



Climate-Resilient Development Pathways in
Metropolitan Regions of Europe

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Version 1

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Abbreviations

Acronym	Full Name
AI	Artificial Intelligence
A&M	Adaptation and Mitigation
CC	Climate Change
CSA	Case Study Area
DMP	Data Management Plan
DT	Digital Twin
DTMS	Digital Twin Management System
EEAB	External Expert Advisory Board
EC	European Commission
IDSS	Impact-Based Decision Support Services
LL	Living Lab
NbS	Nature-Based Solutions
M	Month
MRE	Metropolitan Regions of Europe
MS	Milestone
MSX	Software Platform
PO	Project Officer
R&I	Research & Innovation
TG	Target Group
WP	Work Package
WS	Workshop
IPCC	Intergovernmental Panel on Climate Change
UN	United Nations
JRC	Joint Research Centre
BGP	Bio-geophysical
SE	Socioeconomic
GCMs	Global Climate Models
RCMs	Regional Climate Models

Executive Summary

The deliverable “8.1 Project Management and Coordination - Version 1” serves as the first Progress Report for the CARMINE project, covering the period from Month 1 to Month 12 (February 2024 to January 2025). During this initial reporting period, the project has made substantial progress toward its overarching goals of enhancing climate resilience and adaptation strategies across European metropolitan regions. This document provides an overview of the project's achievements to date and highlights potential future deviations in actions and resources, enabling proactive measures to minimize any negative impacts on project implementation and expected outcomes.

Looking ahead, the CARMINE project remains on track to achieve its anticipated impacts. The next phase will concentrate on finalizing deliverables, refining decision support tools, and ensuring the integration of research results into local and regional climate adaptation strategies.

Additionally, Figure 1 presents the graphical abstract of the Project Management and Coordination Report, offering a visual summary of its key elements.

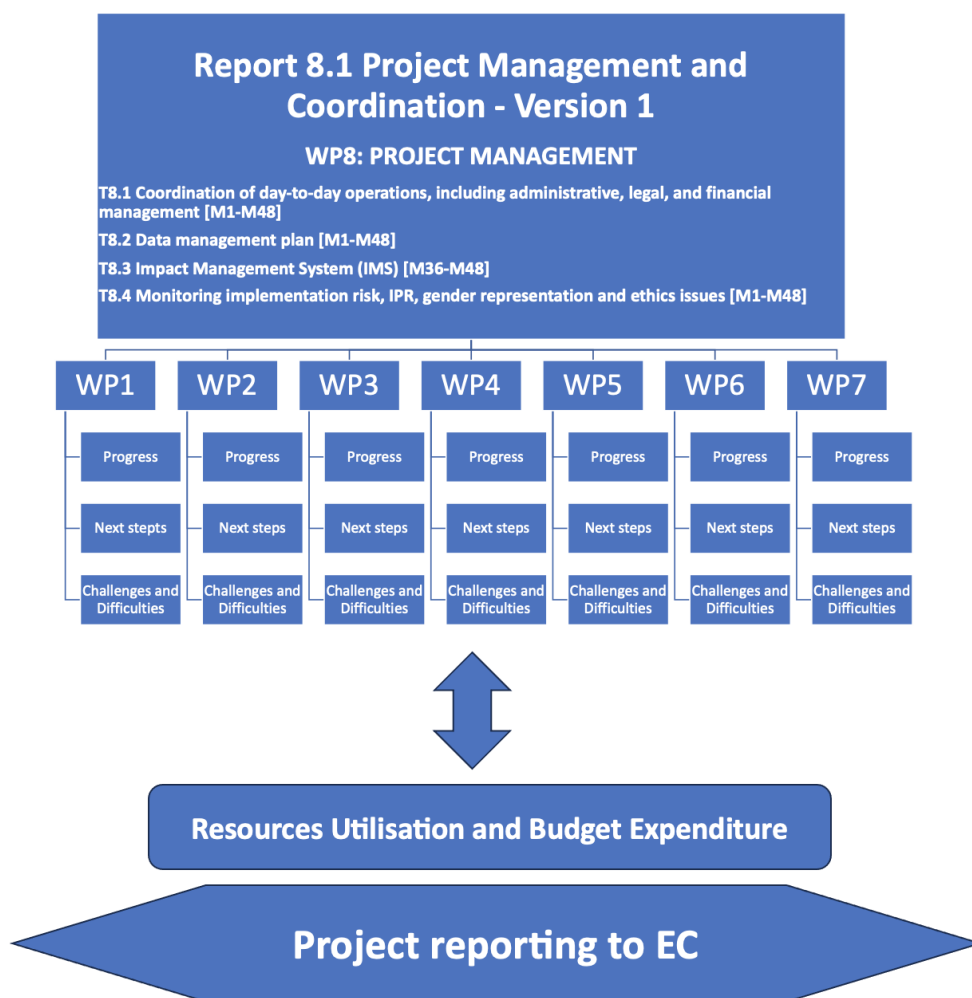


Figure 1: Deliverable 8.1 Graphical abstract

1 Introduction

1.1 Geo-design

CARMINE (Climate-Resilient Development Pathways in Metropolitan Regions of Europe), was initiated under the European Union's Horizon Programme call HORIZON-CL5-2023-D1-01-07/HORIZON-CL5-2023-D1-01-07:Modelling for local resilience - Developments in support of local adaptation assessments and plans and aims to provide knowledge-based **Climate Resilient Development Pathways in Metropolitan Regions of Europe**, that **bridges the local and regional scales** by providing **impact-based decision support services (IDSS)** and multi-level climate governance supporting local adaptation, including both traditional and Nature-Based Solutions (NbS). CARMINE's overarching goal is to help the metropolitan communities become more climate resilient, by co-producing knowledge-based tools, strategies and plans for enhanced adaptation and mitigation actions addressing the Charter of the EU Mission on Adaptation to Climate Change (CC) by 2030.

Focusing on a 2030-2035 timeframe and with a longer perspective up to 2050, CARMINE aims to (Figure 2):

- Co-create and co-develop decision-support services and guidelines for enhanced resilience and adaptive capacity, including early warning and disaster risk management systems,
- Cooperate closely with local to regional communities (stakeholders and users), decision-, and policymakers (local authorities) to co-develop cross-sectoral frameworks for adaptation and mitigation actions,
- Deliver science-based Research & Innovation (R&I) roadmaps for multi-level climate governance supporting local adaptation assessments and plans.

The specific objectives of the project are:

SO1: To review the available resources, tools, practices, policies, and methodologies, and identify the gaps, challenges and barriers that hamper the successful advance of the resilience pathways in the Metropolitan Regions of Europe (MRE).

SO2: To develop high-resolution risk assessment models linking climate, earth system processes, and socio-economic drivers, for enriched data fusion and effectiveness of adaptation and mitigation actions in the MRE.

SO3: To co-produce a climate adaptation and resilience framework combining Living Labs (LL) and Digital Twins (DT) approaches that support decision making processes for resilience and disaster risk management in the MRE, including NbS.

SO4: To provide state-of-the-art IDSS blending climate and environmental data into socioeconomic impact and risk assessments for user-friendly access to high spatially resolved modelling outputs in support of local adaptation assessments and plans.

SO5: To conduct the participatory development of better coordinated and impactful modelling and risk assessment, in support of roadmaps of R&I priorities on adaptation, informed policies, and cross-sectoral plans towards the 2030-2035 timeframe and beyond (i.e., 2050).

The project co-develops a knowledge-based framework to address Adaptation & Mitigation (A&M) in 8 Metropolitan Regions across Europe, through bridging the gap between science and practice and co-creating actionable tools, products and services that enhance the climate-resilience of the local communities and support decision-making at a European level.

Deepening and sharing science-based climate knowledge at a metropolitan scale through:

- i. Top-down and bottom-up approaches, and a multi-sectoral stakeholder participation in the co-production process targeting adaptive capacity building (WP1-WP4),
- ii. Advancing the user-oriented modelling for climate risks and SE vulnerability assessment (WP1-WP3),
- iii. Provision of climate adaptation support tools (WP4-WP6),
- iv. Educational, training and networking initiatives for capacity building on CC adaptation, and improvement or retain of new skills, knowledge, tools by the stakeholder ecosystem and target groups (WP7).

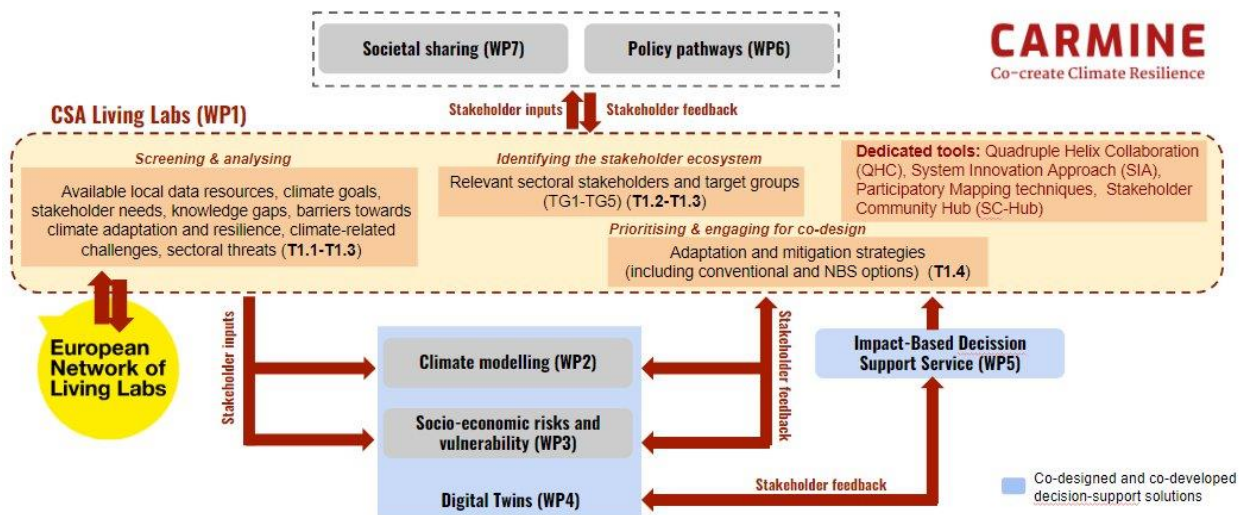


Figure 2: CARMINE project

1.2 Methodology: CARMINE models and assumptions

Living Labs (LL). The project establishes real and virtual LL in each CSA to facilitate the stakeholder's engagement in the co-design process (WP1) for developing a robust benchmark of replicable and locally attuned A&M solutions (including NbS) (WP4, WP5), and enhancing the local/regional climate resilience via a maximised sharing of science-based information and pooled feedback (WP5, WP6, WP7).

Digital Twins (DT) simulations are virtual representations of metropolitan BGP and SE systems, representing physical assets, with both natural and anthropogenic drivers, intended to advance and support the cross-sectoral climate resilience and the management of climate disaster risks in the CSA.

CARMINE facilitates the development of “climate replicas” (i.e. the DT) in each CSA (WP4), using the data sources defined and/or produced in the co-design and co-development activities of WP1, WP2 and WP3, together with existing open datasets relevant to the specific CSA and by exploiting the models developed and customised in WP2.

Nature-based Solutions. CARMINE exploits the benefits of NbS for local climate adaptation and includes them into its assessment of climate risks (WP2, WP3) and development of local/regional modelling framework and climate resilience pathways.

NbS policy and implementation proposed in CARMINE (WP1-WP4) includes cities' neighbouring population centres and hinterlands (WP5, WP6).

Artificial Intelligence (AI), modelling and machine learning (ML) are used to increase the resolution of GCMs and RCMs by integrating natural and anthropogenic drivers (WP2). These tools and methods improve the accuracy and reliability of climate models, making them more useful for local users and adaptation planning.

CARMINE uses several AI/ML-based tools and methods to improve climate models, such as: Machine Learning Algorithms, Big Data Analytics, Cloud Computing, High-Resolution Modelling, and Data Integration.

Case Study Areas (CSA). CARMINE carries out its approach in 8 CSA, where LLs (WP1) are established and analyse the climate risks and SE vulnerabilities (WP2, WP3), to co-develop sectoral DT use cases (WP4), co-design decision-support tools and propose climate-resilient development pathways (including NbS) (WP5, WP6).

The CSAs are selected in 8 countries, focusing on diverse SE profiles, types of communities, vulnerabilities, climate impacts drivers and geographical distribution across Europe: **Prague (CZ), Leipzig (DE), Funen-Odense (DK), Athens (EL), Barcelona (ES), Bologna (IT), Braşov (RO), and Birmingham (UK).**

Figure 3 summarizes the management and methodology of the project.



Figure 3: Activities in CARMINE

Impact of the project

Impact 1. Increased awareness on CC risks and impacts through engagement and participatory approach in metropolitan regions in Europe, resulting in strengthened evidence-based decision-making and improved A&M strategies and plans at regional and national levels.

Impact 2. User-friendly, interactive and customized tools for CC risk assessment and modelling at metropolitan scale (local to regional).

Impact 3. Metropolitan regions prepared to join the EU Charter for EU Mission on Adaptation to CC, incl. Societal Transformation.

1.3 Deliverable 8.1: Project Management and Coordination, Version 1

This deliverable is elaborated within task “8.1 Coordination of day-to-day operations, including administrative, legal, and financial management”, spanning from M1 to M48.

The task partners are MeteoRo, MITIGA, UB, CNR, ICS, INCDS, RUB, PCF, UFR, MM, CNC, DTU, MOHC, ATH-RC, NOA, JLU, WMO, AoA, SDSN, LNH, UoBIR, CMCC, B-KODE, ICLEI, MBV, NMA, MoDG, BCC, LSW, and CAAB.

The “**8.1 Project Management and Coordination - Version 1**” report provides an in-depth overview of the project’s ongoing progress, management strategies, and coordination efforts across all WPs. Its importance lies in ensuring that all aspects of the project, technical, financial, and operational, are being executed according to the defined objectives and timelines, while also maintaining alignment with the broader goals of the Horizon Europe framework.

The report serves several key purposes, all of which contribute to the successful implementation of the project:

1. **Transparency and Accountability:** By detailing the status of each work package, including completed milestones, upcoming tasks, and potential risks, this report fosters transparency in how the project is progressing. This transparency is crucial for ensuring that the project stays on track and that stakeholders, including the European Commission (EC), are kept informed of progress and potential challenges.
2. **Monitoring and Management:** This report highlights the project's management structure and internal processes, which are essential for day-to-day operations. Effective coordination among WP leaders, the steering committee, and other key personnel ensures that the project's objectives are met. Through detailed reporting on each WP, the document allows the management team to monitor activities closely and adjust when necessary.
3. **Risk Identification and Mitigation:** One of the report's functions is to identify risks to the project's successful completion, whether they are technical, financial, or logistical, and to propose mitigation strategies. By addressing potential risks early, the project management team can take corrective actions to minimize disruptions and ensure continued progress.
4. **Financial Oversight:** A detailed financial overview within the report ensures that the project remains within budget and that all partners are managing their allocated resources effectively.
5. **Stakeholder Engagement and Communication:** This report emphasizes the importance of effective communication, both within the project consortium and with external stakeholders. By describing how the project engages with various stakeholders, including policymakers, local authorities, and the public, the report highlights the project's outreach efforts.

2 Progress Reports per Work Package

The project management has monitored the technical progress of each WP and collected progress reports at M9, to ensure the activities are developed as scheduled. The progress of each WP is summarised in this section, including challenges and difficulties.

2.1 WP1: Co-designing adaptation and mitigation actions (including Nature-Based Solutions) for climate resilient development in the CSAs

2.1.1 Progress of WP1

WP1 is dedicated to co-designing adaptation and mitigation actions, including nature-based solutions, for climate-resilient development across the Case Study Areas. The work package encompasses tasks ranging from the establishment of living labs in various CSAs to the development of Geo-designed adaptation and mitigation pathways. This narrative will highlight the main activities completed within WP1.

WP1 has made significant progress in the implementation of Living Labs, documentation of climate change challenges, and the development of Geo-designed adaptation and mitigation pathways. These activities provide a solid foundation for future efforts and set the stage for collaborative co-design work in the coming months. As the project moves forward, the next steps will focus on refining the tools, engaging stakeholders, and ensuring that the Living Lab workshops are successfully implemented. With ongoing coordination, stakeholder involvement, and feedback collection, WP1 is poised to contribute meaningfully to the overall goals of the CARMINE project.

Task 1.1.: Establishment and Organisation of Living Labs in 8 CSAs.

One of the primary achievements in WP1 has been the organisation of Living Labs across eight different CSAs. These labs aim to serve as real-world testing grounds for co-designing solutions to address climate change challenges. A significant portion of the work over the past months has been dedicated to defining the structure and objectives of the Living Labs, which will play a central role in the implementation of nature-based solutions. There has been extensive coordination with CSA leaders, with preparatory meetings held to discuss the needs and goals of each CSA. The core focus was on ensuring a balanced representation of stakeholders, with particular attention paid to vulnerable groups. These stakeholders are key to the decision-making processes, and their involvement in the Living Labs workshops is crucial. As part of Task 1.1, the team also worked on the development of a stakeholder engagement strategy, which culminated in the submission of Deliverables D1.1 and D1.7 by the end of July 2024.

Task 1.2: Participatory Documentation of CC Challenges and Identification of Adaptation Measures.

The documentation of climate change challenges and adaptation measures has been an ongoing task from the outset of WP1, starting in M1. In this phase, a contents page and draft text for Deliverable D1.2 were prepared, laying the foundation for the report on climate change challenges. This report will serve as an important reference for understanding the specific challenges faced by each CSA and will inform the adaptation strategies moving forward. While Task 1.2 is still in progress, it has reached an advanced stage, with the final draft expected by M15. The University of Birmingham has continued to advance with their task, gathering and analysing information from the LLs workshop. This valuable data will be incorporated into the ongoing work, ensuring that insights gained from the stakeholders' discussions are effectively utilized.

Task 1.3: Stakeholder Community Hub: Online Living Lab Tool.

Stakeholder engagement is a cornerstone of WP1's efforts, and Task 1.3 has made significant strides in facilitating meaningful interactions. A key component of this task has been the development of the SC-HUB - a digital platform designed to facilitate interaction and collaboration between stakeholders. The alpha version of the SC-HUB is currently being developed, with a demo release in November. This platform will offer core functionalities to stakeholders, with additional features set to be added in the future. Feedback from the Living Labs will be collected to improve the platform and ensure it meets the users' needs.

In parallel, preparatory meetings with CSA leaders have been held to ensure the alignment of activities for the first LL workshops. The WP1 team worked closely with each CSA to validate the selection of stakeholders, ensuring that vulnerable groups are adequately represented. Coordination and support of CSA leaders in organizing and conducting the first workshop with stakeholders (LL Training Workshop) has been a key focus. This included preparatory meetings with each CSA to align expectations for Workshop 1 (WS1), as well as follow-up meetings to discuss outcomes and lessons learned (Table 1). These efforts ensured that all participants were well-prepared and aligned throughout the process. The findings will be presented during the CSA meeting scheduled for January 28, 2025.

Table 1: Dates of preparatory meetings and workshops in CSAs

CSA	1st Preparatory meeting before WS1	2nd Preparatory meeting before WS1	Additional support meeting before WS1	WS1	Post WS1 meeting
Prague	14/10	12/11	18/11	20/11	27/11
Leipzig	21/10	25/11		09/12	16/12
Funen-Odense					
Barcelona	15/10	25/11		3/12	10/12

Athens	11/10	13/11	19/11	5/12	9/12
Bologna	29/10	18/11		25/11	6/12
Brasov	10/10	18/11		28/11	9/12
Birmingham	10/10	20/11		28/11	11/12

Task 1.4: Geo-designing Adaptation and Mitigation Pathways, including NbS Scenarios.

Task 1.4 focuses on creating Geo-designed adaptation and mitigation pathways, with a particular emphasis on NbS. This task has started with the team drafting the NbS survey and participatory mapping questionnaire. These tools will be essential in gathering data and inputs for the co-design process. The survey and mapping activities were integrated into the first LL workshop. Additionally, the drafting of D1.4, the deliverable on Geo-designed A&M pathways, has started, with a due date set for Month 12. The NbS workshop 1 was successfully conducted across the CSAs in November and December 2024, except for CSA Odense. Data from these workshops is currently being processed and analysed, and the results will be shared with the CSAs shortly.

2.1.2 Next steps for WP1

While the main activities outlined above have laid a strong foundation, there are several important next steps to continue the momentum within WP1. These steps are focused on refining processes, engaging stakeholders, and preparing for upcoming workshops and deliverables.

1. **Living Lab Workshop 2 (WS2):** The next Living Lab workshop with the CSAs is planned for the period between M15-M18. Preparation for this workshop will begin soon, ensuring that it builds on the findings from the first workshop and addresses any challenges or insights that have arisen since.

These workshops are expected to be instrumental in gathering stakeholder feedback and refining the co-design process. To ensure successful implementation, a feedback mechanism will be put in place to collect insights from the workshops. This feedback will be incorporated into Deliverable D1.9, which will document the engagement of five target stakeholder groups for each CSA.

2. **SC-HUB Development and Feedback Collection:** The SC-HUB offers core functionalities for stakeholders. In the coming months, additional features will be developed based on feedback from the LLs. The team will conduct monthly CSA check-in meetings starting from November 5, 2024, to collect ongoing feedback and monitor progress. Bi-weekly WP1/WP6 meetings will also be scheduled to align tasks and ensure that all activities are on track.
3. **Ongoing Documentation and Reporting:** Deliverables D1.2 and D1.4 will be refined and finalized in the coming months. D1.2, which documents climate change challenges and adaptation measures, is expected to be completed by M15. Additionally, the drafting of D1.4, which outlines the Geo-designed A&M pathways, will continue, with a final version due in M15 and M12 respectively.

- 4. Key Events and Milestones:** A key event was the ENOLL conference on September 26, 2024, where the Living Lab Open Days provided an opportunity for wider engagement and dissemination of the project's activities.

2.1.3 Challenges and Difficulties

Several challenges that require special attention and adaptation efforts have arisen during this period.

ATH-RC is in the final stages of deployment for their task, with some delays encountered due to issues with the subdomain and its assignment to the project server. These setbacks have affected the timeline, but progress is now back on track, and they are expected to present their findings during the CSA meeting scheduled for January 28, 2025.

One of the difficulties involved the tight scheduling around the holidays, which made running the workshops and finalizing reports more challenging. Despite these time constraints, significant progress was made in delivering key components of the project.

A notable issue has been the outstanding participation of CSA Odense in WS1. A team member from CSA Odense joined the CSA monthly check-in meeting on January 14, 2025, and provided feedback on the initial meeting with the municipality. Based on this, a follow-up meeting has been scheduled to address the unique aspects of the Odense case. The coordinator will also be included in this discussion to ensure a comprehensive approach moving forward.

2.2 WP2: Integrating climate physical risk assessment models and earth system process

2.2.1 Progress of WP2

WP2 is focused on integrating advanced climate physical risk assessment models and Earth system processes to address the challenges posed by climate change at a local scale. The main objective is to close the knowledge gaps on local-scale climate impacts, which are essential for developing climate-resilient strategies. WP2 aims to achieve this through four interconnected tasks: Task 2.1 (Assessment of modelling framework), Task 2.2 (Developing high-resolution integrated simulation chains), Task 2.3 (Tailoring model outputs to user-relevant scales), and Task 2.4 (Strengthening local-scale modelling for NbS and post-processing tools).

WP2 has made significant strides in integrating climate risk assessment models and Earth system processes for the CARMINE project. With foundational work on gathering requirements from CSA, reviewing existing km-scale data from gridded observations, models and reanalysis, climate simulation models, downscaling protocols, developing pre-processor tools for urban models, and the preparation of key reports well underway, the project is positioned to address critical gaps in local-scale climate impact assessments. The next steps will ensure that the work package remains on track, with continued collaboration and alignment between the tasks, partners, and other work packages.

Task 2.1: Co-design and Set-up the Modelling Framework.

This task contributes to developing the framework for climate modelling and hazard risk evaluation. Task 2.1 began with an extensive review of geo-datasets available for local-scale modelling. This activity is focused on assessing the impact of boundary conditions on modelling potential climate risks. The task team has been engaged in multiple meetings with the CSAs leaders to gather their specific needs, particularly in terms of models, data, indicators, and climate hazards. A key deliverable from this task, the report for Milestone MS18 (due in M11), which consolidates the preliminary outputs, has been finalised. The report contributes to design the modelling chains that will support the modelling activities of WP2, but also the socio-economic vulnerabilities and risk assessments in WP3, and the co-development of the decision-support tools such as the Digital Twins and the Impact-based Decision Support Services in CARMINE. Additionally, a comprehensive matrix has been developed to capture CSA-specific requirements, which will serve as the foundation for later tasks in WP2. This matrix identifies the gaps in data and models and provides the input necessary for the development of a high-resolution simulation framework. Individual meetings with CSA participants and Task 2.2 members were held throughout November and December 2024 to define each group's contributions to the modelling activities. Ongoing work includes refining the guidelines for the modelling framework and preparing the corresponding deliverable.

Task 2.2: Develop and Test Simulation Chains for Risk Assessment Modelling

The activities under Task 2.2 are centred around the development of high-resolution (1-3 km) simulation chains tailored to specific CSAs. This task focuses on enhancing climate models by incorporating localized factors such as urban canopy parameters, local climate zones, and anthropogenic heat flux. The team has been working closely with CSA partners to understand their needs, leading to the definition of protocols outlining the required data from Task 2.1, any existing gaps, and the tailored modelling approaches and strategies for each CSA.

A key achievement in this task is preparing the downscaling protocol, which specifies the methodology combining statistical and dynamical downscaling activities. The team has conducted individual meetings with participants to align their contributions, including statistical and dynamical downscaling activities, data preparation, event-based approaches to test the modelling chain and model validation.

Current activities involve combining the Catalogue of Existing High-Resolution Climate Datasets with Milestone 20 data to support the development of statistical downscaling approaches for several CSAs, including Leipzig, Athens, Birmingham, Barcelona, and Funen-Odense. Additionally, dynamical downscaling tests are being conducted using urbanized RCMs (Regional Climate Models) over Bologna, Prague, and Brasov. Work is also underway to prepare and validate data for MS20. The main highlight of this task has been the development and testing of simulation chains for the assessment of the specific climate hazards.

Task 2.3: Local Modelling Framework Including Support to NbS.

Task 2.3 began in month 7 and focuses on customizing model outputs to suit user needs, particularly in the context of urban modelling and (NbS). The team is working to map adaptable NbS solutions, ensuring that these strategies are incorporated into the local modelling framework.

Task 2.3 will be key to developing the local-scale models that integrate the effects of NbS and provide actionable data for stakeholders. The final report for this task, due at month 42, will outline a comprehensive local modelling framework that incorporates NbS, pre- and post-processing tools.

The task has yielded important results, particularly in scientific publications, with four publications from B-Code and one co-authored with CMCC, focusing on the optimization of urban models. Ongoing activities include the PALM group's work on implementing and testing local-scale processes, such as energy-balance variables, at both 50m and 100m resolution. This includes variables such as temperature (T2m), land surface temperature (LST), and biometeorology indices (UTCI, PET, PT, WBGT, PMV), alongside updates and bug fixes to the PALM-Meteo and PALM-GeM pre-processors. Key results thus far include updated pre-processors, with a paper in progress detailing these developments.

Task 2.4: Develop Hazard Indicators and Post-processing Tools, Including Uncertainty Evaluation for improving Risk Assessment Analysis.

Task 2.4 is set to officially start in month 13 and will focus on developing hazard indicators and post-processing tools that improve risk assessment analysis. The team has initiated the process of gathering required indicators specific for CSA and is preparing for the subsequent steps of tool development and uncertainty evaluation.

The milestone for Task 2.4 will be the development of post-processing tools, which will be functional by M24. These tools will be critical for refining the accuracy and relevance of local-scale climate risk assessments.

2.2.2 Next steps for WP2

As the work progresses, the next steps for WP2 are well-defined and are crucial for maintaining momentum in the project. The immediate next steps include:

1. **Finalise the Preliminary Report** (Milestone M11) - the final version of the preliminary outputs, based on the information gathered from WP1 and the CSAs, will be submitted. This includes refining the CSA requirements matrix and ensuring that all data and modelling gaps are addressed.
2. **Finalise the Catalogue** of existing high resolution climate datasets (Milestone M20), due at month 12 as requested in the amendment: The catalogue will offer a comprehensive overview of existing climate data at km-scale relevant to the CARMINE project. This includes a pathfinder of existing climate information with technical details that could support statistical models training, represent benchmark products to compare new developed models' data, be used to test and validate tools for urban modelling and hazards indicators assessment.
3. **Complete the Downscaling Protocol (Task 2.2):** The team will continue refining the downscaling protocol, incorporating feedback from CSA partners and WP2 contributors. This will ensure that the protocol for modelling activities align with CSA-specific needs and that the models are tailored accordingly.

4. **Test Modelling Activities:** The team will begin test modelling activities for selected CSAs, focusing on applying the downscaling protocols and testing the models' efficacy. This is a critical step in validating the approach and refining the model outputs.
5. **Bi-Monthly Coordination Meetings:** Bi-monthly WP2 meetings will be held to ensure continuous alignment and collaboration across the various tasks and partners involved in the work package.
6. **Synergies with Other Work Packages:** Alignment with WP7 (Data Management) and other relevant WPs will be crucial in ensuring that data from WP2 is properly shared and utilized in the DTs and LLs. WP2 will continue working on clarifying data flow and user requirements in collaboration with WP3 and WP5.
7. **Communication and Outreach:** The team will work on preparing content for the CARMINE website, as already done for the news published on the CARMINE website in November 2024, including updates on the modelling strategies defined for the CSAs. This will help disseminate information about the project's progress and its outcomes to a broader audience.

2.2.3 Challenges and Difficulties

Despite significant progress, WP2 has encountered several challenges. One of the primary concerns is the storage space and computational resource requirements for the high-resolution simulation chains. The full extent of these requirements will only be clear once the protocols for each CSA are finalized. Furthermore, coordinating meetings and ensuring effective communication across a wide range of partners has proved to be challenging. The need for an up-to-date mailing list and streamlined communication channels is essential to address these coordination issues.

The project also faced several challenges related to storage space and computational resources. To address this, the teams asked for support from the national High-Performance Computing (HPC) centres, but external support remains pending. During this period, the Zenodo repository was considered as a potential storage solution, though further evaluation is needed to confirm its suitability.

In parallel, JLU requested computational resources at the German Climate Computing Center (DKRZ), but confirmation is still awaited. Additionally, the project experienced delays in the acceptance of the amendment, which impacted timelines. While awaiting approval, the team has continued to work on finding alternative solutions to keep the project moving forward.

2.3 WP3: Community-Based Socioeconomic Vulnerability and Risk Assessment for Transformative Adaptation in the Case Study Areas (CSAs)

2.3.1 Progress of WP3

Work Package 3 (WP3) is focused on community-based socioeconomic vulnerability and risk assessments for transformative adaptation in the Case Study Areas (CSAs). Two key tasks, Task 3.1 (Socioeconomic Vulnerability Assessment to Climate Change) and Task 3.2 (Risk Assessment Modelling for Co-development of Climate Risk Scenarios), have made significant progress, Task 3.3 To conduct a cost-benefit analysis of adaptation measures (from WP1) has recently started while Task 3.4 To provide an interactive geostatistical analysis and user-oriented representations of adaptation options, incl. conventional and NbS approaches is foreseen to start soon following the timeline in the Grant Agreement.

Task 3.1 has seen the finalization of the Socioeconomic Vulnerability Index (SeVI), based on the integration of multiple international frameworks, including those from the IPCC, UN, and JRC. The final selection of indicators for SeVI is underway, with data sources and analysis scales being defined for the metropolitan and regional levels. The team has held coordination meetings with the Technical University of Denmark (DTU) to align methodologies and to finalize indicators and scales of analysis. CSA meetings have also been held to discuss how the WP3 framework will be applied in each case study, ensuring the methodology is relevant to local contexts. Preparation for the SeVI calculation template, which will standardize normalization and weighting methods, is ongoing.

Task 3.2 has made progress in risk assessment modelling, particularly through the co-development of methodological approach. The application of the capability approach in risk assessment is a highlight of this task, with the selection of appropriate capabilities in progress. Sector-specific damage assessments, such as the storm surge analysis for Odense, have been conducted, emphasizing equity concerns. The development of user interfaces for the risk models has been prioritized, aiming to make the results accessible for stakeholders and municipalities. Coordination meetings with Athena and CSA teams have focused on refining the modelling approaches and aligning the sectoral risk assessments with stakeholder needs.

The ongoing work across the eight case study areas (Prague, Leipzig, Funen-Odense, Bologna, Braşov, Athens, Barcelona, and Birmingham) is producing valuable data on climate impacts such as heatwaves, floods, droughts, and the urban heat island effect. Each case study is addressing local vulnerabilities—such as heat-related mortality in Athens, impacts on elderly and disables in Bologna, wildfire risks in Leipzig, and flood damages in Odense—while integrating socioeconomic factors into the risk modelling process.

2.3.2 Next Steps for WP3

Looking ahead, WP3 is focused on finalizing the socioeconomic vulnerability assessments, advancing the climate risk modelling and the application of capability approach. Several important tasks and meetings are scheduled to ensure progress in the coming months.

1. **Task 3.1:** The next steps involve finalizing the SeVI profiles for each CSA. This includes identifying the appropriate spatial resolution for the selected indicators and synthesizing the data collected across the CSAs. The development of the SeVI calculation template will continue, with a focus on defining the normalization and weighting methodologies to ensure consistency across the data sources. A coordination meeting with DTU on November 8th, 2024, and other subsequent meetings in the first quarter of 2025, will focus on methodological alignment and refining the data processing approaches. The team will continue to work with the CSAs to refine the SeVI profiles and ensure they reflect the local context while maintaining consistency across all case studies.
2. **Task 3.2:** The next steps for the risk assessment modelling include expanding the analysis of climate hazards and their socioeconomic impacts. In Prague, the focus will be on the analysis of spatial patterns related to heatwaves and the use of the UrbClim model to assess risks. In Leipzig, further work will be done to evaluate the effectiveness of urban greening measures on heatwave relief and to assess building energy use. In Funen-Odense, the team will focus on assessing risk reduction from adaptation measures, particularly nature-based solutions. In Bologna, the team will work on connecting the Urban Heat Island (UHI) map with data on vulnerable populations. Other ongoing activities include water scarcity analysis in Braşov and developing vegetation planning strategies in Birmingham.
3. There will also be ongoing meetings with stakeholders to ensure that the risk models are aligned with local needs and that the data reflects the current understanding of vulnerabilities. WP3 will continue to engage with the CSAs to discuss findings and refine the vulnerability and risk assessment frameworks as the project moves forward. The team is also planning a progress meeting in mid-February 2025 to review the work completed thus far and discuss the next steps in detail.

2.3.3 Challenges and Difficulties

Despite the progress, several difficulties and challenges have emerged that are affecting the work within WP3.

Data Harmonization: One of the primary challenges in Task 3.1 is the harmonization of data from diverse sources and across different spatial levels. The complexity of integrating data from multiple frameworks (IPCC, UN, JRC) has made it difficult to ensure consistency, particularly when combining data from different countries and regions. This challenge is compounded by the need to process data at various scales, which requires careful alignment to avoid discrepancies.

Coordination and Consistency: Another challenge is ensuring consistency in the vulnerability and impact assessments across all case studies. Coordinating methodologies and ensuring that the vulnerability indicators are comparable across the CSAs is an ongoing challenge. The team is working to align data collection methods, as well as the interpretation of indicators, to ensure consistency. This process is critical for building a robust Socioeconomic Vulnerability Index (SeVI) that can be applied across different regions.

Climate Hazard Scenarios and Adaptation Conflicts: A significant issue arises when selecting appropriate climate hazard scenarios for the risk assessments. In some cases, the stakeholders in the case studies have already prioritized adaptation options, which might conflict with the socioeconomic criteria and municipal plans. For instance, in some areas, local decision-makers have focused on short-term solutions that may not fully consider the long-term socioeconomic impacts of climate change. Balancing these existing adaptation measures with the scientific and socioeconomic findings from the WP3 risk assessment is proving to be a complex task.

Stakeholder Engagement: Engaging stakeholders from various sectors has also presented some challenges, particularly when it comes to aligning their expectations with the scientific methodologies used in WP3. While some stakeholders are open to the modelling results, others remain focused on practical, immediate solutions that might not fully integrate the broader vulnerability and risk assessment models. Ensuring that the case studies are developed in a way that aligns with stakeholder priorities, while also maintaining scientific rigor, remains an ongoing struggle.

2.4 WP4: Co-developing Digital Twin Simulations to Enhance Cross-Sectoral Climate Resilience Frameworks

2.4.1 Progress of WP4

WP4 is making steady progress toward developing a comprehensive suite of digital twins for European metropolitan regions, with a focus on enhancing cross-sectoral climate resilience. While challenges related to data harmonization, the varying maturity levels of the digital twins, and the alignment of stakeholder policies remain, the work being done will lay a strong foundation for more robust climate adaptation strategies across European cities. The continued collaboration with the Destination Earth initiative and other European projects will further enhance WP4's capabilities and the overall success of the Carmine project. The five tasks of WP4 that have started are: Task 4.1: Co-development of a Federated Data Management Solution for Analytics (UFR); Task 4.2: Architecture design and implementation of the CARMINE DT; Task 4.3: Actual delivery of digital twins for each CSA (Athena RC); Task 4.5: Coordination with DestinE, with task 4.4 Framework and guidelines for DT transferability. planned to start in M18.

Task 4.1: Co-development of a Federated Data Management Solution for Analytics (UFR) has seen positive developments. A survey was sent out in October, and responses were analysed, which led to the decision to begin working with Athens and Braşov as the initial pilot areas for digital twin data management. Early-stage development of the DT Engine will begin, incorporating feedback from the data requirements analysis.

Task 4.2: Architecture design for the digital twins has made significant strides. UFR has discussed the need for a unified API to retrieve dataset information across all digital twins, and preparations are underway to implement the federated data management system. The architectural framework integrated data requirements from all case study areas (CSAs).

Task 4.3: The development of digital twins for various CSAs has progressed with a focus on early-stage simulations:

- **DT-HEAT (Athens and Prague):** These models are being refined with the integration of climate data, mortality data, and deep learning AI for predicting heat-related deaths.
- **Flood Risk Adaptation Planning:** A preliminary digital twin has been developed for flood risk planning in regions affected by flooding.
- **DT-Trees (Birmingham, UK):** Focus on increasing resilience to climate hazards through tree cover, with initial simulations using the JULES land surface model.
- **Other case studies:** Updates were made on urban fragilities, well-being risks, wildfire risk adaptation planning, and governance in metropolitan areas.

For the more mature DTs like Athens and Prague, the focus was on finalizing the methodology for heat exposure, refining the epidemiological models, and integrating climate data into the long-term models. Initial model runs, such as the JULES land surface model in Birmingham, will be compared with observational data for further model development. Continued collaboration with epidemiologists helped and will continue to help refine the heat-related mortality predictions, which are central to the DT-HEAT model.

Task 4.5: Coordination with DestinE, which is focused on collaboration with the Destination Earth (DestinE) initiative, has been fruitful. Meetings with the DestinE team during the IGARSS 2024 conference in Athens and ongoing exchanges regarding technical aspects have provided crucial insight into how the project's digital twins can integrate with the larger European initiative.

Regular coordination meetings have been held, ensuring smooth communication between task leaders and digital twin development teams. A strong international collaboration mechanism was established, fostering efficient exchange of information across WP4 and with other work packages.

2.4.2 Next Steps for WP4

The team will continue developing a more granular architecture for the Digital Twin Management System (DTMS), which includes designing a process model to enhance the interaction between digital twins and data providers.

Coordination with DestinE: WP4 will continue its collaboration with the Destination Earth initiative, focusing on setting up in-person meetings with the ESA (European Space Agency) and exchanging critical data related to heat-related mortality and climate adaptation strategies. Presentations at major conferences, such as the URBIS Conference, will further promote the CARMINE project and strengthen connections with other initiatives in Europe.

WP4 will continue to coordinate with other work packages, especially WP3 and WP5, to ensure that the digital twins' data aligns with broader project objectives, including socioeconomic vulnerability and risk assessments.

Additional meetings and workshops will be scheduled with case study areas to further define and standardize the inputs and outputs for each digital twin, ensuring that the digital twins remain adaptable and relevant to local needs.

The ongoing development of the CARMINE DTMS will play a crucial role in the harmonization of data and ensuring that all case study areas are working within a unified framework.

2.4.3 Challenges and Difficulties

Despite the solid progress, several challenges have arisen in WP4, particularly due to the diversity of the digital twins being developed for different metropolitan regions.

Differing Maturity Levels of Digital Twins: Each digital twin is at a different stage of development, and this discrepancy requires tailored approaches for each case study area. While Athens and Prague are more advanced, other regions, such as Braşov and Birmingham, are still in the early stages, requiring additional resources to bring them up to speed.

Data Management Complexities: As WP4 heavily depends on data from multiple sources, harmonizing datasets across varying spatial scales has proven to be a significant challenge. The interaction between WP3 (socioeconomic vulnerability assessments) and WP4 (data management) remains a critical area of focus, as aligning data requirements for both work packages is essential for coherence across the project. There are also challenges related to ensuring the proper handling of data and aligning policies across different levels.

Integration of Diverse Datasets: With digital twins being developed across metropolitan areas, ensuring that datasets are compatible and standardized for all case studies is complex. For example, the task of coordinating with multiple data providers and aligning their data outputs to a common framework requires substantial effort and communication.

Stakeholder and Policy Alignment: Aligning the digital twin developments with the stakeholders' goals and local policies is a persistent challenge. In certain cases, adaptation options prioritized by local stakeholders may conflict with the socioeconomic criteria and risk assessments, complicating the development of the digital twins.

2.5 WP5: Enabling Impact-Based Decision Support Service (IDSS) for informed local adaptation plans and science-based decision-making

2.5.1 Progress of WP5

Work Package 5 has made solid progress in developing the technical architecture and data models needed to support local adaptation and climate resilience efforts. Despite some ongoing challenges, particularly related to data integration and stakeholder alignment, the team is moving forward with an ambitious and comprehensive plan. By the next set of milestones, WP5 aims to have a functional prototype of the IDSS, with clear, actionable outputs for local decision-makers across the project's case study areas. The following tasks 5.1: Co-develop the open architecture of the IDSS, 5.2: Develop the operational framework and data flow, 5.3: Perform iterative

calibration and validation of the IDSS prototype, with the participation of sectoral stakeholders and TGs and 5.4: Establish operational links with the Mission Adaptation to CC Implementation Platform and Climate-ADAPT platform contribute to the successful completion of WP5.

Task 5.1: Co-development of the Open Architecture of the IDSS.

Significant progress has been made in the development of the technical architecture for the Impact-Based Decision Support Service (IDSS). The team has established the first concept of the architecture, drawing on the "Earth Observation Exploitation Platform Common Architecture" to ensure stability and elasticity. This framework serves as the foundational backbone for the integration of various data sources and services. The technical design is set to accommodate future expansions and modifications as the system evolves, making it adaptable for various use cases and scalable across different regions.

A key milestone has also been the infrastructure provision at Meteo Romania, where the team has implemented a robust IT environment using technologies such as OpenStack, Kubernetes, and Minlo. This infrastructure provides a solid base for hosting and processing large datasets, and it aligns with the project's objectives of ensuring data accessibility and reliability.

In addition, the project has initiated a survey for core partners to gather the necessary technical and functional requirements for the IDSS. This survey is an essential tool to tailor the development of the platform, ensuring that it meets the specific needs of stakeholders and end users, and serves as the groundwork for the system's design.

A dedicated meeting was organized in September to focus on the results of the survey on technical and functional requirements. The outcomes of this meeting will be instrumental in refining the system architecture and ensuring that the final IDSS meets the needs of local stakeholders. Additionally, the team will work on establishing the technical workflows required to integrate the IT infrastructure at Meteo Romania with MetX, the external system from which some of the data for the IDSS will be sourced.

Task 5.2: Development of an Operational Framework and Data Flow.

Work on Task 5.2 has focused on building an operational framework for the IDSS, with particular emphasis on data modelling and flow design. A crucial early deliverable has been the development of an example data model and a data flow for CSA Brasov. This model serves as a proof of concept, demonstrating how data will be processed, structured, and integrated into the IDSS for decision-making in the context of local adaptation plans.

This data flow model provides clarity on how various data sources — ranging from environmental sensors to socio-economic data — will be ingested, processed, and used to generate actionable insights for users. It also sets the stage for integrating the system with existing infrastructure and tools, allowing for a seamless workflow and data interoperability.

Task 5.4: Establish operational links with the Mission Adaptation to CC Implementation Platform and Climate-ADAPT

We have established informal discussions with European Environmental Agency (EEA), and started the preparation. Carmine's Coordinator has been involved in the Thematic Working Group on Climate Services (WGCS) of the Mission Implementation Platform (MIP4Adapt) championed by the projects Valorada and Climateurope2.

Connections with the Climate-ADAPT platform have been established in terms of exploring the possibilities to establish operational links.

2.5.2 Next Steps for WP5

Looking ahead, several key activities are planned to advance the objectives of Work Package 5.

- Bi-monthly WP meetings will continue as the primary forum for sharing progress, identifying challenges, and refining the project's overall direction. These meetings will provide opportunities to engage with stakeholders and clarify the technical requirements of the IDSS, ensuring alignment across the project.
- One of the next milestones will be the technical meeting to define the key aspects of the IDSS architecture in terms of its ability to answer critical questions, such as where and when specific climate-related events will occur, and the magnitude of their impact on local communities. This will involve detailed discussions on how the system can synthesize complex data into actionable decision-support tools that users can rely on to make informed choices.
- Additionally, the team will continue to refine the data model and develop a more detailed architecture for the IDSS. This will include drafting a CARMINE data schema that will help standardize the data for input into the system and define a more granular process model for its operationalization.
- Another priority will be to better understand how to align the IDSS with the broader objectives of local adaptation planning, especially in terms of the decision-making process. This requires deepening the understanding of the key challenges that local authorities and stakeholders face when it comes to climate adaptation and refining the IDSS so that it can provide the most relevant and timely insights.
- Finally, upcoming meetings will focus on understanding the user requirements more comprehensively, particularly in terms of the local community's needs. This will include technical discussions with relevant stakeholders and external experts, ensuring that all aspects of the IDSS are user-centric and tailored to local contexts.

2.5.3 Challenges and Difficulties

Despite the significant strides made, several challenges have surfaced during the execution of Work Package 5. One of the primary difficulties lies in the complexity of the data management and integration processes. The IDSS requires the combination of diverse data sets from various sources, including real-time environmental data, socio-economic statistics, and climate projections. Aligning these data sources into a single, coherent system requires substantial effort, particularly as datasets may vary in format, quality, and frequency.

Moreover, the team has encountered technical challenges with integrating the data model and data flows into the existing infrastructure at Meteo Romania. This involves harmonizing the data pipeline with the infrastructure provided by OpenStack, Kubernetes, and Minio, and ensuring that the platform can handle the large-scale data operations required by IDSS in real-time decision support scenarios.

Another difficulty has been the need to align the system's outputs with the specific needs of various stakeholders, particularly at the local level. For instance, it has been challenging to define the types of questions that the IDSS should answer — such as where, when, and why specific climate events will occur, and how these events will impact the local population. This has required ongoing discussions with local stakeholders to refine the user requirements, ensuring that the IDSS is responsive to their needs.

Finally, the development of the IDSS requires the coordination of multiple work packages (especially WP3 and WP4), as the data that informs the decision support system must be consistent across different regions and scales. As the system develops, ensuring **cross-work package alignment** remains a critical focus.

2.6 WP6: Multi-level climate change governance: policy pathways to support R&I roadmap in Europe

2.6.1 Progress of WP6

WP6 has made commendable progress in its early stages, particularly in developing a systematic methodology for policy review and aligning with other work packages. Moving forward, the team is focused on completing the policy review, engaging with stakeholders, and accelerating the development of the R&I roadmaps. By addressing the difficulties and refining their approach, WP6 will continue to make valuable contributions to the project's overall goals of fostering science-based decision-making and local climate adaptation planning, with task 6.3: Co-develop informed climate policy recommendations, planned to start in M25. To date, WP6 has made significant progress in the following tasks:

Task 6.1: Survey Analysis and Policy Review.

The team has begun analysing survey responses regarding national and international policies for each case study area (CSA). These responses have provided valuable insights into the existing policies that influence climate change adaptation and resilience at multiple governance levels. WP6 has also been collaborating with WP1 to collect basic information on the Living Lab survey, which offers an overview of policies in each CSA. Additionally, bi-weekly coordination meetings with WP1 and other stakeholders have ensured alignment between the tasks and activities of both work packages.

- The team has made strides in developing a systematic policy review methodology, with initial contributions from partners at CNR and UoBIR. This framework aims to evaluate the level of implementation of key EU climate adaptation policies, such as the EU Strategy on

Adaptation to Climate Change (SACC), the EU Green Deal (EGD), and the European Climate Adaptation Platform (Climate-ADAPT). Preliminary analyses of CSA documents, including policies provided by stakeholders, have also been conducted.

- **Establishing a Standardized Workflow:** WP6 has developed a standardized workflow to gather detailed information on existing adaptation measures and their beneficiaries. This workflow will be applied across all case studies, ensuring consistency and enabling better comparison of adaptation strategies. Currently, the Bologna CSA has been used as an example to illustrate this workflow, but it will be implemented across all other case study areas.
- **Collaboration with Other Work Packages:** Cross-package collaboration remains an important focus. Regular bi-weekly meetings with WP1/WP6 have been held to ensure synergies between the activities of the two work packages. These meetings have facilitated coordination on the policy documentation collection process and helped align the overall project strategy. Additionally, WP6 has been in contact with CSA leads to gather the necessary policy details from the international, national, regional, and local levels.

2.6.2 Next Steps for WP6

Looking ahead, WP6 is preparing for an intensification of activities, especially in the coming months. The next steps will focus on completing the data collection and refining the policy review processes:

1. **Policy Documentation Collection:** The team will continue collecting detailed policy documents from each CSA, focusing on the areas of adaptation and resilience. WP6 will also continue its efforts to acquire missing policy documentation, particularly from the Leipzig CSA.
2. **Systematic Policy Review:** WP6 will conduct a deeper analysis of the CSA documents and academic articles related to EU policy implementation. This will include a systematic review of policies related to the EU's SACC, EGD, and other key strategies. The team will focus on identifying any gaps or misalignments between EU policy and local policies in the case study areas.
3. **Living Lab Contributions:** The policy-related outputs from the Living Lab workshop 1 will be further analysed, with insights shared between work packages to enable cross-fertilization of ideas. The results will help refine the methodology and ensure that local perspectives are integrated into the policy review process.
4. **Benchmarking R&I Roadmaps:** Starting in Month 13 (October 2024), WP6 will focus on developing the benchmark research and innovation (R&I) roadmaps for climate adaptation and resilience. This task will involve further engagement with CSAs and stakeholders to develop actionable policy pathways.

5. **Engagement with Stakeholders:** There will be increased engagement with CSA leads to gathering more policy data and feedback on the effectiveness of current adaptation measures. Additionally, WP6 will continue its collaboration with other work packages to streamline data requests and ensure that local authorities are not overwhelmed by information demands.
6. **Framework Co-Development:** WP6 will begin co-developing the framework to integrate vertical and horizontal governance systems. This framework will focus on aligning EU policies with national, regional, and local governance approaches to facilitate more effective climate change adaptation and decision-making.

2.6.3 Challenges and Difficulties

Despite the progress made, WP6 faces several challenges that have impacted its timeline and effectiveness:

- **Missing Policy Documentation:** One of the major challenges encountered so far has been the absence of complete policy documentation for certain CSAs, including Leipzig. This has hindered the ability to conduct a comprehensive policy review and has delayed some aspects of the analysis. The team is actively working to resolve this by liaising with local stakeholders and CSA leads.
- **Availability of Policies in English:** Another difficulty has been the availability of key policy documents in English. Since the project involves international case studies, having access to translated documents or policies written in English is essential for effective analysis. Some regions have provided their policy documentation in their native languages, which requires additional effort for translation and interpretation.
- **Resource Constraints:** There has been a delay in the progress of WP6 activities due to the focus of the UoBIR and CNR teams on delivering WP1 activities, particularly the Living Lab workshop and its report. As a result, the pace of WP6 tasks had been slower than expected. However, now that resources have been fully allocated to WP6, the team anticipates a faster pace in the coming months.
- **Limited Cross-Package Interaction:** A concern raised by WP6 team members, including Sorin Cheval, is the limited interaction between WP6 and other work packages. While Letizia Cremonini has assured that the methodology developed for WP6 will be applied across all case studies, there is still a need for a more comprehensive cross-package strategy to avoid overloading local authorities with redundant requests for information.

2.7 WP7: Societal Sharing and Impact Maximisation - Dissemination, Exploitation, Communication

2.7.1 Progress of WP7

WP7 ensures the CARMINE project's results reach a global audience by developing a comprehensive strategy for dissemination, exploitation, and communication (DEC). The package aims to make research outputs visible and accessible, helping stakeholders integrate them into policy, planning, and operations. By sharing knowledge and providing training material, WP7 promotes the practical adoption of project innovations and enhances their long-term impact. WP7 has made considerable strides in the dissemination, communication, and exploitation of the **CARMINE project**. Despite some challenges, the work package is positioned to further expand its impact, engage more stakeholders, and drive the visibility of the project across Europe and beyond. The upcoming months will be critical for refining communication strategies and leveraging new opportunities for global collaboration and networking.

Task 7.1: DEC framework.

The first version of the Dissemination, Exploitation & Communication (DEC) Strategy has been elaborated, outlining a comprehensive plan of activities targeting all relevant stakeholders and target groups (TGs) across the project. This initial DEC strategy, delivered in M3, establishes key tools, activities, and target audiences, while setting measurable KPIs and a detailed schedule for outreach efforts. It also defines the project's visual identity and emphasizes the connection between research findings and policy adoption, thereby promoting the broader visibility of the project within the international climate community. Aligned with Open Science policies, the DEC strategy is a living document that will be regularly updated to ensure continuous engagement and the uptake of the project's results.

Task 7.2: Communication tools and activities.

Website and Social Media Launch and Performance

The official project website was launched, alongside active social media accounts on platforms like LinkedIn, Instagram, and X (formerly Twitter). This has greatly facilitated communication and engagement within the project community and the public. For the time being, more than 5,400 unique visitors have connected to CARMINE's official website. With a ratio of 1.56 visits per visitor in December 2024 (compared to 1.14 in April 2024), engagement shows consistent improvement as visitors return more frequently over the months (Figure 4).

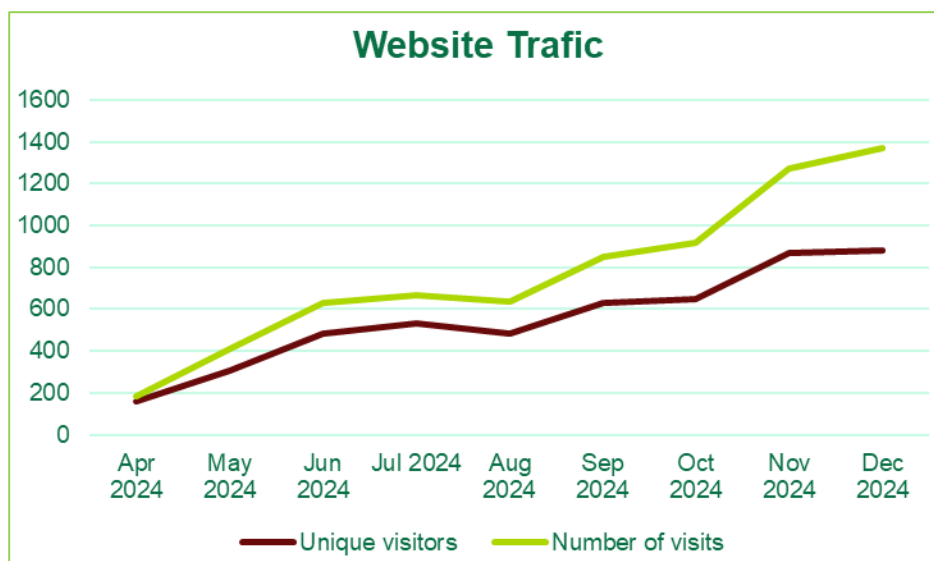


Figure 4: CARMINE's website visitors (April – December 2024)

The analytics for CARMINE's social media presence demonstrate strong performance, with LinkedIn emerging as the top-performing platform. The CARMINE page has grown to an impressive 314 followers (Figure 5), achieving over 19,700 impressions (Figure 6) and generating 1,000 reactions (Figure 7) within its first year. Additionally, the page has reached more than 10,340 users (Figure 8). All these results are organic, meaning that they were achieved without paid advertising or promotions, relying solely on the quality of the content, the partners' efforts, and natural audience engagement - showcasing the effectiveness of the content and engagement strategies.

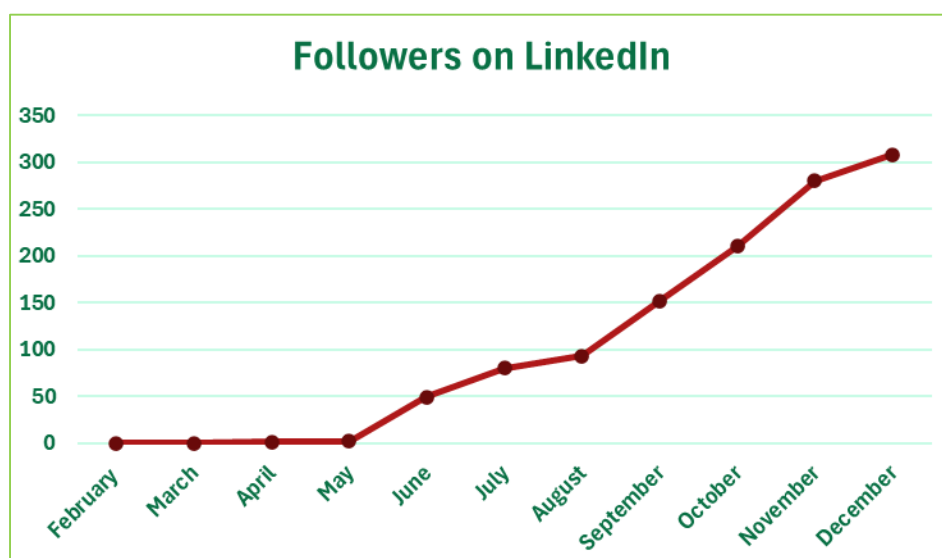


Figure 5: CARMINE's LinkedIn page followers (February – December 2024)

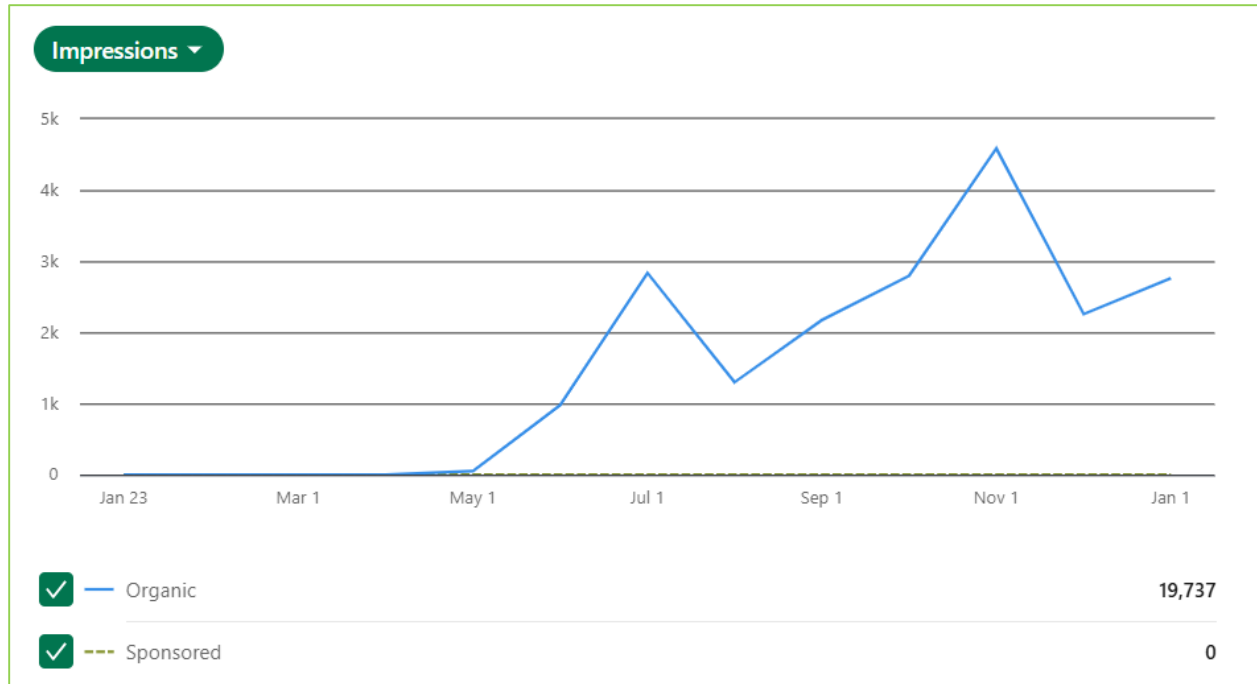


Figure 6: CARMINE's LinkedIn page impressions (February-December 2024)



Figure 7: CARMINE's LinkedIn page reactions (February-December 2024)

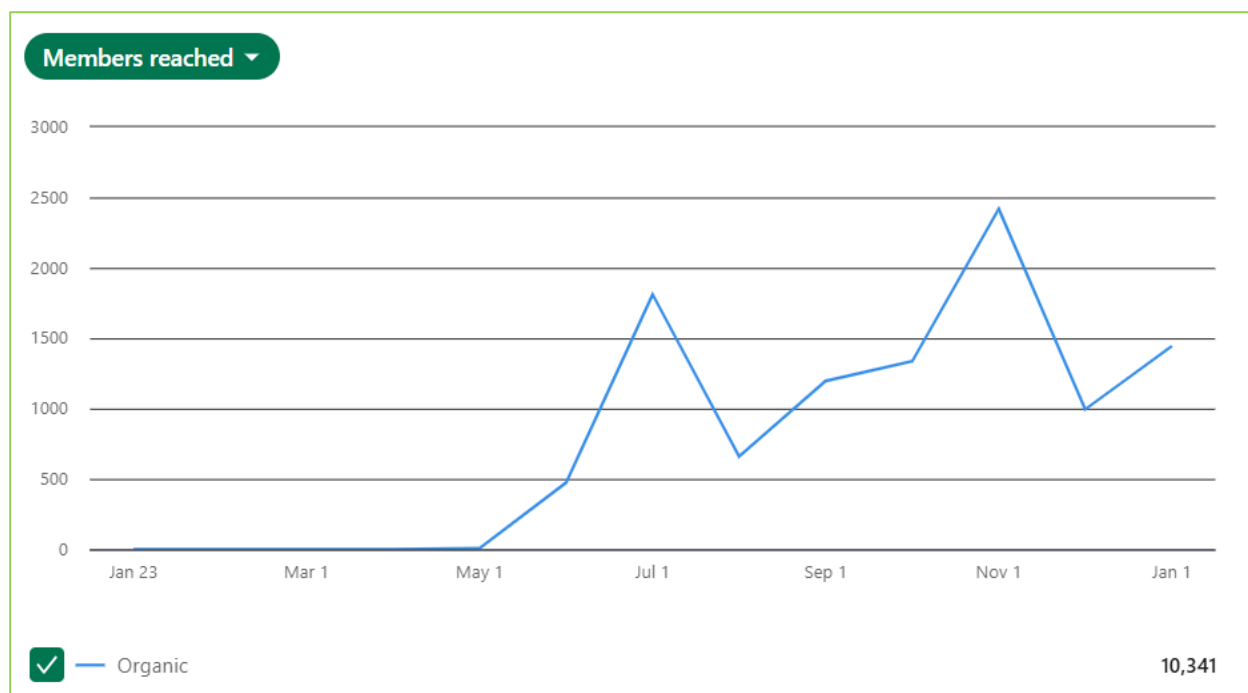


Figure 8: CARMINE's LinkedIn page reach (February-December 2024)

Website and Social Media Activities

WP7 has designed and led several social media campaigns and ensured the communication of a wide number of partners' activities. The first campaign was called "Learn more about CARMINE" and featured weekly visuals on the project's objectives, work packages, funding, solutions and methodologies, to introduce CARMINE's work to the growing audience. The second campaign (still ongoing as of January 2025) is titled "Meet the Partners", and spotlights one consortium member each week by sharing their logo, website link and role in the project.

The various activities of the project have been shared extensively, through social media posts or re-posts, and website articles. Please refer to Appendix B. that displays the communication and dissemination materials mentioned.

Published Content:

- A total of seven (7) **blog posts** have been successfully published on the website, contributing to an updated and seamless showcase of CARMINE, and covering project updates and topical insights into the project's impact on urban resilience.
- A total of 119 **social media posts** across the three CARMINE platforms (LinkedIn, X and Instagram) have been posted since the beginning of the project. Additionally, partners have been tagging the project extensively in their posts.
- A first **newsletter** was launched in December 2024, which highlights key activities, upcoming events, and new collaborations. The letter has been delivered to 152 recipients

and had an open rate of 67.71% showcasing high interest in the information and insights provided.

- A project **flyer** was developed to effectively communicate the project's objectives and achievements, incorporating feedback from partners, in a small printable format and high quality, making it the ideal communication tool for events.
- A project **poster** was published. Contrary to a flyer, the poster is made to be printed in a bigger format (e.g. A3) to present the project during in-person events, networking sessions, stakeholder exchanges; and focuses more on technical aspects, like the tools developed or the CSAs.
- A CARMINE **roll-up** and **banner** were developed along partners' need for large communication material during events. This roll-up and background present the project in a visually appealing manner.
- Creation of a short **set of slides** titled *General introduction to CARMINE*, which presents the project and is particularly useful when attending external meetings and events where the project can be showcased.

Task 7.3: Networking and synergies with similar R&I projects and initiatives, including Horizon Europe funded projects.

1. Engagement with External Partners: WP7 has been actively forging significant synergies and collaborations with key European and global initiatives, to further strengthen the project's visibility. Partnerships initiated include with the Climate-ADAPT platform, discussions regarding the use of satellite data and environmental monitoring tools from the European Space Agency's (ESA) SmartConnect and R3 Accelerator programmes, the alignment of project methodologies with insights from the European Environment Agency's (EEA) Urban Adaptation in Europe: what works? report, and strategic engagements with highly complementary EU Horizon R&I projects such as ICARIA, CLIMAAX, RISKADAPT, PATHWAYS2RESILIENCE, MIRACA and others.
2. Upcoming conferences: CARMINE will be represented at the webstival organized by the CLIMAAX project in January 2025. The project's participation in other conferences, such as in ECCA2025 European Climate Change Adaptation Conference and the Living Planet Symposium in April 2025 are under discussion.

2.7.2 Next steps for WP7

WP7 is moving forward with a structured set of activities aimed at further boosting the visibility of the **CARMINE project**, ensuring effective communication with stakeholders, and maximizing the impact of its efforts.

- Social Media and Website:

The social media campaign will continue with a focus on showcasing the partners involved in the project. A series of posts under the theme “Meet the Partners” will continue to be rolled out, providing insight into the project’s collaborative efforts. A similar campaign about the CSAs will be developed.

The CARMINE website will be regularly updated with more detailed information on the project’s results and other blog posts.

- **Joint Activities with Other R&I Projects:**

WP7 will continue its work on Deliverable D7.8, due by January 2025. This deliverable further elaborates on the synergies between CARMINE and other EU projects, as well as its engagement with international platforms like the WMO and ESA.

Additionally, WP7 will continue its efforts to integrate CARMINE’s results into global initiatives, such as the UN Early Warnings for All initiative, and will leverage these connections to showcase the project at high-profile platforms like the WMO Regional Forum in 2025.

2.7.3 Challenges and Difficulties

Despite these successes, several challenges have emerged that need to be addressed to ensure continued progress and the smooth execution of WP7’s tasks:

- **A continued update of mailing list and contact information:** to ensure timely and effective communication with all partners involved in the dissemination and outreach activities, partners need to ensure that the contact information in the internal database is up to date. Regular reminders are being sent to partners.
- **KPI Performance in some platforms:** although social media and website engagement has shown great progress, other platforms, namely Instagram and X, have experienced low engagement. Due to the difficulty of targeting the audience of these platforms, this indicates a need to optimize audience targeting or recalibrate their use.
- **Coordination with other Work Packages:** the work of WP7 heavily relies on other WPs’ results and activities. Although several channels of internal communication and feedback have been put in place by the WP7 team, specifically to be informed about activities to communicate on, it took time for partners to use them. As the project advances, and results will be developed, coordination between WP7 and other work packages needs to be streamlined, to avoid overwhelming partners and stakeholders with information requests.

2.8 Project Management

2.8.1 Progress of WP8

WP8 has made significant progress in several ongoing activities. In particular, coordination of day-to-day operations, including administrative, legal, and financial management (T8.1), is

proceeding smoothly. The data management plan (T8.2) is also on track, with continuous efforts to ensure GDPR compliance and address stakeholder engagement (T8.4). The project management and governance structure is provided in Figure 9.

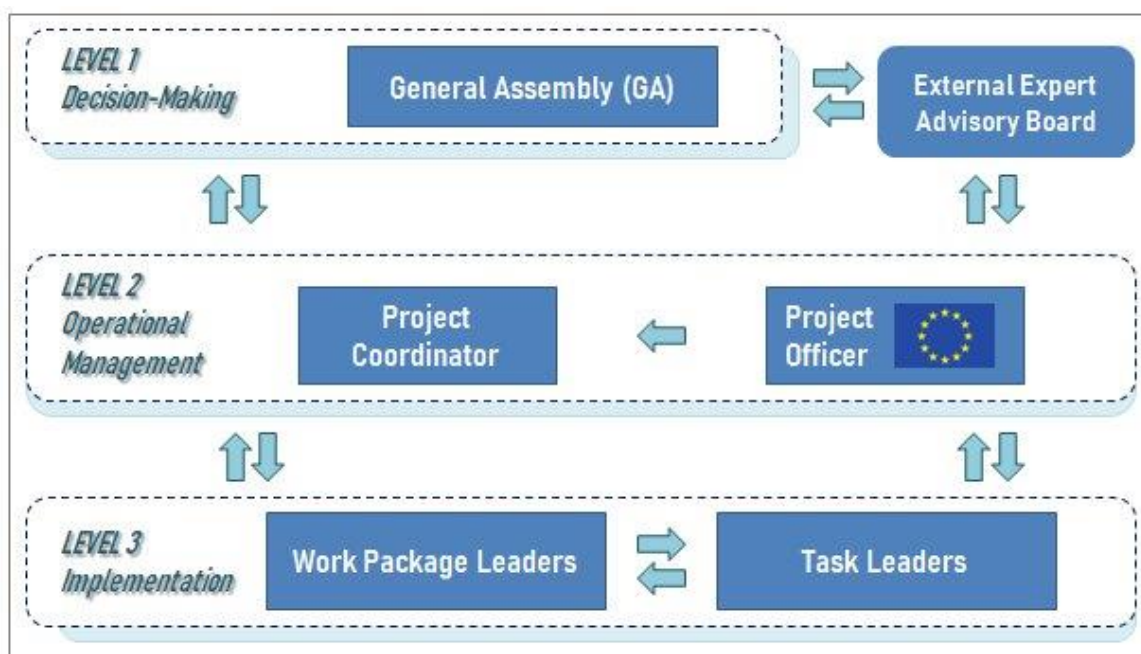


Figure 9: Project Management and Governance

Timely Completion of Project Key Deliverables and Milestones.

The work of the project will be documented in 67 deliverables, of which 14 are in WP8. In the first year, on WP8, 3 project management deliverables have been submitted, as highlighted in table 2.

Table 2: Timely Completion of Project Key Deliverables

WP	WP Lead	No.	Deliverable name	Description	Type	Lead Beneficiary	Dissemination level
1	ATH-RC	D1.1.	Engagement strategy	Participatory approach – Stakeholder Engagement strategy	R	ATH-RC	PU
1	ATH-RC	D1.7.	LL creation in case studies	Living Labs creation in case studies	R	ATH-RC	PU
7	SDSN	D7.1.	DEC strategy - Version 1	Reports on the strategy for dissemination, exploitation, communication, including Open Science practices and procedures	R	SDSN	PU

7	SDSN	D7.16.	Project website	Website	DEC	MeteoRO	PU
8	MeteoRo	D8.5.	DMP - Interim 1	DMP drafted	DMP	MeteoRO	PU
8	MeteoRo	D8.10.	Project handbook Version 1	Project handbook on risk management, IPR, gender, ethics	R	MeteoRO	PU

CARMINE has reached 4 milestones in the first year, out of 18 milestones throughout its lifetime. Three of them are assigned to the Project management WP. They are showcased in the table 3.

Table 3: Achieved Milestones

Milestone	Name	WP	Lead Beneficiary	Means of Verification	Month
14	DEC strategy established	WP7	17-SDSN	DEC strategy in place (WP7/T7.1)	Jul-24
15	Project handbook elaborated	WP8	1-MeteoRo	Project handbook in place (management, risk management, IPR, gender, ethics) and shared with consortium and EC (WP8/T8.1)	Jul-24
16	Creation of an External Scientific Advisory Board	WP8	1-MeteoRo	The External Scientific Advisory Board is established and functional. The Board includes the coordinators of the projects funded under the calls HORIZON- MISS-2021-CLIMA-02-03 (ICARIA, MIRACA, RISKADAPT), and HORIZON-MISS-2021-CLIMA-02-01 (CLIMAAX). The Board has 7 members, experts in the field of CARMINE. (WP8/T8.1)	Apr-24
17	Kick-off meeting	WP8	1-MeteoRo	Meeting held and approval of project organisation (WP8/T8.1)	Apr-24

All deliverables followed the submission timelines as highlighted in the Project Management Handbook and followed the internal management rules and were promptly communicated to all the nominated reviewers and the project partners, with an invitation to provide feedback, offer supplementary information, or suggest any further revisions if necessary. Each deliverable reached its scheduled publication date, according to the GA plan. The list of deliverables, including their publication date are presented in the table 4.

Table 4: Description of deliverables, ordered by publication date

Deliverable 7.1 Dissemination, Exploitation and Communication Strategy – Version 1 April 2024

CARMINE's Dissemination, Exploitation, and Communication (DEC) strategy is a comprehensive plan to effectively communicate, disseminate, and utilize the project's mission, objectives, and results. By leveraging a mix of traditional and digital channels—such as websites, social media, newsletters, media outreach, and events—the strategy aims to enhance stakeholder engagement, knowledge sharing, and project impact.

The DEC approach ensures that messaging reaches diverse audiences, promotes a unified vision, and encourages active participation. Continuous evaluation and monitoring allow for ongoing refinements to maximize outreach effectiveness, align with project goals, and respond to audience needs.

Deliverable 7.16 - Project Website April 2024

This initiative focuses on developing a user-friendly website and active social media presence for the CARMINE project. The website, accessible at <https://carmine-project.eu/>, follows modern web standards to ensure a seamless user experience. Key features include:

- Intuitive navigation for easy information access across all popular browsers.
- Engaging design aligned with existing project style guidelines.
- Core functionalities that support project objectives without added complexity.
- Data security to protect user information.
- Networking and knowledge sharing to enhance collaboration and access to project resources.

The website will centralize project information, updates, and insights for stakeholders and the public. Complementary social media accounts (Twitter, LinkedIn) will also be managed to increase visibility and engagement.

Deliverable 1.1. – Target groups (stakeholders) engagement strategy July 2024

Deliverable 1.1 details a stakeholder engagement strategy that includes interactive workshops aimed at co-designing climate adaptation strategies aligned with Sustainable Development Goals (SDGs). By incorporating tools like Climate Challenge Systems Maps and Digital Twins in Living Lab sessions,

stakeholders actively contribute to shaping adaptation pathways, ensuring that these efforts align with local needs and policies.

Deliverable 1.7 - Living Labs Creation in Case Studies

July 2024

Deliverable 1.7 focuses on Living Labs (LL) as essential collaboration platforms within Case Study Areas (CSAs), where participants co-design climate resilience strategies. These labs gather baseline data, address knowledge gaps, and leverage a Stakeholder Community Hub to expand innovation and learning across sectors.

Deliverable 8.10 Project Handbook - Version 1

July 2024

The CARMINE Project Handbook is a practical guide designed to support all project participants in achieving successful results. It details essential contractual rules, management procedures, and provides helpful tools and advice to ensure participants meet their responsibilities accurately and on schedule.

Deliverable 8.5 - Data Management Plan (DMP) - Interim 1

July 2024

The Data Management Plan (DMP) outlines CARMINE's approach to data collection, organization, curation, storage, access, and security. It covers data quality assurance, metadata, licensing, and protocols for data sharing and deletion during and after the project. Additionally, the DMP explains the project data flow between specific data-driven Work Packages (WP) and ensures that generated data is accessible timely throughout the consortium and to relevant user communities and stakeholders.

Effective Project Monitoring and Progress. To improve monitoring and reporting, two spreadsheets have been introduced to track activities, issues, risks, and deliverables. These documents are now central to project management, linking to other relevant project documents like calendars and risk registers. They are being updated monthly to ensure transparent and up-to-date tracking of project status.

Meeting minutes were drafted for all the project meetings (table 5) and are available for all the partners in the CARMINE shared folder on Teams. All partners were informed once the minutes were finalized and uploaded and were invited to add any complementary information or suggestions if needed.

Table 5: List of CARMINE project meetings

Meeting	Date	Description
Kick off Meeting	12 - 13 March 2024	The meeting provided an overview of the project with the following agenda: context, consortium, vision, goal, specific objectives, methodology (including an overview, concepts, models, and assumptions), case study areas, links to the Climate Adapt Platform, Impact (including results, key performance indicators, dissemination, exploitation, and communication), and implementation.
1-st General Assembly Meeting	13 March 2024	The meeting informed the Project Partners on practical matters related to the project management and discussed project budget and resourcing, reporting practices, status of deliverables and milestones, progress monitoring, risk register, project working methods and communications. The meeting discussed on the membership of the Scientific Advisory Board and External Expert Advisory Board.
2-nd General Assembly Meeting	22 October 2024	The Extraordinary General Assembly meeting was called to discuss proposed amendments to project deliverables and tasks, reiterating proposed changes brought to the GA.
CSA Meeting (WP1, WP2, WP3, WP4)	16 May 2024	The meeting was centred on various topics related to the project's cross-disciplinary nature and the need for a comprehensive data management plan. The coordinator led the discussion on cross-working packages and project objectives, emphasizing the importance of addressing issues affecting activities in all working packages. Participants expressed the need to clarify data collection and management for the project's data management plan and understanding the focus areas for digital twins within the case studies.
Project Progress Meeting 1	09 May 2024	Meeting for the follow up of the WPs' progress: objectives, tasks, achievements, main issues, and the work plan for the next two months.
Project Progress Meeting 2	02 July 2024	WPs' progress covered WPS objectives, tasks, achievements, main issues in months 1-4, and the work plan for the next two months.
Project Progress Meeting 3	11 September 2024	Highlight the key activities completed in the WPs during month 6-7.
Project Progress Meeting 4	05 November 2024	WPs' progress covered WPS objectives, tasks, achievements, main issues. Highlight the key activities completed in the WP during month 8-9.
Amendment Meeting -new PO	12 December 2024	Meeting to discuss the 1 st Amendment review and timelines

Project Progress Meeting 5	16 January 2025	WPs' progress covered objectives, tasks, achievements, main issues. Highlight the key activities completed in the WPs during month 10-11.
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Financial and Technical Reporting. Templates for interim financial and technical reports were distributed to partners. This process aims to keep financial oversight in check while ensuring that the technical progress of the project is adequately recorded and shared among consortium members.

Grant Agreement Amendment. The process of updating the Grant Agreement has been started and the amendment was sent to the PO officer. A meeting was also held to discuss the proposed changes to the GA.

The External Expert Advisory Board (EEAB) been established and the first meeting held on 15May2024, providing valuable expertise and strategic guidance for the continued success of the project.

Task 8.2: The Data Management Plan (DMP) outlines CARMINE's approach to data collection, organization, curation, storage, access, and security. It covers data quality assurance, metadata, licensing, and protocols for data sharing and deletion during and after the project.

Task 8.4. Monitoring implementation risk, IPR, gender representation and ethics issues.

- **Collaborative Framework and Governance:** The consortium agreement has been signed by all project partners, formalizing roles and responsibilities for smooth collaboration. Ethical considerations are being rigorously addressed, with the approval of the ethics committee and the establishment of an internal project ethics board to oversee case study methodologies.
- **Stakeholder Engagement:** Key activities are being undertaken to collect data from stakeholder engagement activities. This includes gathering feedback, identifying stakeholders' needs, and ensuring that stakeholders are properly informed and have provided consent. The necessary documents, such as consent forms and surveys, are being submitted for review by the Independent External Ethics Advisor.

2.8.2 Next Steps for WP8

Moving forward, several key activities and deadlines are crucial to ensure that the project continues to progress and address the outstanding issues.

1. **Grant Agreement Amendment:** The next step is to have the amendment approved.
2. **Monthly Reporting Procedure:** Partners will continue to update the spreadsheets on a monthly basis to track activities, issues, risks, and deliverables.
3. **Stakeholder Engagement:** The collection of feedback and consent from stakeholders will continue. Additional training may be provided to partners to ensure compliance with GDPR and other ethical guidelines.

4. **Financial and Technical Reporting:** Partners will continue to work on their financial and technical reports. This process will help monitor project finances and technical progress to ensure that both remain on track.
5. **Preparation for WP8 Next Steps:** WP8 will continue hosting and sharing relevant documents on the CARMINE Teams & SharePoint area. WP8 will also focus on engaging external stakeholders and addressing any ethical concerns that may arise during the upcoming surveys and interviews.

2.8.3 Challenges and Difficulties

Despite the overall progress, several challenges and issues have surfaced that have impacted the smooth execution of certain tasks.

- **EEAB Delays:** The difficulty in finalizing the EEAB members was largely due to a lack of consensus within the consortium. While this has now been resolved, the initial setbacks delayed the establishment of a functioning advisory board, which has pushed back the planned meeting with the board.
- **Reporting Overload:** The introduction of new reporting tools, while beneficial for tracking and transparency, may lead to a reporting overload for partners. Monthly updates are essential, but the amount of data to be captured may result in inefficiencies, especially if some partners are less familiar with the new process.

3 Project reporting to EC

3.1 Reporting to EC

Reporting is carried out using the online platform provided by the EC which specify the required contents: in essence, a periodic technical report and a periodic financial report. These reports are required within 60 days of the end of the period. Work Package leads are expected to contribute to the technical report, with input from all partners as needed. All partners must provide an individual financial statement detailing their eligible costs for the period.

The interim reporting to the EC will happen in the following periods:

- From month 1 to month 18 (February 2024 – July 2025)
- From month 19 to month 36 (August 2025 – January 2027)
- From month 37 to month 48 (February 2027 – January 2028)

As described in the Grant Agreement of the project these periods will be reported within 60 days after the period termination date.

3.2 Internal reporting

All partners will share interim information regarding efforts, expenses and achievements in an internal report. The internal reporting process will be aligned with the formal reporting to the EC and will permit the Coordinator, and all the partner, to:

1. Collect from all partners information regarding work performed on the project, results and impacts achieved.
2. Collect from all partners their financial statements forecast for the reporting period.
3. Compare project achievements with resource consumptions and confront them with the project plan.
4. Share main findings regarding project execution with all partners.

This internal reporting process will ease the process of formal reporting by all partners and the production of a consolidated report for the project to be formally submitted to the EC during the interim reporting phases. It will also permit the project Consortium to provide the best representation of the efforts and achievement on the project.

The internal reporting will work on the same information to be collect and shared for the formal reporting to the EC, including:

- Brief written reports of the activities of the partner per work package.
- Updates on work on deliverables, risks, problems and planned activities.
- A summary of meetings attended.

- Expenses and financial activities.

Templates that support the reporting of this information were provided to partners and are available in the CARMINE Share Point. When requested, it is important that all participants use this template for the reporting to ease data reconciliation and correct reporting to the EC.

Moreover, core partners which lead work packages are asked to provide updates per task and an overview of the status of the deliverables and milestones. This will enable the PC to track effort and spend against plan and to detect any deviations early. The reporting of the activities in the different WPs will be done during the monthly Project Progress Meetings and will be registered in the minutes for such meetings.

Regarding reporting for expenses and financial activities, this can include:

- The staff effort (person-months) expended in the preceding three months.
- A summary of all personal costs.
- A summary of non-staff costs such as travel, workshop costs etc.

4. Resources utilization and budget expenditure

In the first 9 months, the project was implemented through tasks performed within 7 WPs. Table 6 summarises the expenditure in PM per partners across all WPs. However, the partners highlighted in yellow were not included in the calculations.

Table 6: Summary of staff effort. P-M/PP = Total Person-Months per Project Participant

PM Used	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	Total
MeteoRo	3,16	7,17	1,87	0,69	1,28	2,13	0,87	2,19	19,36
MITIGA	4,00	4,00	0,00	2,00	0,00	0,00	0,00	0,27	10,27
UB	1,50	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1,50
CNR	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
ICS	2,83	4,21	0,00	1,61	0,00	0,00	0,00	0,00	8,65
INCDS	1,50	0,30	0,00	0,30	0,00	0,00	0,00	0,20	2,30
RUB	0,00	1,27	0,00	0,00	0,00	0,00	0,00	0,00	1,27
PCF	1,78	0,27	0,18	0,18	0,00	0,12	0,18	0,10	2,81
UFR	0,75	0,00	0,25	4,50	0,25	0,00	0,00	0,25	6,00
CNC	0,52	0,71	0,31	0,29	0,00	0,00	0,56	0,25	2,64
DTU	3,02	0,00	5,29	1,23	0,56	0,88	1,13	0,22	12,33
ATH-RC	7,45	0,36	2,45	9,42	1,90	3,17	1,95	0,21	26,90
NOA	1,60	1,22	0,36	2,75	0,00	0,00	0,31	0,02	6,26
JLU	0,16	5,74	0,00	0,06	0,01	0,00	0,00	0,03	6,00
WMO	0,00	0,50	0,00	0,50	0,50	0,50	1,88	0,13	4,00
AoA	0,00	0,60	0,20	0,50	0,40	0,00	0,11	0,09	1,90
SDSN	0,08	0,00	0,00	0,00	0,00	0,02	7,77	0,48	8,35
LNH	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CMCC	0,00	1,09	0,00	0,00	0,00	0,00	0,00	0,00	1,09
B-Kode	0,00	5,07	0,00	0,00	0,00	0,00	0,21	0,24	5,52
ICLEI	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
MBV	1,13	0,00	0,67	1,63	0,24	0,50	0,40	0,24	4,81
NMA	4,52	0,00	0,00	0,00	0,00	0,00	2,34	0,00	6,87
MoDG	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
LSW	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CAAB	2,18	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2,18
LUH	6,66	0,00	0,01	0,00	0,00	0,42	0,00	0,21	7,30
Total	42,84	32,50	11,59	25,65	5,13	7,74			148,29

The use of resources summary, Table 7, presents an estimation reported by partners in M1-M9. The values stated in Tables 6 and 7 may undergo minor adjustments until the closing date of the periodic reporting in M18.

Table 7: Budget allocation per partner M1-M9

USED TOTAL	TOTAL Person Months (PM)	B. Sub- contracting	C. Purchase Costs			E. Indirect costs (Flate rate 25%)	Total Costs	Maximum EU Contribution (Funding rate 100%)
			C.1. Travel and Subsistence	C.2. Equipment	C.3. Other Goods, Works & Services			
MeteoRo	19,36	0,00	688,62	0,00	8.100,35	31.162,14	155.810,70	155.810,70
MITIGA	10,27	0,00	1.015,67	0,00	0,00	12.853,92	64.269,59	64.269,59
UB	1,50	0,00	730,95	0,00	0,00	1.365,28	6.826,40	6.826,40
CNR	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
ICS	8,65	0,00	900,15	0,00	3.888,71	7.514,80	37.573,99	37.573,99
INCDS	2,30	0,00	1.122,59	4.664,88	0,00	5.795,28	28.976,41	28.976,41
RUB	1,27	0,00	0,00	0,00	0,00	577,62	2.888,10	2.888,10
PCF	2,81	0,00	800,61	0,00	0,00	3.339,87	16.699,33	16.699,33
UFR	6,00	0,00	0,00	6.553,33	1.660,05	7.179,71	35.898,56	35.898,56
CNC	2,64	0,00	0,00	0,00	0,00	1.085,16	9.415,21	9.415,21
DTU	12,33	0,00	2.269,05	0,00	0,00	26.859,47	134.297,34	134.297,34
ATH-RC	26,90	0,00	5.137,48	1.674,94	3.032,51	35.459,32	177.296,61	177.296,61
NOA	6,26	0,00	465,00	2.000,00	100,00	10.324,11	51.620,55	51.620,55
JLU	6,00	0,00	3.411,19	0,00	0,00	10.525,12	52.625,59	52.625,59
WMO	4,00	0,00	0,00	0,00	0,00	14.131,64	70.658,18	70.658,18
AoA	1,90	0,00	0,00	0,00	0,00	2.536,93	12.684,66	12.684,66
SDSN	8,35	0,00	1.774,73	0,00	0,00	11.264,06	56.320,29	56.320,29
LNH	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CMCC	1,09	0,00	1.005,37	0,00	0,00	2.094,73	10.473,66	10.473,66
B-Kode	5,52	0,00	2.159,14	0,00	0,00	14.037,04	70.185,18	70.185,18
ICLEI	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
MBV	4,81	0,00	0,00	0,00	181,49	2.646,77	13.233,85	13.233,85
NMA	6,87	0,00	0,00	0,00	0,00	5.009,34	25.046,68	25.046,68
MoDG	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
LSW	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CAAB	2,18	0,00	970,11	0,00	0,00	3.995,25	19.976,24	19.976,24
LUH	7,30	0,00	2.344,90	0,00	0,00	11.020,02	55.100,10	55.100,10
TOTAL	148,29	0,00	24795,56	14893,15	16963,11	220777,56	1107877,21	1107877,21

4 Conclusions

At the heart of the project, **WP1** is dedicated to co-designing adaptation and mitigation actions, with a particular focus on nature-based solutions. The establishment of Living Labs in the Case Study Areas (CSAs) has been a cornerstone achievement, helping to document climate change challenges and develop tailored Geo-designed pathways for adaptation. In parallel, **WP2** is addressing the scientific side of climate adaptation. By integrating advanced climate models and Earth system processes, WP2 is closing crucial knowledge gaps related to local-scale climate impacts. This is achieved through the development of high-resolution simulation models and tailored outputs to better support local adaptation strategies. Meanwhile, **WP3** is tackling the socioeconomic dimensions of climate vulnerability. Through community-based vulnerability assessments, WP3 is evaluating how different populations in the CSAs are at risk from climate change and identifying pathways for transformative adaptation. With several key tasks, including cost-benefit analysis and geostatistical analysis of adaptation measures, now underway, WP3 is preparing the ground for integrated solutions that bring together both conventional and nature-based approaches to resilience. **WP4** is laying the technological groundwork for the project's future, focusing on the development of Digital Twins for European metropolitan regions. Although there have been challenges with data harmonization and aligning policies across stakeholders, WP4 has made significant strides in creating a federated data management solution and producing the first digital twins for several CSAs. The collaboration with the Destination Earth initiative is strengthening the capabilities of this work package, positioning it as a central pillar of CARMINE's long-term success.

In **WP5**, technical efforts are focused on developing the architecture and data models that will support local climate adaptation efforts. WP5 is on track to deliver a functional Integrated Decision Support System (IDSS) prototype. This system will provide actionable outputs to help local decision-makers plan and implement climate-resilient strategies more effectively. As these technical and scientific advancements unfold, **WP6** is focused on policy engagement and ensuring that the research outputs are translated into real-world applications. The policy review process is ongoing, with the team working closely with other work packages to ensure that science-based decision-making aligns with local adaptation needs and governance structures. **WP7** plays a key role in ensuring the broader impact of the project. Focused on dissemination, exploitation, and communication, WP7 is driving the visibility of the project's results both within Europe and globally. Finally, **WP8** is overseeing the operational side of the project, ensuring that the administrative, legal, and financial aspects run smoothly. This work package has made strong progress, particularly in managing data compliance and stakeholder engagement, which are essential for maintaining the project's efficiency and ensuring that all regulatory requirements are met.

5 Appendix A – List of partners

#	Acronym	Participant organisation name	Type	CO
P1	MeteoRo	Administratia Națională de Meteorologie R.A. (Coordinator)	PUB	RO
P2	MITIGA	MITIGA Solutions SL	SME	ES
P3	UB	University of Bucharest	HEI	RO
P4	CNR	Consiglio Nazionale delle Ricerche - Istituto per la BioEconomia	RES	IT
P5	ICS	Institute of Computer Science, Czech Academy of Sciences	RES	CZ
P6	INCDS	National Institute for Research and Developed in Forestry	RES	RO
P7	RUB	Ruhr University Bochum	HEI	DE
P8	PCF	Fundacio d'Ecologia del Foc i Gestio d'Incendis Pau Costa Alcubierre	SME	ES
P9	UFR	Albert Ludwigs University of Freiburg	HEI	DE
P10	MM	Meteomatics AG	SME	CH
P11	CNC	National Center for Cartography	PUB	RO
P12	DTU	The Danish Technical University	HEI	DK
P13	MOHC	Met Office Hadley Centre	PUB	UK
P14	ATHENA- RC	Athena Research Center (Sustainable Development Unit)	RES	EL
P15	NOA	National Observatory of Athens	RES	EL
P16	JLU	Justus-Liebig-Universitaet Giessen	HEI	DE

P17	WMO	World Meteorological Organization	INT	CH
P18	AoA	Academy of Athens	HEI	EL
P19	SDSN	SDSN ASSOCIATION PARIS - UN Sustainable Development Solutions Network	NGO	FR
P20	LNH	LNH water aps	SME	DK
P21	UoBIR	University of Birmingham	HEI	UK
P22	CMCC	Fondazione Centro Euro-Mediterraneo sui Cambiamenti Climatici	RES	IT
P23	B-Kode	B-Kode	SME	BE
P24	ICLEI	ICLEI European Secretariat	SME	DE
P25	MBV	Brasov Municipality	PUB	RO
P26	NMA	New Metropolitan Attica S.A.	OTH	EL
P27	ECB	European Central Bank	INT	DE
P28	MoDG	Ministry of Digital Governance	PUB	EL
P29	BCC	Birmingham City Council	PUB	UK
P30	LSW	Stadtwerke Leipzig GMBH	PRC	DE
P31	CAAB	Centro Agro Alimentare di Bologna Spa	PUB	IT
P32	LUH	Leibniz University Hannover	PUB	DE

6 Appendix B – Communication and Dissemination

6.1 Appendix B.1 - Project Flyer

CARMINE

CLIMATE RESILIENT DEVELOPMENT PATHWAYS
IN METROPOLITAN REGIONS OF EUROPE



Goal: To help metropolitan communities become more climate resilient by co-producing knowledge-based tools, strategies and plans for enhanced adaptation and mitigation actions.

Budget: EU Contribution: approx. €10,17M

of Partners: 32 from 11 countries

TOOLS & SOLUTIONS

Living Labs

ATLAS of Climate Resilience

Digital Twins

Impact-Based Decision Support Service

Policy Pathways

Federated Data Management Solution

PROJECT OBJECTIVES

#1
Review resources, tools, practices and policies to identify gaps hindering the advancement of the resilience pathways in the Metropolitan Regions of Europe

#2
Develop risk models integrating climate, earth systems, and socio-economic factors to improve adaptation and mitigation in the Metropolitan Regions of Europe.

#3
Co-produce an adaptation framework combining Living Labs, Digital Twins, and Nature-Based Solutions for resilience in the Metropolitan Regions of Europe.

#4
Provide advanced decision support services integrating climate data with socioeconomic impact assessments for easy access to detailed local adaptation plans.

#5
Develop a coordinated, impactful modeling and risk assessment to guide Research and Innovation (R&I) priorities, policies, and cross-sectoral plans for 2030-2050.

8 CASE STUDY AREAS

Prague (CZ)

Leipzig (DE)

Funen-Odense (DK)

Athens (EL)

Barcelona (ES)

Bologna (IT)

Braşov (RO)

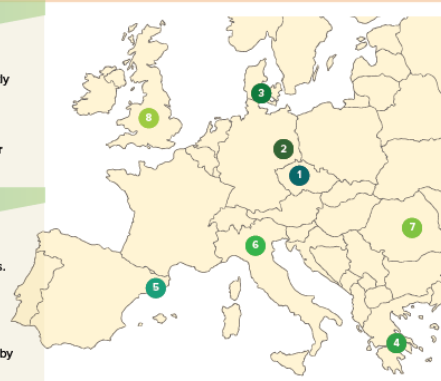
Birmingham (UK)

Case Study Areas

- Implement a framework based on a **System Innovation Approach** for stakeholders to jointly test, develop and create climate-resilient solutions.
- Engagement of the actors via the **Stakeholder Community Hub**, an online tool.

Modelling

- Modelling of **geo-designed adaptation and mitigation pathways**, including NBS scenarios.
- Risk assessment** with hybrid or multi-scale simulation chains modelling.
- Assessment of socio-economic vulnerability** by analysing local physical, economic, social and ecosystem stressors.



Collaborations

- Coordination with the **Destination Earth initiative** to promote a Digital Twin-based solution.
- Links with the **Mission Adaptation to Climate Change Implementation Platform** and **Climate-ADAPT** platform.

Learn more about **CARMINE** and its **partners**

carmine-project.eu

@carmine_project

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@carmineproject



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UK Research and Innovation

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Department of Economic Affairs,
Education and Research (EAER)
State Secretariat for Education,
Research and Innovation (SERI)

Swiss Confederation



6.2 Appendix B.2 - Project Roll-Up



CARMINE
co-create climate resilience

Goal: Help metropolitan communities become more climate resilient by co-producing knowledge-based tools, strategies and plans for enhanced adaptation and mitigation actions.

Budget: EU Contribution of approx. €10,17M

of Partners: 32 from 11 countries

8 CASE STUDY AREAS

- Birmingham (UK)
- Funen-Odense (DK)
- Leipzig (DE)
- Prague (CZ)
- Barcelona (ES)
- Bologna (IT)
- Braşov (RO)
- Athens (EL)

PROJECT OBJECTIVES

1. Review resources, tools, practices and policies to identify gaps hindering the advancement of the resilience pathways in the Metropolitan Regions of Europe.
2. Develop risk models integrating climate, earth systems, and socio-economic factors to improve adaptation and mitigation in the Metropolitan Regions of Europe.
3. Co-produce an adaptation framework combining Living Labs, Digital Twins, and Nature-Based Solutions for resilience in the Metropolitan Regions of Europe.
4. Provide advanced decision support services integrating climate data with socioeconomic impact assessments for easy access to detailed local adaptation plans.
5. Develop a coordinated, impactful modeling and risk assessment to guide Research and Innovation (R&I) priorities, policies, and cross-sectoral plans for 2030-2050.

TOOLS & SOLUTIONS

- Living Labs
- Federated Data Management Solution
- ATLAS of Climate Resilience
- Policy Pathways
- Digital Twins
- Impact-Based Decision Support Service

Connect with CARMINE!

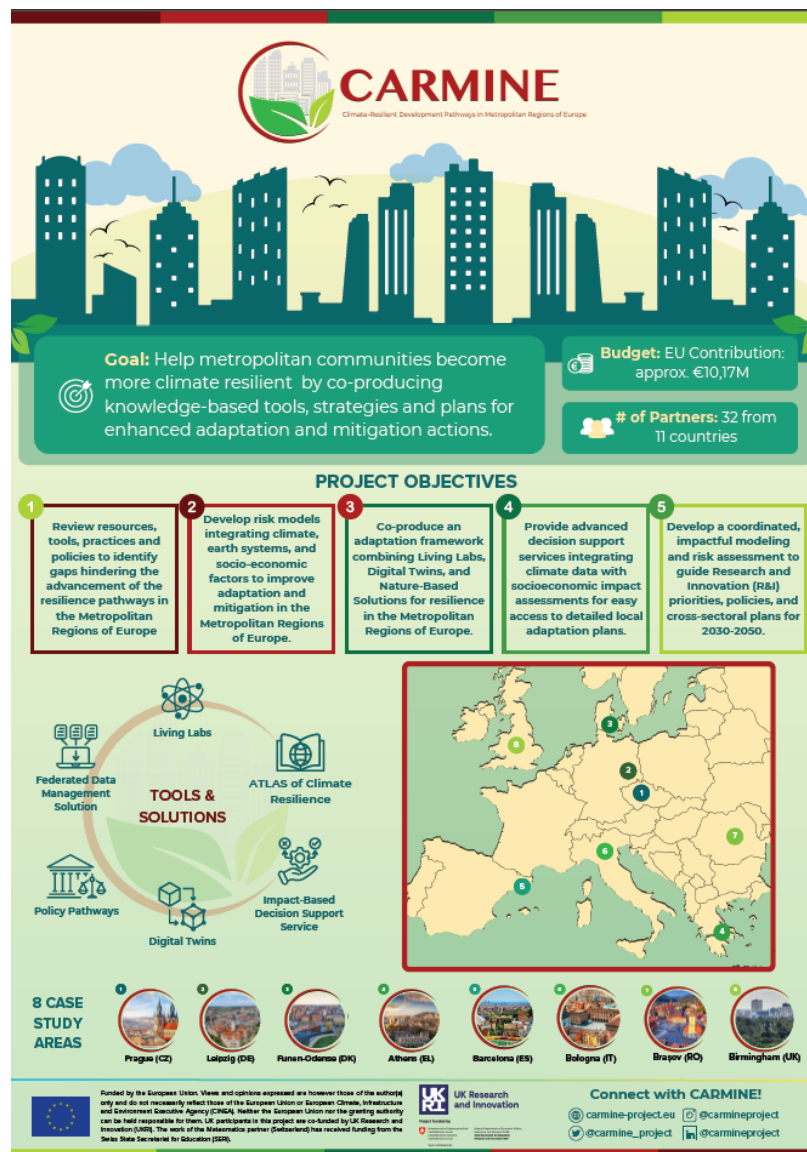
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6.3 Appendix B.3 - Project banner



6.4 Appendix B.4 - Project poster



6.5 Appendix B.5 - Project presentation slides



CARMINE

Climate-Resilient Development Pathways
in Metropolitan Regions of Europe

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Funded by the European Union

Context

HORIZON-CL5-2023-D1-01-07
Modelling for local resilience
Developments in support of local adaptation assessments and plans

Expected outcomes:

- Support to the implementation of the EU Strategy on Adaptation to Climate Change and the Mission on Adaptation to Climate Change, by **enabling better informed adaptation plans and strategies at the regional and local level.**
- **Strengthen science-based decision-making** when it comes to resilience and disaster risk management, including on the role of nature-based solutions.
- Stronger **local adaptive capacity.**
- Improved **synergies between national, regional and local Green Deal objectives**, in particular adaptation action.
- Better coordinated and more impactful R&I activities on **adaptation modelling and risk assessment.**



About

Vision

To provide knowledge-based Climate Resilient Development Pathways in Metropolitan Regions of Europe, that bridges the local and regional scales by providing impact-based decision support services (IDSS) and multi-level climate governance supporting local adaptation, including both traditional and Nature-Based Solutions.

Budget: EU Contribution approx. €10,17M 32 Partners from 11 countries

Goal

CARMINE's overarching goal is to help the metropolitan communities become more climate resilient, by co-producing knowledge-based tools, strategies and plans for enhanced adaptation and mitigation actions addressing the Charter of the EU Mission on Adaptation to CC by 2030.

Duration of 48 months: Start date 1 Feb 2024 – End date 31 Jan 2028

Coordinated by ADMINISTRATIA NATIONALA DE METEOROLOGIE R.A. (MeteoRo)



Objectives

Objective #1 Review resources, tools, practices and policies to identify gaps hindering the advancement of the resilience pathways in the Metropolitan Regions of Europe

Objective #2 Develop risk models integrating climate, earth systems, and socio-economic factors to improve adaptation and mitigation in the Metropolitan Regions of Europe.

Objective #3 Co-produce an adaptation framework combining Living Labs, Digital Twins, and Nature-Based Solutions for resilience in the Metropolitan Regions of Europe.

Objective #4 Provide advanced decision support services integrating climate data with socioeconomic impact assessments for easy access to detailed local adaptation plans.

Objective #5 Develop a coordinated, impactful modeling and risk assessment to guide Research and Innovation (R&I) priorities, policies, and cross-sectoral plans for 2030-2050.

Tools & solutions

- Living Labs
- ATLAS of Climate Resilience
- Digital Twins
- Impact-Based Decision Support Service
- Policy Pathways
- Federated Data Management Solution

Case Study Areas

8 CASE STUDY AREAS



We establish Living Labs and analyse the climate risks and socio-economic vulnerabilities, to:

- co-develop sectoral Digital Twins use cases;
- co-design decision-support tools;
- propose climate-resilient development pathways (including NBS)

8 countries with diverse SE profiles, types of communities, vulnerabilities, climate impacts drivers and geographical distribution across Europe.

An overview of CARMINE

The project prioritizes **local adaptation strategies**, including traditional methods and nature-based solutions.

The project bolsters the resilience of European metropolitan communities to climate change by offering **decision support services and implementing multi-level climate governance.**

To showcase its methodology, the project **digitally replicates the climate and socio-economic characteristics** of eight selected case study areas.

CARMINE develops tools, strategies, and plans aimed at **enhancing adaptation and mitigation efforts** in accordance with the EU Mission on Adaptation to Climate Change by 2030.



Thank you for your attention

Any questions are welcome!



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Swiss Confederation

Federal Department of Economic Affairs,
Education and Research (LAK)
State Secretariat for Education,
Research and Innovation (SERI)

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