



INNOVATION MANAGEMENT PLAN

ClimEmpower Work Package 6, D6.6, v1.1



Project ClimEmpower: User Driven Climate Applications Empowering Regional Resilience

Work package 6, Deliverable D6.6

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Coordinator:	Denis Havlik, Scientist AIT Austrian Institute of Technology Giefinggasse 4, 1210 Vienna, Austria
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Author(s):	Molina P. (AQUATEC), Spain Russo B. (Universitat Politècnica de Catalunya on behalf of AQUATEC), Spain Havlik D. (AIT), Austria

¹ If you wish to reference this template, please reference the latest version thereof at Zenodo

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17/11/2024	Final deliverable v1.1	Denis Havlik (AIT) → EC	

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List of Acronyms

AI/ML	Artificial Intelligence/Machine Learning
AIT	Austrian Institute of Technology
ANDALUS	Consejería de Sostenibilidad, Medio ambiente y Economía Azul
ANET	Anaptixiaki eteria kinotiton periochis troodoys ltd
AQUA	AQUATEC, Proyectos para la gestión del agua
BINGO	Bringing INnovation to onGOing water management (H2020 program, Grant agreement ID: 641739, 2015-2019; https://cordis.europa.eu/project/id/641739)
C3S CDS	Copernicus C3S Climate Data Store
CC	Climate Change
CCI	Commision for Climatology
CDS	Climate Data Store
CERTH	Ethniko kentro erevnas kai technologikis anaptyxis
CET	CETAQUA
CIC	Climate interaction context
CLARITY	Integrated Climate Adaptation Service Tools for Improving Resilience Measure Efficiency (H2020 program, grant agreement ID: 730355, 2017-2020; https://cordis.europa.eu/project/id/730355)
CLIMAAX	CLIMAAX - CLIMAtE risk and vulnerability Assessment framework and toolboX (HORIZON-MISS-2021-CLIMA-02-01, Grant agreement ID: 101093864, 2023-2026; https://cordis.europa.eu/project/id/101093864)
CLIVAR	Climate Variability and Predictability - Component of the World Climate Research Programme (WCRP)
CoP	Community of Practice
CSF	Case Study Facilitators
DoA	Description of Action
DOI	Digital Object Identifier
DRIVER+	DRIVER+ project - DRiving InnoVation in crisis management for European Resilience, 2014-2020 (FR7 programme, Grant agreement ID: 607798, 2014-2020; https://www.driver-project.eu/driver-project/)
ECMWF	European Center for Medium-Range Weather Forecast
EO	Expected Outcomes
ESPRESSO	ESPRESSO project - Enhancing Synergies for disaster PREvention in the EurOpean Union (H2020 program, Grant agreement ID: 700342, 2016-2018; https://cordis.europa.eu/project/id/70034)
EU	European Union
EU-CIRCLE	A panEuropean framework for strengthening Critical Infrastructure resilience to climate change (H2020 program, Grant agreement ID: 653824, 2015-2018; https://cordis.europa.eu/project/id/653824)

ET	Expert Team
FAIR	Findable, Accessible, Interoperable and Reusable
FER	Sveučilišta u Zagrebu Fakultet elektrotehnike i računarstva
FRC	Frederick Research Center
GA	Grant Agreement
GDP/capita	Gross Domestic Product per capita
ICARIA	ICARIA - Improving ClimAte Resilience of crltical Assets (HORIZON-MISS-2021 program, Grant agreement ID: 101093806, 2023-2025; https://cordis.europa.eu/project/id/101093806)
IP	Impact Pathways
IPCC	Intergovernmental Panel on Climate Change
JCOMM	Joint Technical Commission for Oceanography and Marine Meteorology
KISS	Keep it Short and Simple
KNOWING	Framework for defining climate mitigation pathways based on understanding and integrated assessment of climate impacts. Adaptation strategies and societal transformation (HORIZON-CL5-2021 program, GA project: 1011056841, https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/how-to-participate/org-details/999999999/project/101056841/program/43108390/details)
KPI	Key Performance Indicators
MAIA	Maximising impact and accessibility of European climate research (HE Coordination Action)
MUs	Mission Users
OBZ	Osijek-Baranja County (Osječko-baranjska županija)
OBZ-AZP	Public Institution Agency for the Management of Protected Natural Values in the Area of Osijek-Baranja County (Javna ustanova Agencija za upravljanje zaštićenim prirodnim vrijednostima na području Osječko-baranjske županije)
PLINIVS	P.LIN.I.V.S. - Centro Studi per l'Ingegneria Vulcanica Sismica e Idrogeologica
PSTE	Region of Central Greece
RA s	Regional Authorities
RESCCUE	Resilient Cities facing Climate Change (H2020 program, Grant Agreement 70017, 2016 – 2020)
RES-TEC	Technical Results
RES-SCI	Scientific Results
RES-SOC	Societal Results
SICILY	Sicily Region
SMART	Specific, Measurable, Achievable, Relevant and Time-Bound
SO	Strategic Objectives
SOTA	State Of The Art
SSO	Specific Subobjectives
SyGMA	Grant Management System
TROODOS	Troodos Mountain Range in Cyprus

TSCC	Technical, scientific and cross-cutting
URI	Uniform Resource Identifier
WCRP	World Climate Research Programme
WP	Work Package

Glossary

Climate impacts	The consequences of realized risks on natural and human systems, where risks result from the interactions of climate-related hazards (including extreme weather and climate events), exposure, and vulnerability. Impacts generally refer to effects on lives; livelihoods; health and well-being; ecosystems and species; economic, social and cultural assets; services (including ecosystem services); and infrastructure (based on IPCC, 2018).
Climate risk	Climate risk is the potential for climate change to create adverse consequences for human or physical and ecological systems.
Climate Service	A climate service is the provision of climate information and tools to help end-users make climate smart decisions.
Community of Practice	Group of people who share a common interest or concern for a specific activity, practice or topic who engage in a process of collective learning within a shared domain by supporting each other and exchanging information through collaborative activities.
Exposure	Exposure is the situation of people, infrastructure, housing, production capacities and other tangible and intangible assets located in hazard-prone areas.
Hazard	Hazards have the potential to cause loss of life, injury or other health impacts, property damage, social and economic disruption, or environmental degradation.
Stakeholder	A person with an interest or concern in something
Vulnerability	Vulnerability refers to the conditions determined by physical, social, economic, and environmental factors or processes which increase the susceptibility of an individual, a community, assets, or systems to the impacts of hazards.

Executive summary (publishable)

The deliverable highlights the innovation potential of ClimEmpower's outcomes, demonstrating how the project drives advancements in climate resilience through previous projects and integrating and adapting prior tools and methodologies in new climate services.

The document gathers both the results achieved so far and those planned, dividing them according to the Specific Objectives. The specific results linked to these objectives include:

- The establishments of Communities of Practices (CoPs) to foster stakeholder collaboration as one of the main cores of the project. CoPs enable technical partners to gain insight of the regional context. CoPs also participate in the co-design process, and validate the outputs, thus ensuring applicability of the results.
- Address the data gaps and develop methodologies to bridge them. This includes not only data collection in terms of services, datasets, and indicators, but also fostering a better understanding of them and creating new tools and datasets according to stakeholders needs.
- Development of an innovative platform to provide access to retrieved data, generated tools and models, facilitating the application of the project's outcomes.
- Leverage of training and educational materials to better understand the project's outcomes, foster engagement and support informed decision-making.
- Ensure dissemination to raise awareness, creating an effective communication strategy to ensure innovations reach a wide audience.

In addition, the document introduces a structured framework for tracking innovation maturity and stakeholder validation, ensuring that each output evolves consistently across scientific, societal, and technological dimensions. The deliverable also incorporates a risk and barriers assessment to identify potential challenges affecting the uptake and replicability of key innovations.

Finally, the deliverable outlines how the replication potential of these innovations can/will be assessed: Trials are proposed as a mechanism to test and validate the tools ensuring their broader application, and the exploitation strategy of the project is described to provide a robust innovation foundation and impact in the field of climate resilience.

*A major advancement of v1.1 deliverable revision, as compared to original v1 report is the introduction of the **Innovation Maturity and Stakeholder Validation Framework (Section 4.1, 5.1)**, which enables systematic tracking of progress across technical, scientific, and societal dimensions. Alongside this, the risk and barriers assessment offers a proactive approach to mitigating potential obstacles in innovation deployment and replication. In addition, the updated version also incorporates **mechanisms and frameworks that strengthen the monitoring and validation of innovative project results.***

1 ClimEmpower summary

ClimEmpower is a Horizon Europe collaborative research project dedicated to addressing the ongoing Climate Crisis in Europe by empowering the regional stakeholders in some of the most vulnerable European regions (Figure 1).

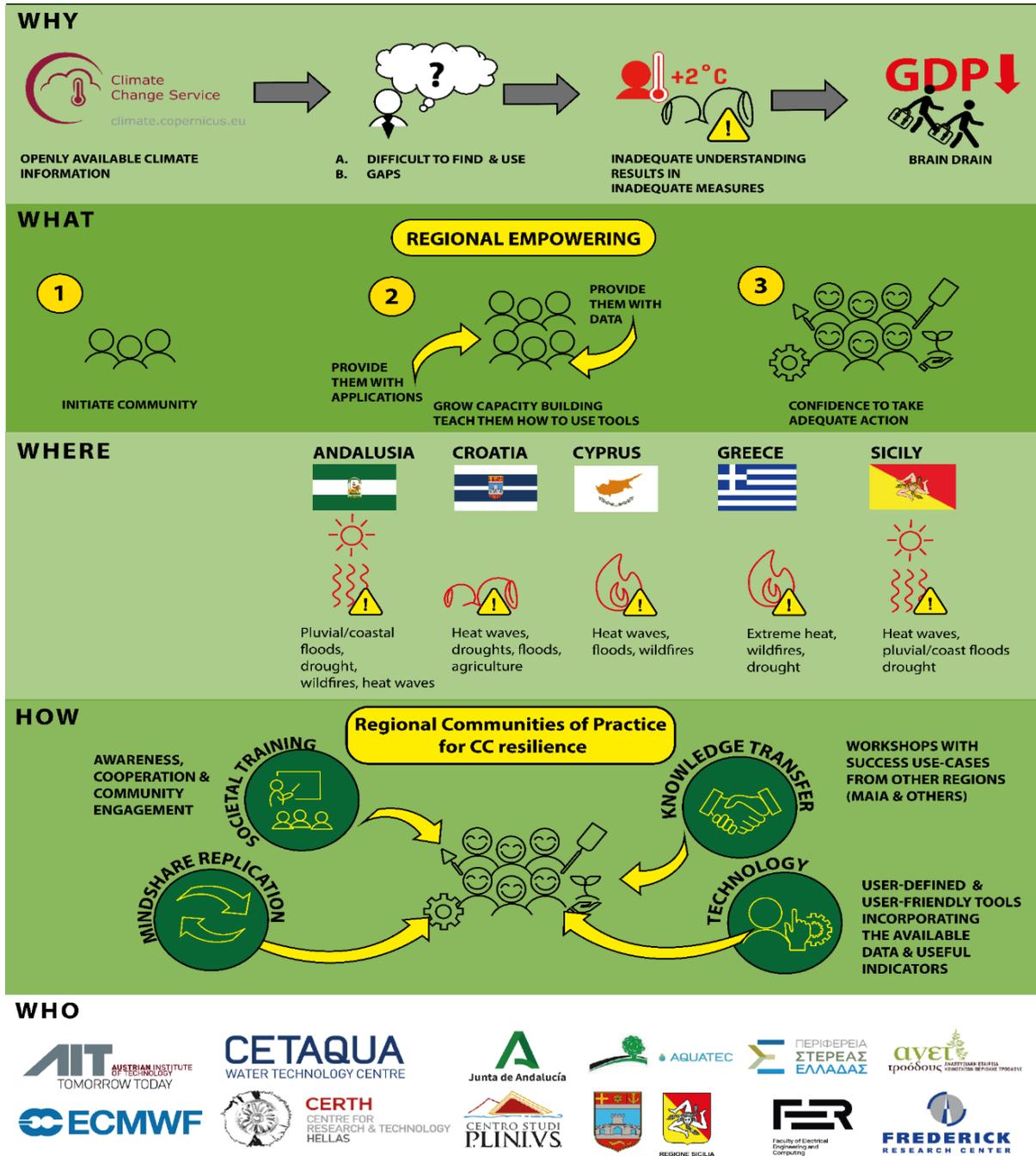


Figure 1: ClimEmpower at a glance: why, what, where, how and who.

1.1 Project Context

Climate risks results from a combination of a hazard, exposure, and vulnerability. Addressing all three aspects is crucial for effective increase of regional resilience. However, exposure, vulnerability, and related aspects, such as adaptive capacity, strongly depend on available knowledge and climate literacy. Consequently, global climate crisis frequently has a higher impact on socioeconomically vulnerable regions, thanks to a higher human and economic potential for addressing the issue in more affluent regions. To maximize its impact, ClimEmpower has therefore chosen to address the EU regions featuring a combination of high potential CC impacts and low and/or stagnant regional GDP/capita. This is mainly the case for regions in South and Southeast Europe (Figure 2).

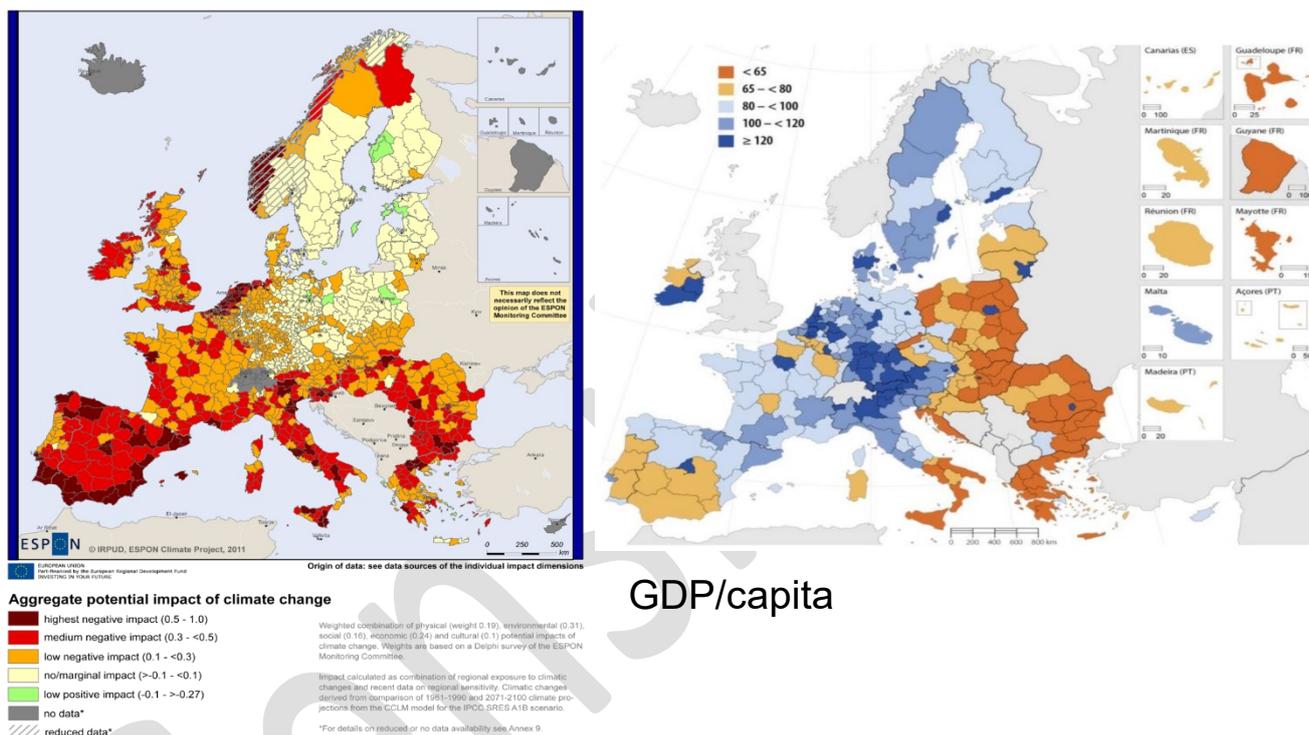


Figure 2 Aggregated potential impact of climate change (<https://www.espon.eu/climate-2012>); GDP/capita (from <https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20210303-1>).

The context the project addresses is thus one of an ongoing global warming, high regional vulnerability and low coping capacity of the participating regions, and the **overarching strategic objective of ClimEmpower** is to empower the Regional Authorities (RAs) and other Mission Users (MUs) in five EU-regions featuring a combination of exceptionally high climate hazards and exceptionally low coping capacity by improving their collective understanding of the Climate Change (CC) hazards, risks and resilient development pathways and supporting their knowledge-based regional planning and development through provision of relevant data, knowledge and user-defined and user-friendly decision support applications.

1.2 Project Objectives

To achieve this overarching goal, **ClimEmpower has identified six SMART² Strategic Objectives (SO)**, each one related to one or several work packages. The SOs have also been classified according to different categories: societal, contributing to improved dialogue, awareness, cooperation and community engagement as highlighted by the European Climate Pact (SO1, SO5); scientific, corresponding to research activities for advances beyond the state of the art (SO2, SO3); technological, suggesting and/or developing novel solutions, integrating state-of-the art and digital advances (SO4); and outreach, aimed at sharing ClimEmpower results to a broader scientific and non-scientific audience, including additional regions and communities, to maximize project impact (SO6).

- SO1 Understand regional background, challenges and expectation (WP1, societal)
- SO2 Addressing the gaps in availability and usability of CC data and services (WP2 and WP4, scientific)
- SO3 Identification, definition, estimating, and communication of climate impact/resilience indicators suitable for local end-users (WP2 and WP4, scientific)
- SO4 Simplify access to CC data and development of end user applications (WP3, technological)
- SO5 Empower the regions to activate and enhance their potential for addressing the climate change challenge. (WP4, societal)
- SO6 Ensure the use and impact of the ClimEmpower outputs (WP4 and WP5, scientific and societal)

ClimEmpower's key ambition is to **prove beyond doubt that CC-resilience should, and can, be an integral part of regional development everywhere in EU and beyond it**. That is, we anticipate that the regional stakeholders will recognise that CC-resilient development pathways offer multiple benefits to them, including but not limited to higher quality of life and reviving economy, and that these can be understood using available data, tools, and services. Second key ambition of the project is to **help the regions address the CC resilience in key community systems addressed in five ClimEmpower trials**.

Underlying philosophy of the project is to **"help the regions to help themselves"**. This will be achieved through various mechanisms, including co-creation and mediation of the regional **"Communities of Practice"**, provision of the **Climate Change -resilience training materials**, as well as in provision and training in use of the user-centric data and services – including those that have already been made available through previous research projects and EU initiatives.

² Specific (related to WPs), Measurable (by relevant KPIs), Achievable (the WPs in which they will be achieved are listed), Realistic (since they are referred and explained in the methodology section), and Timebound (each KPI is related to a deliverable and a month of achievement).

2 Introduction

2.1 Deliverable summary

This deliverable, part of WP6 - Project Coordination and Management, provides an overview of project results and their contribution to advancing project goals through innovation. It includes an analysis of key results from prior projects and highlights how the project builds upon and enhances these by introducing new methodologies and tools to address climate-related challenges. It is a first version of the ClimEmpower Innovation management plan, with second version being scheduled for May 2026.

2.2 Results and expected impacts

This deliverable presents a comprehensive overview of ClimEmpower's (anticipated) achievements, their innovation potential, and future pathways for outreach and sustainability.

In this context, the Deliverables focuses on:

- State of the art of tools and methodologies developed in other EU related projects that inspire ClimEmpower.
- Synthesis of the results achieved across all the Work Packages.
- Strategies for innovation transferability and proposal of a structured approach for testing and validating results through TGM.

Main result of this work is the table of anticipated innovative results of the project, which will inform the work on sustainability and exploitation (D4.7 and D4.8 Sustainability and exploitation plan v1/v2 – due in November 2025 and August 2026 respectively), as well as the outreach and stakeholder engagement activities in WP5.

2.3 Relation to other work

The deliverable coordinates various tasks and work packages:

- This deliverable is directly connected to the work of Work Package 6, which entails general coordination of the project.
- It has some project-wide relevance as it summarizes project results and their potential innovation. In this sense, it presents innovative outcomes achieved through all work packages.

2.4 Data, security, and ethics

2.4.1 Data interoperability

The table of anticipated innovative outcomes produced in preparation of this deliverable are Excels files with “.xlsx” format that task and work package leaders collaboratively filled. The required fields were designed in consultation with the project members. Accessing the tables requires Microsoft Excel or other software capable of displaying it.

While the table of anticipated outcomes will not be made public, majority of data displayed in the mentioned table is intended to be open and accessible, mainly through Zenodo, following the FAIR principles.

For confidential data, such as specific results related to CoPs which involve stakeholders, access will be restricted to the Consortium. However, summaries or other insights derived from this data will be shared.

2.4.2 Data accessibility and reuse:

In preparation of this document, previous project deliverables were extensively used, as they contain the primary outputs of ClimEmpower. The non-confidential deliverables will be available on CORDIS after project review, and other outputs such as posters, presentations, and tables, are publicly available on Zenodo for broader accessibility.

Sensitive deliverables and outputs related to the Communities of Practice (CoPs) can contain confidential information about regional contexts or stakeholder data and are therefore restricted to the Consortium to ensure privacy and data protection. Additionally, best practices and state-of-the-art methodologies from similar projects were incorporated into the deliverable with relevant insights and approaches.

Table 1: Data used in preparation of ClimEmpower deliverable D6.6

Data set name	Format	Size	Owner & re-use conditions	Potential Utility within and outside	Unique ID
ClimEmpower Grant Agreement	PDF	5.2 MB	Sensitive	The Grant Agreement is a legally binding contract between the consortium and the European Commission. The document is available on SyGMa.	GA number 101112728
ClimEmpower D1.1 Community of Practice organisation and expectations		6.24MB	Sensitive	The document is available on Projects' repository and reports the detailing Community of Practice organization.	ClimEmpower D1.1
ClimEmpower D1.2 scenarios	PDF	5MB	Public	The document is available on Projects' repository and will be made available con CORDIS after the M18 project review. It reports the ClimEmpower scenarios.	ClimEmpower D1.2 CORDIS (link)
ClimEmpower D2.1 Climate change resilience: identified data, services and gaps	PDF	4.96MB	Public	The document is available on Projects' repository and will be made available con CORDIS after the M18 project review. It contains a summary of existing European and region-specific datasets and services.	Climempower D2.1 CORDIS (link)
ClimEmpower D3.1 application architecture	PDF	1.61MB	Public	The document is available on Projects' repository and will be made available con CORDIS after the M18 project review. It explains the implementation architecture of ClimEmpower's applications.	ClimEmpower D3.1 CORDIS (link)

Data set name	Format	Size	Owner & re-use conditions	Potential Utility within and outside	Unique ID
ClimEmpower D4.1 Educational materials for increased regional CC resilience	docx	2.75MB	Public	The document is available on Projects' repository and will be made available con CORDIS after the M18 project review.	ClimEmpower D4.1 CORDIS (link)
ClimEmpower D5.1 Project's website	PDF	3.46MB	Public	The document is available on Projects' repository and will be made available con CORDIS after the M18 project review. Not submitted yet. It contains a set of educational materials and tutorials to be used in CoPs.	ClimEmpower D5.1 CORDIS (link)
ClimEmpower D5.2 Dissemination and Communication plan	PDF	1.19MB	Public	The document is available on Projects' repository and will be made available con CORDIS after the M18 project review. Definition of the dissemination plan.	ClimEmpower D5.2 CORDIS (link)
ClimEmpower D6.3 Implementation plan and risk contingency plan v2	PDF	2.09MB	Sensitive	The document is available on Projects' repository. Overview of the project risks, updated regularly by PMT.	ClimEmpower D6.3
ICARIA D6.6 Innovation Management Plan	PDF	1683 KB	Public	The document is available on project's website and CORDIS. It presents the methods to develop results beyond the state-of-art in the field of risk analysis and resilience assessment of critical assets.	ICARIA D6.6 CORDIS (link)

Table 2: Data considered (but not used) in preparation of ClimEmpower deliverable D6.6

Data set name	Format	Size	Owner & re-use conditions	Potential Utility within and outside	Unique ID
ClimEmpower D6.1 Project Management Manual	PDF	1.8MB	Sensitive	The document is available in the Project's document repository in the WP6 directory. The document is available on SyGMA.	ClimEmpower D6.1
ClimEmpower D6.2 Project Implementation and Risk management plan	PDF	2.3MB	Sensitive	The document is available in the Project's document repository in the WP6 directory. The document is available on SyGMA.	ClimEmpower D6.2
ClimEmpower D6.8 Data management plan	PDF	1.4MB	Public	The document is available in the Project's document repository in the WP6 directory. The document is available on SyGMA and will be available on CORDIS.	ClimEmpower D6.8 CORDIS (link) 10.5281/zenodo.10103042

Table 3: Data produced in preparation of ClimEmpower deliverable D6.6

Data set name	Format	Size	Owner & re-use conditions	Potential Utility within and outside	Unique ID
CE_Planned Inputs & Outputs	.xlsx		Sensitive (intended for project-internal use)	The document is available in the Project's document repository in the WP6 directory. Excel file containing the project outputs with its innovation potential.	N/A

2.4.3 Security and Ethics

The document is sensitive as it can contain confidential information from the CoPs.

It also may contain other project outputs that could comprise project's confidentiality, such as methodologies or tools under development that have not yet been made public or sensitive details regarding consortium agreements or collaboration frameworks.

The project also has steps for future strategics plans such as trial implementation which could impact the competitive advantage of the project.

3 Innovation Management Strategy

3.1 ClimEmpower specific subobjectives

ClimEmpower highly relies on innovation to address climate-related challenges by fostering new ideas and reaching new solutions. To guide this process, the project has identified six Strategic Objectives (SO) through the different work packages, classified according to four different categories:

- Societal. This include improving dialogue and engage citizens and local stakeholders in decision-making processes as highlighted by the European Climate Pact.
- Scientific. These objectives focus on advancing scientific knowledge and promote research activities that go beyond the state of the art.
- Technological. It focuses on providing technological advances and solutions by integrating the state of the art and innovative solutions.
- Outreach. Sharing the project's results with a broad audience to maximize project's impact, ensuring it reaches diverse audience and raises awareness.

The Table 4 summarises the six SOs of the project and indicates their classification.

Table 4: Strategic objectives

Number	Title	Category
SO1	Understand regional background, challenges, and expectations	Societal
SO2	Addressing the gaps in availability and usability of CC data and services	Scientific
SO3	Identification, definition, estimating, and communication of climate impact/resilience indicators suitable for local end-users	Scientific
SO4	Simplify access to CC data and development of end user applications	Technological
SO5	Empower the regions to activate and enhance their potential for addressing the climate change challenge	Societal
SO6	Ensure the use and impact of the ClimEmpower outputs	Outreach

3.2 Previous projects

Figure 3 provides an overview of former relevant EU projects and shows the tools, frameworks and methodologies developed that serve as background for ClimEmpower. Each of the projects include contributions from which ClimEmpower can innovate to address its specific challenges.

This way, ClimEmpower takes the “best practices” from former projects and fosters the re-use and improvement of the outcomes.



Figure 3: Previous EU-projects and outputs

3.3 ClimEmpower expected results

ClimEmpower will deliver relevant results through an integrated approach combining technical, scientific, and societal advancements. The expected results are categorized in three main areas: technical (RES-TEC), scientific (RES-SCI) and societal (RES-SOC). In the following Tables, the expected results to be achieved within the lifetime of the project are presented.

Table 5: Technical results

Technical Results (RES-TEC)	
RES-TEC1	Library and service implementing a feature extraction algorithm which allows extraction of CC data.
RES-TEC2	Climate data processing and indicator (micro)services required by ClimEmpower applications.
RES-TEC3	Web-GUI application components and GUI integration environment for user-centric applications.
RES-TEC4	DSS application prototypes to empower the regions.

Table 6: Scientific Results

Scientific Results (RES-SCI)	
RES-SCI1	Gap analysis of existing data and services, including availability and usability.
RES-SCI2	Methodology for overcoming the data gaps, including collection of local data and usage of ML/AI techniques.
RES-SCI3	Portfolio of training materials for enhanced CC-resilience, as well as training materials for the tools developed in the project.
RES-SCI4	CC risk and resilience indicators for local authorities to assess current and future risks as well as impact of measures.
RES-SCI5	Measures and strategies for increased Climate change resilience. Methodology for estimating the impacts of various measures and strategies on CC-resilience, including side-effects and co-benefits.

Table 7: Societal results

Societal Results (RES-SOC)	
RES-SOC1	Five regional CoPs to reach consensus on regional CC-resilient development.
RES-SOC2	Regional CC-resilience recommendations. Input for regional decision makers to be incorporated in regional development plans.
RES-SOC3	Community Validation. Results of trials in five ClimEmpower regions to ensure results meet the expectations of stakeholders.

3.3.1 Short-term outcomes

The short-term **expected outcomes (EO) of the project** focus on establishing a robust foundation for enhancing climate understanding, mobilizing stakeholders, and planning future pathways.

- **EO1.** Increased understanding of climate risks in case study regions. It will be achieved through the provision of training materials, available services and relevant datasets and indicators.

- Related results: RES-SCI1, RES-SCI2, RES-SCI3, RES-SCI4, RES-SCI5
- Related objectives: SO1, SO2, SO3, SO4, SO5
- **EO2.** Mobilising support and engagement of local authorities, stakeholders, and citizens in case study regions. This will be achieved through CoPs to exchange CC knowledge from different sectors of society.
 - Related results: RES-SOC1
 - Related objectives: SO1, SO5
- **EO3.** Formulating a vision for climate resilient regional development in case study regions.
 - Related results: RES-SCI3, RES-SCI4, RES-SCI-5, RES-SOC2, RES-TEC4
 - Related objectives: SO1, SO5, SO6

3.3.2 Towards CC-resilient regions: the mid-term pathway

The mid-term pathway involves the transition from the initial groundwork to the continuation of the CoP activities beyond the project end and promoting the re-use of the results to enforce the project's impact.

- **EO4:** Continued operation of the CoPs after the project end.
 - Related results: RES-SCI3, RES-TEC4, RES-SOC1, RES-SOC2, RES-SOC3
 - Related objectives: SO5, SO6
- **EO5:** High Interest for replicating ClimEmpower results in follower regions and beyond. Follower regions will participate on regional COP workshops to learn about ClimEmpower and how to implement its results.
 - Related results: RES-SCI2, RES-SCI3, RES-SCI4, RES-SCI5, RES-TEC4, RES-SOC1, RES-SOC2
 - Related objectives: SO5, SO6
- **EO6.** ClimEmpower R&D results used and further developed by R&I community. Ensure that ClimEmpower results will be re-used and further developed in other R&I projects and eventually turn into commercial products.
 - Related results: RES-SCI2, RES-SCI3, RES-SCI4, RES-SCI5, RES-TEC4, RES-SOC1, RES-SOC2
 - Related objectives: SO2, SO3, SO4

3.3.3 Towards CC-resilient regions: the long-term pathway

ClimEmpower proposal aims to foster the resilience of EU regions and communities by providing practical knowledge about the potential impacts of climate related hazards, measures and strategies for improving the regional CC-resilience. This is achieved through development of training materials, models and services for mending the CC-resilience data and knowledge. The project has defined the following long-term objectives or **Impact Pathways (IP)**:

- **IP1.** Mobilise all actors, such as EU Member States, regional and local authorities, research institutes, investors and citizens to create real and lasting impact.
- **IP2.** Provide general support to European regions and communities (especially to less developed ones, with lower coping capacity) to better understand, prepare for and manage climate risks and opportunities. Accelerate transformations to climate resilience: cooperate with

at least 150 regions and communities to accelerate their transformation to a climate resilient future, supporting them in the co-creation of innovation pathways and testing of solutions. Description of SSO and development beyond State of Art

- **IP3.** Demonstrate systemic transformations to climate resilience: deliver at least 75 large-scale demonstrations of systemic transformations to climate resilience across European regions and communities.
- **IP4.** Mission calls will foster the development of a balanced portfolio of solutions across the different climate risks and innovation areas, as identified in the Mission Implementation Plan and the different biogeographical regions, as defined by the EEA.

The following section provides a thorough description of each SSO together with the methods and tools that will contribute to their development and the tangible results expected in each case.

Sensitive

4 Summary of outputs and innovation potential

Table 8 presented a comprehensive overview of anticipated innovative project's outputs, along with their respective innovation potential. Each output has been assigned a numeric code (see first column) for easy reference throughout the document.

The table provides a summary of each output, highlighting its contribution to advancing the state of the art, format, and size, as well as the Work Package and task to which it belongs. This approach facilitates understanding of how the project's deliverables contribute to ClimEmpower objectives.

This table will be maintained throughout the project, used as input for ClimEmpower sustainability and exploitation planning in WP4, and used to tune the Dissemination, communication, and stakeholder's engagement activities in WP5.

Sensitive

Table 8 Innovation potential of ClimEmpower’s outputs

CODE	Innovation type	Status	Title	Summary	Justification of novelty	Prove nance	License /IPR	Unique ID
I01	Other (Scientific)	v1	Knowledge hubs and educational materials	Table of educational resources that aggregate other resources and sort them in a meaningful way.	Innovative methodology for developing educational materials, starting with the identification of “Knowledge Hubs” to aggregate resources. Based on these hubs, tailored educational materials were categorized with multiple examples. These resources will be validated by stakeholders to ensure their relevance. Initial tests in cooperation with the MAIA CSA have shown that Generative AI (Generative Pre-trained Transformer) software can be successfully used to speed up the analysis of	WP4, Task 4.1	Public	ClimEmpower D4.1, (pending review) 10.5281/zenodo.13944850 ClimEmpower D4.1, (TODO)
I02	Presentation (Scientific)	Final	ClimEmpower: Graphic summaries of CoP's key points	Graphic summaries with the main conclusions detected in the first CoP meetings in each region	Illustrations that were developed out of the first CoP meeting conclusions to be more understandable. It's a new format of presenting the inputs that will be used for the rest of WPs	WP1, Task 1.1	Public	10.5281/zenodo.13950188
I03	Other (Societal)	Final	Community of Practice organisation and expectations	Deliverable with information from the regions	Stakeholders were reunited and the first CoP was held in the 5 regions to gather the information on the regions and their needs. Different innovative materials and methods such as questionnaires and interactive tools were used to engage stakeholders. All the information is collected in D1.1.	WP1, Task 1.1 and 1.2	Confidential	ClimEmpower D1.1 (not public!)

CODE	Innovation type	Status	Title	Summary	Justification of novelty	Prove nance	License /IPR	Unique ID
I04	Other (Scientific)	In review	Regional Climate Resilience Assessment of the ClimEmpower regions	Regional Climate Resilience Assessment (graphics and tables) according to 10 resilience components. It's part of D1.2.	A new methodology to evaluate climate resilience was applied in the 5 ClimEmpower regions, to provide an overview of the strengths and weaknesses regarding resilience in each region.	WP1, Task 1.3	Public	ClimEmpower D1.2 (pending review) 10.5281/zenodo.11370245
I05	Other (Scientific)	Final	Questions for regions	A template to assess the expectations of stakeholders regarding data services needs was provided to the regions. It is integrated in D1.2, and D2.1	It is a new way of categorizing service needs along two dimensions (customization and integration). It provides a structured yet flexible framework for evaluating and prioritizing project results. This method enables a comprehensive understanding of stakeholder expectations and allows the development of data services that align with their needs.	WP1, WP2, WP3, WP4	Public	ClimEmpower D1.2 (pending review)
I06	Other (Scientific)	Draft	Resilience Recommendation table	A table designed as a cross-referential matrix. It has columns that represent a taxonomy of possible interventions/action that could contribute to resilience. The rows are composed by different socio-economic, environmental and hazard components.	The matrix format allows for a comprehensive overview of the interplay between interventions and socio-economic, environmental, and hazard-related factors. The data at these intersections helps to inform and shape the broader resilience recommendations by illustrating how these efforts collectively contribute to overall resilience	WP4, Task 4.2	Public	Will be used as input for I15, likely to be published as part of the project's dissemination efforts.
I07	Other (Scientific)	Draft	Combination of datasets for Regional Climate resilience	Integration of different datasets, indices, and methodological approach for susceptibility mapping in hazard identification	It is an innovative approach in disaster management planning. The integration of data and methodological innovation indicates a tailored and adaptable approach applicable in any region according to their needs and their available data. The accuracy of susceptible mapping led to identification of vulnerable areas.	WP2, Task 2.2	Public	ClimEmpower D2.2 (pending review)

CODE	Innovation type	Status	Title	Summary	Justification of novelty	Prove nance	License /IPR	Unique ID
I08	Other (Scientific)	Draft	S2 Data Downscaling	Downscaling S2 satellite images facilitating a multi layered analyses by combining optical data with other indices and historical data.	Downscaling data allows finer spatial resolution and localized hazard assessments by generated more detailed maps. Also improve data's utility and become an impressive tool for multi-scale analysis.	WP2, Task 2.2	Public	ClimEmpower D2.3 (pending review)
I09	Other (Scientific & Technological)	Draft	Social Media Crawler	Collection of X's (former Tweets) provides crowdsourced insights in real time monitoring and offers an understanding of the impact for the community. Additionally social media posts are indicators for early hazard identification.	Social media is an important source information during natural hazards. Integration of Social media posts, Sentinel 2 images and susceptibility maps in hazard identification offers a comprehensive monitoring and real time validation for various hazards.	WP2, Task 2.2	Public	ClimEmpower D2.3 (pending review)
I10	Software (Technological)	Draft	Polytope Data Access Software	Software library and REST API for tailored access to Copernicus data for use in models	The library builds on the existing Copernicus data access APIs that only allow retrieval of global fields. This new library allows users to extract data specific to the region without the need for post-processing.	WP3 Task 3.1	Public	https://github.com/ecmwf/polytope
I11	Other (Technological)	Final	ClimEmpower application architecture	Modular implementation architecture for climate services and applications, designed with openness, transparency, and reusability / transferability in mind.	ClimEmpower System architecture aims to facilitate rapid development of Climate Services and applications that are tailored to the needs of the regions / stakeholders. It provides a flexible and scalable framework that maximizes reuse of existing data, algorithms and software and facilitates transferability potential across ClimEmpower case study to other European regions.	WP3, Tasks 3.1, 3.2 and 3.3	Public	ClimEmpower D3.1 (pending review)

CODE	Innovation type	Status	Title	Summary	Justification of novelty	Prove nance	License /IPR	Unique ID
I12	Software (Technological)	In development	Data processing and indicator services	On demand data / indicator services	ClimEmpower data processing and indicator services will implement the algorithms defined in WP2 to derive the necessary data/indicators to the end-user applications on demand. Innovative part is to do this in a flexible way, so that the algorithms (e.g. realised and tested in Jupyter notebooks) can be easily made available as a service.	WP3, Task 3.2	Public	ClimEmpower D3.2 (TODO)
I13	Software (Technological)	In development	Web-GUI components and integration environment	Web-GUI components and integration environment for rapid prototyping of regional Climate Adaptation applications	In combination with I10, I11 and I12, this output will allow rapid customization / development of the Climate Adaptation applications for European regions.	WP3, Task 3.3	Public	ClimEmpower D3.2 (TODO)
I14	Other (Societal)	In progress	Communities of Practice	Regional organisations of the stakeholders with interest in CC resilience.	The integration of multiple stakeholders from diverse backgrounds in regional CoPs is a central pillar of the project and a core element contributing to societal innovation in ClimEmpower and beyond the project. CoPs serve as dynamic collaboration platforms, fostering the co-creation of strategies and validating the outcomes to ensure their relevance and applicability. This collaborative approach contributes to the sense of “problem ownership” among the regional stakeholders.	WP1, WP4	Public	ClimEmpower D1.1 (not public) ClimEmpower D1.2 (pending review) ClimEmpower D4.2 (pending review) ClimEmpower D4.3(pending review)

CODE	Innovation type	Status	Title	Summary	Justification of novelty	Prove nance	License /IPR	Unique ID
I15	Other (Societal)	In develop ment	Trials	Methodological approach for assessing the innovative potential of ClimEmpower solutions	ClimEmpower will apply the “Trial Guidance Methodology” (Initially developed in the DRIVER+ project) to the problem of validation of the project results (“solutions”) and assessment of their innovative potential for increasing the regional resilience in ClimEmpower regions and beyond. Thanks to the close connection with ICARIA, ClimEmpower team is in a good position to establish “good practices” for use of Trial Guidance Methodology in CC domain.	WP4	Public	ClimEmpower D4.5 (TODO) ClimEmpower D4.6 (TODO)
I16	Other (Scientific)	Planne d	Measures and strategies for increased Climate change resilience	An overview of measures and strategies for increasing the regional CC resilience.	This overview of “best practice” recommendations for CC-resilience measures and strategies will inform the planning the CC resilient development in ClimEmpower case study regions. We anticipate that the results will be integrated in relevant knowledge services (e.g. KNOWING Knowledge Base) and useful for other European regions beyond this project.	Task 2.3	Public	ClimEmpower D2.4 (TODO)
I17	Other (Societal)	Planne d	Regional CC-resilience recommendations	Recommendations for CC-resilient development in the five ClimEmpower case study regions.	These recommendations are the result of the CoP consultations in the five Case Study regions, informed by I06 and I14 and provide an opportunity for the regional stakeholders to reach an informed agreement on desirable interventions and inform their local governments of their ideas in informal way.	Task 4.2	Public	ClimEmpower D4.3, (TODO) ClimEmpower D4.4 (TODO)

4.1 Stakeholder validation mechanisms

Stakeholder engagement and validation are crucial not only for enhancing relevance and acceptance of innovation outputs, but also for ensuring long-term impact and usability. Mechanisms such as co-creation, user-feedback loops, and participatory design are repeatedly identified as enablers for bridging the gap between what is technically feasible and what end users actually need (Loureiro, Romero, & Bilro, 2020).

This is especially important in ClimEmpower project: innovations must be not only novel, but also acceptable and adaptable to the diverse contexts of case study regions. Therefore, each ClimEmpower innovative output undergoes a tailored validation process involving regional stakeholders from the five communities of practice.

The validation approach depends on the nature of each output:

- Knowledge-based and educational outputs (e.g. knowledge hubs, educational materials, recommendations) are reviewed through participatory feedback loops. Stakeholders in the CoPs assess their relevance, clarity, and usefulness, and refinements are incorporated in subsequent deliverables.
- Methodological outputs (e.g. resilience assessment frameworks, CoP structures, trials methodology) are validated through their practical application within the regions. Their use in workshops and assessments serves as a real-world test of robustness and transferability.
- Technological outputs (e.g. software tools, data services, APIs, GUIs) are validated through demonstrations, usability testing, and regional trials. Tutorials, prototype evaluations, and end-user feedback inform their continuous improvement.
- Cross-cutting outputs (e.g. integrated recommendations and composite tables) are validated through iterative discussions with stakeholders and experts, ensuring alignment between scientific, technical, and policy dimensions.

The Table 1Table 9 summarises the stakeholder validation mechanisms and current status for each innovative output.

Table 9. Stakeholder validation mechanism for each output

Output ID	Description of the output	Stakeholder validation mechanism	Validation status
I01	Knowledge hubs and educational materials	Reviewed with regional stakeholders; refinements planned according to feedback during WP4 meetings and other activities	Ongoing
I02	ClimEmpower: Graphic summaries of CoP's key points	Collected from stakeholders during CoP workshops using post-its, questionnaires, Mentimeter and open discussions. Validated by the Case Study Facilitators (CFS).	Completed
I03	Community of Practice organisation and expectations	Functions as a validation mechanism itself through direct engagement of stakeholders. Expectations' information, in the first CoP, was collected through open discussion and workshops in the CoP	Completed
I05	Questions for regions	Validated with regional representatives through a meeting and open discussion.	Continuous
I06	Resilience Recommendation table	Validated through consortium meetings and discussion with regional representatives.	Completed first version/Ongoing

Output ID	Description of the output	Stakeholder validation mechanism	Validation status
I07	Combination of datasets for Regional Climate resilience	Preliminary version validated conceptually within CoPs; to be refined through integration into ClimEmpower platform with consortium.	Completed first version/Ongoing
I08	S2 Data Downscaling	Validated externally by presenting the works in a conference? Validated through CoPs	Preliminary
I09	Social Media Crawler	Demonstrated in CoPs and consortium meetings for feedback	Preliminary
I10	Polytope Data Access Software	To be validated through tutorials and feedback sessions with regional end-users during training activities	Planned
I11	ClimEmpower application architecture	Validated iteratively through CoP demonstrations and interface feedback sessions during consortium meetings.	Ongoing
I12	Data processing and indicator services	Validation foreseen through integration tests and stakeholder trials	Planned
I13	Web-GUI components and integration environment	Validation through end-user testing and prototyping in regional contexts	Planned
I14	Communities of Practice	Continuous validation mechanism by nature; ensures co-creation and stakeholder ownership of outcomes. After some of the CoPs, some information about expectations is planned to be collected (questions to be answered by people about satisfaction with CoP)	Continuous
I15	Trials	To be applied as validation framework for testing ClimEmpower solutions across regions	Planned
I16	Measures and strategies for increased Climate change resilience	Validated through integration in web platform and regional consultation rounds	Ongoing
I17	Regional CC-resilience recommendations	Validated through CoP consensus process, incorporating feedback from all regional stakeholders	Ongoing

5 Description of SSOs and development beyond state of the art

Six strategic subobjectives have been established through the different work packages of the project. These SOs are designed to be SMART: Specific, Measurable, Achievable, Relevant and Time Bound, and they are categorized in societal, scientific, technological, and outreach.

The following points describe each SSO and how will they contribute to innovation within the project framework.

5.1 Innovation maturity and stakeholder validation framework

To ensure that ClimEmpower's innovations evolve consistently across scientific, societal and technological dimensions, a structured monitoring system will be implemented. This framework combines maturity tracking and stakeholder validation through a periodic assessment using questionnaires and workshops.

Each result of the Strategic Sub-Objective (SSO) is evaluated against predefined maturity dimensions. These dimensions are visualised through a maturity radar chart that reflects three stages:

- (i) initial level at project start,
- (ii) current level, and
- (iii) expected level at project end.

This allows a transparent overview of progress and helps identify areas requiring further development.

The maturity dimensions defined are the following:

- **Technical robustness:** Measures the reliability and stability of the output and indicates whether the solution is well made technically ready for use.
- **Scientific novelty:** Assesses the originality of the approach, methodology, or concept, and how much it advances beyond the existing state of the art in the context of the regions.
- **Stakeholder validation:** Evaluates the degree to which end users and other stakeholders have tested, reviewed, and provided feedback on the output.
- **Integration with KPIs/exploitation:** Reflects how well the output aligns with the project's key performance indicators, exploitation plans, and expected impact pathways.
- **Scalability/replicability:** Indicates the potential for the output to be applied or adapted in other regions, contexts, or projects beyond the initial case studies.

In Figure 4, an example of the innovation maturity radar is presented, illustrating the evaluation of a Community of Practice. The final results will be delivered in Deliverable D6.7

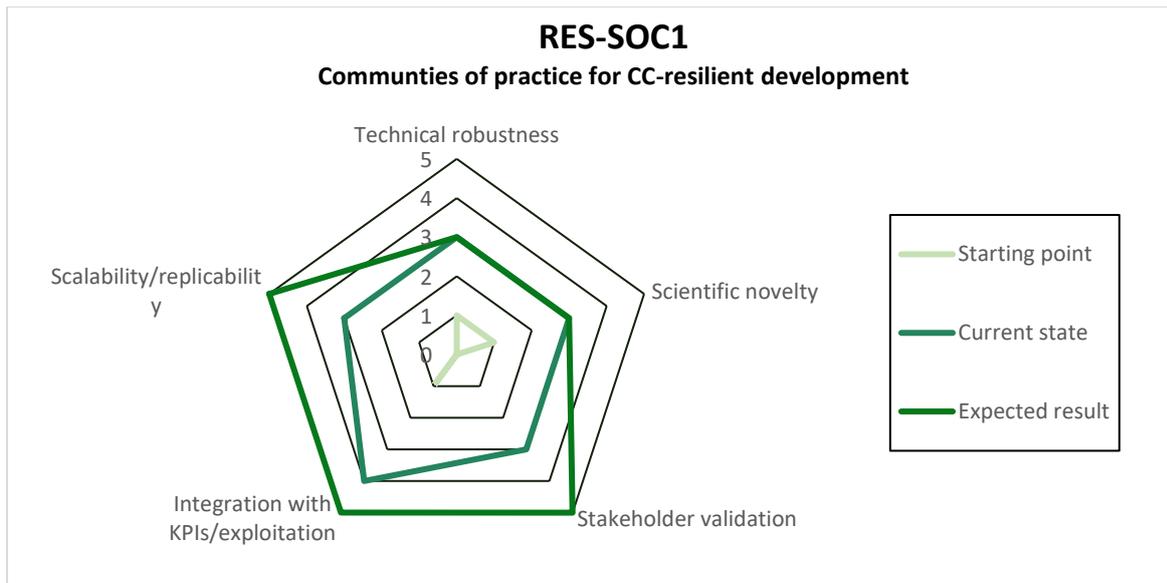


Figure 4 Example of maturity tracking system for RES-SOC1 - Communities of practice for CC-resilient development

Feedback from stakeholders, collected through the Communities of Practice (CoPs), regional trials, and targeted surveys, complements the maturity tracking process. This ensures that technological and methodological advances are aligned with user expectations and that societal innovations are effectively validated in real contexts.

The final evaluation of maturity evolution for each SSO and innovation output will be consolidated in the next innovation deliverable, D6.7 – Innovation Progress Assessment, providing a full overview of advancements beyond the state of the art and lessons learned across the project lifecycle.

5.2 SO1.Understand regional background, challenges, and expectations

5.2.1 SO1 description

A Community of Practices (CoP) is a group of people who share a common interest or concern for a specific activity, practice or topic who engage in a process of collective learning within a shared domain by supporting each other and exchanging information through collaborative activities (Wenger-Trainer, 2022). Regional Communities of Practice (CoPs) for climate resilient development will be established in the five ClimEmpower regions, and regional stakeholders will be activated, to develop a common understanding of the baseline regional needs, capabilities, gaps, and barriers for increasing the CC-resilience and to co-create the Case Study Scenarios.

5.2.2 State of the art and progress beyond

Five regions participating in ClimEmpower are among the least well positioned to address the socioeconomic challenges of Climate Change in Europe in terms of the problem awareness, coping capacity, data availability, planning tools and strategies. At the project start, the Regional Authorities (RAs) and the associated Case Study facilitators (CSFs) invited other regional stakeholders (city and regional planning authorities, services managers, utilities, citizens networks and other local communities) to establish a regional CoP. In a co-creation process, each CoP will then establish the baseline understanding of regional “needs, gaps, and barriers” with respect to data, services, understanding of current regional CC risks and future impact scenarios, the regions’ preparedness, and opportunities for increasing the regional CC-resilience. In a dialogue with technical, scientific and cross-

cutting partners (TSCC), this knowledge will be integrated in the project context and used to decide on most efficient ways to advance beyond State Of The Art (SOTA) and to design a coherent, ambitious and realistic set of Case Study Scenarios. For each region, scenarios indicate the project ambitions and expectations based on already existing and yet to be developed data, knowledge, resources, organisation, development strategies and support tools for increased CC-resilience.

5.2.3 Methods contributing to SO1

A key objective and central component of the project is the co-creation process with regional stakeholders. This involves significant efforts to understand the local context and expectations to align project outcomes with regional needs. Work Package 1 has primarily focused on analysing this regional background, collected in deliverable 1.1 (output #3) and summarized in output #2, and it will be transferred to the rest of the Work Packages.

The formation of a Community of Practice (CoP) to discuss CC-topics stands as an innovative element in most regions (output #3 in the table). It was drawn on insights and successful practices from prior projects, such as BINGO (H2020 program, Grant ID: 641739, 2015-2019) and ESPREssO (H2020 program, Grant ID: 700342, 2016-2018).

Additionally, ClimEmpower plans to reuse the "Trial Guidance Methodology" (Fonio & Widera, 2020) from the DRIVER+ project (FR7 programme, Grant ID: 607798, 2014-2020), which is successfully being applied in ICARIA (HORIZON-MISS-2021-CLIMA-02-03, Grant ID: 101093806), one of the sister projects of ClimEmpower. This methodology will bring to light new challenges, ways to tackle them and validation to ensure that the developed tools are relevant and applicable.

The CoP approach has been since the beginning planned and enhanced by the inclusion of the figure of the Case Study Facilitator (CSF), which plays a crucial role in maintaining oversight, informing WP leaders, and serving as a communication hub for CoP members. This system provides an innovative structure to support ongoing feedback and alignment with the project's evolving objectives.

The launch of the CoP was itself an innovative endeavour, with a detailed plan and a range of targeted materials created specifically to support effective initial engagement.

In addition, after gathering all the information from the CoPs, it was carried out a regional resilience assessment in each region (output #4). This assessment provided a comprehensive overview of the strengths and weaknesses specific to each region, serving as a foundation for developing tailored solutions.

5.2.4 Expected specific results within SO1

In the following table, the status of this first objective, which has already been achieved in the first year of the project, is outlined. With a clear understanding of each region's background and expectations, the focus will shift to Work Package 4 to organize successive CoPs and develop a more detailed plan aimed at achieving CC-resilient solutions.

Table 10: Status of expected specific results of SO1

Code	State	Objective	Description	Justification of novelty	Mechanisms of validation
RES-SOC1	 FINISHED	Communities of Practice for CC-resilient development.	The Communities of Practice (CoPs) were successfully launched across the five project regions, providing a collaborative space where stakeholders shared expertise, experiences, tools, and resources relevant to regional CC-resilience. A significant effort was also dedicated to ensuring that this information was effectively transferred to the rest of the project across work packages to allow cohesion and integration of local insights	This output represents the creation of structured CoPs that integrate diverse stakeholders. CoPs in ClimEmpower act as active co-creation and feedback platforms, ensuring that local knowledge continuously informs the design and testing of tools and indicators. These CoPs combine societal engagement with scientific input and technological support, advancing beyond the state of the art observed in other projects. The inclusion of graphic summaries, the delivery of CoP reports and the use of interactive engagement tools further enhances engagement.	Validation through iterative CoP workshops, questionnaires for participants and feedback loops integrated with WPs 2–4. A questionnaire for stakeholders is planned to be delivered after each CoP meeting to ensure that they align with their expectations.

The established Key Performance Indicators (KPIs) have been addressed through an approach that involves stakeholder engagement and a comprehensive regional analysis. The key performance indicators for this subobjectives and the actions taken to fulfil them are the following:

- KPI1.1 [D1.1, section on CoP statutes, m6]: This indicator required the definition of CoP statutes and problem statements, outlining the goals of the CoPs, identifying participating stakeholders, and establishing FAIR data governance and management mechanisms. It also entailed a baseline understanding of regional climate change adaptation (CCA) preparedness, needs, gaps, and barriers. To fulfil this KPI, CoP meetings were organized to gather input from stakeholders, resulting in a compilation of their needs and insights within deliverable D1.1.
- KPI1.2 [D1.2, m9]: This KPI focused on developing case study scenarios that reflect the project's ambitions, encompassing data, knowledge, organizational structures, preparedness plans, and support tools for CCA and mitigation. Deliverable D1.2. was developed to address this, incorporating ClimEmpower scenarios. It includes a detailed analysis of regional challenges and opportunities, along with a resilience assessment to establish the initial strengths and weaknesses of each region.

5.2.5 Summary and milestones of each result

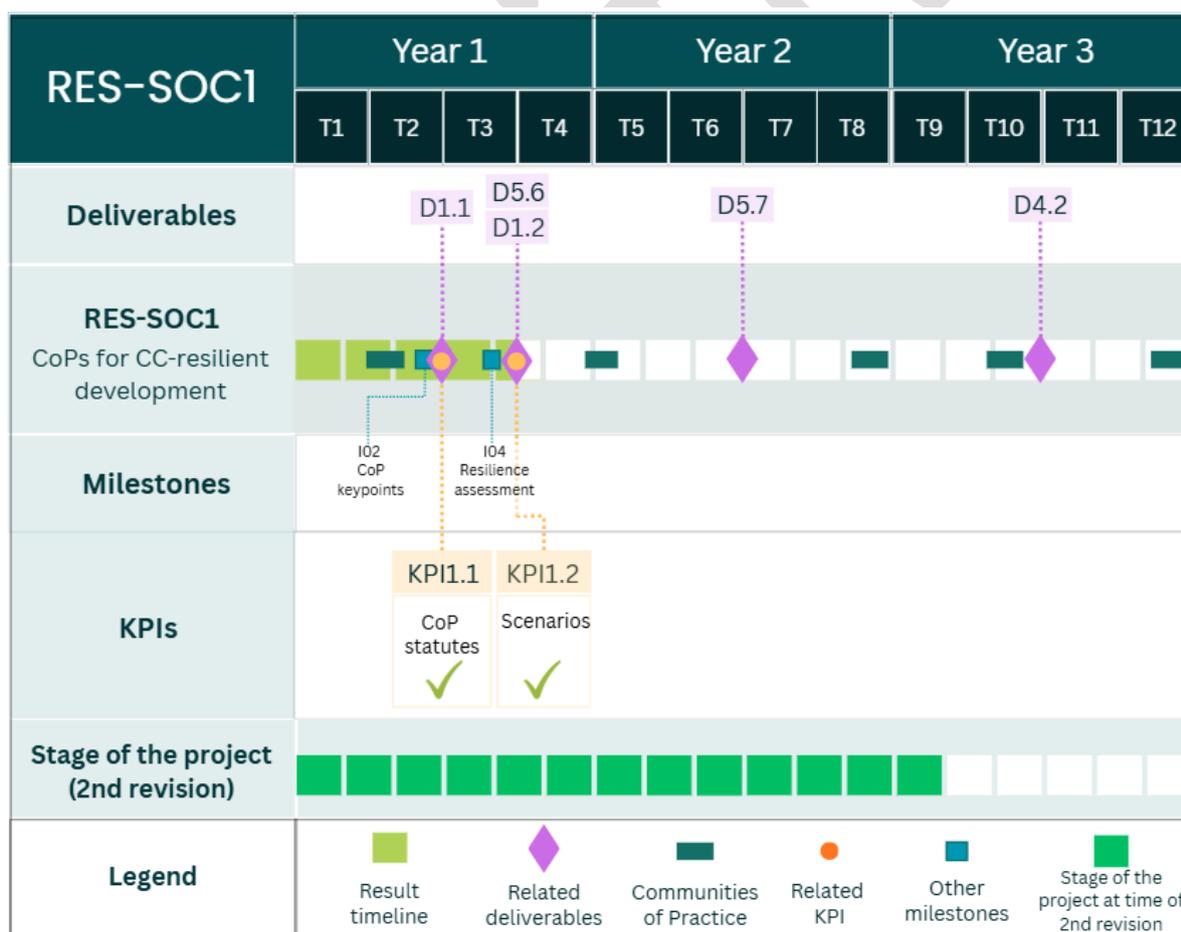


Figure 5 Tracking table for RES-SOC1 showing the implementation period, deliverables, KPIs and other milestones

5.3 SO2. Addressing the gaps in availability and usability of CC data and services

5.3.1 SO2 description

TSCC partners will perform a gap-analysis of existing European datasets (e.g. climate, land-use, socio-economic...), and services (e.g. Copernicus data store, Climate-ADAPT,...) with respect to their completeness, spatial and temporal resolution, availability and usability for non-expert local users. In combination with the experiences from the participating regions, gaps are identified with respect to availability, retrieving and interpretation of local information. Further, the provision of understandable training material is investigated and if missing provided to enhance capacity building.

5.3.2 State of the art and progress beyond

ClimEmpower regions are among the least affluent in EU and provide an excellent opportunity for understanding how a minimal viable hazard, vulnerability and exposure dataset can be produced at demand from existing EU-wide and locally available data, in a cost-effective way, to estimate climate risk. Climate hazards, land use and socio-economic data is available for the whole Europe, but often not in the necessary resolution and/or quality. There are principally two types of missing data: complete lack of data and lack of site-specific data (i.e. temporally, and/or geographically representative) including low resolution data (Huijbregts et al., 2001). These data gaps refer to data or values that are unavailable, but that are necessary to improve the accuracy and reliability of the output and remove the potential of a bias (Little et al., 2012; Mwambi & Ziegler, 2015). Different approaches are leveraged to address the gaps, ranging from crowdsourcing approaches (including social media activity) to create real data (Muller et al., 2015) to advanced ones focusing on AI/ML methods (Baño-Medina, 2021). Furthermore, techniques such as data augmentation can be applied to artificially increase the amount of data, which can improve the size and quality of training datasets so that they can be used to create a more generalizable and accurate model (Shorten & Khoshgoftaar, 2019; Wen et al, 2021). Apart from the temporal enrichment of climatological and satellite data, there is a need to enrich them spatially, since their resolution does not allow decision-making and interpretability at a very local level. Additional data sources, such as BlueSky or X (former Twitter) data, can provide data analytics to assist the explainability and interpretability of natural hazards, in a two-way direction between the citizens and local/regional authorities. For existing data, there are multiple European services designed to support non-experts with respect to sector specific data, as well as climate impacts or indicators. Yet, their usability for non-experts is still limited due to missing knowledge on how to best access and interoperate the available data. Therefore, ClimEmpower will gather the barriers identified within the regions and will set-up a training material, developed and tested with the participating regions, on how to use the available services, as well as more generic materials for increased CC literacy. Further, ClimEmpower will reach out to the service providers via the CDS partner and foster the exchange to improve their usability for all.

5.3.3 Methods contributing to SO2

The first step taken toward addressing gaps involved compiling an inventory of regional datasets and services as part of deliverable 2.2 (see output #7 in the table). This inventory covers the three key components of climate risk: hazard, exposure, and vulnerability. It provides a comprehensive overview of existing datasets, climate services, and any gaps relevant to climate resilience assessments, that in many cases were unknown among regions. These mapped datasets will be also validated in upcoming CoPs with stakeholders, creating an innovative and collaborative approach to identify data gaps.

Additionally, each region received a targeted sheet that was included in a presentation outlining specific data gaps to address, separated by type, such as crowdsourcing needs, downscaling needs or other data gaps, and specifying the objective of this data to shape and tailor solutions like models. This approach also allows to monitor data availability. In certain cases, these gaps can be filled directly

through engagement with stakeholders, fostering a collaborative approach, which contributes to enhancing regional data resources for climate resilience planning.

In addition to this, ClimEmpower is implementing a novel approach to enhance disaster management planning by integrating diverse data sources and methods for hazard identification, as part of deliverable 2.3 (output #7).

This includes downscaling the spatial resolution of Sentinel-2 satellite imagery in the regions, offering high-detail visual data that can be used for precise hazard assessments. Additionally, the project is gathering crowdsourced data for monitoring, calibration, and the development of integrated indicators (in detail in outputs #8 and #9). By combining these crowdsourced insights with satellite imagery, ClimEmpower provides a more comprehensive understanding of identified hazards.

To train stakeholders in the use of tools and enhance their knowledge, educational materials were carefully compiled. Initially, these materials were collected from “knowledge hubs”—platforms and websites that gather accessible resources. Subsequently, the hubs were reviewed, and relevant materials were summarized and restructured to ensure easier access (output #1). This approach enables the re-utilization of resources from diverse sources and previous projects while presenting them in an innovative format tailored to ClimEmpower’s objectives.

For this subobjective, the following Key Performance Indicators have been defined:

- *KPI2.1 (D2.1, m9): Data and service Gaps. Availability, usability, and gaps in data sets and services.* To achieve this, it has been compiled an inventory of datasets and services covering hazard, exposure and vulnerability. Gaps were identified and will be validated with stakeholders through CoPs meetings.
- *KPI2.2 (D2.3, m15): Methodology for overcoming the data gaps, by means of spatial data downscaling, social sensing and fusion of different data types.* With the aim of monitoring and indicator development, it will be taken into account the downscaled sentinel-2 imagery for hazard assessment, and it will be incorporated crowdsourcing data.
- *KPI2.3 (D4.1, m12; D4.2, m30). Educational materials for increased regional CC literacy and effective use of available data, applications and services successfully developed (50% for D4.1, 100% when D4.2 delivered).* Educational resources were compiled by consolidating and restructuring materials from “knowledge hubs” and other sources to support stakeholder training and improve climate knowledge.

5.3.4 Specific results achieved within SO2

The table outlines the status of the specific results included in this sub-objective. The gap service analysis and an initial version of the training materials have already been achieved. It is important to note that updated versions of these training materials will be delivered throughout the project. Additionally, the technical team from Work Package 2 is actively working on developing the methodology for addressing data gaps.

Table 11: Status of expected specific results of SO2

Code	State	Objective	Description	Justification of novelty	Mechanisms of validation
RES-SCI1	 FINISHED	Gap analysis of existing data and services	A comprehensive analysis was conducted across the regions, supported by valuable input from various CSFs and regional representatives. One key conclusion from the gap analysis is the general scarcity of vulnerability data, highlighting a critical area for further development.	The novelty lies in integrating diverse data sources and stakeholder insights to systematically identify data and service gaps related to climate resilience. Unlike previous projects, this analysis does not only review available datasets but also connects the technical limitations with societal needs.	Validation through iterative consultations with regional representatives and CSF, ensuring that identified gaps reflect real user needs. Results were cross-checked through CoPs discussions and internal review among WP teams.
RES-SCI2	 FINISHED	Methodology for overcoming the data gaps	Achieved through release of D2.3; This document contains methodology to overcome data gaps, based on statistics, IA/ML methods, etc.	This methodology goes beyond traditional interpolation or empirical estimation techniques by introducing machine learning models that adapt to regional. It represents a methodological advancement over the state of the art in vulnerability and hazard mapping.	Feedback from regional experts and the CoPs used to refine performance and ensure practical usability. Final validation will be performed through trials.
RES-SCI3	 FINISHED	Portfolio of training materials for enhanced CC resilience	First version of the deliverable compiles existing easy to use training and educational materials and aims to support the regional stakeholders in improving the knowledge on hazard, risk and potential adaptation and mitigation actions through self-study and group exercises. Training materials will be further developed until month 28.	The novelty stems from combining scientific outputs (data, models, indicators) with capacity-building tools tailored to local users. This portfolio is linked to project results (datasets, maps, CoPs outcomes), fostering science-to-practice transfer.	Feedback was collected from regional CoPs, regional partners and CSF. Improvements and additional materials will be co-created during subsequent CoPs and trials to ensure sustained applicability.

5.3.5 Summary and milestones of each result

RES-SCI1	Year 1				Year 2				Year 3			
	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
Deliverables												
RES-SCI1 Gap analysis of existing data and services												
Milestones	<p>Assessment of available data (T1-T2)</p> <p>I05 Questions for regions (T3)</p> <p>2nd CoP gaps & needs validation (T5)</p>											
KPIs	<p>KPI2.1: Data & services gap (T4) ✓</p> <p>KPI2.2: Methodology for overcome data gaps (T6) ✓</p>											
Stage of the project (2nd revision)												
Legend	<ul style="list-style-type: none"> Result timeline (Green bar) Related deliverables (Purple diamond) Communities of Practice (Blue square) Related KPI (Orange circle) Other milestones (Blue square) Stage of the project at time of 2nd revision (Green bar) 											

Figure 6 Tracking table for RES-SCI1 showing the implementation period, deliverables, KPIs and other milestones

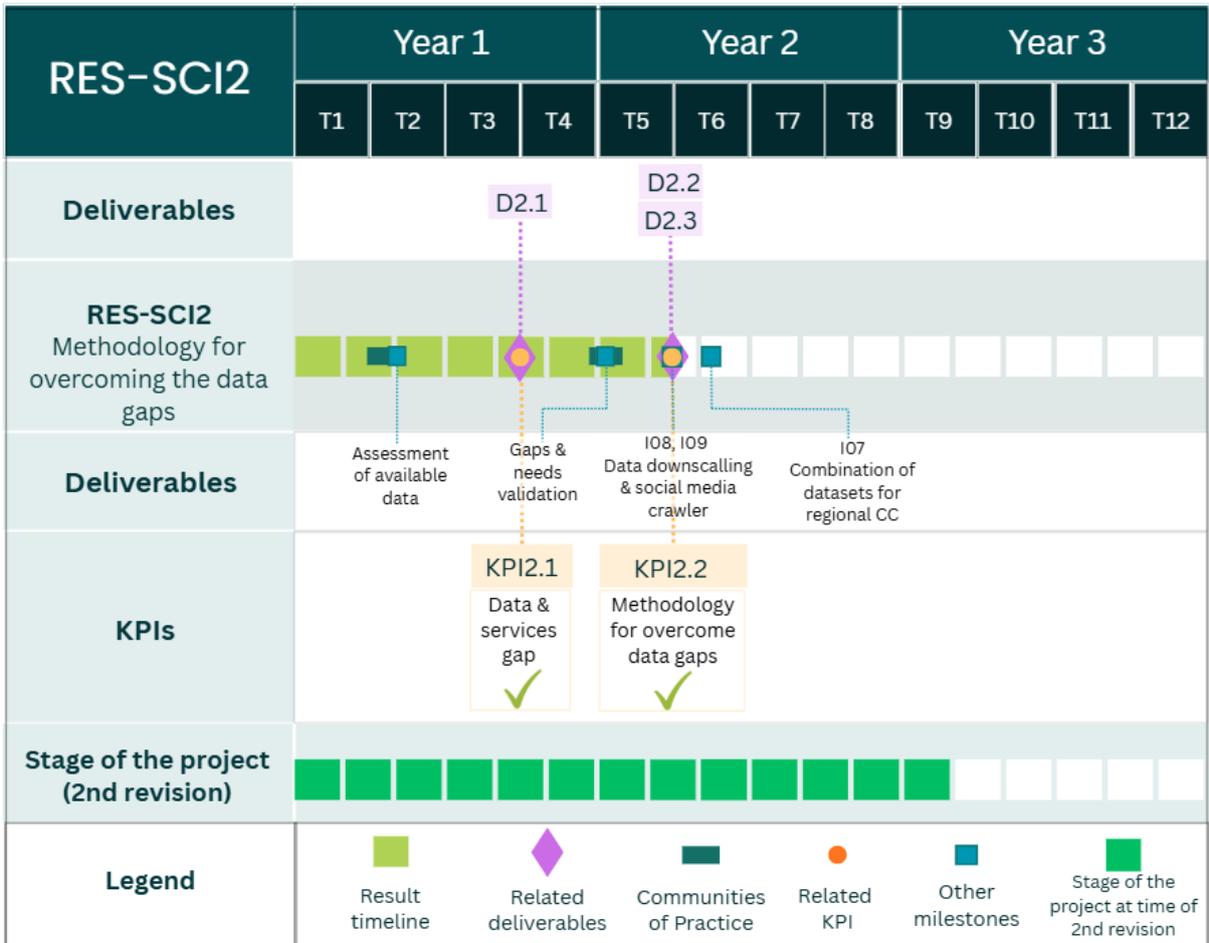


Figure 7 Tracking table for RES-SCI2 showing the implementation period, deliverables, KPIs and other milestones

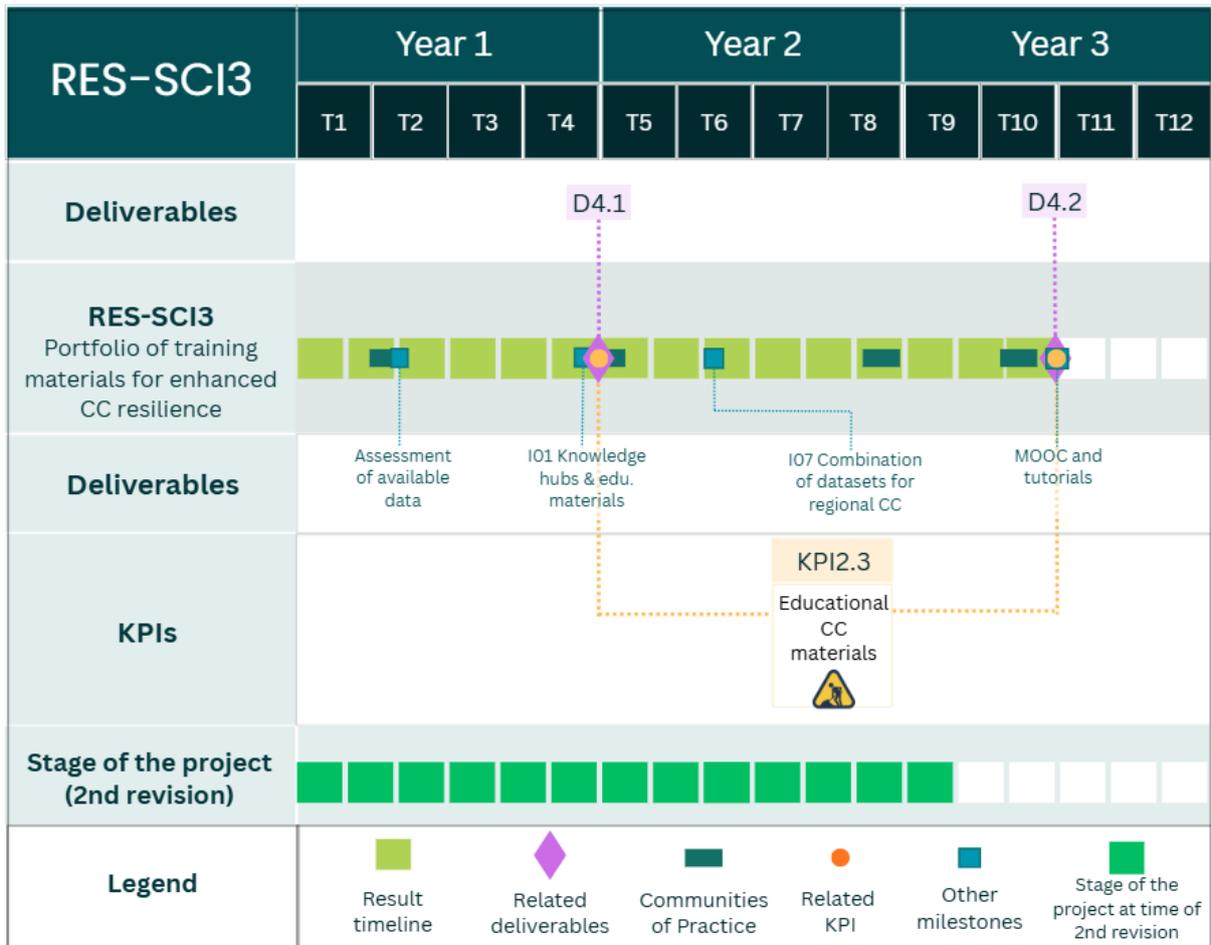


Figure 8 Tracking table for RES-SCI3 showing the implementation period, deliverables, KPIs and other milestones

5.4 SO3.-Identification, definition, estimating, and communication of climate impact/resilience indicators suitable for local end-users

5.4.1 SO3 description

TSCC partners will analyse the available climate change and impact indicators, their suitability to describe CC related risks and their usability for local authorities and other end-users. A common set of indicators linking climate hazards with socio-economic impacts is set-up, tested and validated for the participating regions. Further, indicators representing climate resilience, through combined datasets, and its dependence on adaptation, mitigation measures as well as (institutional) governance of regions are analysed and simulated to determine the resilience of the participating regions.

5.4.2 State of the art and progress beyond

Climate Indicators show the long-term evolution of several key variables which are used to assess the global and regional climate in an easy-to understand way. They describe the mean climate state, observed/simulated climate change (e.g. amount of summer days currently vs. 2050-2080), as well as extreme events (e.g. maximum amount of rain within 1 day). To cover these aspects, the joint

CCI/CLIVAR/JCOMM Expert Team (ET) on Climate Change Detection and Indices (ETCCDI) defined 27 core indices which are calculated from daily data (Easterling et al, 2003; Karl et al., 1999; Vincent et al, 2005). These indices describe climate states or climate related hazards, but only partly reflect risk, since risk depends on hazard, exposure and vulnerability (IPCC, 2021).

To include these factors also socio-economic indicators (e.g. Gross-Domestic-Product, or life expectation) and environmental (e.g. land use) or governance indicators (e.g. participation) need to be evaluated and the three aspects combined. Ultimately, a consistent definition of climate risk indicators and ways to estimate them is of great importance and will be developed in co-creation with local stakeholders to ensure their completeness and usability. The effects of measures and strategies (combining technological, nature-based, organisational and socioeconomic measures) related to the scenarios will be directly evaluated.

5.4.3 Methods contributing to SO3

The same work as with climate datasets and services is currently being performed to compile indicators from different sources (literature, regulations, previous European projects, among others) to create an ultimate “database” to facilitate tackle the regional challenges. This provides a comprehensive analysis of global wide and region-specific indicators.

The initial step involved conducting a literature review to evaluate the current state of indicators and determine the most effective design and application methods, tailored to each region’s unique context and challenges. Following this, relevant indicators are being carefully collected and selected to ensure alignment with regional needs. This task is part of output #7.

Finally, the subsequent work of the CoP will focus on assessing the usability of these indicators aiming to present them in a way that is accessible and practical for regional authorities. This process includes identifying gaps and working closely with stakeholders to address them, ensuring that the indicators are actionable and can directly support informed decision-making for regional resilience.

The Key Performance Indicators are outlined below:

- KPI3.1 (D2.2, m15): Summary of existing socio-economic, governance and climate (impact/risk/resilience) indicators covering the needs of all five regions (0-100%, max 20% per region if indicators fully cover the needs of D1.2 scenarios). It was conducted a literature review to evaluate current indicators and tailor their design to regional contexts and creating a database for regional challenges. Initial suitability assessment and validation with stakeholders are ongoing.
- KPI3.2: (D2.4, m21): Methodology for estimating the impacts of various measures and strategies on CC-resilience, including side-effects and co-benefits. (0-100%, max 20% per region). This methodology is planned for the project’s final stages.

5.4.4 Specific results achieved within SO3

Table 12: Status of expected specific results of SO3

Code	State	Objective	Description	Justification of novelty	Mechanisms of validation
RES-SCI4	 FINISHED	CC risk/resilience indicators	Set of climate risk and climate resilience indicators suitable for local authorities to assess current and future risk as well as impact of measures, that will be validated through regional trials.	This output introduces a multi-dimensional indicator framework that integrates physical, socio-economic, and governance dimensions of resilience, going beyond conventional hazard- or exposure-based indices. Many resilience frameworks were researched and indicators were adapted to regional contexts to ensure local relevance.	Validation through feedback loops between regional CoPs and WP2, through workshops and questionnaires. Coordination with WP3 will ensure that the indicators are technically feasible.
RES-SCI5	 WORK IN PROGRESS	Measures and strategies for increased Climate Change resilience	Methodology for estimating the impacts of various measures and strategies on CC-resilience, including side-effects and co-benefits and concrete recommendation of solutions and strategies.	The novelty lies in developing an integrated assessment framework that quantifies not only the effectiveness of adaptation and mitigation measures but also their co-benefits and potential trade-offs. It considers resilience performance indicators and stakeholder preferences.	Validation through the application of the methodology in the regional trials

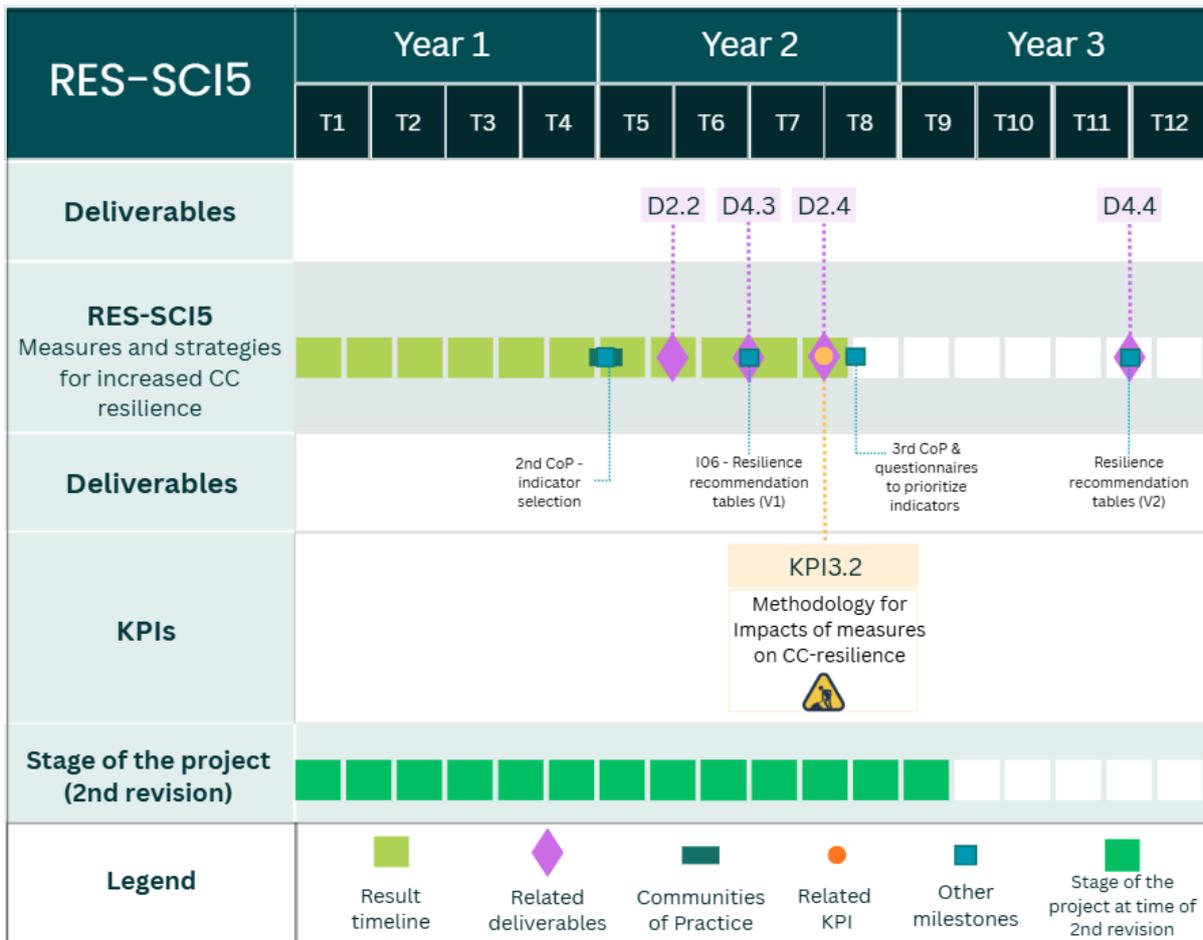


Figure 10 Tracking table for RES-SCI5 showing the implementation period, deliverables, KPIs and other milestones

5.5 SO4.- Simplify access to CC data and development of end user applications

5.5.1 SO4 description

TSCC partners will develop a “CC-resilience toolbox” - a set of data access, data transformation, visualisation and visual analytics elements that will simplify the task of accessing the relevant openly available climate data and development of user driven applications and tools for regional and local authorities, and other end users, focusing on climate impacts, data and knowledge. The user-centric decision support applications built utilising the toolbox will help users to prioritize climate adaptation measures tailored to the local conditions that concurrently bring benefits in terms of greenhouse gas emissions, societal justice and sustainability.

5.5.2 State of the art and progress beyond

The Copernicus C3S Climate Data Store (C3S CDS) is a prime source of openly available climate data in Europe. However, downloading large amounts of data from C3S in order to do localised climate studies, is challenging, especially for users with limited hardware and technical expertise. ClimEmpower will develop a new way of easily working with this data. Firstly, by developing a feature extraction library and service for Copernicus data to facilitate extracting only the small part of the C3S CDS data that is necessary for the application, on demand.

Secondly, by developing a set of microservices that transform the input data from C3S and other sources into results of direct interest for the end-users. These services will materialise WP2 results and recommendations (SO2 and SO3, WP2) for use in regional user-centric decision support applications (SO5, WP4). Finally, ClimEmpower toolkit will offer a set of single-page reusable HTML5 applications for data presentation, manipulation and visual analytics, as well as a low-code/no-code environment that allows the developers to rapidly prototype user-centric applications by ordering these elements in an application workflow and providing them with the application context. The proof of concept for this application development approach has already been successfully realised in the CLARITY H2020 project, albeit with very limited data visualisation, manipulation, and visual analytics.

5.5.3 Methods contributing to SO4

To start creating the ClimEmpower platform and its architecture for regional stakeholders, a structured table was designed to serve as an input, allowing developers and technological partners to analyse requirements effectively (output #7). This document, grounded in prior research, categorizes potential applications along two key dimensions: customization and integration. This approach is innovative, serving as a dynamic tool for capturing and aligning stakeholder expectations with technical capabilities and enhancing the platform's usability.

In this context, an initial GUI draft was created based on stakeholder expectations, and it will be validated in upcoming CoP sessions to ensure it aligns with user needs and usability standards (output #15).

Simultaneously, efforts have begun to outline the system architecture. Technological partners are set to develop an initial prototype by adapting Jupyter Notebooks provided by the CLIMAAX project to suit regional case studies (output #12). This approach is expected to culminate in a decision support tool as a key project outcome. Additionally, integrations from other projects, such as KNOWING, ICARIA, and MARIA, will be incorporated and its functionalities will be enhanced, adapting them to ClimEmpower.

5.5.4 Specific results achieved within SO4

Table 13: Status of expected specific results of SO4

Code	State	Objective	Description	Justification of novelty	Mechanisms of validation
RES-TEC1	 WORK IN PROGRESS	Climate data feature extraction library and service	This library will be made available both as a web service simplifying access to pan-European open data, and as a standalone library for use by the regions. It will allow feature extraction on common datacube libraries such as xarray. This functionality will be thoroughly tested by ClimEmpower data transformation microservices and leading to future integration with Copernicus Data Store.	The innovation lies in extending existing Copernicus Data Access APIs by introducing regionalized data retrieval and automated feature extraction capabilities. Unlike existing tools that only allow global queries, this system enables direct extraction of tailored regional datasets, reducing post-processing needs and supporting local-scale model applications.	Validation will occur through integration testing in WP3 (Tasks 3.1–3.2), where the library will be used to feed ClimEmpower’s microservices. Further validation will include user feedback from consortium partners using the service within pilot trials to assess ease of use and interoperability
RES-TEC2	 WORK IN PROGRESS	Climate processing and indicator (micro) services	Processing and indicator (micro) services will simplify re-use of existing algorithms and services based on recommendations from KNOWING, ICARIA and MAIA and literature research performed in WP2, and provide an easy way to adapt the algorithms to the context of the project.	Introduces a modular microservice architecture that operationalises climate data processing and indicator generation. The novelty lies in transforming algorithms prototyped in Jupyter notebooks into reusable and scalable services.	The services will also be tested within regional applications and validated by end-users during trials to confirm reliability and relevance for resilience planning.
RES-TEC3	 WORK IN PROGRESS	Web-GUI application components and GUI integration environment	The team is working on an adaptable GUI component library and integration platform that uses a flexible and modular design. A first mock-up of the User Interface will be presented in future CoPs to design it according to stakeholders’ requirements.	The GUI integration environment introduces a modular and reusable set of interface components for rapid prototyping of regional climate adaptation applications. The novelty is in its interoperable design.	Validation will follow a participatory co-design process through Communities of Practice and regional trials. Technical partners will review early mock-ups and prototypes to ensure usability.
RES-TEC4	 WORK IN PROGRESS	Applications for enhanced CC-resilience	Applications will be delivered and tested in the final project year, utilise the RES-TEC1, RES-TEC2 and RES-TEC3 and address the needs of the regional stakeholders.	Combines all previous technological outputs into complete, ready-to-use applications, offering an end-to-end solution: users can directly access climate data, process indicators, and visualize the results through interactive tools, all within a single environment. This simplifies the use of complex climate information and supports evidence-based decision-making.	Validation will occur through regional demonstration trials (WP4–WP5), where the applications will be tested by end-users under real operational conditions.

The Key Performance Indicators for the Strategic Objective 3 are listed below:

- *KPI.4.1 (m12) (D3.1). Implementation architecture for rapid prototyping of climate adaptation planning applications.* A requirements table has been developed to guide the platform architecture, categorizing applications by customization and integration needs.
- *KPI.4.2 (m24) (D3.2). ClimEmpower services for climate feature extraction, data processing and indicator building on top of the C3S Climate Data Store and CopDS 2.0.* The team is making progress on the development of a standalone library for climate data feature extraction. Algorithms and services for data processing will adapt findings from projects KNOWING, ICARIA and MAIA.
- *KPI.4.3 (m33) (D3.3). ClimEmpower HTML5 framework facilitating rapid development of climate risk assessment and adaptation planning applications, and applications based on this framework.* It will be designed a modular system architecture, and a first GUI mock-up has been drafted. Stakeholder-driven applications will be developed by the project’s end to enhance CC-resilience.

5.5.5 Summary and milestones of each result

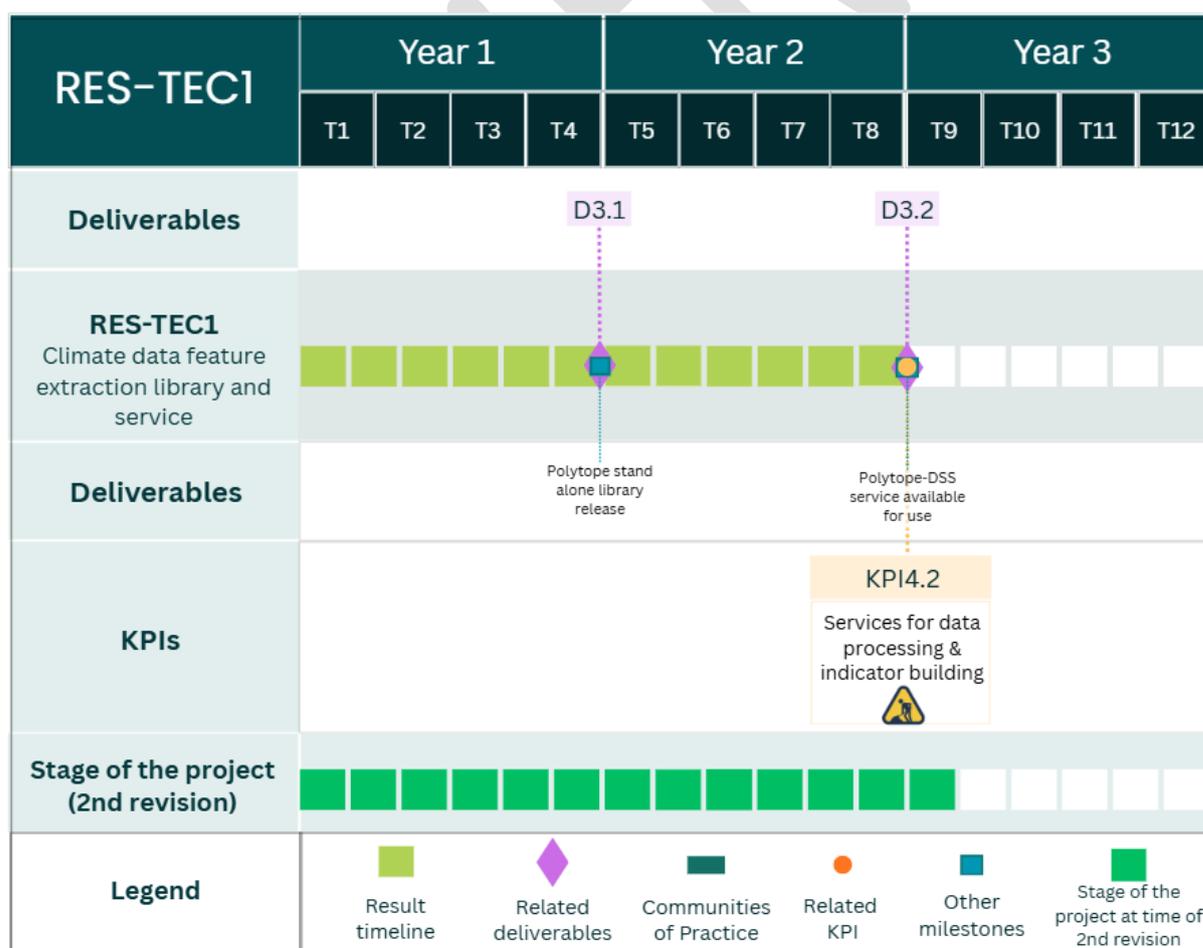


Figure 11 Tracking table for RES-TEC1 showing the implementation period, deliverables, KPIs and other milestones

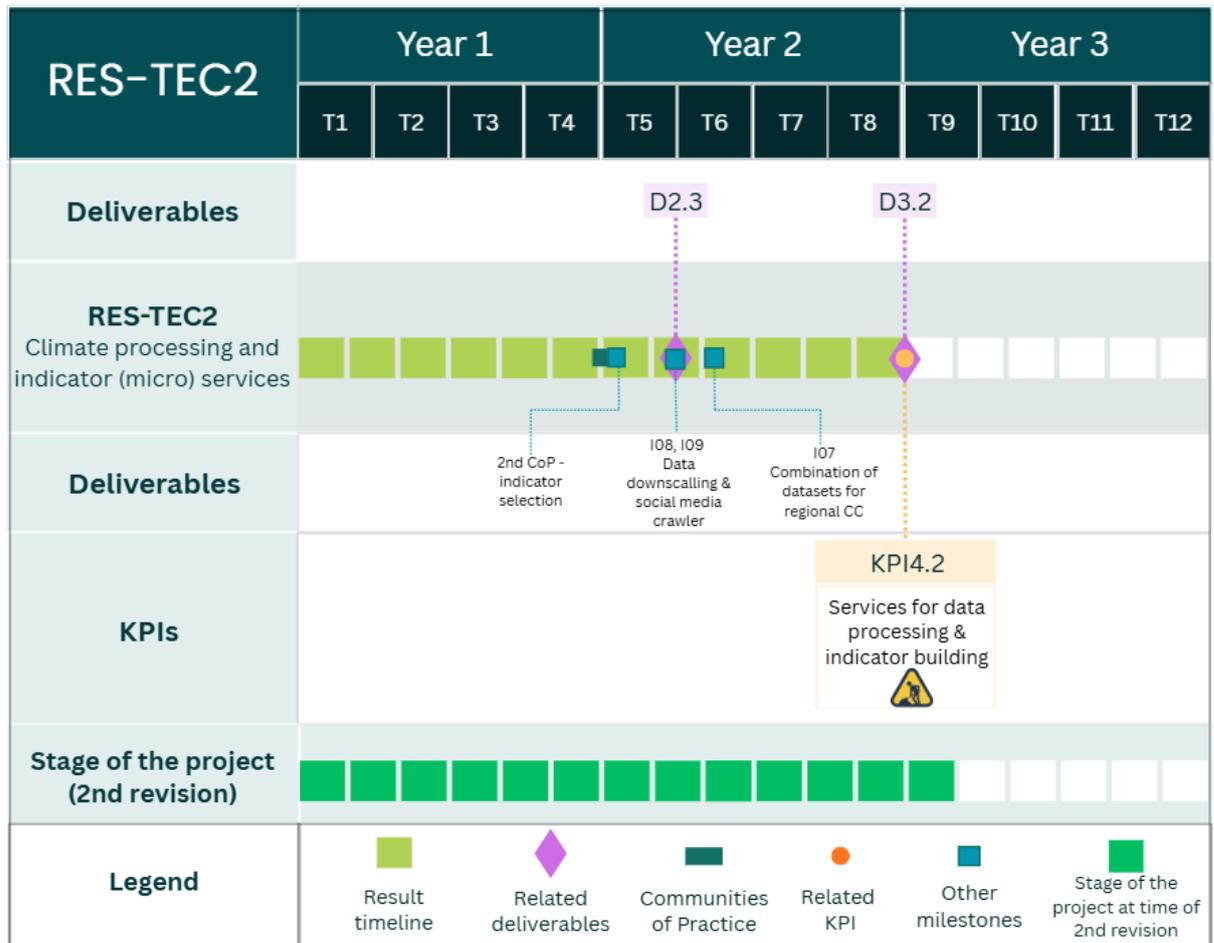


Figure 12 Tracking table for RES-TEC2 showing the implementation period, deliverables, KPIs and other milestones

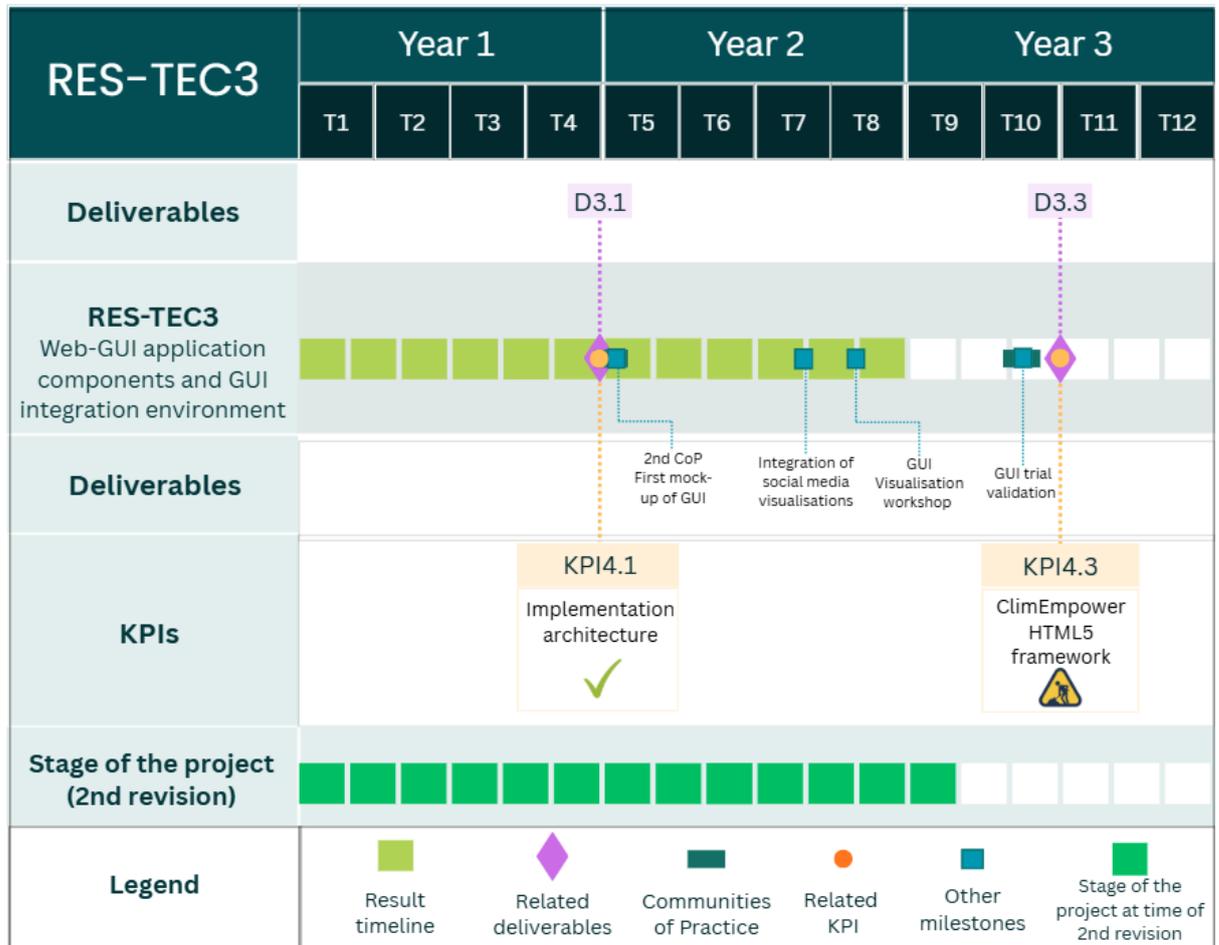


Figure 13 Tracking table for RES-TEC3 showing the implementation period, deliverables, KPIs and other milestones

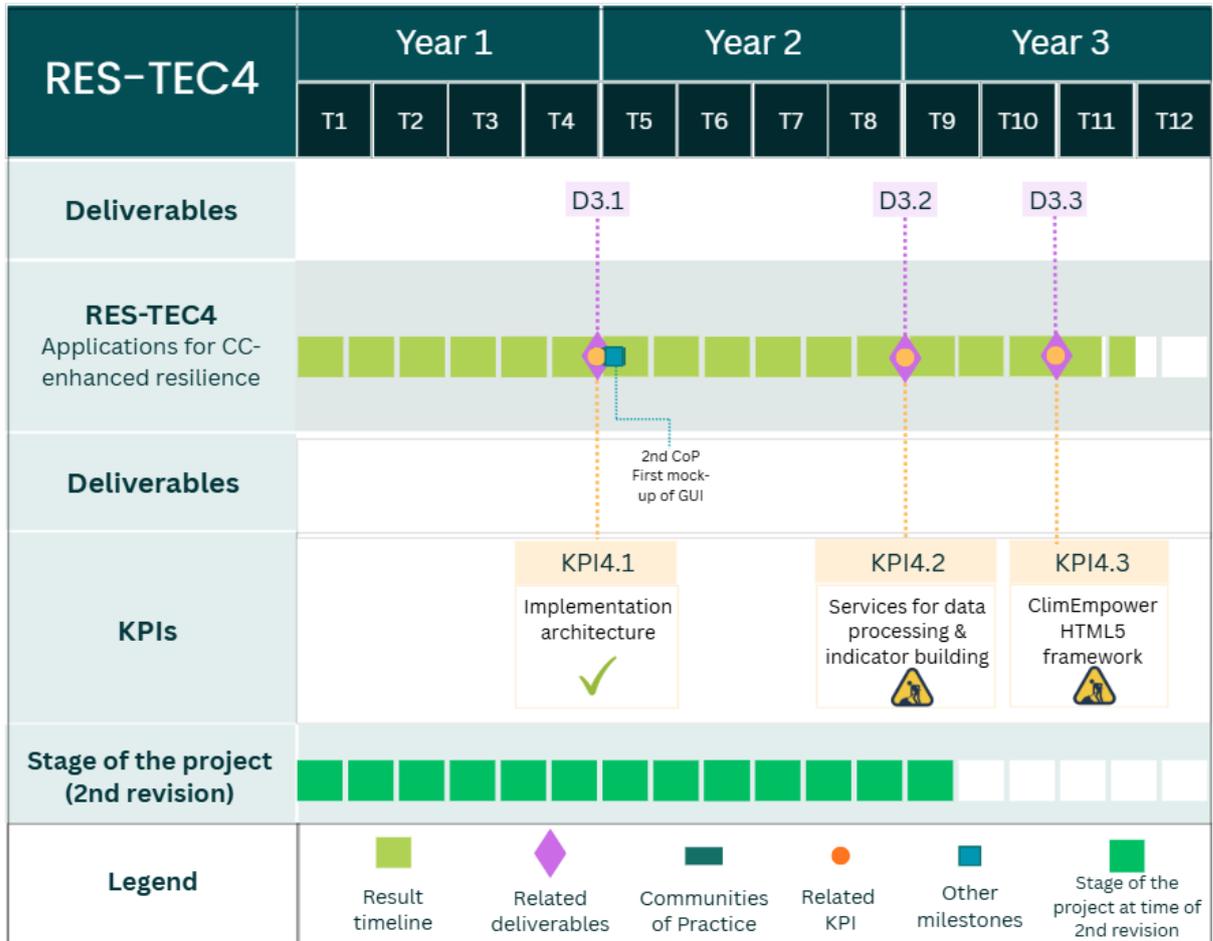


Figure 14 Tracking table for RES-TEC4 showing the implementation period, deliverables, KPIs and other milestones

5.6 SO5.- Empower the regions to activate and enhance their potential for addressing the climate change challenge.

5.6.1 SO5 description

Stakeholders from ClimEmpower trial regions will be empowered to address the CC challenges by improving their collective understanding of climate change risks and possibilities for increasing resilience at regional level through science-informed, evidence-based and data-driven planning and governance informed, evidence-based and data-driven planning and governance.

5.6.2 State of the art and progress beyond

Findings from H2020 ESPREssO project highlight how efforts are being made by EU Member States to improve the coherence and transparency of risk assessments undertaken at the national level, also with the view of making them more comparable between countries. However, the lack of a common methodology and the presence of different standards for data collection and disaster risk/impact analyses and assessments (i.e. hazard, exposure, vulnerability, impact on communities and built/natural environment) represent a weakness in the whole process. A systemic approach tackling economic,

social and environmental dimensions within an integrated perspective is required to streamline challenge-driven, solutions-oriented, trans-disciplinary research and innovation pathways, and innovative methods for the co-creation of knowledge and co-delivery of outcomes with economic, industrial and research actors, public authorities and communities. Based on successful experiences of creating multi-stakeholder collaboration environments (H2020 BINGO, ESPREsSO, BRIGAD), ClimEmpower will not only provide the regional actors with data, tools, and training/capacity building, but also establishing the operational environment (the CoPs) for better coordinating different stakeholders, finding synergies, facilitating mutual learning, identifying the most suitable CC-resilient development strategies, as well as to identifying and mobilising financing opportunities. Therefore, the CoPs will organize and implement thematic workshops and related activities using collaborative tools (e.g. design thinking workshops, collaborative mapping, knowledge-sharing, co-design sessions, serious games, and interviews/questionnaires) at local/regional level.

5.6.3 Methods contributing to SO5

While Communities of Practice (CoPs) themselves are an established concept, their implementation within this project brings a more structured, sustained platform for collaborative learning and decision-making on climate resilience. The CoPs are designed to persist beyond the project timeline, potentially evolving into the long-term for local actors to share knowledge, exchange resources, and collaboratively address climate-related challenges.

These challenges across the regions are heterogeneous. Through these CoPs, stakeholders are not only introduced to collaborative dialogue but also engaged in identifying and discussing region-specific hazards and vulnerable sectors. This participatory framework is innovative for many local participants, helping build resilience awareness and ownership of the outcomes.

A roadmap for the CoPs to be held throughout the project has been carefully designed to validate outputs and gather feedback for future developments. The planning of the CoPs is strategically aligned with the project's milestones.

Another strength of the project is the discussion of the existing tools, strategies and plans, bringing local resources and "hidden" tools to the forefront. For gaps that cannot be addressed with existing tools, other types of pioneering materials will be developed, but always in line with stakeholders' expectations.

Work Package 4 has also begun developing an innovative composite table on resilience recommendations (output #6). This table provides a comprehensive overview of the interplay between interventions and various socio-economic, environmental, and hazard-related factors, offering a structured approach to understanding and addressing resilience challenges.

Key Performance Indicators:

- KPI5.1 (D4.2, m30). Consensus decision on regional recommendations for CC-resilient development reached in all five regional CoPs (20% per case study region where recommendations are available). Stakeholders have identified in a collaborative way the region-specific hazards, vulnerable sectors and opportunities. An innovative composite table to structure resilience recommendations is being developed.
- KPI5.2 (D4.5, m24). Successful co-definition of trials achieved in all five regions. It will be designed a structured roadmap for CoPs ensuring the co-definition of trials to validate project outputs and gather feedback to refine tools.
- KPI5.3 (D4.6, m36). Successful validation of the project results through regional trials. This final stage will evaluate the outputs, and it will serve to measure stakeholder satisfaction.

5.6.4 Specific results achieved within SO5

Table 14: Status of expected specific results of SO5

Code	State	Objective	Description	Justification of novelty	Mechanisms of validation
RES-SOC2	 WORK IN PROGRESS	Regional CC-resilience recommendations	Recommendations for CC-resilient, sustainable, and societally just regional development, representing the societal consensus obtained through discussions in five regional CoPs. Input for regional decision makers, to be incorporated in regional development plans. Presented as a combination of recommendations common to all regions and region-specific recommendations to ease re-use in other European regions and beyond Europe.	These recommendations are co-created with regional stakeholders, combining scientific and societal inputs. The innovation lies in the structured integration of multi-regional consensus into recommendations, going beyond typical top-down policy guidance.	Validated through regional CoPs: workshops, questionnaires, and interactive discussions. Feedback loops with local stakeholders ensure that recommendations are relevant, actionable, and aligned with local priorities.
RES-SOC3	 NOT STARTED	Community validation	Results of trials in five ClimEmpower regions, indicating both technical/scientific soundness of the results and the level to which they meet expectations of the RAs and CoP members.	Introduces a structured validation framework combining scientific, technical, and societal evaluation.	Conducted through regional trials where stakeholders test tools, provide feedback, and assess applicability. Includes structured surveys, workshops, and feedback sessions to evaluate technical accuracy and societal relevance

5.6.5 Summary and milestones of each result

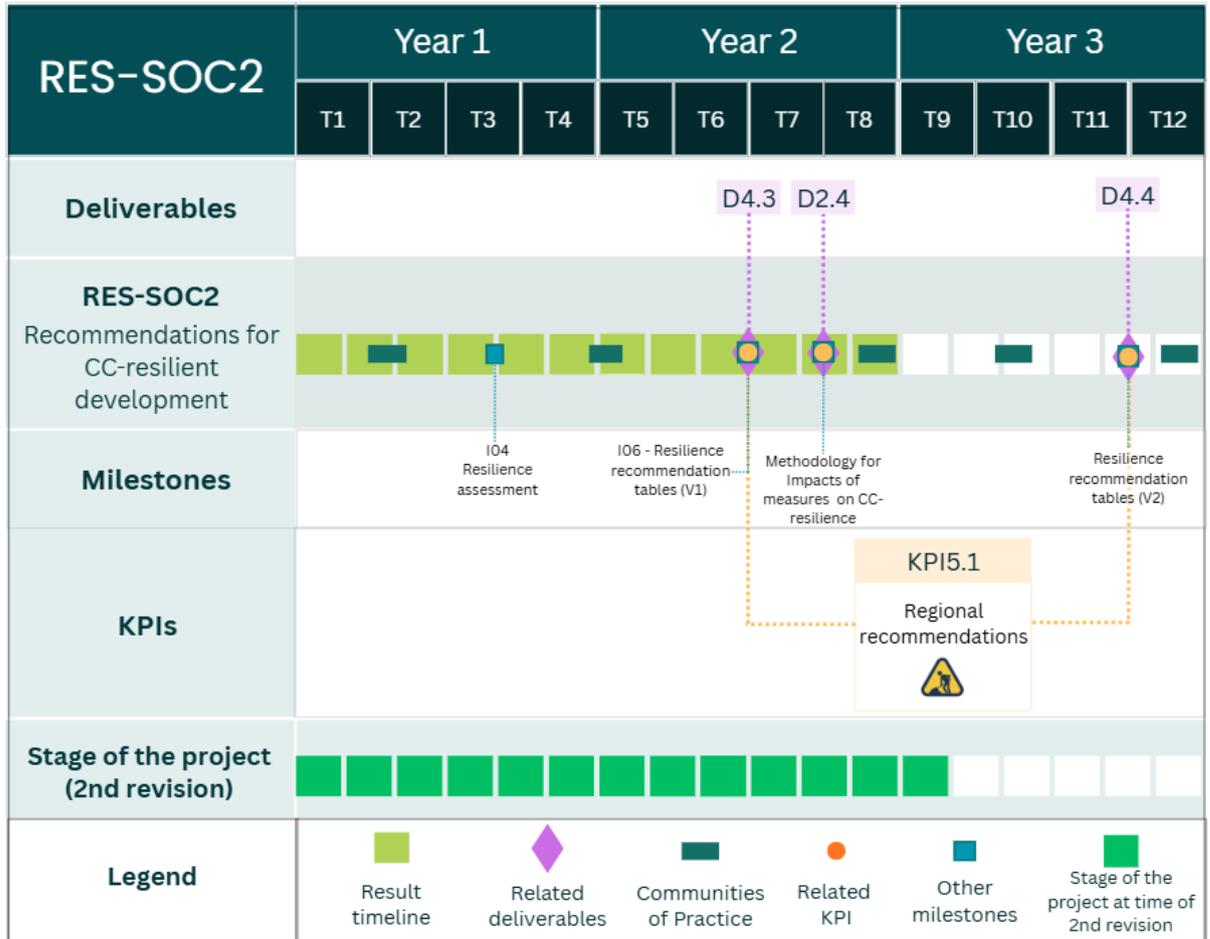


Figure 15 Tracking table for RES-SOC2 showing the implementation period, deliverables, KPIs and other milestones

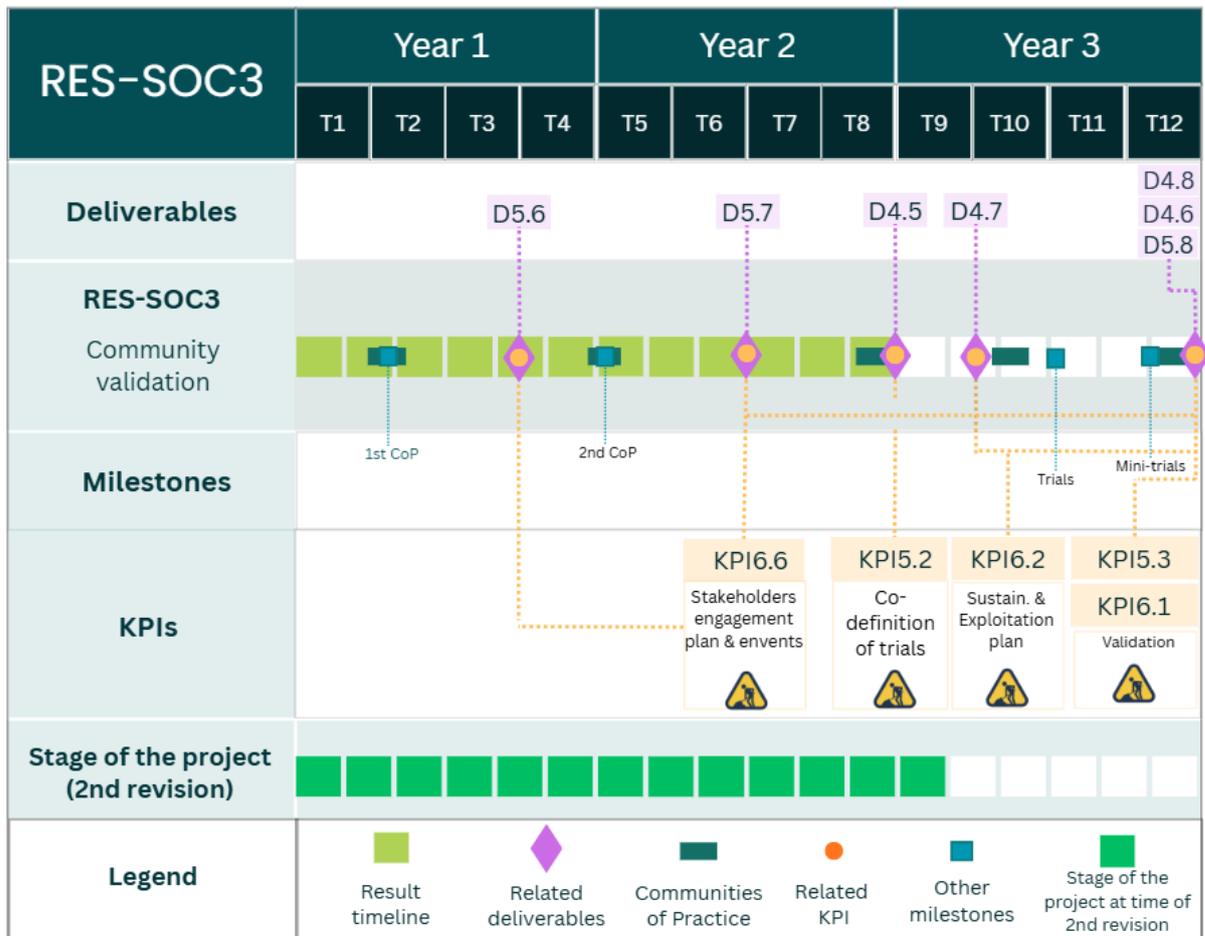


Figure 16 Tracking table for RES-SOC3 showing the implementation period, deliverables, KPIs and other milestones

5.7 SO6.-Ensure the use and impact of the ClimEmpower outputs

5.7.1 SO6 description

Ensure the implementation, replicability and exploitation of ClimEmpower methods and outputs through a participatory process involving and engaging local stakeholders within and outside the project framework.

5.7.2 State of the art and progress beyond

ClimEmpower includes a dedicated task (T4.1) producing informational and educational materials and tools aimed at raising awareness of project partners from specific regions (to be used by regional CoPs T4.2) but also other similar regions, industry and general public (to be used in EU workshops in T5.4). A range of documents, leaflets, infographics, cartoons and video content will be prepared to raise awareness about climate change and its possible impact, about available models and tools as well as data sources and published on ClimEmpower web site (T5.1) and through other channels (T5.2). These materials will also address the valuable information on possibilities for financing the necessary activities. Throughout the project timeline, these materials will be presented to all consortium partners but also to neighbouring follower regions and other interested parties. They will be intensively used in ClimEmpower regional (T4.2, T4.4) and EU workshops (T5.4). Within at least two of the regions the information will be printed and handed out to the general population. On top of this, two CC-resilience

education field trips will be organised for students and general population in Croatia. Scientific dissemination in journals and on relevant conferences (T5.3) and liaison activities (T5.5) will be used to maximize the projects impact among the R&I community and maximise impact on, and reuse of ClimEmpower SCI- and TEC- results in ongoing and future research, innovation and product development. Finally, the project results will be validated by RAs and other stakeholders (T4.4) and the interest of project partners and third parties in further use and improving the project results assessed and summarised in sustainability and exploitation plan.

5.7.3 Methods contributing to SO6

Work Package 5 is especially dedicated to dissemination, outreach, communication and stakeholder engagement. It has developed strategies to maximize project visibility and impact which incorporates regular updates across various media channels. Social media platforms such as Facebook, LinkedIn, Quora, and Zenodo are leveraged to share project insights, promote engagement, and facilitate data management, offering stakeholders and the general public an array of sources to interact with the project.

The project website (<https://climempower.eu/>) serves as the central hub of information, featuring project activities, results, best practices, and other relevant content. What sets this platform apart is its unique, interactive front-end design, which presents materials developed for the case studies in a user-friendly manner. This innovative interface enhances the accessibility of project outcomes and provides an efficient way for stakeholders to explore ClimEmpower's resources.

In parallel, ClimEmpower has produced a variety of creative materials from scratch, such as posters, presentations, leaflets, and infographics. These resources are tailored to identify and promote the project during Community of Practice (CoP) meetings, conferences, and other events.

Participation in conferences and events is a cornerstone of the project's dissemination activities. The team is actively preparing to showcase results and innovative solutions developed during the project. Furthermore, efforts are underway to publish several scientific papers and contributing to the advancement of climate resilience knowledge and tools.

Through its dissemination activities, ClimEmpower fosters dialogue and cooperation among stakeholders, creating opportunities for the exchange of ideas in a collaborative approach. Meanwhile, its innovative communication efforts not only enhance the project's reach but also drive meaningful engagement and inspire positive change across diverse regions.

Key Performance Indicators:

- *KPI6.1 [D4.6, m36]. Community Validation of ClimEmpower SCI and TEC results.* Regional trials are planned to gather feedback from stakeholders on technical and scientific outputs through CoPs. Feedback loops will validate project results to ensure they meet stakeholders' expectations.
- *KPI6.2 [D4.7, m27, D4.8, m36]. Sustainability and exploitation plan. [50% for D4.7, 100% for D5.6b].* Actions still have not taken place, but a final sustainability and exploitation plan will ensure that outputs create impact beyond the project's lifetime.
- *KPI6.3 [D5.1, m6]. Project web site.* The project website (<https://climempower.eu/>) was successfully launched.
- *KPI6.4 [D5.2-D5.4, m6, m18, m36] Dissemination and communication plan [33% for each version].* The first version of the Dissemination and Communication Plan was delivered on month 6.

- *KPI6.5 [D5.5, m33] A set of dissemination materials that were developed by the project. A set of materials such as posters, leaflets, infographics and presentations have been produced to support CoP meetings, conferences and workshops.*
- *KPI6.6 [D5.6-D5.8, m9, m21, m36] Stakeholders engagement plan and event reports. The Stakeholder Engagement Plan was submitted in month 9 and guides interactions with participants. Additionally, reports from CoP sessions, workshops and conferences have been developed.*

Sensitive

6 Risk and barriers assessment

A preliminary risk management plan was already presented in Deliverable D6.3 and Deliverable D6.4, focusing on project-wide technical, organizational, and operational risks. In this section, we focus specifically on risks and barriers associated with the project's innovation outputs. The Table 15 highlights both previously identified risks that relate to innovation and new ones detected

Table 15. List of identified risk relevant to innovation

Risk	Associated outputs	Probability	Impact	Tracking	Mitigation strategy
Insufficient engagement of stakeholders and local actors in the co-creation.	RES-SOC1, RES-SOC2	Medium	High	11/2023: Ras are showing great interest in the project and the work is progressing. 05/2024: Regional CoPs have been formed and stakeholders are showing interest in the work of the project. 02/2025: Stakeholders are well integrated.	Track stakeholder's engagement and attendance to CoP meetings and develop other ways of involving them (questionnaires, on-line/in-person meetings, more adapted workshop to their interests..)
Regional data that is necessary for the project work cannot be (efficiently) obtained or produced by consortium members	RES-TEC1, RES-TEC2, RES-TEC3, RES-SCI2	Medium	Medium	No problems detected until revision 05/2024, when Croatia decided to purchase missing data. Cyprus and Sicily have not yet finalized their planning. 02/2025: Main risk largely mitigated. No additional data purchases foreseen, but manageable if needed.	Consortium has regional scientific/technical partners with experience in collection of regional data for CC-adaptation. In Croatia and Cyprus we nevertheless plan to purchase some data / get knowledge transfer from regional experts. If necessary, this could be done in other regions too
Unclear hosting arrangement for ClimEmpower services	RES-TEC1, RES-TED2, RES-TEC4	Low	Medium	In several WP3 meetings, it has been discussed who could host the services.	WP3 partners will identify who will host the services.
Training materials materials not relevant or engaging for stakeholders	RES-SCI3, RES-SOC1	Medium	High	Collect feedback and validate with stakeholders on materials.	Interactive validation with regions and feedback loops
Not finding datasets or projections resolution that fulfill stakeholders' expectation	RES-SCI, RES-SCI41	Medium	Medium	New detected risk.	Questionnaires have been sent to stakeholders to prioritize indicators and datasets and define the resolution required.
Visualization tools may not meet the expectations or technical capacities of regional users (e.g., performance, accessibility).	RES-TEC3	Low	Medium	New detected risk.	Conduct iterative user testing with regional CoPs and Ras.

7 Exploitation strategy to ensure maximum replicability of ClimEmpower results

7.1 Implementation and replicability strategy

In ClimEmpower, the replicability of results will be assessed through the application of the Trial Guidance Methodology on five trial locations. This methodology provides a structured approach to test and refine the methods and tools developed during the project, ensuring their adaptability and scalability to other regions. With the use of this framework, ClimEmpower aims to transfer innovative solutions and methodologies beyond the original trial areas, achieving a broader impact.

The first step in this process is to identify and define a specific challenge to address in each region. This research objective will be established through deliberation in the Communities of Practice (CoPs) meetings, ensuring alignment with local priorities and hazards. Once the regional challenges are identified, the tools, materials, and methods developed within the project will be designed to address these specific needs.

Key results, such as the service and indicator findings (RES-SCI4), training materials (RES-SCI3), tools (RES-TEC4), and the Graphical User Interface and the context of the ClimEmpower platform (RES-TEC3), will be evaluated for feasibility and usefulness. Feedback loops involving local stakeholders will refine these functionalities and ensure that the solutions are effective and useful.

This iterative process will enable comprehensive testing of the project's outcomes, ensuring their relevance and practicality.

Table 16. Implementation in the trials and related KPIs

Result Code	Implementation in the trials	KPI related	KPI progress
RES-SOC1	Not directly implemented in the trials, as the work focused on establishing the Communities of Practice (CoPs) and defining the baseline scenarios. The result has been validated through stakeholder participation and D1.1 – D1.2 (CoP statutes and regional needs).	KPI1.1 (CoP statutes and problem statements); KPI1.2 (Case Study Scenarios)	Achieved. CoPs established in all five regions; baseline scenarios completed and validated (100%).
RES-SOC2	Recommendations were developed based on CoP discussions and consortium meetings but not implemented in the trials. They serve as strategic input for regional authorities and will guide replication beyond the project.	KPI5.1 (Regional recommendations).	In progress. Draft recommendations validated in 5 regions. Working on second version and further integration within the project.

Result Code	Implementation in the trials	KPI related	KPI progress
RES-SOC3	Implementation pending. Community validation of trial results will occur in the five regional trials during the second half of the project.	KPI5.2 (Co-definition of trials), KPI5.3 (Validation through regional trials) KPI6.1 (Community validation), KPI 6.2 (Sustainability and exploitation plan); KPI6.6 (Stakeholders engagement plan & events report)	In progress. Stakeholder engagement plan defined; Currently working on trials preparation and on sustainability and exploitation plan.
RES-SCI1	Scientific foundations for CC-resilience indicators will be used as input to design trial methodologies but not directly implemented. Validated via analytical work, workshops in CoPs discussions and deliverables.	KPI2.1 (Data and service gaps); KPI2.2 (Methodology for overcome data gaps)	Mostly achieved. Methodology defined and used across WPs; validation ongoing.
RES-SCI2	Methodology for addressing data gaps has been validated by the technical team. Likely to be tested in trials.	KPI2.1 (Data and service gaps); KPI2.2 (Methodology for overcoming data gaps)	Mostly achieved. Methodology defined (D2.3) and used across WPs, validation ongoing.
RES-SCI3	Partially used in preparing data inputs for trials; full implementation foreseen during the operational phase.	KPI2.3 (Educational CC materials)	Partially achieved. First version of educational materials delivered. It will be refined in the next months.
RES-SCI4	Not yet implemented in trials; serves as analytical input for risk assessment tools.	KPI3.1 (Summary of indicators)	Mostly achieved. Indicators defined and prioritized. Feedback collected from stakeholders. Implementation and vinal validation in trials outstanding
RES-SCI5	Will be implemented and validated within the regional trials, where different adaptation and mitigation strategies will be tested using resilience performance indicators and stakeholder feedback.	KPI3.2 (Methodology for impacts of measures on CC-resilience)	In progress. The methodology is being prepared for application in the regional trials.
RES-TEC1	Not implemented in the trials yet; validation is carried out internally through library testing and feedback from meetings.	KPI4.2 (Services and climate feature extraction, data processing and indicator building)	In progress. Library development ongoing, first integration tests included in D3.2.
RES-TEC2	Will be tested within regional applications during the trials. End-users will validate the reliability, usability, and relevance of the services for resilience planning, providing feedback for refinement.	KPI4.2 (Services and climate feature extraction, data processing and indicator building)	In progress. Early prototypes are available; validation will occur during the RP2 trails with regional stakeholders.
RES-TEC3	GUI components and mock-ups presented in CoPs for feedback; full testing will take place during trials with stakeholders interacting with the prototypes.	KPI4.1 (Implementation architecture); KPI4.3 (ClimEmpower HTML5 framework)	Partially achieved. First demos validated; refinements ongoing.

Result Code	Implementation in the trials	KPI related	KPI progress
RES-TEC4	Integration and testing of operational services in the five trials.	KPI4.1 (Implementation architecture), KPI4.2 (Services and climate feature extraction), KPI4.3 (ClimEmpower HTML5 framework)	Implementation architecture completed (KPI4.1), microservices under development (KPI4.2), GUI mock-ups available (KPI4.3).

7.2 Exploitation strategy

The exploitation strategy of ClimEmpower aims to maximize the project's impact and ensure the broad transferability of its results. This involves effectively utilizing, scaling, and transferring the project's outcomes to achieve lasting value and influence. The foundation of this strategy lies in the following pillars:

- Foster collaboration, innovation, and knowledge sharing through the creation of a robust Community of Practice (CoP) within each Case Study region. These CoPs serve as dynamic platforms for exchanging knowledge, co-creating strategies, and addressing regional challenges during and after the project end. CoPs are guided by the four-helix model of innovation, which integrates academia, industry, government, and civil society perspectives.
- The platform, the tools and all the materials developed will adopt an open-source approach to encourage widespread adoption and incentivise accessibility and scalability. This way, other regions can adapt the solutions to their contexts.
- The project will engage Follower Regions with similar background and contexts as the main Case Studies. These regions, though not directly involved in the trials, will receive guidance to replicate the project results, and will be invited to the CoPs.
- Journals and conferences to reach diverse audiences such as research and authorities, contributing to the scientific community.

Other research initiatives and collaboration with other projects, building synergies to enhance its influence. By aligning with projects such as ICARIA, KNOWING and MAIA, ClimEmpower fosters shared learning and ensures the lessons learned are maximized.

8 Conclusions

This document was developed by gathering outputs achieved from different task and work package leaders, emphasizing the innovative potential of the project's results. Each Strategic Objective with its related KPIs were carefully reviewed to identify which innovative results contributed to achieving these objectives. The updated version also incorporates mechanisms and frameworks that strengthen the monitoring and validation of these results.

The integration of multiple stakeholders from diverse backgrounds has been a central pillar of the project. This collaborative approach has enabled a thorough understanding of the regional context and the key hazards that need to be addressed.

In this sense, one of the key outcomes of the project has been the establishment of the Communities of Practice (CoPs), which will continue beyond the project's lifetime. These CoPs serve as dynamic collaboration platforms, fostering the co-creation of strategies and validating the outcomes to ensure their relevance and applicability.

The compilation of indicators, services, and training materials is on the way to improve the general understanding the current state of data availability. The collection and generation of new, relevant data in addition to existing will significantly enhance the development of climate resilience measures and strategies.

A major advancement of this revision is the introduction of the Innovation Maturity and Stakeholder Validation Framework, which enables systematic tracking of progress across technical, scientific, and societal dimensions. Alongside this, the risk and barriers assessment offer a proactive approach to mitigating potential obstacles in innovation deployment and replication.

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