalities, and institutional coordination needs. Finally, it introduces the architectural choices and lessons learned, emphasizing the importance of usability, accessibility, and long-term sustainability for a dashboard intended to support regional adaptation planning across Central Europe.

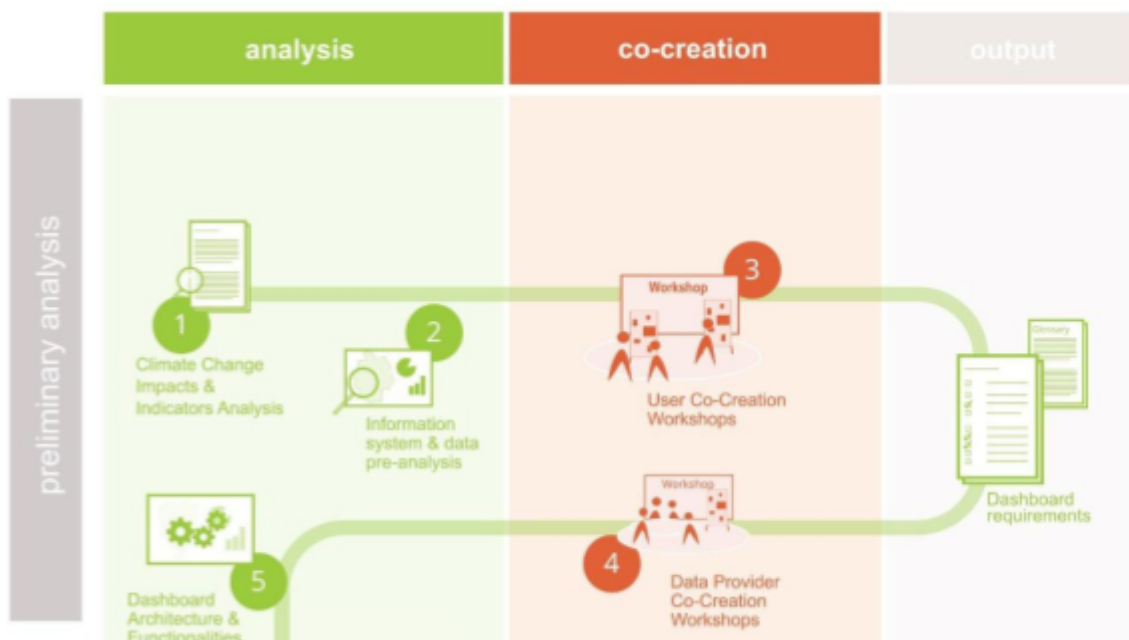


Figure 4: Preliminary Analysis of the revised, 'idealised' roadmap for the dashboard co-creation process (© Eric Neuber @ IOER)

It is critical to spend time and effort on this foundational process to facilitate:

- **User-Centered Design:** Early engagement with stakeholders ensures that the dashboard is tailored to real-world needs, increasing its relevance, usability, and likelihood of long-term uptake.
- **Efficient Data Integration:** By mapping available datasets and identifying technical barriers upfront, the process allows for targeted integration efforts, reducing duplication and streamlining future data updates.
- **Enhanced Interoperability:** Defining data standards, metadata structures, and cross-sector linkages early on supports seamless interoperability across regions, sectors, and platforms.

- **Institutional Buy-In and Trust:** Involving data providers and end-users from the beginning builds mutual understanding and trust, laying the groundwork for sustained cooperation and shared data governance.
- **Scalability and Replicability:** The clearly documented methodology and outputs (e.g. indicator lists, glossary, metadata framework) serve as ready-to-use components that facilitate scaling the dashboard to new regions or adapting it to other policy contexts.

These benefits help ensure that future steps—such as dashboard testing, pilot implementation, and post-project scaling—are more efficient, effective, and grounded in stakeholder realities.

1 Climate Change Impacts and Indicators Analysis

To define the most important **climate change impacts and climate-related indicators** ①, working groups for the project foci (i.e. for Climate_CRICES heat and drought, flooding, impact on biodiversity) can be established to derive lists of impacts and indicators, which are relevant for the project regions.

The initial phase focuses on compiling a **broad set of climate change impacts and corresponding indicators**. Working groups systematically select key impacts and indicators relevant for the project's impact scope. Sources can include major scientific references, particularly the current IPCC Assessment Report, and in European regions the EU Adaptation Strategy, as well as the indicator sets from the European Environment Agency. These initial lists should be circulated among all project partners for feedback and the possibility to add more impacts/indicators.

In the Climate_CRICES project, this analysis resulted in a list of 25 impacts and 44 indicators, each described with additional information such as definition, calculation methods, units, and the appropriate monitoring scale (local, regional, or national).

2 Information system and data pre-analysis

Analysing **existing information systems** ② gives key insights into the capabilities, strengths, and limitations of these platforms and enables the identification of gaps that are relevant to the goals of the project (see Deliverable D.1.3.1 for an overview of how this was done in Climate_CRICES). The analysis can be done via fact sheets collected by the partners in their respective regions, considering regional, national, and global platforms. For each system reviewed, the partners provide key information, such as a representative image, web link, the institutions responsible for its implementation, a brief system overview, and an assessment of its key strengths and limitations. Key variables for the assessment of strengths and limitations can be: User friendliness, spatial resolution, comparability functions and trends analysis and options for data import and export.

The data pre-analysis enables an overview of existing datasets relevant for climate change adaptation and gives a first impression of what kind of data needs to be included. Starting from the information system analysis datasets included in these information systems can be analysed by:

- **Topic:** which of the project foci is addressed by the dataset
- **Receptor or Impact dataset:** Does the dataset contain data on meteorological impacts (e.g. temperature, precipitation, ...) or receptors (e.g. nature conservation areas, species data, water bodies, ...)
- **Coordination system and data format:** Determining for dashboard architecture requirements.
- **Projections:** Gives an overview if historical and/or future time periods are covered.
- **Covered time periods:** Clearly stating which time periods are covered.
- **License:** Important for the integration of data into a new product.
- **Data source:** Findability, to later integrate data into the dashboard.

In the Climate_CRICES project, 31 information systems on regional, national and European/international level were analysed. These platforms were selected based on their relevance to climate risk management, data accessibility, institutional credibility, and alignment with policy frameworks. Together, these systems illustrate the range of institutional approaches, data integration capabilities, and policy alignment mechanisms informing evidence-based decision-making in climate adaptation. The initial data collection for 8 regions, already showcasing a huge quantity of available data but with limited overlap. These dataset collections were later reused and refined to match the impacts and indicators lists. This process is described under [Dashboard architecture and functionalities](#).

Together the information system and data pre-analysis reveal first requirements for the dashboard architecture by showcasing best practices that can be implemented, limitations that can be targeted and data visualisation needs that have to be considered.

3+4 Co-Creation of Knowledge

Best practices in the field of co-production for climate services are still emerging and developing. Spaces such as the WMO Regional and National Climate Outlook Fora have been providing valuable insight into the challenges of sharing climate information that is relevant to a heterogeneous user group in the past 10 years (Hewitt et al., 2020). Boon et al. (2024) showed in a Delphi study with climate services experts that twelve elements are critical for successful climate services for adaptation (see Figure 5). These relate largely to elements that define the quality of the climate service, such as the communication of uncertainty, and a suitable communication format of the information to users (e.g. in the choice of language). These also relate to the results that follow from the production and use of the climate service, such as the increased understanding of a particular issue, e.g. the impacts of climate change, or better decision-making abilities for adaptation. Lastly, the Delphi study showed that elements describing the production process of the climate service itself are less relevant and only pertain to the need that the information provided is relevant to the user needs, problems, or decision-making.

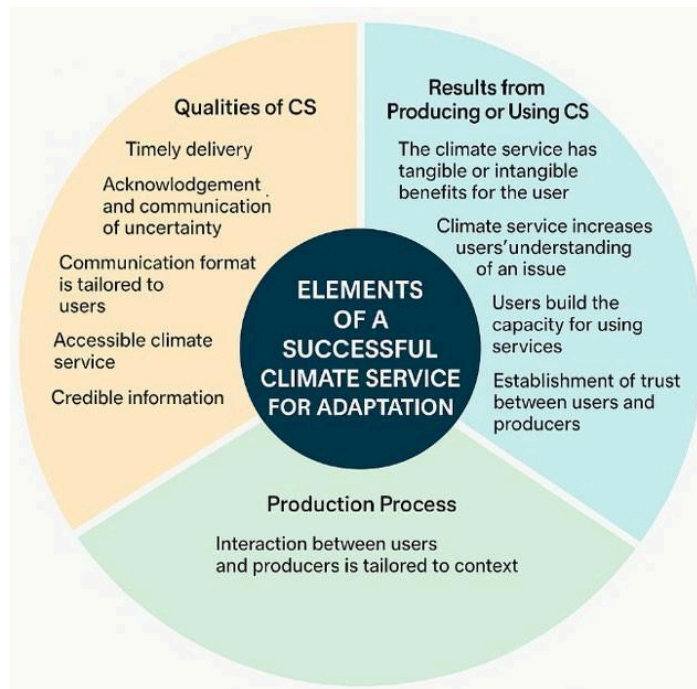


Figure 5: Elements that are relevant for successful climate services (CS) for adaptation (redrawn from table 2 of Boon et al. 2024)

In addition, Daniels et al. (2020) came up with an ideal process for climate services development (Figure 6). The respective online guidance tool can also be used to help work through guiding questions in the different stages (<https://weadapt.org/tandem/>) and is added here as an alternative source of inspiration to guide co-creation processes for the development of climate services.

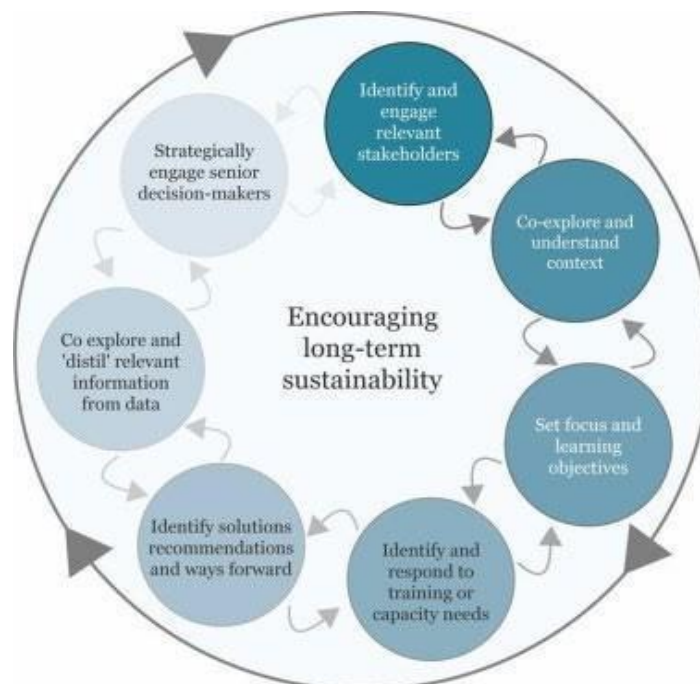


Figure 6: Ideal co-production process for climate services development that ensures long-term use of information, source: <https://weadapt.org/tandem/>

Identification of relevant stakeholders

While in the Climate_CRICES project, stakeholder engagement happened at a much later stage, integrating valuable stakeholder inputs and considering their capacity, needs, and barriers is necessary right from the beginning. In the Climate_CRICES project, the stakeholder engagement followed the stakeholder engagement handbook, which is displayed below in a generalised way (more information can also be found in Deliverables D.1.2.1 and D.1.2.2). The aim of the document was the organisation of the first regional workshops.

One effective way to systematically identify relevant stakeholders is to combine an ex-ante approach with a more flexible, ad-hoc method. The process often begins with the project team mapping stakeholders across a set of predefined categories, providing a structured starting point. This initial list can then be expanded through the snowball method, in which existing stakeholders suggest others who may be relevant. This blended approach helps ensure that no significant actors are overlooked. The five stakeholder categories used to guide the initial identification are outlined in Table 1.

Table 1: Overview of stakeholder groups relevant for the dashboard development

GROUPS	GROUP EXPLANATION	STAKEHOLDER CATEGORIES	PRACTICAL EXAMPLES
1) DEVELOPERS AND IMPLEMENTERS	Officials or other stakeholders who work with the adaptation plans and are responsible for its realisation	<ul style="list-style-type: none"> Local authorities Regional authorities Others from public administration 	Official River basin manager
2) POLICY MAKERS	Stakeholders who, at the final level, decide on the implementation of specific measures and approve the adoption of strategies	<ul style="list-style-type: none"> Elected representatives of local/regional governments 	(Deputy) Mayor (Deputy) Governor
3) LOCAL USERS	Stakeholders who benefit from the climate change adaptation	<ul style="list-style-type: none"> NGOs Local businesses and industries Environmental organisations Private enterprises Other potential users 	Local company director Farmer
4) EDUCATIONAL AND RESEARCH INSTITUTIONS	Researchers connected to climate change	<ul style="list-style-type: none"> Universities Schools Research institutions 	Researchers
5) OTHERS	Mainly added by snowball method		

It is advisable to make a list of stakeholders with contact information. Efforts should be made to invite stakeholders from groups 1-4 (1-3 is the minimum). Although stakeholders may have varying interests or levels of influence, the goal is to engage all of them in the discussion. It is essential to navigate the entire engagement process and aim to involve them across all four levels: informing, consulting, involving, and collaborating¹.

- a) **Inform:** Share clear and accessible information about the project’s goals, activities, and expected outcomes to ensure stakeholders understand its purpose and relevance.
- b) **Consult:** Gather feedback from stakeholders through discussions to identify their needs, concerns, and priorities.
- c) **Involve:** Actively engage stakeholders in shaping strategies and solutions, ensuring their perspectives are integrated into decision-making processes.
- d) **Collaborate:** Work closely with stakeholders to co-develop and implement solutions. Maintain long term relationships with stakeholders.

Development and organisation of co-creation workshops

In the Climate_CRICES project, we followed five distinct steps in the preparation, organisation and evaluation of the workshop, as illustrated in Figure 7. We show these here as an example of how to organize co-creation workshops in a generalized manner.



Figure 7: Steps undertaken in Climate_CRICES for stakeholder co-creation workshops

1. Identifying Stakeholders

Before engagement begins, it’s essential to map relevant stakeholders involved in climate adaptation – ranging from public authorities and data providers to researchers, practitioners, and community representatives. Involving these groups ensures that the dashboard and adaptation strategies reflect real regional needs and capacities.

2. Preparing for Engagement

Clear communication is key to motivating stakeholder participation. Invitations should be sent at least one month in advance, including logistical details, workshop goals, and translated materials like brochures. Promotion through media and professional networks helps raise awareness. Materials must be tailored to the regional context, summarizing local adaptation policies, climate

Note that stakeholder engagement usually entails five levels - the fifth one being often empowerment (Arnstein, 1969). In Climate_CRICES empowerment will follow in the second and third phase of the project, which is why it is not represented here.

impacts, and proposed indicators. Selecting appropriate engagement methods – such as interactive mapping or breakout groups – ensures inclusive dialogue.

3. Organizing the Regional Workshop

Workshops are designed around a shared agenda to ensure comparability across regions. They serve to inform stakeholders about the project, consult on their current practices and challenges, and actively involve them in identifying data and policy gaps. Hybrid participation options (e.g. via Zoom) and interactive methods (e.g. World Café, SWOT groups, digital tools like Slido) support dynamic engagement.

4. Creating Uniform Outputs

After each workshop, partners complete standardised templates capturing stakeholder input, including data needs, policy alignment, and potential barriers. A workshop report documents the discussion and collaboration, while a self-assessment reflects on successes, gaps, and stakeholder readiness to engage.

5. Maintaining Relationships

The engagement process does not end with the workshop. Maintaining contact with participants, sharing follow-up results, and integrating their feedback into future dashboard enhancements reinforces trust and cooperation. These relationships lay the groundwork for continued collaboration in cross-border climate adaptation planning.

For this revised strategy, we suggest at least four rounds of workshops:

- (1) an early engagement workshop with the potential users of the platform, primarily aimed at introducing the project and identifying user needs **3**.
- (2) an early engagement workshop with potential data providers to the platform, focused on exploring issues related to data availability, format, scale and interoperability **4**.
- (3) once the initial platform is available, a joint workshop, bringing users and providers together to clarify the platform's functionalities, and to address potential data gaps **6**.
- (4) lastly, the final workshop in this project phase will introduce the dashboard to a wider audience and assess further capacity development needs to enhance the usability and usefulness of the tools **10**.

The aims and ideas for the individual 4 workshops are represented in this document through red boxes, as can be seen below.

3 1st Co-Creation Workshop for Users

These initial workshops serve as a platform to effectively involve local communities, governmental bodies, and other relevant stakeholders in the revision of regional adaptation strategies.

The objectives are threefold:

Stakeholder Engagement: Understanding the diverse needs, barriers, and feedback of stakeholders to ensure that adaptation strategies are inclusive and effective. By actively involving a range of voices in the discussion, solutions that are tailored to the unique challenges faced by each region can be created.

Dashboard Design and Data Needs: A significant focus of the workshops will be on the design of an interactive dashboard that will facilitate informed decision-making. Participants will discuss the types of data required and the ideal indicators that should be included to enhance the dashboard's utility. This includes also the identification of climate change impacts and their indicators. This collaborative approach will ensure that the dashboard meets the practical needs of users and supports ongoing adaptation efforts.

SWOT Analysis Contributions: The workshops will also offer valuable insights for developing a comprehensive SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis of the current and potential use of climate data in creating and updating adaptation policies within pilot areas. This analysis will serve as a foundational tool for understanding the existing state of regional adaptation initiatives and identifying opportunities for enhancement.

The following questions can be used to guide the workshop

(from <https://weadapt.org/tandem/>):

- What local organisations and initiatives are already working on issues of climate resilience and related issues? Are there partnership opportunities?
- Which institutional actors are critical to engage in this process? E.g. the local meteorological department or NHMS; national government; local government decision-makers and councillors; private sector; civil society, etc.
- What data needs are there beyond climate impact indicator data?
- Do all participants understand climate change and the differences between weather and climate and the terms that are used by climate providers? Exploring the basics of climate change and the terminology used in climate change and adaptation can provide a strong foundation for discussing participants' understanding and experience of weather and climate impacts and agreeing on use of shared language.

Expected Outputs from the 1st Co-Creation Workshop for Users:

1. User-Centered Functional Requirements for the Dashboard

A prioritized list of functionalities and features drawn from direct input by user groups. This includes the types of climate change impacts they wish to track, key indicators needed for decision-making, preferred data formats and visualization methods (e.g. maps, reports, graphs), and platform usability features. These requirements will directly inform dashboard design and development to ensure fitness for purpose.

2. Identification of Practical Data Needs and Gaps

A consolidated overview of specific data needs from users at different governance levels (e.g. local governments, civil protection, planning authorities), including information on spatial and temporal resolution, thematic coverage (e.g. water stress, land use change), and interoperability concerns. This will guide dialogue with data providers and the technical specifications for dashboard integration.

3. Stakeholder Mapping as a Snowballing Exercise

A dynamic and participatory process to identify key actors already involved in adaptation efforts, complemented by a mapping of currently absent but necessary stakeholders for robust and inclusive implementation (e.g. utilities, private sector, local meteorological services). This snowballing approach will support the expansion of the stakeholder network over time and guide future engagement activities.

4. Institutional-Level Understanding of Vulnerabilities and Adaptation Barriers

Insights into the institutional drivers of vulnerability and adaptation challenges—such as governance fragmentation, lack of mandates for climate planning, insufficient technical capacity, or gaps in vertical coordination between national and local levels. These findings will inform the adaptation strategy refinement process and help align dashboard outputs with institutional planning realities.

For Climate_CRICES the result from the co-creation workshop carried out with dashboard users showed the following needs (based on the results of the SWOT analyses as described in Deliverable D.1.2.2):

1. Requirements for the Dashboard Development

The dashboard must be user-friendly and open-access, ensuring that non-specialists—from small municipalities to civil society organizations—can navigate and use it effectively. A centralized and interoperable structure is key, enabling fragmented datasets to be consolidated in one place while allowing for import/export to support regional comparisons and policy coordination. To serve varied users, the platform should offer customizable visualizations, including regional overlays,

sectoral breakdowns, or mobile-access features. Long-term sustainability is also critical; this means defining clear funding and maintenance responsibilities from the outset. Finally, stakeholder training and iterative testing are essential to ensure the dashboard meets real-world needs and builds user confidence.

2. Practical Data Needs and Gaps

Current climate data is often fragmented and inconsistently formatted, making integration and harmonization a major challenge. Much of the existing data is stored in overly technical formats that are inaccessible to many end-users, especially local planners and municipal staff. Additionally, data is not always updated regularly, which reduces trust and weakens its value for decision-making. There is also a clear lack of localized or disaggregated data, leaving smaller jurisdictions without actionable insights. Furthermore, the absence of proper metadata and unclear data provenance makes it difficult for users to understand how and why data may have changed, further limiting usability.

3. Stakeholders to be Further Involved

The dashboard's development and implementation require deeper engagement from local and regional authorities, particularly smaller municipalities that are often left out of digital planning processes. Universities and research institutions can support with both methodological rigor and training delivery. Environmental and public health agencies hold critical data on climate-related risks and must be involved to ensure sectoral relevance. National-level data providers and planning agencies are also needed for strategic alignment and to guarantee data access. Finally, EU and national funding bodies play an indispensable role in supporting the platform's long-term financial sustainability and wider deployment.

4. Institutional Vulnerabilities and Barriers

A lack of technical capacity, especially within small municipalities, remains a major barrier—many local administrations lack the staff or expertise to work effectively with climate data. Institutional fragmentation compounds the problem, with unclear roles and poor communication between relevant bodies. Overreliance on a few key experts makes ongoing projects vulnerable to disruption through staff turnover. Moreover, many platforms lack a stable funding or maintenance plan, undermining their long-term usefulness. Finally, in some regions, political or administrative leadership still fails to prioritize climate data use, limiting institutional support and slowing progress toward adaptation goals.

O1 Dashboard Requirements

Determining the requirements for the dashboard is crucial to choose a fitting architecture with the functionalities. The requirements can be derived from the previous steps:

- Key lessons learned, inspiration and limitations to be targeted from the information system analysis;
- Data format requirements from the data pre-analysis to ensure that the architecture can handle the most formats and is OGC-conform;
- First data visualization and resolution requirements based on available data resolutions, the data format, the geographical projection and available time periods;
- User requirements regarding for example (open) accessibility, usability, import/export functionalities, comparability features, data scope (e.g. which indicators are (regionally) mandatory) and visualization needs from the first co-creation workshops;
- Keeping track of license information right from the beginning.

As such, key requirements derived from the **analysis of existing information systems** (Deliverable D.1.3.1) and the **stakeholder workshops** (Deliverable D.1.2.2) resulted in the following dashboard requirements in Climate_CRICES:

1. Interoperability and Multi-Scale Data Integration

The dashboard must support the seamless integration of local, regional, national, and international datasets, with the ability to import/export and compare data across administrative borders. It should be interoperable with existing platforms to promote transboundary planning and reduce duplication.

2. User-Centric Design and Accessibility

The interface must be intuitive, multilingual, and open-access, ensuring usability by non-specialists, including local authorities, civil society, and the general public. It should feature clear visualizations, contextual explanations, and guided navigation, with attention to accessibility across devices (e.g., mobile-friendly).

3. Real-Time and Regularly Updated Data

The dashboard should integrate real-time or near-real-time climate data streams where possible, along with a system for structured, periodic updates. This ensures timely and relevant information for decision-making, with clear metadata and source transparency.

4. Customizability and Sectoral/Geographical Coverage

Users should be able to tailor data visualizations, compare regions or sectors, and explore multi-sectoral data (e.g., water, biodiversity, infrastructure) at various spatial scales. This supports targeted adaptation planning and cross-sectoral analysis.

5. Sustainability, Training, and Iterative Improvement

A clear long-term maintenance and funding strategy is essential, along with institutional responsibility for updates. The platform should be rolled out with training workshops, include practical testing, and incorporate a feedback loop for continuous improvement based on user experience.

Not all of the above-mentioned requirements could be met within the project, as for example features such as real-time data integration, dynamic map overlays, and advanced user customization were identified as desirable but currently out of scope.

At this point in time, it becomes critical to better align user needs with available data and sources. We saw in Climate_CRICES, that it would have helped bringing in data providers early on to help overcome apparent data gaps, interoperability and scalar integration issues. This can also help in building connections that are based in trustworthy relationships across users and providers, with the research project acting as a bridge (see also 3rd workshop bringing users and providers together). Hence, we suggest to include here a workshop with data providers (see box below).

4 2nd Co-Creation Workshop for Data-Providers

A critical component of climate services and their information is climate related data, and those underpinning impacts assessments as well as adaptation measures. We thus consider it to be critical for 'data providers' to also provide their perspective on the dashboard requirements.

The following objectives are of relevance:

Setting up cooperation with data providers: Data providers are essential to feed the dashboard with credible and curated data and information. Creating an active and trustful setting for cooperation between users and providers is crucial to the effective use of the platform for climate adaptation.

Dashboard Design and Data Availability: A significant focus of the workshops will be on the design of an interactive dashboard that will facilitate informed decision-making. Data providers play an active part in making the dashboard useful. Understanding how available data can be integrated into the dashboard needs to happen early on to address issues of scale and interoperability. This includes also the identification of climate change impacts and their indicators.

The following questions can be used to guide the workshop

(from <https://weadapt.org/tandem/>):

- How can activities be designed to communicate to and engage participants on various approaches to climate risk assessment, global climate modelling and projections and downscaling of data? The use of graphics, maps or narratives may assist in

communicating medium to long-term climate patterns and change with different stakeholders.

- Can specific information needs at relevant time and spatial scales now be articulated for particular decision-making processes or the development of plans, processes or tools? These information needs may be weather and climate-related but also wider e.g. groundwater abstraction and recharge rates, rates of population growth and projected water demand.
- How is data and information being communicated, shared and disseminated? How does this need to vary and be tailored to different groups e.g. technical staff, senior decision-makers, media etc?

Expected Outputs from the Co-Creation Workshop for Data Providers:

1. Inventory of Available and Relevant Datasets

A compiled list of existing datasets held by regional, national, or sectoral data providers, including metadata on spatial/temporal resolution, data formats, update frequency, and licensing. This output will identify what data can realistically be integrated into the dashboard in the short- and medium-term and highlight any critical data gaps.

2. Data Interoperability and Standardization Requirements

A shared understanding of the technical and institutional requirements for data integration, including preferred standards (e.g. INSPIRE, ISO), APIs or data portals in use, and protocols for ensuring interoperability between heterogeneous data sources (e.g. between hydrological, biodiversity, and climate projections).

3. Initial Set of Climate Impact Indicators

A shortlist of climate change impacts and corresponding indicators (e.g. temperature anomalies, flood frequency, soil moisture deficits) that data providers can supply or co-develop. This includes agreement on calculation methods and the feasibility of disaggregating indicators at local/regional scales.

4. User-Specific Data Delivery and Visualization Preferences

Insights into how different audiences (e.g. municipal planners, national agencies, NGOs) should receive and interpret climate data. This includes preferred visualization formats (e.g. interactive maps, graphs, narrative summaries), update frequency, and levels of technical complexity suitable for diverse users.

5. Framework for Long-Term Cooperation and Data Sharing

A preliminary roadmap or agreement on how to sustain cooperation beyond the workshop, including roles and responsibilities, data governance protocols, and potential mechanisms for regular updates and co-maintenance of the dashboard's data streams.

5 Dashboard architecture and functionalities

As the final step in the preliminary analysis which allows selecting a fitting **dashboard architecture and functionalities** ⑤, all requirements derived from the previous steps should be considered, including the specifications from the second workshop with data-providers. The dashboard architecture selection should follow an open, transparent, and structured decision-making process. The objective is to identify an architecture that best meets the dashboard's functional and strategic requirements – derived from the previous steps.

All relevant inputs must be consolidated and translated into **architectural priorities**. These priorities should cover critical aspects such as:

- Spatial data handling
- System scalability
- Export and reporting capabilities
- Interoperability with existing systems
- Accessibility and usability standards
- Use of open-source technologies, where appropriate

These priorities guide the evaluation of both backend and frontend components:

- **Backend architecture** should be evaluated in terms of spatial database efficiency, robustness of data pipelines, API architecture, adherence to open standards, and the ease of integration with external systems.
- **Frontend architecture** should prioritize dynamic and responsive map rendering, tools for data comparison and analysis, user-friendly export functionality, and the ability to extend or customize features using open-source libraries.

Throughout the process, teams should ideally remain open to alternative technical approaches—balancing innovation with feasibility and long-term maintainability. Often, project and funding contexts, however, restrict the possibilities of free platform choices.

In Climate_CRICES, the dashboard architecture was predetermined by the technical partner and there was no open architecture selection process. Nevertheless, critical features of the Climate_CRICES dashboard supported the overall project objectives. In contrast to most of the existing information systems analysed in the Climate_CRICES project, the implemented dashboard is based on Microsoft Power BI, which is a business intelligence tool and not a Web-GIS tool. The dashboard supports some key features identified by the information system analysis as lacking in many existing information systems:

- Availability of synthesised reports linked to specific climate policies ready to download
- Comparability of policies and indicators across local, regional, and national contexts
- Freely accessibility of the content in multiple languages

Power BI offers a suite of features that align closely with the project's ambitions for inclusiveness, transparency, and policy relevance:

- **Ease of Use and Accessibility:** Power BI features a user-friendly interface and allows filtering, customization, and data export without technical expertise
- **Cost-Effectiveness:** Compared to many GIS tools, Power BI is relatively affordable, especially when considering its integration, licensing, and maintenance requirements
- **Custom Visualizations and Interactivity:** Power BI enables tailored maps, graphs, and dashboards that communicate climate data in a narrative, engaging format
- **Web Integration:** Dashboard can be embedded into partner websites using a simple URL. Once embedded, any updates to the source dashboard are automatically reflected across all portals—ensuring consistency and easy dissemination.

While not all functionalities could be implemented, the approach adopted ensures that transparency and usability remain at the forefront. The Climate_CRICES dashboard is not a static data viewer – it is a strategic and dynamic tool that reflects regional ambitions, highlights data and policy gaps, and fosters cooperation across Central Europe.

Data Collection and Dashboard Development

Having arrived at initial user requirements, this section now outlines the process of **developing the data repository and dashboard** (see Figure 8), emphasizing how regional climate impacts, adaptation policies, and available datasets can be systematically analysed and structured. It explains how a metadata-based repository can be developed further to support integration and comparison of cross-regional data, and how entities such as impacts, policies, objectives, measures, indicators, and datasets can be defined and classified. The section also describes the third co-creation workshop, where users and providers jointly address unresolved technical and governance issues. It concludes by detailing how European and global datasets can be used to bridge regional data gaps, ensuring consistency and completeness for the dashboard across e.g. Central Europe.

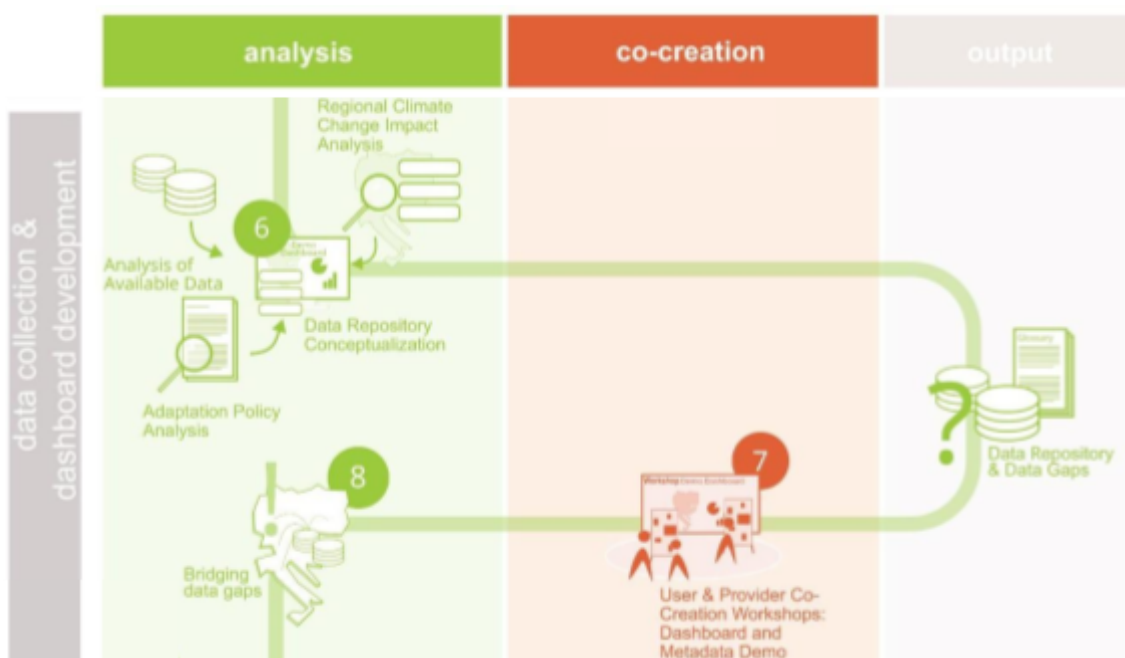


Figure 8: Data Collection and Dashboard Development of the revised ,idealised' roadmap for the dashboard co-creation process (© Eric Neuber @ IOER)

6 Data Repository Conceptualization

The **data repository conceptualization** ⑥ is based on two things: (a) the dashboard architecture and (b) the data that drives the dashboard. The following three steps can be undertaken here:

1. Analysis of regional climate change impacts
2. Analysis of climate change adaptation policies
3. Collection of available data (referring here to: impacts, indicators and their descriptions in policy documents, and indicator values)

The following three subsections describe each step with regard to their influence on the repository conceptualization, whereas key takeaways for the repository are outlined in the last subsection.

1. Analysis of Regional Climate Change Impacts

The relevance of selected climate impacts can be further assessed through a systematic review of strategic and adaptation policy documents from the pilot regions. The analysis focuses on identifying which impacts are explicitly mentioned in these documents. These findings are then compared with the initial list of climate impacts to evaluate their regional relevance.

This comparison can result in three possible outcomes:

1. The impact is mentioned in both the policy documents and the initial list.
2. The impact appears only in the adaptation strategy.
3. The impact is included only in the initial list.

For impacts mentioned only in adaptation strategies, it is important to assess their relevance in other regions. If they are found to be significant elsewhere, they can be added to the revised list. Even if they are specific to one region, they may still be included, depending on the project's scope. Impacts that appear only in the initial list but are not relevant to any pilot region may be removed. However, since the initial list is based on established scientific literature, such exclusions should be made cautiously. The absence of certain impacts in all reviewed strategies could point to gaps in those policies rather than irrelevance. Therefore, an additional literature review is recommended to validate any such decision.

In Climate_CRICES this analysis led to the inclusion of the following three additional impacts: loss of snow cover and its duration, land cover and land-use change, and strong winds. Sea-related impacts are only relevant for the Veneto region, which is the only coastal pilot region. Due to their high importance, they remained in the list.

Impacts are the first entity in the metadata structure, which is the basis for the data repository. The associated metadata components are listed in Figure 9. A second entity describes the analysed policies by the components listed *ibid*.

2. Analysis of Climate Change Adaptation Policies

Climate change adaptation policies can be further analysed in terms of the objectives, measures and indicators contained. Starting from the analysis of regional climate change impacts and their inclusion in policies, also the presence of corresponding objectives and measures can be analysed. For this analysis both the analytical sections and action plans within the documents would be subject to derive objectives and particularly the action plans are relevant to identify corresponding measures. Objectives and measures can be linked with each other and with the impacts they are counteracting as well.

Additionally, the presence of impact indicators in the policies can be analysed. The indicator analysis can focus on three levels: Relevance of indicators in the regions, definition of the indicators in the policies and the availability of data to represent the indicators or of an option to calculate them. Based on this analysis a detailed record can be created, listing missing indicators and highlighting where potentials for the data collection lie. Analogous to the revision of the impacts list, additions and dismissions to/from the indicators list can stem from this analysis.

In the Climate_CRICES project this analysis revealed gaps, as some highly relevant indicators lacked policy recognition or available datasets. For example, indicators like "Duration of soil moisture droughts" and "Daily max flow" were recognized as highly relevant but were seldom mentioned in policies. Others, like the "Common bird index," showed critical gaps in data availability. By this analysis three additional entities for the metadata structure are built: Objectives, Measures and Impact-Indicators.

3. Analysis of Available Data

The key element for the repository conceptualization is the initialization of the **structured collection of available datasets**, representing the selected indicators. Based on the data pre-analysis from [Information system and data pre-analysis 2](#), the data collection can be refined and focused on the selected indicators from the revised indicators list. The actual indicator dataset collection can start from the definition of the data repository, enabling findability of the datasets and links to the indicator's entity. Therefore, the entity datasets can be determined by the metadata components listed in Figure 9.

This collection and analysis of available datasets enables the assessment of the coverage of the indicators list in the individual regions and paves the way for future dataset integration into the dashboard.

O2 Data Repository

Three things can be determined from the previous analysis: **(1) regional data gaps**, **(2) data visualization needs** and **(3) data provision needs**. Data provision is especially relevant for datasets that are not openly available and therefore their integration possibility depends on the support from data providers. The data repository can initially be built by the following metadata entities (definitions of terms as per the [Climate_CRICES GLOSSARY](#)):

- Impacts – The consequences of realized risks on natural and human systems, where risks result from the interactions of climate-related hazards (including extreme weather/climate events), exposure, and vulnerability.
- Policies – In the context of the Climate_CRICES project policy refers to the analysed climate change adaptation strategies of the pilot regions. These are documents managing the expected impacts of climate change, grounded on projections and expected impacts of climate change.
- Objectives – In the context of the Climate_CRICES project objectives are the specific goals for adaptation derived from the analysed policies.
- Measures – In the context of the Climate_CRICES project measures refer to the specific interventions for mitigation and adaptation that are specified in the analysed policies.
- Impact-Indicators – Impact-indicators describe the effects of climate change.
- Response-Indicators – Response-indicators describe adaptation measures or activities and conditions that support the adaptation process.
- Data – Quantitative data and information that describe the indicators; often hydro-meteorological and/or socio-economic data.

If necessary more entities, based on the project's scope can be added or the entities can be described by additional metadata components. The metadata structure enables cross-border analysis and visualisation. Due to the diversity of climate adaptation policies and indicators across countries and regions comparison depends on a common framework.

Figure 9 presents links between the here described entities. This promotes comparability of policies in the dashboard and the findability of objectives, measures and indicator datasets to support climate change adaptation. This can be supported by the implementation of a classification system for the entities. The classification enables to filter, compare and link the different entities and is an important step on the way to the provision of integrated multi-scalar climate change adaptation data.

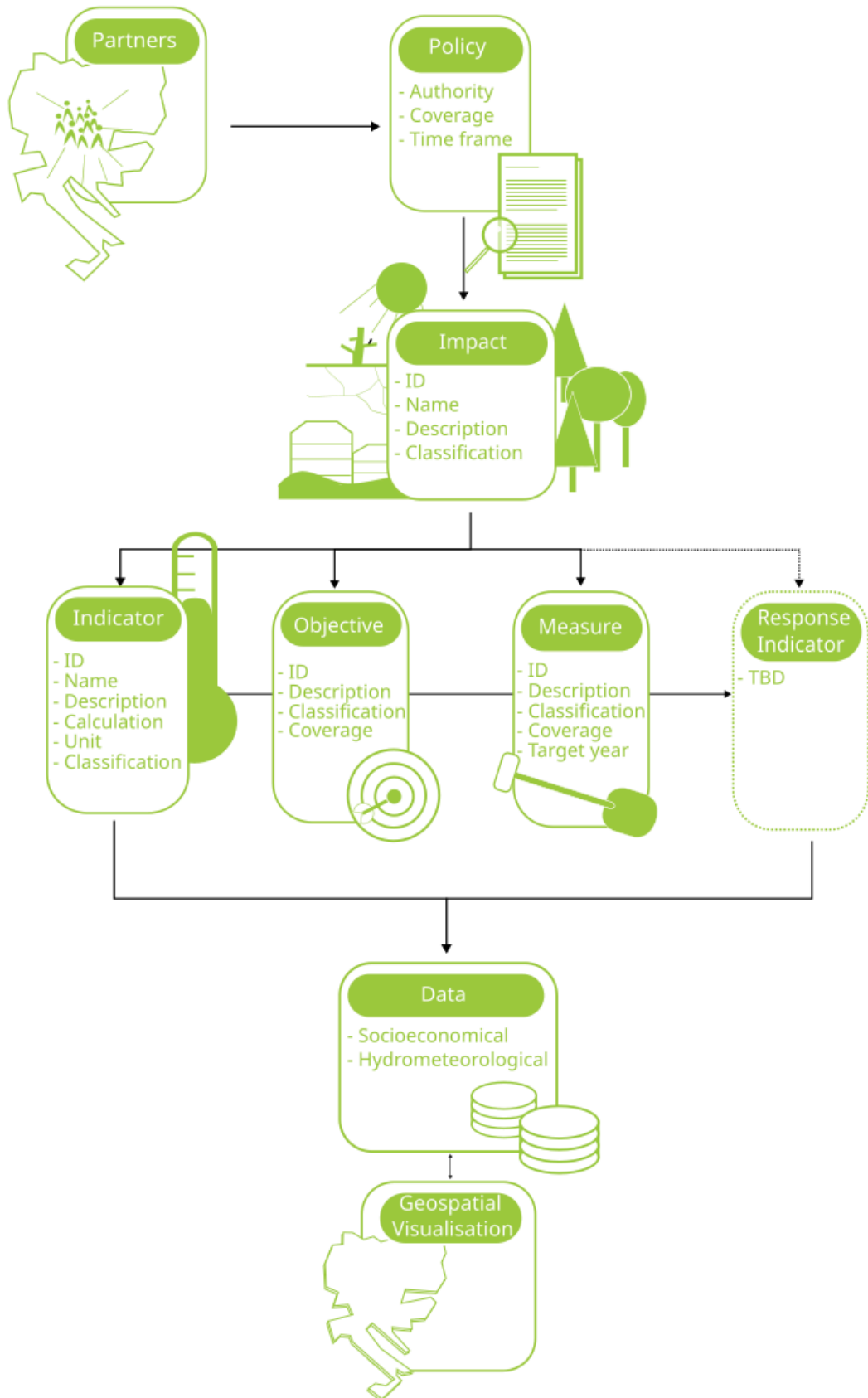



Figure 9: Entities metadata structure of the Climate_CRICES project (© Eric Neuber @ IOER)

In Climate_CRICES the entities classification aimed at findability of data in the entities and supported linking this information with other entities:

- The **impacts classification** was designed to link the project foci with the impacts in two levels: **Level 1** is representing the **foci**: heat and drought, flooding, impact on biodiversity and is supplemented by the additional category 'other extreme weather events.' **Level 2** allows to differentiate the **climatological impacts by subcategories** like general warming, water scarcity (heat & drought), heavy precipitation, river flooding (flooding) or hail and wind (other extreme events). Impacts on biodiversity were distinguished by affected ecosystem type, e.g. freshwater or terrestrial ecosystems.
- Subsequently the **indicator classification** allows distinguishing between **meteorological impact indicators** and **receptor related indicators** in **level 1**. **Level 2** again links the meteorological impact indicators with the project **foci** and distinguishes several possible **receptors** (e.g. agriculture, forestry, biodiversity, and energy).
- **Objectives** can be classified on **level 1** based on their orientation on different **risk determinants** (e.g. hazard prevention, vulnerability/exposure reduction, resilience promotion, and (overall) risk minimization). On **level 2** different **action fields** can be identified, such as land use, biodiversity, water, infrastructure, human health and others.
- The same **action fields** are the basis for the **classification of adaptation measures** to be undertaken.

The classification is a powerful tool to link entities with each other apart from directly connecting single elements. Together with the entities metadata structure it allows regional datasets and policies to be compared – even if the underlying data stems from different models or methodologies.

7 Promoting trust through continuous stakeholder engagement

At this stage, a preliminary dashboard is available and requirements have been assessed and contrasted against functionalities. The logic of how data and information are connected is available in the entities metadata structure and needs to be explained and made transparent to users and providers alike. Bringing stakeholders back and explaining to them what parts of their feedback was taken up and which ones fall out of scope is critical to sustain trust in the process. Bringing both users and providers together in this third workshop  further fosters trust and allows for learning from each other.

© 3rd Co-Creation Workshop for Users and Providers

The primary objectives of these workshops are:

Feedback and expectation management: Not all requirements could be fulfilled. This needs to be communicated in a transparent manner and explained. A discussion on the implications of a lack of fulfilment needs to ensure to be able to fully grasp the impacts the tool can then have or not for users but also for providers.

Overcoming data gaps: As was seen in the project, data gaps but also issues of interoperability across scales and datasets exists. These data gaps and mismatches need to be discussed and their implications assessed. Ideally, the workshop would result in a common decision of how to deal with data gaps, potentially aiming at closing some that might be deemed critical for policy fulfilment.

Fostering direct connections: Bringing users and providers together in the same room also intends to foster trust across these communities. Often language (jargon) and capacity issues hinder a fluid and sustained communication between these groups (e.g. use of the glossary created in the project). Research projects often allow for neutral, non-political spaces that foster trust building.

The following questions can be used to guide the workshop

(from <https://weadapt.org/tandem/>):

- How can activities and engagements be designed to co-explore and recognise different perspectives and priorities and address the complexity of system-wide multi-sector issues in a collaborative and simple/accessible way?
- Have specific needs emerged from the co-exploration 'phase'? This may be particular needs or requests for training, further exploration and unpacking of a particular aspect of the adaptation issue or engagement of additional stakeholder groups identified as critical to decision-making processes.
- What solutions and recommendations can be identified? These may be the design and delivery of particular outputs, projects, policies, the strengthening of capacities through particular training or support, innovations in data sharing or the development of new partnerships or increased collaboration between institutions. Are these at appropriate temporal and spatial scales to address the adaptation issue(s) identified?
- Can examples from other cities or contexts help to spur possible adaptation measures?
- Where have 'windows of opportunity' been identified or created? E.g. a new political cycle, issues that are high on current political or social agendas, new initiatives, tools or processes that are under development or on the horizon. How can solutions build on existing efforts and initiatives or leverage existing partnerships to limit replication of work?

Expected Outputs from the 3rd Co-Creation Workshop for Users and Providers include:**1. Consolidated List of Prioritized Technical Requirements**

This includes confirmation of functionalities already implemented, identification of technically feasible next steps, and documentation of deferred or out-of-scope features. This list forms the basis for the platform's next development iteration and informs its sustainability roadmap.

2. Technical Recommendations to Address Data Gaps and Interoperability

This includes addressing unresolved data issues, including standard formats and metadata for better interoperability, identification of critical data gaps, provisional solutions such as proxies or scenario ranges, and workflows for integrating decentralised or partner-specific data feeds.

3. Preliminary Data Governance and Maintenance Need

This part provides insights into the governance structures needed to ensure ongoing data integration and dashboard updates, including defined roles for data maintenance, requirements for regular data refreshes, and proposals for inter-institutional cooperation such as data-sharing protocols or memoranda of understanding.

4. Training and Capacity-Building Needs for Platform Use

This includes priority topics for upcoming workshops, suggestions for user support materials like manuals or video guides, and capacity-building measures for stakeholders with limited technical expertise.

8 Bridging data gaps

Based on the regional data gaps derived from step 6 **Data Repository Conceptualization**, possibly reduced by inputs from the workshop in step G **Promoting trust through continuous stakeholder engagement, bridging data gaps** 8 is a challenge in any similar project. Data gaps can be closed by developing the respected data sets for the regions where they are missing. This is an undertaking with great outlay, depending on how many data gaps are apparent and on the complexity of the missing datasets. Nevertheless, this approach can ensure high consistency with data requirements, such as data format, spatial resolution, availability of future projections, and covered time periods.

In the Climate_CRICES project a different approach was followed, ensuring time efficiency and data availability across all of Central Europe: European and global data sources were included into the data collection to bridge data gaps. The partnership of the Climate_CRICES project selected in total 64 European/ global data sets by May 2025, including the following sources:

- Copernicus and Euro Cordex for data on e.g. temperature and precipitation, flow and ecological status of rivers, air and soil humidity, change in land cover (CORINE land cover),
...
- Eurostat for data on the species related indicators
- National Aeronautics and Space Administration (NASA) for data on hail risk
- European Environmental Agency for data on forests and landscape fragmentation

To clarify the sources used in the Climate_CRICES dashboard, information shows how each indicator is linked to detailed metadata – including data origin, methodology, and geographic/ temporal resolution. This helps users understand the context and limitations of the information they are viewing. Where gaps or inconsistencies exist, they are not hidden but made visible.

Dashboard Deployment

This third and last section describes the final phase of the dashboard development, focusing on the **deployment and public presentation** of the tool (see Figure 10). It outlines how the dashboard integrates climate data and policy information via a structured metadata framework, resulting in a comprehensive and user-oriented platform for regional adaptation planning. The section explains how two core pillars – climate data (impacts and indicators) and adaptation strategies (objectives and measures) – are interlinked in the dashboard, offering multiple entry points for users. It also introduces the launch strategy, emphasizing stakeholder recognition, capacity-building needs, and communication plans to support the dashboard's use and outreach.

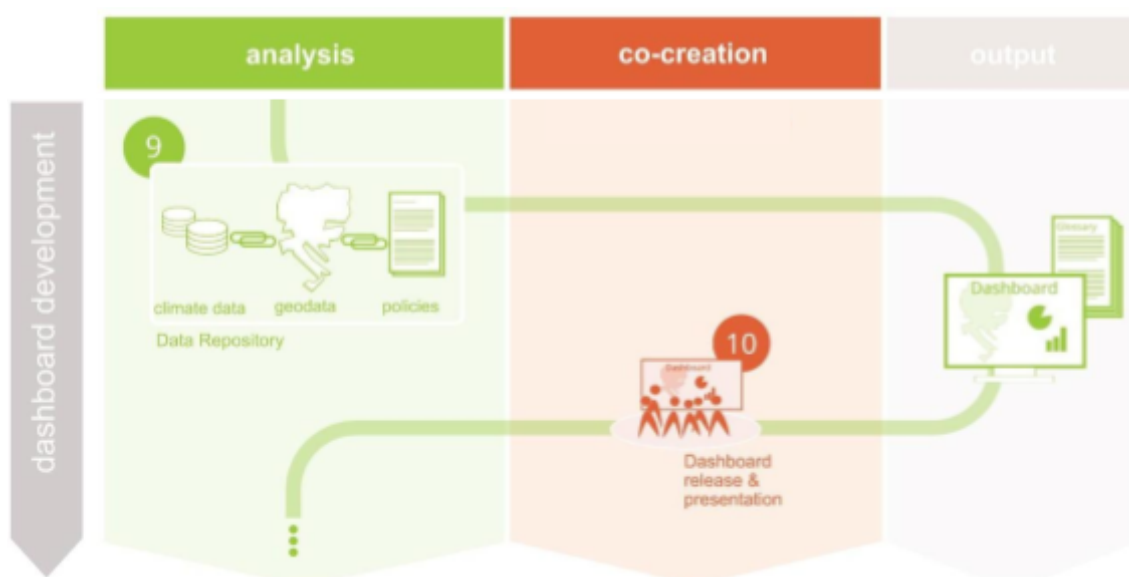


Figure 10: Dashboard Deployment of the revised 'idealised' roadmap for the dashboard co-creation process (© Eric Neuber @ IOER)

9 Data repository

The last analytical step is the compilation of the **Data repository** ⑨ interlinking climate data, geographic data and policy content, based on the metadata structure and visualising this content in the dashboard. This step is the compilation of all previous steps and has a two-pillar approach:

- **Data pillar:** The data pillar focuses on **climate change impacts and indicators** (①), which are representable by datasets (② and ⑥). Arising data gaps can possibly be bridged in cooperation with data providers or need to be made visible as a minimum requirement (⑧). The representation is realised via a user-oriented (③/④) data-driven dashboard (⑤).
- **Adaptation pillar:** The climate impact information in the data pillar is supplemented with structured and accessible adaptation information. This pillar is based on the analysis of a broad collection of **climate adaptation strategies** (① and ⑥). The objectives and measures of these strategies, aiming at the selected impacts, are portrayed in a user-oriented way in

the data-driven dashboard (5), enabling **findability, comparability and inspiration**. Through the integration with the data pillar cross-validation with the regional intensity of the climate change impacts is enabled.

The two pillars are linked on several levels: Impacts are represented by indicators and their inclusion in adaptation strategies in the whole project area can be mapped. Objectives and measures in those policies are linked with the impacts, making them findable and accessible for interested users.

O3 Dashboard

In Climate_CRICES, the data repository supported by the metadata structure (Figure 9) enables accessing integrated, compiled and visualized multi-scale data on many different levels, which become the entry points for the dashboard landing page (see Figure 11):

1. Starting from impacts to browse possible adaptation options or compare regional intensities;
2. Starting from policies to compare them supported by knowing the intensities of regional climate change impacts, uncovering adaptation gaps and best practices;
3. Starting from objectives and measures to find solutions for specific adaptation challenges.

By these means the dashboard based on this data repository guides future climate change adaptation in an increasingly complex and interconnected world.



Figure 11: View of the dashboard landing page

10 Launch and presentation of the dashboard

Once this revised and revisited version is ready and launched, a respective communication campaign acknowledging the stakeholders that supported its co-development is needed **10**. This is also the point at which capacity development needs beyond videos and handbooks can be assessed and integrated into the subsequent activities of the project to allow for sustained and effective use of the product. We suggest thus in the box below a dashboard release strategy.

10 Launch and presentation of the dashboard

At this advanced stage, it is important to get back to the engaged stakeholders and show them what has been done with all the input they provided and show the demo version to them. This marks the time where the dashboard goes live and is accessible for the wider public.

The primary objectives of these workshops are thus:

Show gratitude to stakeholders for their feedback: It's critical to acknowledge stakeholder's time and efforts in the co-creation process. Showing gratitude and clearly presenting how the stakeholders' feedback was taken up and included in the tool development is critical to sustain trust and stakeholder engagement in the future use of the tool.

Building capacity: Using the tool may come with its own challenges. While handbooks and tutorials may not be sufficient for effective use, further capacity building activities may be needed. Assessing the stakeholders needs for further capacity development for the sustained use of the tool is essential for its success.

Communicating to the wider audience: The dashboard will go live with this event. The timing and communication strategy around this event may need to be chosen in a manner as to maximize its impact.

The following questions can be used to guide the workshop:

(from <https://weadapt.org/tandem/>)

- Have specific needs emerged from the co-exploration 'phase'? This may be particular needs or requests for training, further exploration and unpacking of a particular aspect of the adaptation issue or engagement of additional stakeholder groups identified as critical to decision-making processes.
- What key messages and new information emerging from the process need to be communicated to key influencers and senior decision-makers?

From Prototype to Practice

Ensuring Uptake and Longevity of the Regional Adaptation Dashboard

The **dashboard** is a cornerstone output of the Climate_CRICES project, aiming to provide an integrated, user-friendly access point to climate and environmental data across the Central European pilot regions. It is designed to support informed decision-making on climate adaptation planning through harmonised data, indicator-based reporting, and analytical tools aligned with regional and EU frameworks.

To ensure the **effective uptake of the dashboard during the lifetime of the project**, a series of actions are planned under upcoming work packages **WP2 and WP3**. These include:

- **Stakeholder empowerment activities**, such as regional workshops and co-design sessions, where associated partners and further public authorities will receive hands-on training on how to use the dashboard in their planning and monitoring routines.
- **Pilot actions** that will demonstrate the application of the Climate_CRICES strategy in specific territorial contexts, using the dashboard to support decision-making, identify data gaps, and track progress. These pilots will serve as real-life examples of how the tool can be operationalised.
- **Targeted capacity building**, through guidance materials and tutorials tailored to the needs of different user groups (e.g. planners, environmental officers, cross-border authorities), helping them to integrate the dashboard into their day-to-day work.
- **Feedback loops** to improve the dashboard's usability and relevance, gathering input from pilot sites and workshops to refine functionalities and ensure the tool is responsive to end-user needs.

Alongside these technical and participatory measures, the project will deploy **classical communication tools** to promote awareness and use of the platform beyond the immediate partnership. Press releases, social media posts, presentations at (regional) scientific and non-scientific conferences, and printed materials will help position the dashboard as a credible and useful solution for climate adaptation planning.

Looking beyond the project period, the **post-project uptake and upscaling** of the dashboard an action plan will be developed in the final phase of the project which may want to consider the following set of forward-looking measures:

- **Development of an Action Plan for the Strategy's implementation**, detailing how the Climate_CRICES framework can be adopted by additional regions. This plan will include steps for policy alignment, capacity needs, and entry points for integration into existing planning cycles.
- **Sustainability planning**, including the identification of institutional hosts and technical stewards who will take over maintenance and updates of the platform after the project ends.

The goal is to ensure continuity of data services and availability of the dashboard as a public good.

- **Network expansion efforts**, aimed at involving a broader range of stakeholders from across Central Europe and the EU. This includes outreach to cities and regions facing similar climate challenges, engagement with EU-level platforms such as Climate-ADAPT, and alignment with initiatives like the Covenant of Mayors or national adaptation planning processes (e.g. planned addendums to strategies in Climate_CRICES).
- **Promotion of the dashboard as a transferable model**, supported by documentation of lessons learned, technical guidelines, and examples from the pilot sites. This will facilitate replication in other territorial contexts and potentially inform EU-level discussions on regional monitoring systems.

Training and communication will remain central to the post-project strategy. The consortium will continue to offer **capacity-building opportunities for new users**, including short courses, webinars, and on-demand technical assistance. Where feasible, links will be created with other EU-funded projects or policy platforms to embed the dashboard and strategy into broader knowledge exchange and governance frameworks.

In summary, the Action Plan will outline a robust path from early adoption during the project, through pilot-based validation, to post-project scaling and integration. The combined focus on empowerment, visibility, sustainability, and replication is designed to ensure that the Climate_CRICES dashboard not only delivers immediate value but also becomes a durable tool for regional climate resilience across Central Europe and beyond.

V. Conclusions

The Climate_CRICES project set out to support regional climate adaptation in Central Europe by developing a dashboard that could visualize and organize multi-scale data on key climate challenges: heat and drought, flooding, and impacts on biodiversity. At the heart of this effort was a predefined, expert-driven roadmap that aimed to guide the identification of user needs, the integration of fragmented datasets, and the development of an accessible and policy-relevant tool.

Over the course of the project, it became clear that **technical solutions alone are insufficient**. Instead, **co-production of knowledge** emerged as a critical pillar for success. As highlighted in recent literature, climate services are most effective when they are not only scientifically robust, but also tailored to the specific needs and capacities of their users. This requires sustained collaboration between climate service providers – such as hydrometeorological agencies, research institutes, and boundary organisations – and end-users, including regional authorities, municipal staff, and civil society. Without this collaboration, even the most advanced tools risk being underused or misunderstood.

Throughout the Climate_CRICES project, the process evolved from a largely linear, expert-led structure into an **iterative, user-centred approach grounded in co-creation**. Key lessons emerged that now inform a revised roadmap for future use:

- **Early and continuous engagement with users** – through regional workshops and ongoing feedback loops – proved essential for aligning the dashboard with real-world adaptation needs. This engagement helped surface critical local challenges and allowed for contextual tailoring of content and indicators.
- **Flexibility and iterative design** replaced the original rigid roadmap. Workshops revealed gaps in assumptions and design choices, prompting real-time adaptations in the dashboard's structure, metadata, and functionalities.
- **Shared structures – such as a common glossary and metadata framework – enabled transparency and comparability** across fragmented datasets, even in the absence of full technical integration. Importantly, these structures were co-developed with stakeholders to ensure relevance and usability.
- **Accessibility and trust were prioritized**. Shifting to a Power BI platform with intuitive filters and multilingual features expanded the dashboard's reach to non-technical users. Transparent communication of data limitations helped manage expectations and build credibility.

The co-creation workshops themselves were a cornerstone of the project. They not only strengthened regional engagement but also uncovered deeper systemic issues – from capacity gaps in small municipalities to the challenges of aligning data with policy. The use of tools like SWOT

analysis enabled stakeholders to reflect on both regional particularities and cross-cutting trends, adding strategic value to the engagement process.

In parallel, a comparative review of 31 existing climate platforms provided a wider lens on the state of climate information systems. While some platforms stood out for their usability and policy alignment, many struggled with accessibility, metadata transparency, or cross-border relevance. This reinforced the project's approach: rather than duplicating or replacing existing systems, **the Climate_CRICES dashboard acts as a synthesis tool—fostering transparency, supporting strategic planning, and filling key usability gaps.**

In sum, Climate_CRICES illustrates that building climate resilience requires more than data: it demands **inclusive processes, shared understanding, and tools designed with – and not just for – those on the frontlines of adaptation.** The revised roadmap presented in this deliverable reflects these principles and offers a practical, replicable strategy for others aiming to bridge the gap between climate knowledge and climate action. By putting co-creation at the centre, the project has laid the groundwork for more effective, equitable, and sustainable adaptation planning across Central Europe and beyond.

References

- Arnstein, S. R. (1969). A ladder of citizen participation. *Journal of the American Institute of Planners*, 35(4), 216–224. <https://doi.org/10.1080/01944366908977225>
- Boon, E., Meijering, J. V., Biesbroek, R., & Ludwig, F. (2024). Defining successful climate services for adaptation with experts. *Environmental Science & Policy*, 152, 103641. <https://doi.org/10.1016/j.envsci.2023.103641>
- Daniels, E., Bharwani, S., Gerger Swartling, Å., Vulturius, G., & Brandon, K. (2020). Refocusing the climate services lens: Introducing a framework for co-designing “transdisciplinary knowledge integration processes” to build climate resilience. *Climate Services*, 19, 100181. <https://doi.org/10.1016/j.cliser.2020.100181>
- Gill, J. C., Duncan, M., Ciurean, R., Smale, L., Stuparu, D., Schlumberger, J., ... Ward, P. (2022). *MYRIAD-EU D1.2 Handbook of multihazard, multi-risk definitions and concepts (H2020 MYRIAD-EU Project No. grant agreement number 101003276)*.
- Giordana, C. (2025). *D.1.4.2 Implementation of the Data Dashboard*. Climate_CRICES Project. <https://doi.org/10.5281/zenodo.15672609>
- Hewitt, C., Allis, E., Mason, S. J., Muth, M., Pulwarty, R., Shumake-Guillemot, J., et al. (2020). Making society climate-resilient: International progress under the global framework for climate services. *Bulletin of the American Meteorological Society*, 101, E237–E252. <https://doi.org/10.1175/BAMS-D-18-0211.1>
- Hubina, T. (2025). *D.1.3.1 Analysis of the existing information systems supporting the climate change management plans*. Climate_CRICES Project. <https://doi.org/10.5281/ZENODO.15606816>
- Hubina, T., & Bedin, C. (2025). *D.1.3.2 Data-gaps and data improvement report*. Climate_CRICES Project. <https://doi.org/10.5281/ZENODO.15606968>
- Hubina, T., & Giordana, C. (2025). *D.1.3.3 Capitalisation of data systems and methods*. Climate_CRICES Project. <https://doi.org/10.5281/ZENODO.15607052>
- IPCC. (2023). *Climate change 2022 – Impacts, adaptation and vulnerability: Working Group II contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (1st ed.). Cambridge University Press. <https://doi.org/10.1017/9781009325844>

Jacob, D., St. Clair, A. L., Mahon, R., Marsland, S., Murisa, M. N., Buontempo, C., ... Pulwarty, R. S. (2025). Co-production of climate services: Challenges and enablers. *Frontiers in Climate*, 7. <https://doi.org/10.3389/fclim.2025.1507759>

Sandrini, R., & Tegen, M. (2025). *D.1.1.1 Climate change impact analysis reports*. Climate_CRICES project. Zenodo. <https://doi.org/10.5281/zenodo.15672518>

Truhlářová, Š., Zaňková, L., & Machac, J. (2025). *D.1.2.2 Stakeholder data utilization SWOT analysis*. Climate_CRICES Project. <https://doi.org/10.5281/ZENODO.15606674>

Umweltbundesamt (Ed.). (2023). *Monitoringbericht 2023 zur Deutschen Anpassungsstrategie an den Klimawandel*. <https://www.umweltbundesamt.de/publikationen/monitoringbericht-2023>

Zaňková, L., Truhlářová, Š., & Machac, J. (2025). *D.1.2.1 Stakeholder engagement report*. Climate_CRICES Project. <https://doi.org/10.5281/ZENODO.15582805>