



Climate-Resilient Development Pathways in Metropolitan Regions of Europe

Deliverable 5.3 Operational links with EU MACC and C-A platform -
Version 1

July 2025

Grant Agreement Number 101137851

Deliverable No:	D5.3
Deliverable nature:	Report
Work Package and Task:	WP5, Task 5.4
Dissemination level:	Public
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Contractual submission date:	31 July 2025
Actual submission date:	31 July 2025

Technical References

Project title	Climate-Resilient Development Pathways in Metropolitan Regions of Europe
Project acronym	CARMINE
Grant agreement number	101137851
Instrument	Horizon Europe
Call	HORIZON-CL5-2023-D1-01
Starting date of the project	1st February 2024
Project duration	48 months

Document history

Version	Date	Description
0.1	10 June 2025	Initial structure
1.0	01 July 2025	First draft submitted for consortium review
1.1	24 July 2025	Second draft after internal review
1.2	30 July 2025	Final version

Disclaimer

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UK participants in this project are co-funded by UK Research and Innovation (UKRI).

The work of Meteomatics partner (Switzerland) has received funding from the Swiss State Secretariat for Education, Research and Innovation (SERI).

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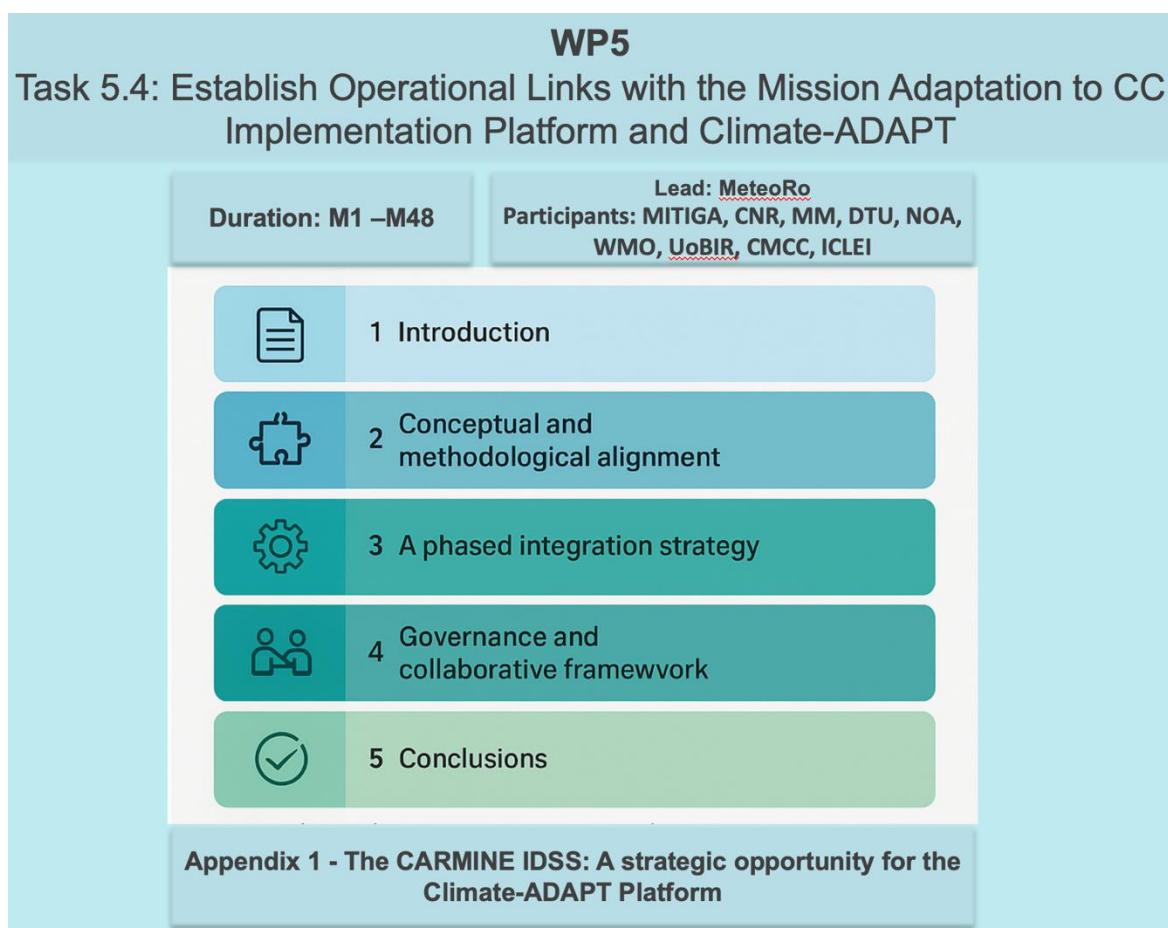
Abbreviations

Abbreviations	Full wording
A&M	Adaptation and Mitigation
API	Application Programming Interface
C-A	European Climate-ADAPT
CINEA	European Climate, Infrastructure and Environment Executive Agency
CSAs	Case Study Areas
DestinE	Destination Earth
DTs	Digital Twins
ECMWF	European Centre for Medium-Range Weather Forecasts
EEA	European Environment Agency
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
ICLEI	Local Governments for Sustainability
IDSS	Impact-Based Decision Support Service
MACC	Mission on Adaptation to Climate Change
MeteoRo	Romanian National Meteorological Administration
NBS	Nature-Based Solutions
NOA	National Observatory of Athens
SACC	Strategy on Adaptation to Climate Change
SERI	Swiss State Secretariat for Education, Research and Innovation
UKRI	UK Research and Innovation
WMO	World Meteorological Organization
WP	Work Package

Executive Summary

This report details the strategy and progress for developing the CARMINE Impact-Based Decision Support Service (IDSS), not merely as a standalone project tool, but as a functional prototype for a future decision-support component for the European Climate-ADAPT (C-A) Platform. Currently, the C-A Platform serves as Europe's primary knowledge repository for climate adaptation, but it lacks a dynamic component to help users translate this knowledge into prioritized, actionable plans. The CARMINE IDSS is being specifically designed to fill this important gap.

This document outlines the phased integration strategy, which moves from initial co-design and technical harmonization to prototyping, validation with stakeholders and, ultimately, a soft transfer of the service to ensure its long-term sustainability within the C-A ecosystem. This report details the conceptual synergy between the CARMINE methodology and C-A principles, the technical framework built for interoperability and the governance structure established to ensure a close and productive collaboration with the European Environment Agency (EEA) and other relevant bodies.



Key words

Decision Support System, interoperability, European Climate-ADAPT, Mission on Adaptation to Climate Change, European platforms, digital twins, co-creation, impact assessment, stakeholder engagement, climate adaptation.

1 Introduction

Within the CARMINE project, the IDSS is a key output conceived as an advanced advisory and analytical service to support informed climate adaptation planning. It is designed to bridge the gap between complex scientific data and practical decision-making by integrating diverse data streams, including physical risk models, socioeconomic vulnerability data, outputs from the project's eight Digital Twins, and local stakeholder knowledge. Through a user-friendly web interface featuring interactive maps and tailored dashboards, the IDSS allows users, including non-experts, to visualize potential climate impacts and analyze the effectiveness of various adaptation measures. The ultimate goal is to support the prioritization of cost-effective solutions and enhance local climate resilience.

The C-A Platform is the most important European effort to share adaptation knowledge. While it is an important resource for case studies, publications and tools, it currently does not offer an integrated service that allows decision-makers to dynamically assess climate impacts, explore adaptation pathways, and prioritize actions based on local data and modelling.

Task 5.4 "Establish Operational Links with the Mission Adaptation to Climate Change Implementation Platform and Climate-ADAPT" spans the entire project duration of 48 months and is led by MeteoRo, with contributions from the following partners: MITIGA, CNR, MM, DTU, NOA, WMO, UoBIR, CMCC, and ICLEI. The objective is to ensure sustained coordination and data exchange with the Mission Implementation Platform and Climate-ADAPT, supporting integration, visibility, and alignment with EU-wide adaptation strategies.

From the project conception, the CARMINE initiative views this as a strategic opportunity. The core purpose of Task 5.4 is not just to "link" to the C-A Platform, but to actively co-develop the IDSS as the answer to this need. The vision is for the IDSS to evolve from a CARMINE-specific output into a scalable and integrated service that enhances the C-A Platform's value for all regional and local authorities across Europe.

This report outlines the strategy for achieving this vision. It serves as a progress update on the activities undertaken to ensure the IDSS is technically, methodologically, and conceptually prepared for this future integration.

2 Conceptual and methodological alignment

The CARMINE project was designed from its inception to be closely linked with the C-A Platform, both conceptually and operationally. This alignment is a cornerstone of our integration strategy.

2.1. The CARMINE IDSS as the proposed solution

The IDSS is being engineered as a comprehensive advisory service that combines data from Earth system sciences and socio-economics to inform decision-making. Its core functions are precisely those required for a dynamic decision-support component:

- **Data integration** - it is designed to synthesize complex data streams, including high-resolution outputs from the Digital Twins (DTs) (WP4), local data from Case Study Areas (CSAs) (WP1), physical risk modeling (WP2) and socioeconomic vulnerability assessments (WP3).
- **Impact-based analysis** - the service empowers users to identify, visualize and constantly verify the possible effects of transformative adaptation measures, helping to prioritize cost-effective solutions.
- **Interactive visualization** - <https://www.meteomatics.com/en/weather-visualization/>The IDSS will provide user-friendly access to interactive maps, charts, and tailored dashboards, making complex data understandable and actionable for non-expert users. This is achieved using the [Meteomatics Weather Visualization Tool MetX](#) visualization engine, a powerful and validated software solution from partner Meteomatics, which is specifically adapted for CARMINE to transform diverse data streams (such as climate models, socioeconomic data and Digital Twin simulations) into intuitive graphical formats.

2.2. Conceptual and methodological synergy

The project's methodology mirrors the C-A Platform's six-stage approach to adaptation, ensuring its outputs are compatible and complementary. CARMINE directly contributes to the C-A platform's core principles by:

- **Aligning adaptation with sustainable development** - the project activities and goals are directly linked to the EU [Strategy on Adaptation to Climate Change\(SACC\)](#) and [Mission on Adaptation to Climate Change \(MACC\)](#).
- **Promoting evidence-based planning and stakeholder engagement** - the methodology is built on a participatory approach involving all target groups, from citizens to policymakers, across all project stages.
- **Consolidating information on costs and effectiveness** - WP3 is dedicated to conducting cost-benefit analyses of adaptation options, addressing a key knowledge area for the platform.
- **Focusing on tailored responses** - the IDSS and the eight specialized Digital Twins (WP4) are designed to provide customized solutions that address the specific vulnerabilities of each metropolitan region (Prague, Leipzig, Funen-Odense, Athens, Barcelona, Bologna, Braşov and Birmingham).

Despite this strong conceptual alignment, the CARMINE project team recognizes the practical and institutional challenges inherent in transitioning a research-based prototype into an operational component of a major European platform. This integration represents the strategic ambition of this project, as stated in the proposal phase. However, a primary challenge is the absence of a standardized, formal institutional pathway for the C-A platform to ingest and operationalize complex, externally developed technological solutions like the IDSS. This reality means that technical excellence and methodological synergy alone are not sufficient for successful adoption. Therefore, the project's strategy relies heavily on the co-creation process, continuous communication and building strong collaborative relationships with the EEA and the C-A Platform's technical teams, as outlined in this deliverable's phased integration plan.

2.3 Case Study in successful Integration: the Athens Digital Twin and Destination Earth

While the primary focus of this deliverable is the strategic integration of the IDSS with the C-A Platform, it is valuable to highlight a parallel success story from within the CARMINE project. The early and successful implementation of the Athens [DT-HEAT+](#) on the Destination Earth (DestinE) platform serves as a relevant case study. As this report is being written up, DT-HEAT+ is included in the “Coming Soon” services of DestinE (<https://platform.destine.eu/services/service/dt-heat/>), with a schedule to become operational in the last week of July 2025 (the reader is invited to visit <https://platform.destine.eu/services/> for the latest updates). It demonstrates the project's technical capability and commitment to engaging with major European initiatives, offering important lessons and expanding to a much wider community. . From its inception, the CARMINE project identified Destination Earth as a key global initiative for synergy and collaboration. Task 4.5 is entirely dedicated to "Coordination with DestinE" with the objective of building a DT-based approach that helps monitor, simulate and predict the interaction between natural phenomena and human activities. . This strategic alignment was boosted with the “Most Promising Proposal” prize of the 2nd DestinE innovation challenge award to DT-HEAT+ and the subsequent partnership agreement between the National Observatory of Athens (NOA) and DestinE's core entities (ECMWF, EUMETSAT, ESA) (<https://destination-earth.eu/news/destine-joins-forces-with-the-national-observatory-of-athens/>).

3 A phased integration strategy

The integration of the IDSS into the C-A Platform ecosystem is envisioned as a multi-year, collaborative process. The strategy is broken down into three main phases.

3.1. Phase 1: Co-design and technical harmonization (current phase: M1-M24)

The focus of this initial phase is to build the foundations for a successful integration. In a strategic project meeting held on July 17, 2025, focused on maximizing the project's European impact, representatives from the World Meteorological Organization (WMO, P17) offered a key recommendation. Leveraging their extensive experience with European and international bodies, the WMO suggested a proactive engagement strategy with the EEA. The WMO advised the consortium to prepare a concise strategic document to formally introduce the CARMINE project and, most importantly, to present the IDSS as a potential implementation to enhance the C-A platform's capabilities. The rationale was to frame the initial contact with the EEA not as a simple introduction, but as a clear, value-driven proposal for a strategic collaboration. Acting on this advice, the consortium prepared the document (Appendix 1), which now serves as the formal basis for the initial dialogue with the EEA's most relevant expert, Kati Mattern.

Following a coordination meeting focused on the integration of the IDSS (Integrated Decision Support System) component of the CARMINE project into the C-A platform, several key action points and responsibilities were agreed upon. The meeting opened with logistical clarifications regarding participation and continued with a presentation of the platform by the C-A manager. The main objective of the meeting was to explore how the IDSS could be effectively integrated into C-A and to outline the steps necessary for this process, including documentation, content management and long-term sustainability.

The IDSS architecture has been finalised, and a document is now being prepared to describe how this component addresses the requirements of the project call and how it interacts with C-A. This document will be submitted to the EEA for review.

The importance of formalizing all discussions into structured documentation was emphasised. Participants were encouraged to coordinate closely with CARMINE project members for support in preparing these documents. The next steps will involve finalizing the integration and maintenance documentation, sharing it with relevant stakeholders and planning a follow-up meeting to review progress and define a long-term strategy.

Phase status: progress is on track. Communication has been initiated with the EEA to present the project's vision for the IDSS and to begin collaborative discussions. The IDSS architecture (D5.1) has been designed with interoperability as a core principle, using standard-compliant APIs and a flexible component-based structure.

3.2. Phase 2: Prototyping and iterative validation (M25-M42)

This phase will focus on developing and refining the IDSS prototype with direct input from stakeholders and the C-A Platform team.

Plan: Early prototypes of the IDSS will be shared with the C-A team for technical feedback and evaluation. Joint workshops will be organized to engage sectoral stakeholders and potential end-users (e.g. Public Administration & Urban Planning, Emergency Services & Civil Protection, Environment & Natural Resource Management, etc.), ensuring the tool is legitimate, relevant and meets their needs. The IDSS will be iteratively calibrated based on this feedback loop.

3.3. Phase 3: Operational integration and soft transfer (M43-M48)

The final phase aims to achieve a functional integration and ensure the service's long-term sustainability.

Plan: This phase will involve the final technical work to link the validated IDSS with the C-A Platform. We will develop joint user manuals, training materials and tutorials to facilitate user adoption. The primary goal is to complete a "soft transfer," where the IDSS becomes a live, active and maintained service within the C-A framework, fulfilling the project's commitment to sustainability.

4 Governance and collaborative framework

A successful partnership requires clear governance. The CARMINE consortium has established a framework for managing the collaboration with the EEA and other European bodies.

- **Lead partners** - key partners with extensive experience in European policy and networking, such as MeteoRo (P1), WMO (P17) and ICLEI (P24) are designated to lead the engagement and communication activities.
- **Communication protocol** - a protocol for regular meetings, joint workshops and technical exchanges is being developed to ensure continuous alignment and to address challenges proactively.
- **Joint action plan** - as the project progresses into Phase 2, a formal joint action plan will be co-developed with the C-A Platform team, outlining specific milestones, roles and responsibilities for the integration process.

5 Conclusions

The CARMINE IDSS represents a strategic opportunity to significantly enhance Europe's climate adaptation infrastructure. By developing it as a functional prototype for a decision-support component within the C-A Platform, the project aims to deliver a lasting legacy. The phased, collaborative strategy ensures that the final integrated service will be robust, user-centric, and well-positioned to empower a new generation of evidence-based climate action at the local and regional levels across Europe.

6 Appendix 1 - The CARMINE Impact-Based Decision Support Service (IDSS) - A strategic opportunity for the Climate-ADAPT Platform

6.1. Introduction

The [CARMINE \(Climate-Resilient Development Pathways in Metropolitan Regions of Europe\)](#) project is a Horizon Europe initiative designed to help metropolitan communities become more climate-resilient. The project addresses the urgent need to close the knowledge gap between large-scale climate projections and the high-resolution, actionable information required for local adaptation planning.



The methodology is centered on a deep, co-creation process with stakeholders in eight diverse Metropolitan Regions of Europe, known as Case Study Areas (CSAs) in the CARMINE project. Within these CSAs, we are developing advanced tools, including Digital Twins ("climate replicas") and Nature-Based Solutions (NBS) scenarios, to model and address specific climate challenges such as heatwaves, flooding and wildfire risk. The ultimate goal of CARMINE is to develop transferable frameworks and tools that empower local and regional authorities to design and implement effective, evidence-based adaptation and mitigation (A&M) plans.

6.2. The CARMINE Impact-Based Decision Support Service

One of the flagship outputs of the CARMINE project is the Impact-Based Decision Support Service (IDSS). The IDSS is not just a data repository; it is an advisory and analytical service designed to function as the critical bridge between complex scientific data and practical, on-the-ground decision-making.

Core Functionalities of the IDSS:

- **Integrates multi-domain data** - the IDSS is architected to synthesize data from a wide array of sources: outputs from high-resolution climate physical risk and earth system models (WP2), socioeconomic vulnerability assessments (WP3), stakeholder knowledge

gathered from our Living Labs (WP1) and the simulation results from the eight specialized Digital Twins (WP4).

- **Provides interactive and intuitive visualization** - built upon a validated technical solution (Meteomatics Weather Visualization Tool MetX), the IDSS offers a highly interactive, user-friendly interface. Users can explore data through customizable multi-layer maps, dynamic charts, animations, and tables, allowing them to visualize complex relationships – for instance, overlaying a flood risk map with socioeconomic data to identify the most vulnerable communities.
- **Enables prioritization of actions** - the service is explicitly "impact-based." It helps decision-makers to not only see potential climate hazards but also to understand their consequences, assess the cost-effectiveness of various adaptation options (including NBS), and ultimately prioritize investments and policies for enhancing climate resilience.

The IDSS is being built from the ground up with interoperability in mind, utilizing standard-compliant APIs to ensure that it can seamlessly connect with other platforms.

6.3. A strategic opportunity for the Climate-ADAPT Platform

The CARMINE IDSS presents an important and timely opportunity to enhance the capabilities of the C-A platform. While C-A is the undisputed European hub for adaptation *knowledge*, the IDSS is designed to provide the next logical step: a dynamic *decision-support* component.

Key Opportunities for EEA and Climate-ADAPT:

- **Filling a strategic gap** - the IDSS can serve as the prototype for a much-needed decision-support functionality within C-A, allowing its vast user base to move from accessing static information to performing dynamic, localized analysis.
- **From knowledge to action** - by integrating the IDSS, the C-A platform would empower its users (from municipal planners to regional authorities) to translate knowledge into prioritized, evidence-based action plans tailored to their specific context.
- **Increased user engagement and value** - adding a highly interactive, data-driven tool like the IDSS would significantly increase user engagement with the C-A platform.
- **A collaborative pathway to innovation** - CARMINE does not propose to deliver a finished product. The project is built on co-creation, and envisages a close, collaborative partnership with the C-A team. This would involve joint workshops and technical exchanges to ensure the IDSS is developed and refined to perfectly fit the C-Aecosystem and the needs of its users.

The CARMINE consortium is committed to ensuring its outputs have a lasting impact. We see this collaboration as the primary pathway to achieving that goal. We are eager to continue our dialogue with you and to define a concrete roadmap for integrating the IDSS, creating a powerful synergy that will benefit communities across Europe.