

D5.5 Stakeholders engagement events report



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D5.5 Stakeholders engagement events reports

Summary

This document represents the ICARIA D5.5 Stakeholders Engagement Events Report, which documents the implementation, outcomes, and lessons learned from the Communities of Practice (CoPs) established across the project's three Case Study (CS) regions: Barcelona Metropolitan Area (AMB), South Aegean Region (SAR), and Salzburg Region (SLZ). Building on the methodological framework outlined in Deliverable D5.4 Stakeholder Engagement Plan, this report systematically records the execution of the workshops for each CoP – from launch and scoping to methodological validation, tool testing, Trial and Mini-trial execution, and final dissemination – facilitating dialogue, knowledge exchange, co-creation of adaptation solutions, and enhanced governance for climate-resilient critical infrastructures.

The report serves both as a traceable record of participatory processes that happened during the ICARIA project and as a guide for future engagements, detailing agendas, attendee profiles, discussion outputs, and cross-case analyses in line with the Trial Guidance Methodology (TGM). Key achievements reached during the realisation of the CoPs include validation of the holistic multi-hazard modelling framework for risk/impact assessment, hands-on refinement of the project tools – Adaptation Portfolio, Resilience Assessment Framework (RAF), and Resilience Assessment Tool (RAT), Decision Support System (DSS) – as well as identification of data gaps and involvement of different stakeholders. The hybrid formats of the workshops ensured broad participation, while the use of standardised tools (surveys, mapping) led to cross-case comparison, enabling the transposition of insights in other Work Packages (WPs) of the project (WP1–WP5), advancing all Strategic Sub-Objectives (SSOs), particularly SS07 on exploitation. This report will foster replication in follower regions, maximising ICARIA's societal impact through stakeholder-aligned innovation.

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List of Acronyms and Abbreviations

AMB	Barcelona Metropolitan Area
CoP	Community of Practice
CI	critical infrastructure
CS	Case Study
CSF	Case Study Facilitators
DSS	Decision Support System
KPI	Key Performance Indicator
RAF	Resilience Assessment Framework
RAT	Resilience Assessment Tool
SAR	South Aegean Region
SFINCS	(Super-Fast INundation of CoastS)
SLZ	Salzburg Region
SMA	Soil Moisture Accounting
SSO	Strategic Subobjective
TGM	Trial Guidance Methodology
WP	Work Package

Executive summary

This document presents ICARIA D5.5 – Stakeholders Engagement Events Report, which comprehensively documents the realisation, outcomes, and analytical synthesis of the Communities of Practice (CoPs) implemented across the project's three demonstrator Case Studies (CSs): the Barcelona Metropolitan Area (AMB), South Aegean Region (SAR), and Salzburg Region (SLZ). Building directly on the methodological foundations and stakeholder engagement roadmap outlined in Deliverable D5.4 (Stakeholder Engagement Plan), this report operationalises a structured series of workshops per CoP – realised during project months 7 to 39 – to foster iterative dialogue, knowledge co-production, risk perception enhancement, and co-creation of climate-resilient adaptation pathways for critical infrastructures amid multi-hazards such as pluvial and coastal floods, storm surges, droughts, heatwaves, and wildfires as specifically analysed by each case study.

As detailed in **Section 1** (Introduction to Project ICARIA) and **Section 2** (Objectives of the Deliverable), D5.5 serves five interconnected purposes: (i) providing granular traceability of the realised workshops via agendas, attendee profile and characterisation and analysis of the key aspects; (ii) explicitly linking participatory processes to WP1–WP5 Trials and Mini-trials, thus positions the CoPs as integral to ICARIA's holistic asset-level modelling framework and Strategic Sub-Objectives (SSOs) – especially SS07; (iii) rendering CoP methodologies replicable in the follower regions envisioned in the project; (iv) systematising outputs, such as data gap inventories, and usability feedback on project tools – including Adaptation Portfolio, Resilience Assessment Framework (RAF), Resilience Assessment Tools (RAT) and Decision Support System (DSS) – directly feeding modelling refinements; and (v) capitalising lessons for exploitation.

Section 3 (Community of Practices) underscores CoPs' theoretical anchoring in Wenger's joint enterprise-mutual engagement-shared repertoire model, operationalised via Trial Guidance Methodology (TGM) phases (i.e., preparation, execution, evaluation) to embed end-user validation into RAF, RAT, and DSS development.

Section 4 (The ICARIA Case Studies) contextualises hazards, their impacts, and further cascading effects on targeted assets, primarily critical infrastructures, and related services across the three ICARIA CSs – AMB, SAR, and SLZ – reflecting their diverse geographical and socio-economic settings. These contexts provide the operational context for implementing stakeholder engagement activities, as well as for testing and validating the ICARIA modelling approach, methods and tools through Trials and Mini-trials.

Section 5 (Reports on CoPs and Local Workshops) delves into the description and analysis of each site-specific CoP implementation. The section analyses the progression of AMB's CoP from priority scoping (Workshop 1) to DSS prototype testing (Workshop 4) and dissemination (Workshop 5); SAR's CoP island mapping (combined Workshops 1–2), validation of models (Workshop 3), and DSS hands-on evaluation (Workshop 4); as well as SLZ's CoP evolution from risk/impact framing (Workshop 1) through data-gap validation (Workshop 2) to national dissemination (Workshop 5) and followers region dissemination and involvement (6th, final event). The analysis of the attendees to each CoP and the related attendee tables reflects diverse profiles, demonstrating the growing interest and participation

in the project outputs and outcomes. The section also includes the 6th event, the final event of the project which provided a forum for critical reflection on multi-level governance, risk management, and the transferability of ICARIA outcomes to broader contexts.

Section 6 (Analysis of Outcomes) synthesises cross-case findings: convergent priorities for scenario-comparable DSS, data gaps, strengths in hybrid engagement and visuals, challenges like jargon and planning misalignments, mitigated by glossaries and agility, helping in affirming CoPs' transformative role in SS07.

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1 Introduction to Project ICARIA

The number of climate-related disasters has been progressively increasing over the last two decades, and this trend could be drastically exacerbated in the medium- and long-term horizons, according to climate change projections. It is estimated that, between 2000 and 2019, 7,348 natural hazard-related disasters have occurred worldwide, causing 2.97 trillion US\$ losses and affecting 4 billion people (UNDRR, 2020). These numbers represent a sharp increase in the number of recorded disaster events in comparison with the previous twenty years. Much of this increase is due to a significant rise in the number of climate-related disasters (heatwaves, droughts, flooding, etc.), including compound events, whose frequency is dramatically increasing because of the effects of climate change and the related global warming. In the future, by mid-century, the world stands to lose around 10% of total economic value from climate change if the temperature increase stays on the current trajectory, and both the Paris Agreement and 2050 net-zero emissions targets are not met.

In this framework, **Project ICARIA** has the overall objective to promote the definition and the use of a comprehensive asset-level modelling framework to achieve a better understanding of climate-related impacts produced by complex, compound and cascading disasters and the possible risk reduction provided by suitable, sustainable and cost-effective adaptation solutions.

This project will be especially devoted to critical assets, primarily critical infrastructures, and related services that are susceptible to climate change, in the sense that local effects can result in significant increases in the cost of potential losses for unplanned outages and failures, as well as maintenance – unless an effort is undertaken to make these assets and services more resilient. ICARIA aims to understand how future climate might affect life-cycle costs of these assets in the coming decades and to ensure that, where possible, investments in terms of adaptation measures are made up front to face these changes.

To achieve this aim, ICARIA has identified 7 Strategic Subobjectives (SSO), each one related to one or several work packages. They have been classified according to different categories: scientific, corresponding to research activities for advances beyond the state of the art (SSO1, SSO2, SSO3, SSO4, SSO5); technological, suggesting and/or developing novel solutions, integrating state-of-the art and digital advances (SSO6); societal, contributing to improved dialogue, awareness, cooperation and community engagement as highlighted by the European Climate Pact (SSO7); and related to dissemination and exploitation, aimed at sharing ICARIA results to a broader audience and number of regions and communities to maximize project impact (SSO7). The specifications for each SSO are provided below:

- SSO1 - Achievement of a comprehensive methodology to assess climate-related risk produced by complex, cascading and compound disasters.
- SSO2 - Obtaining tailored scenarios for the case study regions.
- SSO3 - Quantify uncertainty and manage data gaps through model input requirements and innovative methods.

- SS04 - Increase the knowledge on climate-related disasters (including interactions between compound events and cascading effects) by developing and implementing advanced modelling for multi-hazard assessment.
- SS05 Better assessment of holistic resilience and climate-related impacts for current and future scenarios.
- SS06 Better decision-making for cost-efficient adaptation solutions by developing a Decision Support System (DSS) to compare adaptation solutions.
- SS07 Ensure the use and impact of the ICARIA outputs.

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2 Objectives of the deliverable

The **Deliverable 5.5 – Stakeholders Engagement Events Reports** is structured to clearly and operationally define how stakeholders have been involved in the project and to systematically document what occurred during the Communities of Practice (CoPs) and local workshops, in terms of participants and outcomes. This type of deliverable, within a European project on climate resilience and co-creation of solutions, serves both as a methodological guide and as a technical and traceable record of the participatory process throughout the entire project life cycle, in line with the stakeholder engagement planning already established in ICARIA (see Deliverable 5.4; Turchi et al., 2023a). To reach this goal, the D5.5 follows five different objectives:

- to make explicit the link between the participatory process and the specific objectives of the Work Package (WP) and Trials and Mini-trials envisioned in the project ICARIA, beyond pure dissemination activities.
- to define and make replicable the methodology for organising CoPs and local workshops, by describing criteria for stakeholder selection, meeting formats, participatory tools employed (co-creation exercises, risk perception questionnaires, facilitation tools, etc.), and approaches to ethical and communication issues.
- to provide a detailed documentation of the organisation and actual implementation of each event for enabling future users or follow-up projects to understand how the process was effectively carried out in practice.
- to systematise the outputs emerging from each workshop and integrate them into an analytical framework that can directly feed modelling activities, measures, and the definition of scenarios and strategies at the case study level.
- to evaluate and capitalise on the engagement process, by highlighting strengths, challenges encountered, and lessons learned, together with recommendations on how to improve subsequent iterations of the CoPs or how to replicate the experience in other territorial contexts.

In this sense, the “engagement plan and events reports” functions both as an operational tool for the ongoing project and as a transferable knowledge product, useful for those wishing to set up similar CoPs and participatory processes on climate-related risks/impacts, critical infrastructures, and resilient governance.

3. Community of Practices (CoP)

3.1 What is a CoP and its importance for ICARIA

To address SS07 within the ICARIA project, which emphasises the implementation, replicability, and exploitation of methods and outputs through participatory mechanisms, dedicated CoPs have been instituted in each CS. CoPs are groups of people who share a concern or passion for a specific domain and learn how to do it better through regular interaction. The concept, introduced by Lave and Wenger (Wenger-Trayner, E. et al., 2015) and further developed as a social theory of learning, highlights joint enterprise, mutual engagement and a shared repertoire as defining features. Within ICARIA, three CS CoPs operate in well-defined and differentiated geographical areas - AMB, SAR, and SLZ - each conceived as a locally based learning community that collects actors around the shared domain of climate-related multi-risk/impact to critical infrastructures and the co-production of adaptation pathways, building on the ICARIA holistic asset-level modelling framework (see Deliverable 1.1; Turchi, A., 2023b) (Leone et al., 2025).

CoPs are organized in a sequence of workshops that mirror the progression from risk/impact framing (WP1) to Trial and Mini-trial execution (WP4) and awareness-raising (WP5). Each of them brings together different stakeholders: scientific and technical partners, local and regional authorities, operators and risk owners of critical infrastructures (e.g. water, energy, transport, emergency response, health), and, where appropriate, community and territorial organisations. Decision-makers, planners and infrastructure operators are particularly involved in mid- and late-cycle workshops structured to the validation of methods, DSS, Trials and Mini-trials.

In each CS, a Case Study Facilitator (CSF) from the scientific partners coordinates local CoP activities and ensures alignment between technical work packages and local needs. The workshops are structured around project goals and evolving local issues such as emergent hazards or institutional changes, providing a continuous interface between modelling, Trials/Mini-trials and stakeholder expectations.

CoP workshops rely on participatory and co-creation techniques - facilitated discussions, participatory mapping, scenario and threshold exercises, and hands-on sessions with the ICARIA's innovative tools – such as advanced multi-hazard risk/impact modelling, the Adaptation Portfolio, Risk Assessment Framework (RAF), Resilience Assessment Tool (RAT), and the DSS, to improve stakeholders' knowledge as well as to identify gaps in the project's outputs. Although anchored in a common stakeholder engagement framework (see Deliverable 5.4; Turchi et al., 2023a) CoP activities are tailored to each CS in terms of hazard and risk/impact focus, infrastructure systems, workshop timing and format, thereby reinforcing local ownership and the prospects for post-project continuation.

A core function of CoPs lies in embedding end-user perspectives directly into the iterative design and refinement of methodologies and digital solutions, particularly the DSS, which facilitates comparative analysis of cost-effective adaptation options under compound climate-related risk/impact like pluvial and coastal floods, storm surges, droughts, heatwaves, and wildfires. This integration enhances

usability by incorporating feedback on interface intuitiveness, data input requirements, scenario relevance, and output interpretability, thereby bridging technical sophistication with operational feasibility during Trial phases as per the Trial Guidance Methodology (TGM) (Fonio et al., 2020; 2023), which was introduced in Deliverable 4.1 (Havlik et al., 2024).

Through structured engagement, data, narratives and priorities emerging from ICARIA CoP workshops are systematically channelled back to the other WPs and related deliverables, linking the multi-hazard risk/impact and resilience assessment with the institutions and communities responsible for climate resilience planning in each CS (**table 1**). Early-phase workshops offer baseline information on hazards, historical impacts, critical infrastructure inventories and decision contexts, providing key inputs to holistic scenario construction and risk/impact assessment in WP1 (see Deliverable 1.1; Turchi et al., 2023b) (Leone et al., 2025). Mid-cycle validation events provide feedback on indicators, models and data strategies, supporting the refinement of the holistic asset-level modelling framework and its application in CSs, and informing the configuration of Trials (see Deliverable 4.2; de la Cruz Coronas et al., 2026) and Mini-trials (see Deliverable 4.3; Turchi et al., 2026). Furthermore, the CoPs amplify ICARIA's visibility and knowledge dissemination at local, national, and transnational scales, leveraging hybrid events, tailored reports, and network expansions to disseminate validated results, best practices, and open-access resources.

Table 1. Contribution of the CoPs to WP

n. of workshop/event	specific contribution of the CoPs to WP
Workshop 1	case studies, alienation with the project proposal, development of CS architectures and ICARIA framework discussion
Workshop 2	validation of hazard modelling tools (wp2) and impact assessment methods (wp3)
Workshop 3	presentation of hazard model development (WP2) and work plan definition for RAF and RAT implementation in CS (wp3), also TGM presentation (WP4);
Workshop 4	trial implementation to validate risk assessment results (WP4) and DSS testing (WP3/4)
Workshop 5	mini-trial implementation (WP5)
Final Event	results and tools dissemination among follower regions (WP5)

3.2 CoPs in ICARIA: a link between Trial Guidance Methodology and the CoPs

The TGM, initially developed and rigorously tested within the DRIVER+ project (EU FP7, Grant ID: 607798, 2014-2020), constitutes the methodological framework for ICARIA's comprehensive stakeholders' engagement, testing and validation processes (Fonio et al., 2020; 2023). TGM emphasises active stakeholder participation throughout Trial lifecycle, ensuring solutions are user-centric and validated against real-world needs.

Within ICARIA, TGM has been applied across the AMB, SAR and SLZ CSs to assess climate resilience improvements of critical infrastructures under multi-hazard risk/impact conditions – including pluvial floods, storm surge, droughts, heatwaves, and wildfires – which may occur as compound, coincident and/or consecutive events. These assessments are implemented through Trials and Mini-trials.

In ICARIA, the CoPs forge a direct conduit between the core Trial/mini-trial team and diverse stakeholders – ranging from scientific/technical partners and local/regional authorities to infrastructure operators (risk owners), emergency responders, and community organisations – as articulated in Section 4 of Deliverable D5.4 (Turchi et al., 2023a). CoPs exemplify the linkage between TGM's methodological backbone and practical stakeholder engagement, particularly in the evaluation phase's data synthesis step, where CoP discussions yield deeper insights, lessons learned, and adaptations for subsequent Mini-trials. For instance, Trial executions incorporate CoP feedback on scenarios and thresholds, while post-Trial workshops validate data quality and usability, to mitigate deviations and enhance output interpretability (e.g., GIS dashboards, scenario comparisons).

CoPs' participants work together with two main objectives: (1) to improve the understanding and management of climate-related risks/impacts, and (2) to contextualise and align the ICARIA scientific activities with the needs and interests of the local stakeholders.

This collaboration is materialised in regular interactions and workshops to help identify local priorities, gaps, and perceptions regarding multi-hazard risk/impact, contribute to data collection, and support the co-creation of adaptation solutions. These events address targeted themes: baseline hazard and risk/impact contexts and data gaps in early phases; method credibility (e.g., climate projections, damage estimation), in project's mid-cycle; tool usability and workflow integration during Trials; and holistic resilience outcomes (socio-economic impacts) at closure, directly feeding WPs 1-5 (WP1/WP2 scoping, WP3 assessments, WP4 Trials/Mini-trials, WP5 engagement).

4. The ICARIA Case Studies

The three ICARIA CSs serve as the project's core demonstrators and provide the operational context for implementing stakeholder engagement activities (see Deliverable 5.4; Turchi et al., 2023a) and for testing the modelling approaches and decision-support tools described in this deliverable.

The selected CSs – AMB, SLZ, and SAR – are characterised by marked geographical, environmental, and socio-economic diversity. This heterogeneity enables the project to capture a wide spectrum of climate-related hazards, exposure and vulnerability conditions, as well as governance contexts, thereby supporting the development and validation of the comprehensive ICARIA asset-level modelling framework for risk/impact and resilience assessment (see Deliverable 1.1; Turchi et al., 2023b) (Leone et al., 2025), as well as related methods and tools (see Deliverable 4.2; De La Cruz et al., 2026 and Deliverable 4.3; Turchi et al., 2026).

The multiple risk assessment studies were split in Trials and Mini-trials, as summarised in **Figure 1**.

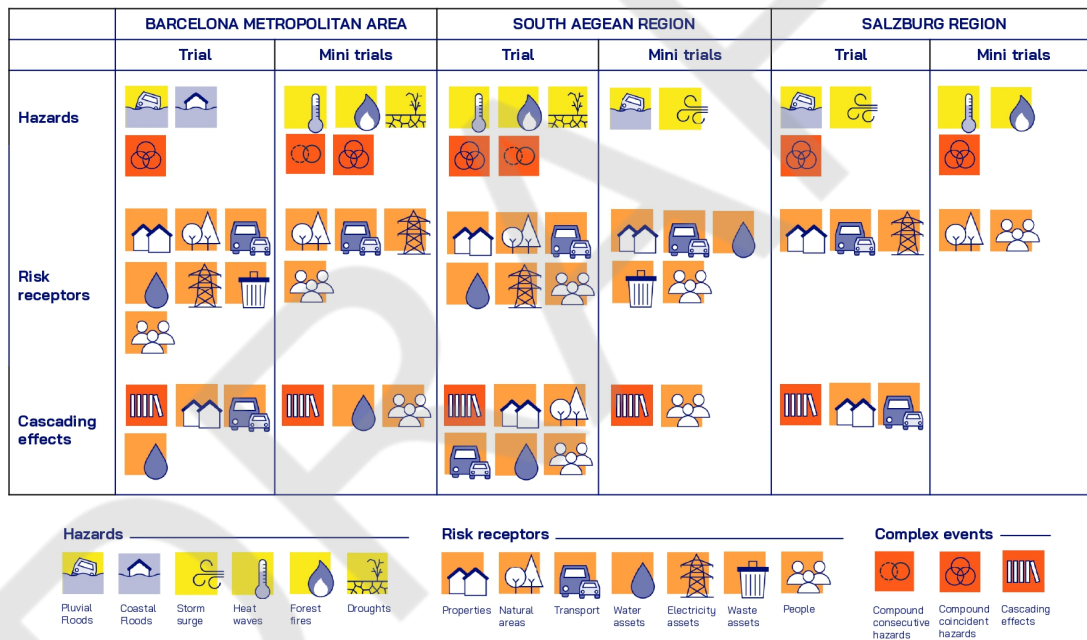


Figure 1. Updated ICARIA Trials and Mini-trials modelling architecture in the three CS regions updated according to Deliverable 1.5; Leone et al., 2026.

4.1 The Barcelona Metropolitan Area

The Metropolitan Area of Barcelona (AMB) extends over 636 km² and encompasses 36 municipalities with a total population of about 3.3 million. The territory features steep peri-urban slopes together with low-lying riverine and coastal zones, a configuration that enhances rapid surface runoff and flood propagation during heavy rainfall. (De La Cruz et al., 2023).

The **Trial configuration** implemented in the AMB Case Study addresses **pluvial and coastal floods**, with a focus on hazard dynamics, impact pathways, cascading effects, and associated damage mechanisms (see Deliverable 4.2; De la Cruz et al., 2026).

From a multi-hazard perspective, the AMB case study explored the combined effects of extreme precipitation and storm surge events, which may intensify flood hazards. Particular attention was devoted to analysing cascading impacts within the electricity network, where disruptions can propagate across interdependent urban systems. To address this a 1D/2D metropolitan-scale hydrodynamic model was developed based on previous European projects such as RESCCUE (Russo et al, 2020), BINGO (Martinez-Gomariz et al., 2019) and CORFU (Russo et al., 2015)

The **Mini-trial covered droughts, heatwaves, and wildfires** (see Deliverable 4.3; Turchi et al., 2026).

Relating to the **Drought Mini-trial**, the triggering event corresponds to a prolonged lack of rainfall, which leads to the onset of drought conditions and a progressive reduction in available water resources. This results in environmental and social impacts, along with broader economic losses affecting sectors such as agriculture, industry, and services.

Relating to the **Heatwave Mini-trial**, the triggering event corresponds to a sustained increase in air temperature above a specific threshold. In densely built-up and populated areas, urban heat island effect can occur, leading to direct short-term impacts on people and assets.

Relating to the **Wildfire Mini-trial**, the triggering conditions include dry weather and high temperatures, combined with wind, creating favourable conditions for fire ignition. Wildfires then emerge as the main hazard, leading to direct short-term impacts mainly on natural areas. The sequence of events reflects a rapid-onset impact pathway, in which impacts occur shortly after ignition, materialising in loss of vegetated/semi-vegetated areas.

4.2 The South Aegean Region

The South Aegean Region (SAR), located at the southeastern periphery of Greece, comprises the island groups of the Cyclades and the Dodecanese, with a combined population of around 309,000 residents – roughly 3% of the national total. Key climatic hazards affecting the area include sea level rise, rising air temperatures leading to heatwaves, the increasing frequency of wildfires, and episodes of intense rainfall that can trigger floods and related damage. The **Trial** in the SAR Case Study was implemented in two islands separately; **on the island of Rhodes the Trials focused on wildfires, while on the island of Syros on heatwaves** (see Deliverable 4.2; De la Cruz et al., 2026).

Relating to the **Wildfire Trial**, exposure and vulnerability were assessed for four main receptor categories – population, ecosystems, critical infrastructure (CI), and buildings. The classification of assets at risk relies on the likelihood of experiencing certain damage levels as a function of hazard intensity.

Relating to the **Heatwave Trial**, the trial adopted the European Standard EN 1991-1-5, which defines procedures for evaluating thermal actions arising from climatic and operational temperature variations. This standard enables the determination of uniform and differential temperature components reflecting realistic environmental conditions, based on heat transfer principles and regional temperature data.

The **Mini-trial configurations** implemented in the SAR CS specifically addressed **extreme winds on the island of Syros** and **pluvial floods on the island of Naxos** (see Deliverable 4.3; Turchi et al., 2026).

Relating to the **Extreme wind Mini-trial**, the triggering event corresponds to a sustained increase in wind speed, which progressively evolves into extreme wind conditions. This leads to direct short-term impacts on transport assets, followed by disruptions to transport services and subsequent socio-economic losses across multiple sectors, particularly tourism, as well as impacts on community well-being.

Relating to the **Pluvial Flood Mini-trial**, the triggering event corresponds to prolonged heavy rainfall. This results in direct short-term impacts on properties and on wastewater assets, as well as service disruptions affecting transport, and wastewater management systems.

4.3 The Salzburg Region

The Salzburg Region, located in the Eastern Alps is among Austria's most important tourist destinations and simultaneously a key area for renewable energy generation, largely due to its extensive network of hydropower facilities, with a population of over 550.000 residents. The **Trial configuration** implemented in the SLZ Case Study addresses **pluvial and river floods**, as well as **storm surge**, with a focus on hazard dynamics, impact pathways, cascading effects, and associated damage mechanisms.

Relating to the **pluvial and river floods Trial**, during the first ICARIA Community of Practice meeting held in Pinzgau, stakeholders highlighted river flooding as a predominant hazard for this area of the federal state of Salzburg, located in the Austrian Alps. Thus, the Trial focused particularly on the municipality of Mittersill.

Regarding the extreme wind **extreme winds trial**, regional stakeholders identified windstorms as a secondary but relevant climate threat during the first CoP meeting. The main impacts are associated with structural damage to buildings and forest disturbance, including the uprooting and falling of trees. The electricity network is also frequently disrupted, either through direct wind impacts or due to fallen trees.

Following the same approach, the **Mini-trial configurations** implemented in the SLZ CS specifically address **heatwaves** and **wildfires**, providing insights into hazard dynamics, exposure/vulnerability characterisations, impact pathways, cascading effects, and associated damage mechanisms (see Deliverable 4.3; Turchi et al., 2026).

Relating to the **Heatwave Mini-trial**, the triggering event corresponds to a sustained increase in air temperature, progressively evolving into a heatwave. Relating to the **Wildfire Mini-trial**, the triggering conditions include a prolonged lack of rainfall and high temperatures, combined with wind speed, creating favourable conditions for fire ignition, which is assumed to originate from human-related sources (e.g., discarded cigarettes). Wildfires then emerge as the main hazard, leading to direct impacts on natural areas.

5 Reports on CoPs and local workshops

5.1 Overview of organised events

The Stakeholder Engagement Plan documented in Deliverable D5.4 outlines a structured series of five workshops spanning Months 7 to 35 (M7-M35), tailored to the three CS (Turchi et al, 2023b). Due to the amendment of the project, the workshops have been subsequently moved up until month 39 (March 2026). These workshops aim to progressively build stakeholder involvement, from initial familiarization to advanced tool validation and final impact assessment (**table 2**).

Workshop 1, scheduled for M7, introduced participants to the overarching ICARIA project framework and objectives and the specific contextual dynamics of each case study, validated the hazards and risk receptors of interest to define the CS's architecture while eliciting discussions on prevailing challenges and emergent opportunities in climate resilience for critical infrastructures.

Workshop 2 at M13 elucidated the risk assessment methodologies employed, and analysed persistent gaps in models, data, focusing on the hazard modelling and impact assessment methods selected by each CS.

Workshop 3, convened between M21 and M23, showcased maturation of risk and impact models, preliminary modelling outputs, and delineated a forward-looking work plan for deploying Climate Resilience Assessment tools. This encompasses the Resilience Assessment Framework (RAF), Resilience Assessment Tool (RAT), and initial conceptualization of the Decision Support System (DSS), culminating in preliminary deliberations to synchronize Trial and Mini-Trial execution protocols.

Workshop 4 realised during M34-M36, included the presentation of the most recent case study-specific results, disseminating the fully developed DSS for stakeholder interaction. Participants engaged in hands-on testing to evaluate the tool's performance and usability via participatory methods, with comprehensive feedback harvested through structured surveys, observational protocols, and interactive dialogues. The overall objective of this workshop was to identify the DSS's strengths, limitations, and targeted enhancements.

Workshop 5, set for M39, synthesized insights derived from full-scale Trial implementations, instituting a collaborative evaluation of their contextual appropriateness, merits, and shortcomings within each case study. It transitioned into Mini-Trials, adhering to TGM principles but employing simplified models, scenarios, and risk assessments relative to primary Trials, complemented by stakeholder questionnaires to capture nuanced perceptions and recommendations.

Following the CoPs' workshops, a 6th event, organized at M39, **The ICARIA Final Event** represents the culminating dissemination activity of the ICARIA project. The event synthesized the project outcomes to promote replication in follower regions and inform policy, aligning with EU Climate Change Adaptation Mission goals for cost-efficient adaptation and stakeholder uptake. By bridging scientific modelling with practitioner needs, it advances multi-risk assessment and socio-economic impact evaluation for resilient urban futures.

This phased engagement scaffolding ensured iterative refinement, stakeholder ownership, and maximized exploitation potential, as evidenced in ongoing CoP implementations across the case studies.

Table 2. ICARIA CoPs work plan

WORKSHOP	TITLE	TOPICS	MONTH
Workshop 1	Presentation of ICARIA and identification of challenges and opportunities	<ul style="list-style-type: none"> • Introduction to the ICARIA project and CoP organization • Risk & gaps identification → expectations 	July 2023 (M7)
Workshop 2	Discussion and validation of the Risk Assessment approach	<ul style="list-style-type: none"> • Present and discuss tools and model design • Present Trials and Min-Trials methodology 	January 2024 (M13)
Workshop 3	Evaluation of preliminary results	<ul style="list-style-type: none"> • Present and discuss preliminary results and gaps • Present Trials and Mini-Trials organization 	November 2024 (M23)
Workshop 4	Trial execution	<ul style="list-style-type: none"> • Present and evaluate Trial outcomes • Identify further interests of Stakeholders 	October/December 2025 (M34- M36) Rescheduled
Workshop 5	Mini-Trials and socio-economic impacts & Outreach beyond CoPs	<ul style="list-style-type: none"> • Present and evaluate Mini-Trial outcomes • Present (almost) final version of the DSS • Demonstration of tools replication potential • Foster project outreach 	March 2026 (M39) Rescheduled
Final event	ICARIA FINAL EVENT	<ul style="list-style-type: none"> • critical reflection on multi-level governance • transferability of ICARIA outcomes to broader European contexts 	March 2026 (M39)

5.2 The Barcelona Metropolitan Area CoP

The Community of Practice (CoP) implemented for the Barcelona Metropolitan Area (AMB) was established as a core stakeholder engagement and validation mechanism to ensure that ICARIA’s scientific developments—multi-hazard risk and impact modelling and the associated decision-support system—were continuously aligned with metropolitan operational realities and end-user expectations.

Across five workshops, engagement evolved from the identification of shared priorities and framing to methodological validation and implementation planning, followed by hands-on DSS evaluation and a final results-oriented dissemination and discussion workshop (**table 3**).

This trajectory supports both the “technical robustness” dimension (through validation discussions around models, scenarios and data) and the “operational uptake” dimension (through usability feedback, data-readiness considerations, and explicit articulation of stakeholder expectations and commitments). The 5th workshop functioned as a closing dissemination milestone for AMB, consolidating and communicating the results generated in the case study and positioning them for potential uptake in metropolitan planning and sectoral decision processes.

Table 3. Barcelona Metropolitan Area (AMB) CoPs.

<i>Barcelona Metropolitan Area CoPs</i>		
Workshop n.	date	Format/localisation
1	<i>26 June 2023</i>	AQUATEC’s office at Ciutat de l’Aigua, Barcelona
2	<i>30 January 2024</i>	AQUATEC’s office at Ciutat de l’Aigua, Barcelona
3	<i>9 September 2024</i>	AQUATEC’s office at Ciutat de l’Aigua, Barcelona
4	<i>30 October 2025</i>	AQUATEC’s office at Ciutat de l’Aigua, Barcelona
5	<i>24 February 2026</i>	Online - Microsoft Teams

5.2.1 Description of workshops

Workshop 1 – Launch, stakeholder scoping, and expectation setting

The 1st AMB CoP Workshop was aimed at establishing a common baseline among participants, combining a presentation of ICARIA, a discussion on the role and functioning of CoPs within the project with a dedicated participatory component to elicit stakeholder interests and knowledge gaps regarding climate-related hazards and infrastructure resilience in the AMB CS. (Table 4). The workshop also included a participative moment to define the expectations and commitments which demonstrates the bidirectional nature of engagement: stakeholders clarified what they could contribute with (e.g., operational perspectives, data and expertise), and what they expected to gain (e.g., improved assessment capacity and decision support).

Table 4. Agenda of 1st CoP Workshop for the Barcelona Metropolitan Area CS.

<i>1st CoP Workshop – Barcelona Metropolitan Area CS 26 June 2023</i>	
Hour	Activity
10:00 – 10:15	Welcome and presentation of the 1 st CoP Workshop
10:15 – 10:45	Presentation of the ICARIA project
10:45 – 11:30	Presentation of the role of CoPs in ICARIA
11:30 – 12:00	Coffee break
12:00 – 12:45	Survey on the interest of stakeholders in climate risk assessment in the AMB
12:45 – 13:00	Definition of expectations for the ICARIA project
13:00 – 13:15	Wrap-up

Workshop 2 – Validation of the risk assessment approach and elicitation of tool requirements

The 2nd AMB CoP Workshop was conceived as a methodological validation checkpoint. During the event, the ICARIA holistic modelling framework for multi-hazard risk/impact assessment was presented. After that hazard and impact assessment methodologies across multiple receptors have been discussed and a first introduction of the ICARIA tool suite under development (Resilience Assessment Framework–RAF; Resilience Assessment Tool–RAT; Adaptation Measures Portfolio; DSS) was given. Importantly, this workshop formally connected stakeholder engagement to ICARIA’s validation strategy by presenting the Trial Guidance Methodology (TGM) and framing forthcoming evaluations as trial cycles implemented through CoP collaboration. The workshop concluded with a

short survey (via [mentimeter.com](https://www.mentimeter.com)) to capture early perceptions of applicability, usefulness, and priority functionalities, providing structured evidence to inform subsequent iterations. (Table 5)

Table 5. Agenda of 2nd CoP Workshop for the Barcelona Metropolitan Area CS.

<i>2nd CoP Workshop – Barcelona Metropolitan Area CS</i>	
January 30th 2024	
Hour	Development
10:00 – 10:15	Welcome and presentation of the 2 nd CoP Workshop
10:15 – 10:45	Presentation of the ICARIA “holistic modelling framework” for multi hazard risk/impact assessment
10:45 – 11:30	Discussion on multi-hazard risk/impact assessment method
11:30 – 12:00	Coffee break
12:00 – 12:45	Presentation of the Decision Support System (DSS) and portfolio of the Adaptation measures + Discussion on related expectations
12:45 – 13:00	Presentation of the Trial Guidance methodology (TGM)
13:00 – 13:15	Wrap-up

Workshop 3 – Implementation planning for resilience assessment tools and DSS conceptualisation

The 3rd AMB CoP Workshop marked a transition from “understanding what is needed” to “organising how to test and implement it.” A strategy was defined for the implementation of climate resilience assessment tools—RAF and RAT—clarifying that, while both rely on questionnaire-based inputs and generate resilience metrics, they differ in scope and intended users (RAF more suitable for regional/administrative resilience planning; RAT oriented to critical infrastructure and asset-level assessment). The workshop also served to validate a testing action plan and allocate responsibilities aligned with stakeholder expertise, thus supporting feasibility and ensuring that the engagement process translated into concrete tool-testing activities. Finally, the workshop presented and discussed the conceptualisation of the DSS as the integrative web-based environment designed to consolidate ICARIA knowledge and services, including risk/impact assessment workflows and decision-support functions such as scenario comparison and map-based result visualisation. (Table 6)

Table 6. Agenda of 3rd CoP Workshop for the Barcelona Metropolitan Area CS.

<i>3rd CoP Workshop – Barcelona Metropolitan Area CS</i>	
9 September 2024	
Hour	Development
10:00 – 10:15	Welcome and presentation of the 3 rd CoP Workshop
10:15 – 10:45	Status report of the risk and impact models of ICARIA
10:45 – 11:30	Implementation of Climate Resilience Evaluation tools
11:30 – 12:00	Coffee break
12:00 – 12:30	Presentation of the “Decision Support System” (DSS)
12:30 – 12:40	Wrap-up

Workshop 4 – Participatory evaluation of the DSS prototype

The 4th AMB CoP Workshop was configured as the most explicitly “user-centred testing” workshop. The session began with the presentation of flood-study results, including early outputs from detailed flood risk mapping developed through a validated combined 1D/2D modelling approach. The core of the workshop was a structured participatory evaluation of the DSS prototype: participants were organised into groups, supported with step-by-step scripts and pre-arranged access credentials, and guided through dedicated testing blocks covering (i) risk/impact assessment and resilience assessment components and (ii) adaptation measures and map viewer functionalities. **(Table 7)** Feedback collection was intentionally triangulated through post-workshop surveys, systematic observation of user interactions, and facilitated discussions, to generate implementable recommendations for tool refinement within the project’s iterative development trajectory.

Table 7. Agenda of 4th CoP Workshop for the Barcelona Metropolitan Area CS.

<i>4th CoP Workshop – Barcelona Metropolitan Area CS</i> October 30th 2025	
Hour	Development
09:45– 10:00	Arrival of participants
10:00 – 10:20	Welcome and introduction of the meeting
10:20 – 10:45	Presentation of flood study results
10:45 – 11:00	Preparation for the participatory evaluation of the Decision Support System
11:00 – 12:00	Part 1 of the participatory evaluation
12:00 – 12:30	Break
12:30 – 13:30	Part 2 of the participatory evaluation
13:30 – 14:00	Conclusions and closing of the meeting

Workshop 5 – last workshop: dissemination of results

The 5th AMB CoP Workshop it’s the only one realized as an online event. The agenda was explicitly results-oriented. The workshop objective was to share the results obtained for the AMB case study, with results presented by AQUATEC and IREC and discussed with participants. Workshop 5 was linked to the trial roadmap and framed as a presentation of the results and lessons learnt from trial implementation, supported by visual materials (maps and graphs) derived from project results. **(Table 8)**

Table 8. Agenda of 5th CoP Workshop for the Barcelona Metropolitan Area CS.

<i>5th CoP Workshop – Barcelona Metropolitan Area CS</i> February 24th 2026	
Hour	Development
15:30 – 15:35	Welcome and presentation of the 5th CoP Workshop
13:35 – 15:40	Context of the ICARIA project

15:40 – 16:25	ICARIA results: Pluvial flood risk at the AMB
16:25 – 16:35	ICARIA results: Drought model
16:35 – 16:45	ICARIA results: Heatwave effect on infrastructures
16:45 – 16:55	ICARIA results: Forest fires
16:55 – 17:00	ICARIA results: Holistic resilience at the AMB
17:00 – 17:15	Q&A and closing of CoP

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5.2.2 Attendees and stakeholder profiles

The AMB CoP engaged a diverse mix of stakeholders to address metropolitan climate resilience, including governance actors (e.g., AMB), infrastructure operators (e.g., AQUATEC, ENDESA, TERSA), research partners, and third parties like insurance (Consortio de Compensación de Seguros) and climate services (Servei Meteorològic de Catalunya).

This composition bridged strategic policy needs with operational realities, such as asset vulnerability and data gaps, while varying attendance per workshop reflected event-specific focuses (**table 9**).

This multi-actor configuration is methodologically relevant because it creates conditions for identifying the divergence across sectors in terms of information needs, data standards, and decision logics. This type of divergence is particularly important in terms of integrated decision-support environments, such as the DSS, to be usable in real-world planning contexts.

As engagement progressed towards tool testing (e.g., Workshop 4), the CoP's composition was further expanded to include public transport (TMB) and civil protection for realistic DSS usability evaluation; Workshop 5 featured broader representation for results dissemination.

The multi-actor setup highlighted sectoral divergences in data needs and decision logics, essential for effective integrated tools like the DSS in planning contexts.

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Table 9: list of attendees for each AMB Cop workshop

Barcelona Metropolitan Area CS							
Stakeholder	Description	Category	1 workshop participants	2 workshop participants	3 workshop participants	4 workshop participants	5 Workshop participants
Aigües de Barcelona (AB)	AB is the public-private operator of most of the drinking water services and infrastructures in the AMB.	ICARIA consortium member	2	2	4		2
AQUATEC	AQUATEC is a private company with a research and development department focused on urban climate resilience and flooding risk assessment.	ICARIA consortium member and Case study coordinator	4	2	3	3	3
Àrea Metropolitana de Barcelona (AMB)	The Barcelona Metropolitan Area (AMB) is the public administration of the metropolitan area of Barcelona, which encompasses 36 municipalities with more than 3.2 million inhabitants.	ICARIA consortium member and Risk Owner	1	1	2	0	6
CETAQUA	CETAQUA is a research private company with extensive expertise in EU research projects related to a wide variety of topics.	ICARIA consortium member	2	2	0	2	1

Consorcio de Compensación de Seguros (CCS)	CCS is a public business organisation that is attached to the Ministry of Economic Affairs and Digital Transformation. It performs many functions within the insurance field among which those related to coverage of extraordinary risk, compulsory vehicle insurance, combined agricultural insurance and liquidation of insurance companies stand out.	CoP 3rd party	1	1	0	1	1
ECOPARC 1	ECOPARC 1 is a waste management facility belonging to the Barcelona Metropolitan Area authority. It joins the CoP as a local representative of waste facility operators.	CoP 3rd party	1	1	0	1	1
TERSA	Public company operating solid waste management facilities	CoP 3rd party	1	2	0	1	2
ENDESA	ENDESA is the largest company in the electric sector in Spain. It is responsible for the electricity distribution network and related infrastructures (e.g., substations) in the context of the Barcelona Metropolitan Area CS.	CoP 3rd party	1	1	0	1	0

Oficina Catalana del Canvi Climàtic (OCCC)	OCCC is the technical unit of the Government of Catalonia, being in charge to promote the establishment of climate change strategies, plans and projects in Catalonia. Hence, the OCCC is also responsible for submitting to the Government proposals relating to the mitigation of emissions and climate change adaptation.	CoP 3rd party	1	1	1	0	0
Servei Meteorològic de Catalunya (SMC)	SMC is a public company ascribed to the Government of Catalunya. It is the organisation responsible for the weather observation system and meteorological forecast in Catalonia.	CoP 3rd party	0	1	1	1	0
Institut de Recerca en Energia de Catalunya (IREC)	IREC is a publicly owned research centre specialized in the field of energy, sustainability and development.	ICARIA consortium member	2	1	0	1	2
Fundación Investigación del Clima (FIC)	FIC is the expert member of the ICARIA consortium in climate data projections	ICARIA consortium member	1	1	1	0	0
Universitat Politècnica de Catalunya	Department of Flumen, a research institute with expertise on hydrology and modelling associated with the UPC.	ICARIA consortium member and scientific coordinator	0	0	0	3	0



Transports Metropolitans de Barcelona (TMB)	TMB is a public transport company in charge of the Barcelona Metropolitan Area.	CoP 3rd party	0	0	0	1	1
Protecció Civil	Is a part of the government dedicated to preparing communities in case of any kind of hazards	CoP 3rd party	0	0	0	1	0

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5.2.3 Main discussion points and outputs

Shared priorities and engagement commitments (Workshop 1).

The first workshop generated foundational outputs by systematically eliciting stakeholder interests, perceived knowledge gaps, and sectoral priorities regarding climate hazards and resilience assessment in the AMB. Stakeholders indicated a strong interest in hydrological hazards (including floods and droughts, and groundwater salinisation), followed by heatwaves and coastal erosion, thereby providing an empirically grounded prioritisation of hazards considered most salient in the metropolitan context (Figure 2).

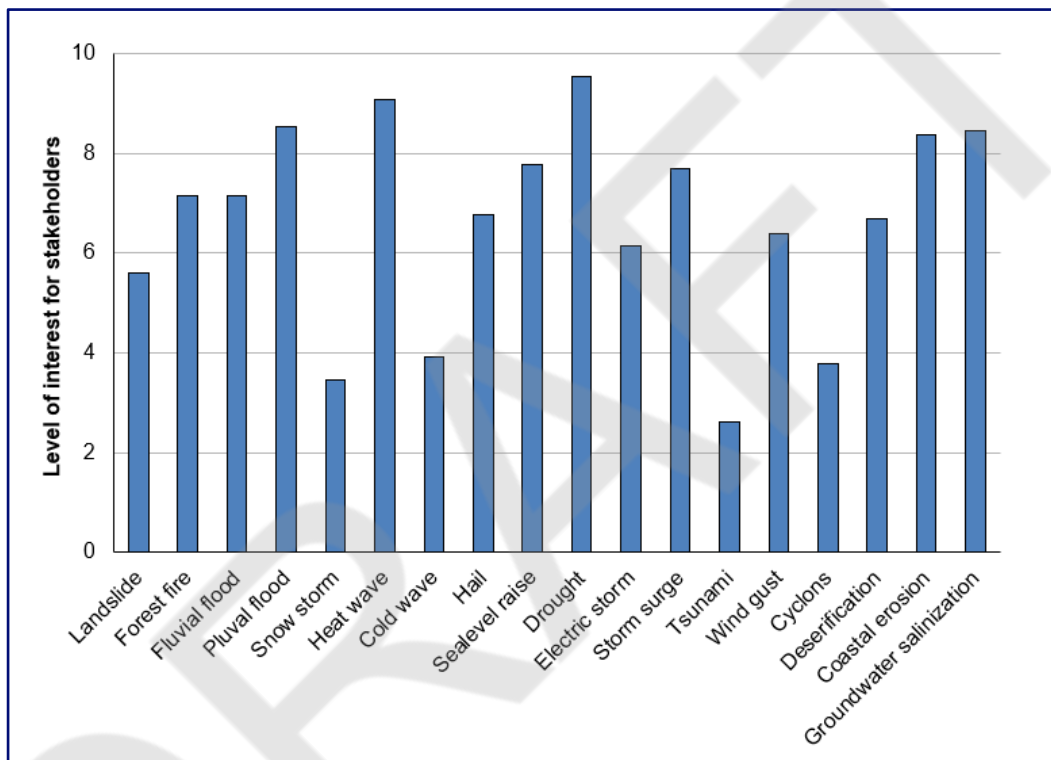


Figure 2. Level of interest for the CoP stakeholders of different natural hazards (scale of 0-10)

The workshop also revealed a lack of conclusive agreement on the most relevant hazards for specific infrastructure sectors, which participants attributed to two main factors: the spatial diversity of networked assets exposed to different hazards, and the absence of metropolitan-scale resilience assessments that could provide a shared evidence baseline (Figure 3). In addition, the workshop documented a broader uneven shared understanding of climate resilience and asset-level risk concepts across stakeholders, which complicated interpretation of certain survey questions and reinforced the need for a harmonised framework and common language within ICARIA.

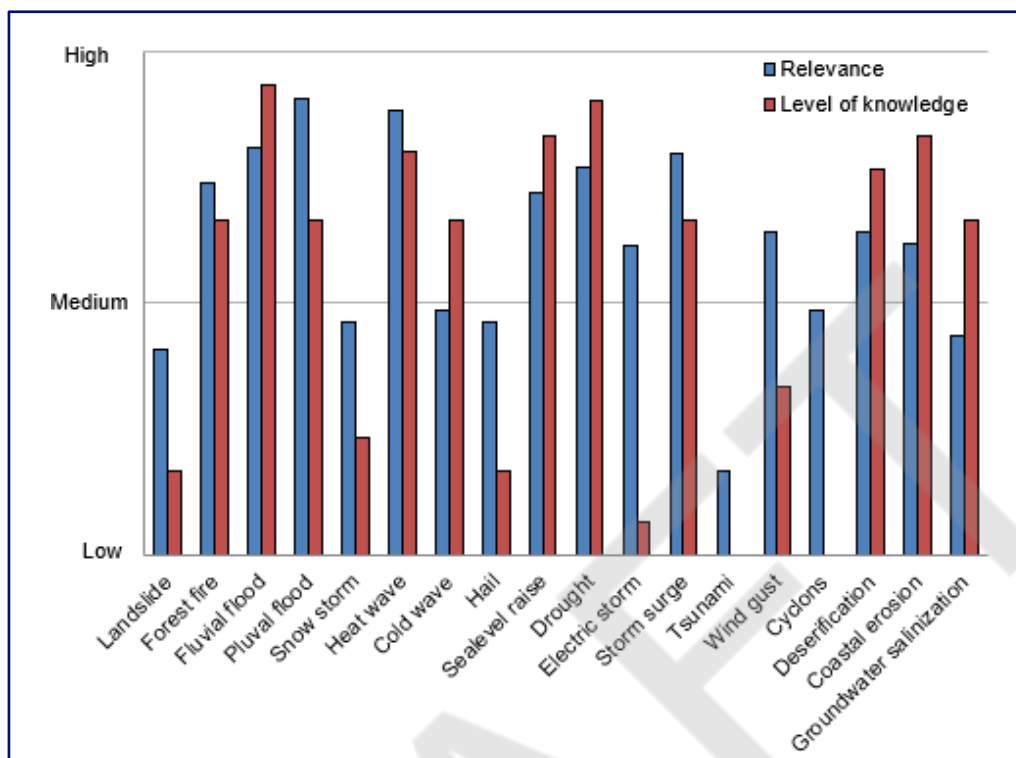


Figure 3. Relevance and level of knowledge of natural hazards in the AMB (low-medium-high scale)

Beyond perceptions, the workshop investigated, through a participatory activity, the articulation of expectations and commitments by participating organisations, which helped establish the CoP as a sustained collaboration mechanism and created a traceable basis for subsequent activities requiring stakeholder inputs, such as data provision, validation of model assumptions, and tool-testing responsibilities (Figure 4).

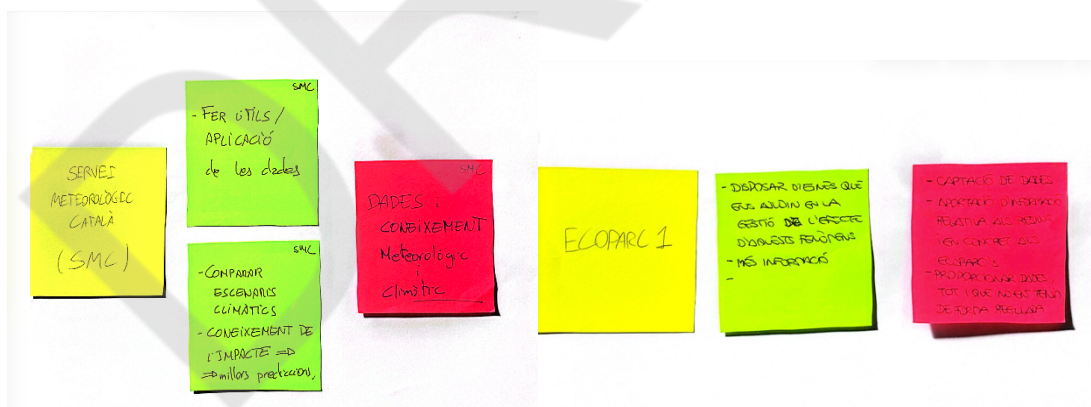


Figure 4: AMB workshop 1: participatory activity to define priorities (open text comments)

Methodological validation and initial tool feedback (Workshop 2).

The second workshop advanced from scoping to methodological validation by presenting the ICARIA holistic framework and discussing its adequacy for addressing multi-hazard and compound risk in AMB (Figure 5). A specific emphasis was placed on the need to move beyond single-hazard

approaches and to consider interdependencies across metropolitan services, with explicit attention to cascading effects and the potential role of electricity as a critical interdependency pathway.

Survey

PART 1: Discussion on risk/impact assessment framework

1. Have you ever employed a similar methodology throughout your professional career?
 - Yes, regularly
 - Yes, occasionally
 - No, never used
 - Not sure

2. Do you believe that the methodology proposed within the ICARIA project could somehow positively facilitate Disaster Risk Management (DRM)?
 - Yes, definitely
 - More yes than no
 - More no than yes
 - No, I don't see its utility

- 3a. If yes, which phase of the DRM cycle do you think it might most significantly affect?
 - Prevention
 - Preparedness
 - Response
 - Recovery

- 3b. If no, please explain your answer:

4. Indicate which specific advantages you foresee from proper development and implementation of this methodology (select 1 to 3 responses most significant for you):
 - In-depth analysis of the most significant extreme climatic events (in terms of frequency and intensity) for the case study
 - Construction of plausible climatic scenarios
 - Greater accuracy in the quantitative and qualitative estimation of climate risk (in terms of hazard, exposure, vulnerability, dynamic vulnerability)

Figure 5: AMB workshop 2: survey on risk/impact assessment

The survey and discussions indicated an overall positive appraisal of the potential applicability of the tools, while also surfacing early suggestions related to scope, usability, and the importance of providing functionalities that are meaningful across heterogeneous sectors and user roles. Moving from the findings of the first workshops and from the consciousness of different levels of knowledge among the stakeholders, a common taxonomy is presented and given to the stakeholders to better prepare the field for future discussion (**Figure 6**).

TAXONOMY

ICARIA holistic modelling framework for
multi-hazard risk/impact assessment


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Figure 6: TAXONOMY ICARIA holistic modelling framework for multi-hazard risk/impact assessment

The workshop also introduced stakeholders to the ICARIA tool ecosystem and clarified how the DSS is intended to integrate outputs from resilience assessments and the adaptation portfolio to support scenario-based decision-making.

Operationalisation of testing and recognition of data-readiness constraints (Workshop 3).

The third workshop validated a work plan for testing resilience assessment tools and confirmed the conceptual direction for the DSS as an integrative platform. Discussions highlighted that, although questionnaire-based tools may (like RAF and RAT) provide rich resilience metrics, their effective use can require substantial expertise and coordination, potentially benefiting from multidisciplinary teams rather than isolated users (**Figure 7**).

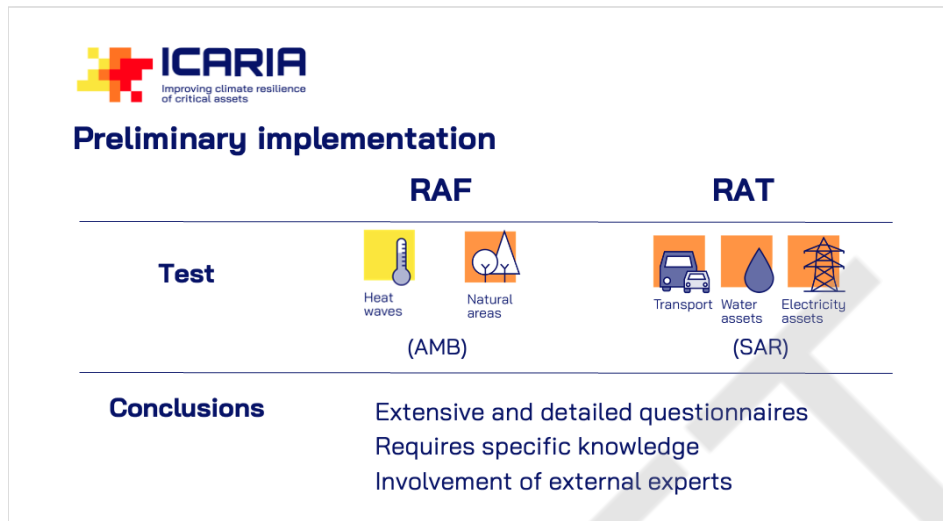
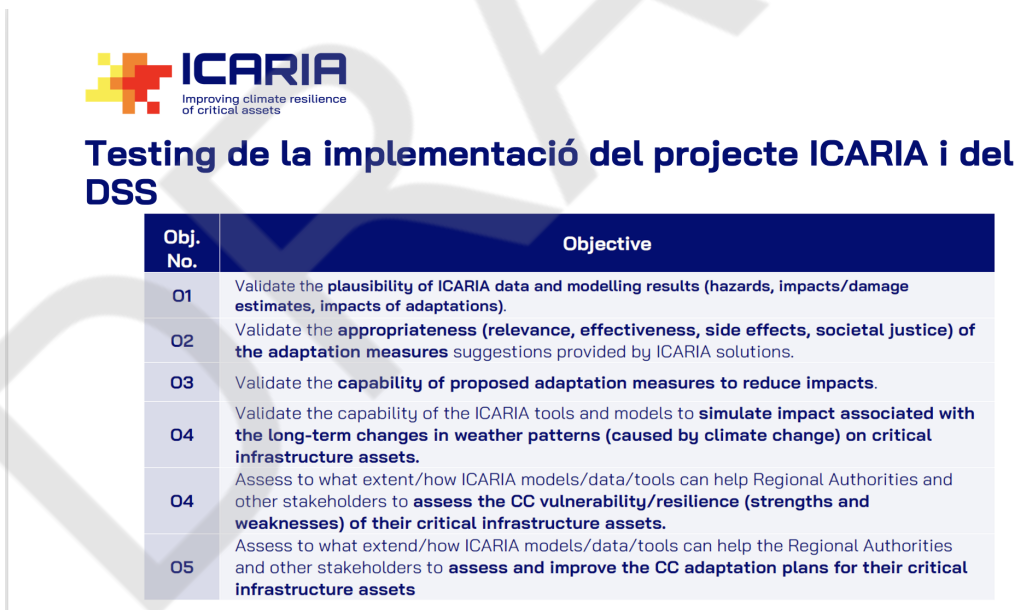


Figure 7: AMB workshop 3: evaluation of RAF and RAT

A key cross-cutting output was the explicit recognition of data limitations as an adoption barrier: even when stakeholders are the most relevant data owners for AMB, accessing and compiling the required datasets for correct tool operation was reported as challenging. This finding is particularly relevant since it highlights that tool usability depends not only on interface design but also on organisational capacity, data governance, and the availability of guidance materials that lower the threshold for participation in trial activities (Figure 8).



Obj. No.	Objective
01	Validate the plausibility of ICARIA data and modelling results (hazards, impacts/damage estimates, impacts of adaptations).
02	Validate the appropriateness (relevance, effectiveness, side effects, societal justice) of the adaptation measures suggestions provided by ICARIA solutions.
03	Validate the capability of proposed adaptation measures to reduce impacts.
04	Validate the capability of the ICARIA tools and models to simulate impact associated with the long-term changes in weather patterns (caused by climate change) on critical infrastructure assets .
04	Assess to what extent/how ICARIA models/data/tools can help Regional Authorities and other stakeholders to assess the CC vulnerability/resilience (strengths and weaknesses) of their critical infrastructure assets .
05	Assess to what extent/how ICARIA models/data/tools can help the Regional Authorities and other stakeholders to assess and improve the CC adaptation plans for their critical infrastructure assets

Figure 8: AMB workshop 3: preliminary testing of DSS

Hands-on DSS evaluation and actionable improvement requirements (Workshop 4).

The fourth workshop generated the most detailed evidence on end-user experience with the ICARIA DSS prototype, thanks to a hands-on approach and a simulation. Stakeholders confirmed their interest in the information provided by the DSS and considered it potentially actionable across

several sectors, which supports ICARIA’s objective of developing a decision-support environment with broad applicability. Participants identified as a major strength the DSS’s ability to compare multiple hazard and adaptation scenarios and to visualise differences under alternative climate projections, features that are central to planning under uncertainty (Figure 9).

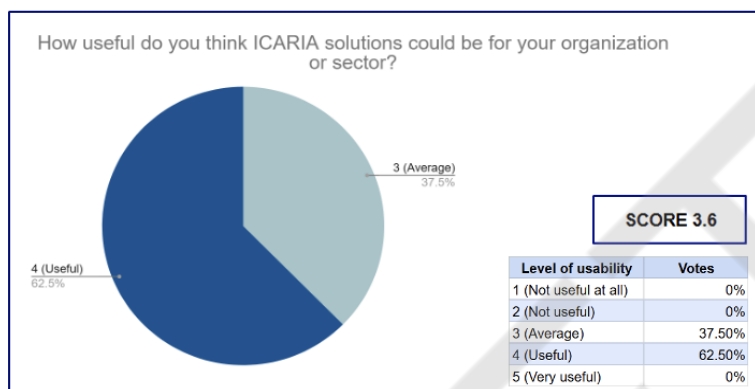


Figure 3: Answers to the question of usability of ICARIA solutions

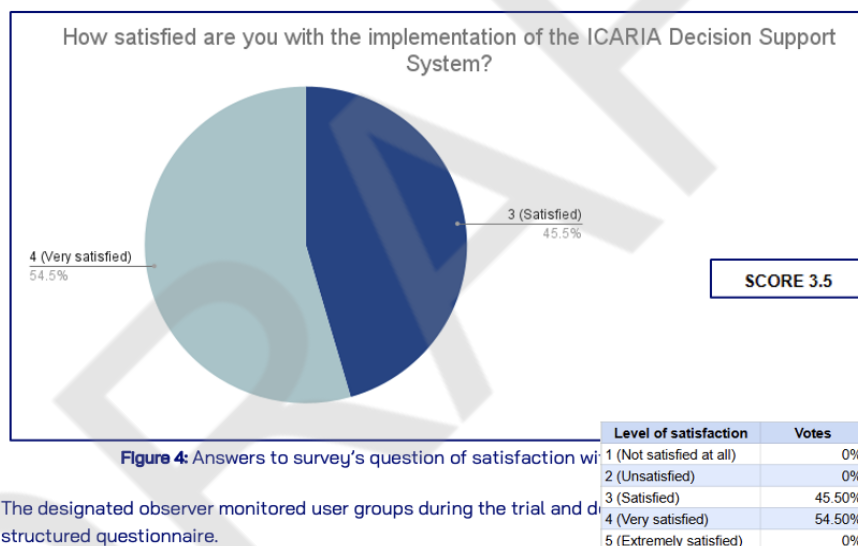


Figure 4: Answers to survey’s question of satisfaction with implementation of the ICARIA Decision Support System

The designated observer monitored user groups during the trial and distributed a structured questionnaire.

Figure 9: AMB workshop 4: stakeholders’ satisfaction of DSS (5-level Likert scale)

At the same time, the workshop documented a critical usability barrier: participants reported difficulties in understanding and preparing the necessary data inputs for the risk/impact assessment workflow (including hazard maps, exposure maps, and vulnerability curves) and explicitly requested non-expert-friendly guidance to reduce reliance on specialised technical support. Participants also expressed interest in further development directions, particularly interoperability/collaboration features and the representation and assessment of cascading effects, which they considered among the most valuable future enhancements.

The workshop also documented methodological constraints affecting the depth of evaluation, including time limitations that necessitated reliance on pre-prepared datasets and pre-completed assessments, and a restricted spatial focus (Barcelona city rather than the full metropolitan area) for feasibility within the session format. These limitations are not merely procedural; they provide an important interpretative frame for the evaluation results and highlight clear opportunities for

improvement in future CoP cycles (e.g., longitudinal testing, broader spatial coverage, and more user-led data preparation steps).

Results dissemination and consolidation (Workshop 5).

The primary output of the fifth workshop was the structured presentation and discussion of AMB case study results across multiple hazard domains, with particular emphasis on pluvial flood risk as the main focus area where the largest body of results was obtained.

The pluvial flood session included explanation of the 1D/2D flood modelling approach (highlighted as precise and with limited precedent at this scale), description of data collection and climate projection/scenario design, and the sharing of flood maps for the AMB (Figure 10).



Figure 10: AMB workshop 5: flood modelling results presentation (legends in Catalan for improved CS uptake)

Furthermore, results were presented for socioeconomic impacts under single-hazard, multi-hazard and adaptation scenarios across future time projections, including impacts on multiple receptors such as property damages, pedestrian risk and transport network risk, and that additional discussion addressed impacts on waste management infrastructure, wastewater treatment plants and public transport stations (Figure 11).

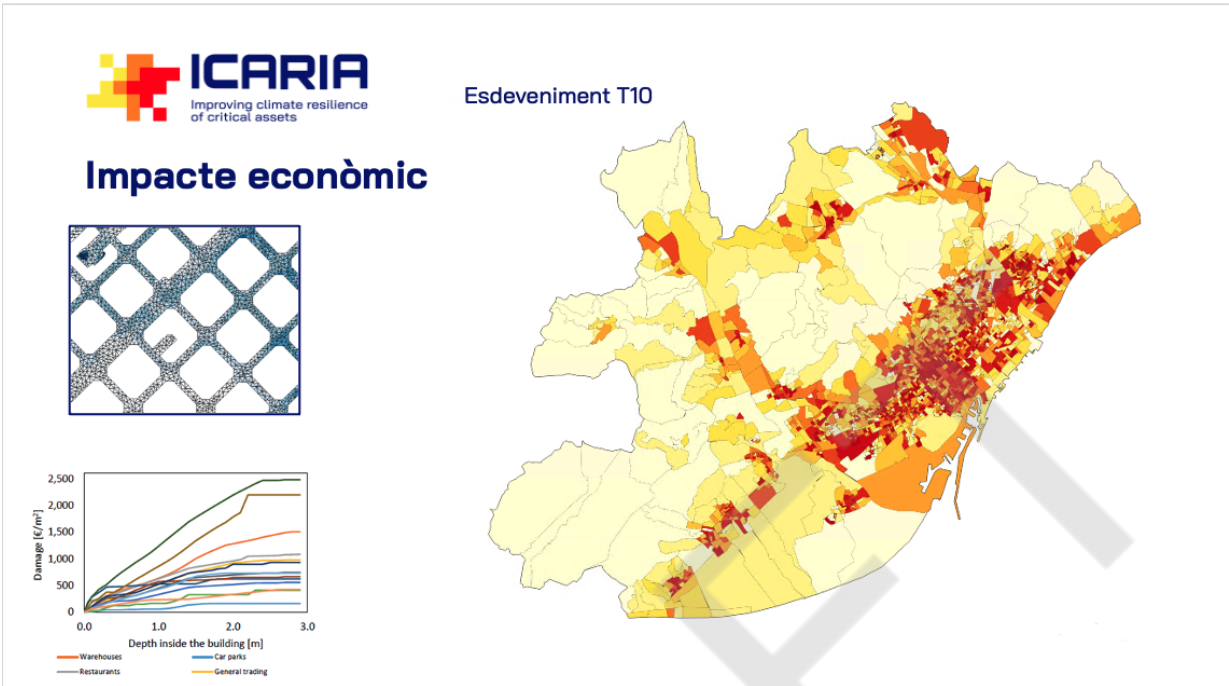


Figure 11: AMB Workshop 5: economic impacts presentation (legends in Catalan for improved CS uptake)

The workshop also included dissemination of results for drought, heatwave impacts on infrastructures, forest fires, and holistic resilience at AMB, followed by a Q&A regarding the direct application of ICARIA project outputs, thereby consolidating the case study’s evidence base for stakeholder uptake and future planning use (Figure 12).

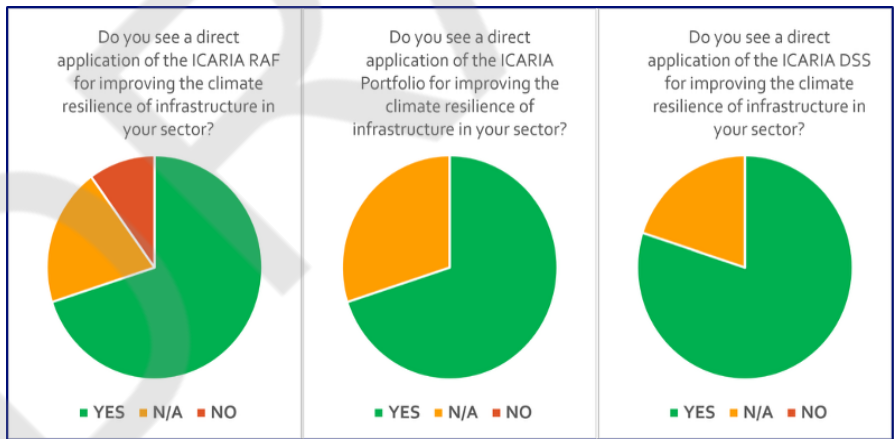


Figure 12: AMB workshop 5: perception of direct application of ICARIA outputs

5.3 The South Aegean Region CoP

The Community of Practice (CoP) established for the South Aegean Region (SAR) case study was conceived as an iterative, stakeholder-led interface to support the contextualisation, co-development, and validation of ICARIA’s multi-hazard risk and impact assessment approach and its associated decision-support services in a geographically fragmented, insular setting.

The design of the CoP pathway explicitly considered the logistical realities of an archipelagic region by limiting travel while preserving participation across islands through a combination of on-site meetings and hybrid configurations.

Across four documented workshops (with the 1st and 2nd implemented as island-specific sessions in 2023; and the 3rd and 4th delivered in hybrid mode in 2025), the SAR CoP progressively evolved from scoping (hazards, assets, and data sources) to methodological validation (wildfire and heatwave risk assessment approaches) and ultimately to tool-centred engagement through DSS demonstration and hands-on working groups aligned with upcoming mini-trials.

Table 10. South Aegean Region (SAR) CoPs.

<i>South Aegean Region (SAR) CoPs</i>		
Workshop n.	date	Format/localisation
1	Rhodes: 6 September 2023	Rhodes: South Aegean Region premises (Etiquette room)
2	Syros: 15 September 2023	Syros: Conference Hall of the Chamber of Commerce of Cyclades
3	23 May 2025	Rhodes: South Aegean Region premises (Etiquette room) & online
4	12 December 2025	Rhodes: South Aegean Region premises (Etiquette room) & online

5.3.1 Description of workshops

Workshops 1 and 2 – Foundational engagement and island-specific scoping

The first phase of South Aegean Region (SAR) stakeholders’ engagement was implemented with two CoP events held in September 2023, explicitly planned in close temporal proximity to reduce travel burdens while ensuring representation from different CI and institutional contexts. The workshop format was deliberately kept consistent across CI, with the principal difference being the island-specific climate and hazard presentations, thereby enabling comparability of stakeholder inputs while capturing localised exposure and impact patterns (**table 11**).

After a structured introduction of the ICARIA project, planned actions and the role of the CoPs, historical and projected climatic data for the host islands were presented. After that semi-structured interviews with CoP members regarding critical infrastructure and key characteristics led to a facilitated discussion of historical extreme events and associated damages and participatory mapping activity used to translate local knowledge into spatially explicit information. CoP members identified high-risk areas on island maps, providing a pragmatic pathway to capture place-based evidence relevant for trials where public datasets are incomplete or insufficiently granular.

Table 11. Agenda of 1st and 2nd CoP Workshop for the South Aegean Region (SAR)

1st and 2nd CoP Workshop – South Aegean Region (SAR) CS 6/15 September 2023	
Hour	Development
10:00 – 10:15	Welcome and presentation of the CoP Workshops
10:15 – 10:45	Presentation of the ICARIA Project and the actions planned though the Project.
10:45 – 11:15	Presentation of the Climatic data for the island (historical and projected data).
11:15 – 11:30	Coffee break
11:30– 12:30	Interviews with the CoP members about the CI and their characteristics
12:30 – 13:30	Discussion on historical extreme events and their damages
13:30 – 14:00	Wrap-up

Workshop 3 – Methodological validation: wildfire and heatwave risk assessment

The 3rd SAR CoP workshop took place in Rhodes as a hybrid event, with Syros-based CoP members joining online. The agenda was explicitly designed to consolidate progress since the 2023 scoping phase and to focus stakeholder dialogue on two core hazard domains relevant for the region: wildfire and heatwave risk assessment methodologies. Following a project progress update, the workshop presented the wildfire and heatwave methodology and concluded with a discussion segment aimed at capturing stakeholder perspectives on the adequacy, interpretability, and operational relevance of the proposed approaches (**table 12**). This workshop functioned as an intermediate “methodology checkpoint,” testing whether end-users recognised the presented methods as aligned with their risk governance needs and whether assumptions were consistent with operational experience.

Table 12. Agenda of 3rd CoP Workshop for the South Aegean Region (SAR)

3rd CoP Workshop – South Aegean Region (SAR) CS 23 May 2025	
Hour	Development
10:00 – 10:15	Welcome and presentation of the CoP Workshops
10:15 – 10:30	Presentation of the ICARIA Project progress since the previous CoP
10:30 – 11:30	Presentation of the Wildfire risk assessment methodology
11:30 – 11:45	Coffee break
11:45– 12:30	Presentation of the Heatwave risk assessment methodology
12:30 – 13:30	Discussion on findings of the methodologies and
13:30 – 14:00	Wrap-up

Workshop 4 & 5 – DSS demonstration and hands-on working groups

The 4th SAR CoP workshop took place in Rhodes as a hybrid event, with Syros participants joining online. Due to stakeholders' availability, workshop 4 and 5 have been merged. The agenda shifted toward tool engagement: after a progress update, the workshop presented the DSS and its capabilities, followed by a working group session providing hands-on DSS experience and a structured discussion on its usability and user experience. The workshop narrative linked the DSS to forthcoming mini-trials, showcasing the use of the DSS for wildfire assessment and flood risk assessment planned for the mini-trials, thereby strengthening the connection between CoP engagement and ICARIA's trial guidance methodology (Table 13).

Table 13. Agenda of 4th CoP Workshop for the South Aegean Region (SAR)

4th CoP Workshop – South Aegean Region (SAR) CS 12 December 2025	
Hour	Development
11:00 – 11:15	Welcome and presentation of the CoP Workshops
11:15 – 11:30	Presentation of the ICARIA Project progress since the previous CoP
11:30 – 12:30	Presentation of the DSS and its capabilities
12:30 – 12:45	Coffee break
12:45– 13:45	Working group session on the DSS
13:45 – 14:30	Discussion on DSS usability and experience
14:30 – 15:00	Wrap-up

5.3.2 Attendees and stakeholder profiles

The SAR CoP was structured to ensure representation of the institutions that are central to climate risk governance and crisis response in an island environment, alongside the technical and research actors responsible for tool development and methodological delivery (**Table 14**).

The CoP events included ICARIA consortium members alongside island-specific stakeholders for climate risk governance and crisis response.

In Syros, these included (among others) fire services at multiple administrative levels, the Hellenic Coast Guard (Port Authority of Syros), the electricity distribution operator (HEDNO/HEDMO), healthcare services (Syros hospital), and municipal authorities (Municipality of Hermoupolis), as well as actors related to environmental or territorial stewardship (e.g., a social cooperative enterprise active in a Natura 2000-protected area).

In Rhodes, the stakeholder profile included risk-owning and operational organisations such as the municipal water utility (DEYAR), the Hellenic Coast Guard (Central Port Authority of Rhodes), the Technical Chamber of Greece, healthcare services (Rhodes hospital), municipalities, and consortium partners (READ S.A., South Aegean Regional Authority, NCSR “Demokritos”).

This mix balanced infrastructure operators (e.g., utilities, electricity) with governance actors (e.g., emergency services, administrations), capturing real coordination needs for DSS feedback.

The hybrid workshops retained this cross-sector composition forming a multi-actor forum for validating tools in preparedness, response, recovery, and planning contexts

Table 14: list of attendees for each SAR Cop workshops

South Aegean Region CS					
Stakeholder	Description	Category	1 & 2 workshop participants**	3 workshop participants	4 workshop participants
Water Utility company of Rhodes	DEYAR (Municipal Water Supply and Sewage Enterprise of Rhodes) manages water supply, sewage, and irrigation for the entire Municipality of Rhodes, tracing origins to 1927's E.G.A.R. under Italian rule and evolving through post-war entities into a non-profit public utility owned by Rhodes Municipality since 1980 (Law 1069/80).	CoP 3rd party and Risk Owner	1(R)	-	-
Hellenic Coastguard	Central Port Authority of Rhodes is the local branch of the Hellenic Coast Guard, based in Rhodes town, responsible for maritime law enforcement, port security, border control, and search and rescue across the island's surrounding waters and ports such as Mandraki and the commercial harbour.	CoP 3rd party and Risk Owner	1(S), 1(R)	-	-
Technical Chamber of Greece	The Technical Chamber of Greece is the official professional body for engineers in Greece and the state's technical advisor, founded in 1923 as a public legal entity based in Athens with 17 regional departments. It maintains the engineer register, grants professional licenses after exams, and promotes science, technology, and sustainable development	CoP 3rd party and Risk Owner	1(R)	1	1

	across all engineering disciplines while advising the government on technical, environmental, and infrastructure policy				
Ministry of Health – Rhodes Hospital	The General Hospital of Rhodes “Andreas G. Papandreou” is the main public hospital on Rhodes, operating 24/7 under Greece’s Ministry of Health and the 2nd Regional Health Authority of Piraeus & Aegean, with around 280–335 beds	CoP 3rd party and Risk Owner	1 (R)	1	1
Municipality of Rhodes	The Municipality of Rhodes (Δήμος Ρόδου) is a single island-wide local authority in the South Aegean Region, created by the 2011 Kallikratis reform through the merger of ten former municipalities and today covering 1,407.94 km ² with about 125,000 residents.	CoP 3rd party	2 (R)	1	-
Ministry of Health – Syros Hospital	The General Hospital of Syros “Vardakeio & Proio” provides comprehensive public healthcare to Syros and Cyclades islands from its location at 2 Georgiou Papandreou St. in Ermoupoli. Established in 1958 via philanthropists’ endowments under the Ministry of Health’s 2nd Regional Health Authority, it offers emergency, surgical, pathological, pediatric, dialysis, and diagnostic services with around 150 beds.	CoP 3rd party and Risk Owner	1 (S)	1	-
Municipality of Hermoupolis	The Municipality of Hermoupolis governs the entire island of Syros, including Ermoupoli as its capital and seat, plus Gyaros and nearby islets, covering 101.9 km ² with 20,791 residents as of 2021. Formed in 2011 under the Kallikratis reform by merging former municipalities of Ermoupoli, Ano Syros, and Poseidonia.	CoP 3rd party	2 (S)	1	1

<p>SCE Apano Meria</p>	<p>SCE Apano Meria, a social cooperative enterprise launched in 2017 on Syros, champions sustainable development and heritage preservation in the island's northern Apano Meria region—a 45% Natura 2000-protected area—via research, cultural events, volunteering, geotourism, organic farming, and eco-friendly pursuits like hiking and upcycling.</p>	<p>CoP 3rd party</p>	<p>1 (R), 1 (S)</p>	<p>-</p>	<p>-</p>
<p>READ S.A.</p>	<p>READ S.A. (Regional Development Company of South Aegean Region) is the Development Agency of the South Aegean Region, based in Rhodes, supporting regional authorities with project planning and management in areas such as cultural heritage, tourism infrastructure, civil protection, sustainability, and EU-funded programs</p>	<p>ICARIA consortium member</p>	<p>2 (S)</p>	<p>1</p>	<p>1</p>
<p>South Aegean Regional authority</p>	<p>The South Aegean Regional Authority headquartered in Ermoupoli on Syros, governs the Cyclades and Dodecanese island complexes spanning 5,286 km² with 13 regional units and 33 municipalities. Established in 1987 and reformed by Kallikratis in 2010.</p>	<p>ICARIA consortium member</p>	<p>3 (R), 2(S)</p>	<p>-</p>	<p>1</p>

<p>NCSR "Demokritos"</p>	<p>NCSR Demokritos is Greece's largest multidisciplinary public research centre, founded in 1961 as a nuclear research facility and now spanning fields such as energy and environment, nanotechnology and materials, biosciences, nuclear and particle physics, and informatics and telecommunications. Hosting around 180 tenured researchers and over 500 research staff, it operates five institutes under the General Secretariat for Research and Innovation, combining cutting-edge R&D with graduate education, and high-tech services.</p>	<p>ICARIA consortium member</p>	<p>2 (R), 1 (S)</p>	<p>1</p>	<p>1</p>
<p>Decentralized Administration of the South Aegean</p>	<p>The Decentralized Administration of the Aegean is a key regional authority in Greece, established in 2011 via the Kallikratis Plan. Headquartered in Piraeus, it manages the North and South Aegean regions, spanning islands like Lesbos, Chios, Samos, and Cyclades, with responsibilities in urban planning, environment, migration, and local government oversight.</p>	<p>CoP 3rd party</p>	<p>1 (S)</p>	<p>1</p>	<p>1</p>
<p>Civil aviation authority</p>	<p>The Hellenic Civil Aviation Authority (HCAA) is Greece's regulatory body for civil aviation, overseeing air traffic management, airport operations, aircraft safety, and licensing from its base in Glyfada, Athens. It ensures compliance with EU and ICAO standards while handling recent challenges like the January 2026 Athens FIR blackout, prompting the governor's resignation.</p>	<p>CoP 3rd party</p>	<p>1 (S)</p>	<p>-</p>	<p>-</p>
<p>South Aegean region Fire Service</p>	<p>The South Aegean Region Fire Service is a decentralized unit of Greece's Hellenic Fire Service, responsible for firefighting, rescue operations, and emergency response across islands like the Cyclades and Dodecanese. It coordinates local fire stations,</p>	<p>CoP 3rd party and Risk Owner</p>	<p>1 (S)</p>	<p>1</p>	<p>-</p>

	volunteer crews, and specialized units for wildfires, accidents, and disasters under the national framework.				
Cycladic region Fire Service	The Cycladic Region Fire Service operates as a prefectural unit of Greece's Hellenic Fire Service, managing firefighting, rescues, and emergencies across Cyclades islands like Syros, Paros, Naxos, and Santorini. Based under the South Aegean regional command with stations such as Messaria on Santorini and outposts on Andros, it tackles wildfires, accidents, and civil protection, often coordinating volunteers amid high fire risks.	CoP 3rd party and Risk Owner	1 (S)	-	-
Syros island Fire Service	The Syros Island Fire Service is a local fire brigade under the Cyclades prefectural and South Aegean regional commands of Greece's Hellenic Fire Service. It responds to fires, rescues, and emergencies on Syros, collaborating with municipal authorities and volunteers for island-specific risks like wildfires.	CoP 3rd party and Risk Owner	1 (S)	-	-
Hellenic Coastguard	The Hellenic Coast Guard Port Authority of Syros, located in Ermoupoli, functions as the primary maritime authority for Syros and nearby Cyclades islands under the Hellenic Coast Guard's 6th Regional Command headquartered on Syros. It manages search and rescue missions, port security, anti-smuggling efforts, pollution control, and navigation enforcement across areas including Andros, Tinos, Mykonos, Naxos, Paros, Kea-Kythnos-Milos, and Thira, utilizing patrol vessels and collaborating with local agencies for island-specific operations.	CoP 3rd party and Risk Owner	1 (S)	1 (S), 1 (R)	-

<p>Hellenic Electricity Distribution Network Operator S.A. (HEDMO)</p>	<p>HEDNO S.A., the Hellenic Electricity Distribution Network Operator oversees the operation, maintenance, and expansion of Greece's electricity distribution infrastructure, spanning 241,000 km of lines and serving 7.5 million customers across the mainland and islands including Syros. Established in 2012 under EU unbundling rules as an independent entity from PPC, it ensures non-discriminatory grid access, invests in smart grids and renewables integration, and reports to the Regulatory Authority for Energy (RAE) from its Athens headquarters.</p>	<p>CoP 3rd party and Risk Owner</p>	<p>1 (S)</p>	<p>1</p>	<p>1</p>
<p>Rhodes island Fire Service</p>	<p>The Rhodes Island Fire Service operates as a regional command of Greece's national Hellenic Fire Service under the Ministry for Citizen Protection. It manages fire suppression, rescues, and disaster response across the island, addressing frequent wildfires, urban fires, and emergencies in this tourist-heavy Mediterranean area.</p>	<p>CoP 3rd party and Risk Owner</p>	<p>-</p>	<p>1</p>	<p>1</p>
<p>Centre for Research and Technology (CERTH)</p>	<p>The Centre for Research and Technology Hellas (CERTH) is one of Greece's largest research centres, founded in 2000 as a non-profit private law entity supervised by the General Secretariat for Research and Innovation under the Ministry of Development. Headquartered primarily in Thessaloniki with operations across six regions, CERTH employs over 1,100 scientists and engineers across five institutes focusing on areas like clean energy, climate change mitigation, artificial intelligence, advanced robotics, smart cities, precision agriculture, and circular economy.</p>	<p>CoP 3rd party</p>	<p>-</p>	<p>1</p>	<p>1</p>

** R= attendee at the Rhodes event; S= attendee at the Syros event

5.3.3 Main discussion points and outputs

Foundational knowledge capture and hotspot identification (Workshops 1 & 2)

The principal outputs of the first two workshops were the structured capture of island-specific hazard experience and critical infrastructure characteristics, paired with the identification of high-risk areas based on stakeholder local knowledge, clarifying: (i) which hazards and receptors are most salient for stakeholders, (ii) where critical assets are perceived to be exposed, and (iii) which data gaps and access constraints would need to be addressed to operationalise risk and impact assessment workflows. Through facilitated discussion, stakeholders provided information that is often incomplete in public records thereby enabling ICARIA partners to better align analytical demands with realistic data inputs and decision needs. The participatory mapping exercise—where CoP members placed high-risk areas on island maps—created a practical validation layer that can support hazard model checking and the prioritisation of receptors/areas for analysis and demonstration (Figure 13).

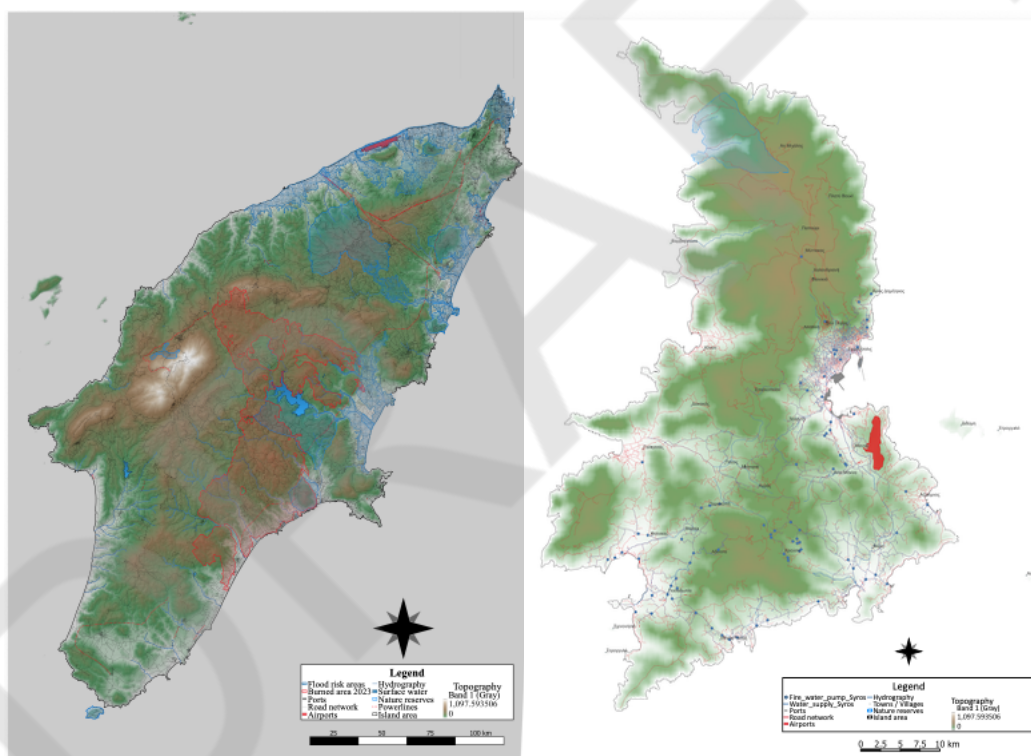


Figure 13: SAR-Workshop 1&2: participatory mapping exercise

A recurring theme emerging from this early phase of the CoP concerns data and coordination constraints. The stakeholders explicitly noted limited data availability for some critical infrastructures and highlighted the structural challenge of performing rapid, data-intensive assessments in resource-constrained settings and the need for workflows that can incorporate delayed post-event information without losing relevance. Additionally, the CoP recorded that communication across sectors needed improvement—an issue with direct implications for the DSS, given that the tool’s practical value depends on the ability of multiple actors to access shared evidence, interpret results consistently, and coordinate responses and adaptation options. At the

same time, stakeholders expected the DSS to become a valuable instrument for regional planning, establishing an early benchmark of anticipated utility that later workshops sought to test through direct interaction with the platform (**table 15**).

Table 15. SAR workshop 1 & 2 discussed themes

Workshop (month)	Theme	Topics to be covered	Matters to be considered
Workshop 1 and 2 (M13)	<p>Presentation of ICARIA and identification of challenges and opportunities</p> <p>Discussion of the Risk Assessment approach</p>	<ol style="list-style-type: none"> 1. Inform stakeholders about the ICARIA project. 2. Introduction to CoP objectives and procedures. 3. Risk & gaps identification: key hazards and assets and services at risk that aren't sufficiently well assessed today. 4. Define contribution from stakeholders (bidirectional perspective: 5. Definition of the specific Trial context of each CS. 6. Present the solutions project is developing and get feedback on needs, expectations etc.: <ul style="list-style-type: none"> • Expected DSS features • Evaluation of Portfolio of Adaptation Measures • Discussion of risk assessment methods developed 7. Present data/knowledge gaps and define possible solutions gaps of the models. 8. Present the Trial methodology and organisation: <ul style="list-style-type: none"> • Assess the trial gaps, objectives and research questions • Assess the proposed scenarios and discuss the roles of CoP members in these scenarios/trials 	<ul style="list-style-type: none"> • Prepare a concise presentation of the following: <ul style="list-style-type: none"> ○ Overall framework (Task 1.1) ○ Hazard assessment methods (Task 2.2) ○ Impacts assessment method (Task 3.1)

Validation of wildfire and heatwave methodologies and engagement quality improvements (Workshop 3).

Workshop 3 functioned as a method-focused validation forum, presenting wildfire and heatwave risk assessment approaches and explicitly seeking stakeholder feedback on their adequacy and applicability. Key recorded outputs included improved data availability via additional CI information provided by the CoP members, and the delivery of wildfire impact information which together indicate that the CoP is not only a discussion space but also a mechanism for incremental evidence mobilisation (**Figure 14**). Stakeholders provided positive feedback, suggesting that the approaches were communicated in a way that was meaningful to end-users and that the modelling logic was not perceived as disconnected from local experience.

Results – Impact

Asset	Asset total	Asset's impact	(%)
Buildings	68637	2008	3%
Road network (km)	4818	446	9%
Power distribution grid (km)	163	15.6	10%
Green areas (km ²)	99.95	13.27	13%

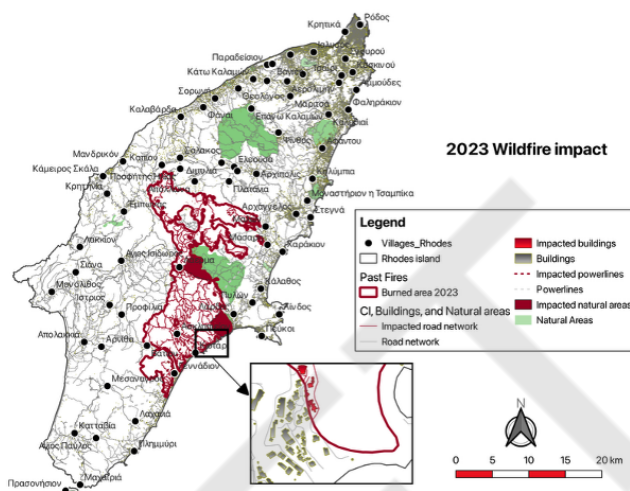


Figure 14: SAR workshop 3: impact results

Workshop 3 also recorded improvements in communication among sectors compared with the prior CoP, which is an important enabling condition for subsequent tool use and trial execution in multi-actor CI governance settings. The positive assessment of the hybrid setup reinforces the feasibility of sustained engagement across islands and supports the scalability of the CoP model in contexts where travel is costly, and stakeholder availability is limited (table 16).

Table 16. SAR workshop 3 discussed themes

Workshop (month)	Theme	Topics to be covered	Matters to be considered
Workshop 3	Evaluation of preliminary results	<ol style="list-style-type: none"> 1. Presentation of the results of the three "Lab Tasks". 2. Discuss the newly identified gaps in the risk assessment methods and results. 3. Present and validate the Trial organization and planning: <ul style="list-style-type: none"> • Define Trial objectives • Define specific roles and expectations of CoP members during the Trial 4. Reevaluation of alignment between project results and CoP expectations. 	<ol style="list-style-type: none"> 1. Present a plan of the trial implementation with all the roles and duties already defined. 2. Participation process to reevaluate CoP needs and expectations.

DSS usability, data readiness, and mini-trial alignment (Workshop 4).

Workshop 4 generated the most explicit outputs regarding tool uptake conditions and user experience. Stakeholders experienced a hands-on approach on the DSS evaluation and assessed the DSS as user-friendly overall, while also identifying language and terminology barriers. CoP members considered the DSS valuable for adaptation and regional planning; a mini-trial demonstration for Naxos using the DSS was successfully demonstrated while still highlighting the expected need for describing specific data characteristics indicating that usability is constrained not only by the interface but also by the availability of curated hazard/exposure/vulnerability inputs and by the capacity to describe CI characteristics in a structured manner.(Figure 15).

Διαδικασία στο DSS

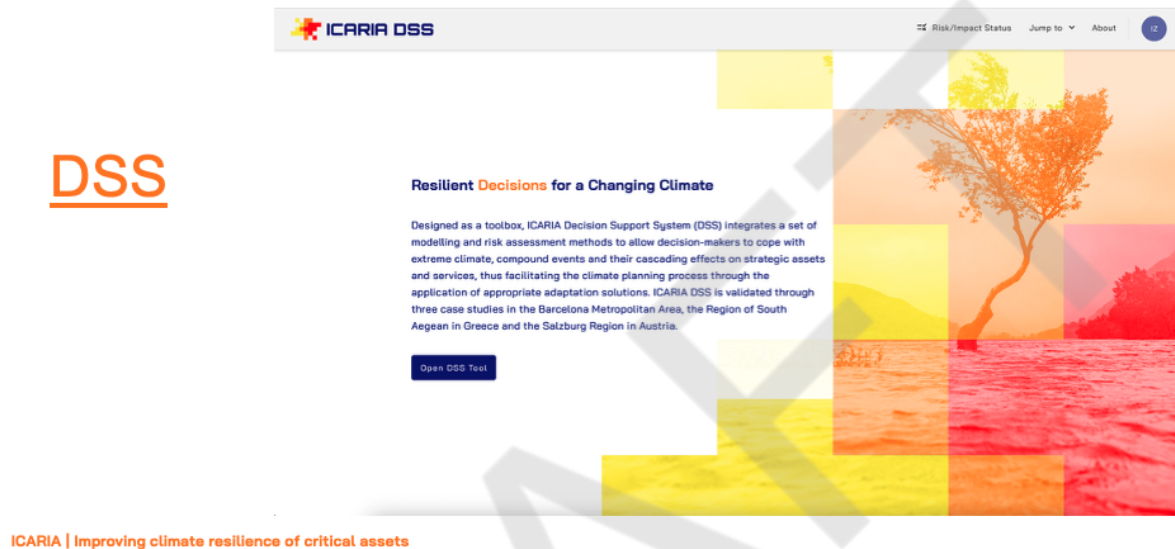


Figure 15: SAR workshop 4: DSS testing

Stakeholders concluded that the DSS can significantly support adaptation planning and regional planning, which strengthens the evidence base for the tool’s perceived utility beyond expectations expressed in the first workshops. The successful demonstration of the Naxos mini-trial using the DSS provides an additional, practice-oriented indication that the platform can support demonstration workflows, while simultaneously confirming that data on CI characteristics remains a critical prerequisite for meaningful analysis (table 17).

Table 17. SAR workshop 3 discussed themes

Workshop (month)	Theme	Topics to be covered	Matters to be considered
Workshop 4	Trial execution	<ol style="list-style-type: none"> 1. Evaluate preliminary DSS design and features (2. Execution of the Trial: CoP Members are actively involved in it as observers and evaluators of the results. 3. Identify further interests of CoP that can be developed in the Mini-Trial phase. 4. Identify which aspects of the trials are particularly relevant for the end-users/suitable for demonstrators, and for the dissemination/communication. 	<ul style="list-style-type: none"> • Prepare a concise presentation of the following: <ul style="list-style-type: none"> ○ Results of the trial implementation ○ Data/results gaps identified • Execute the Trials with the whole CoP in a demonstration process. • Participation process to identify further CoP needs and expectations. • Participatory process to evaluate current features of DSS and define further developments of interest.

5.4 Case Study: The Salzburg Region

5.4.1 Description of workshops

The Community of Practice (CoP) established for the Salzburg (SLZ) case study was designed as an iterative stakeholder interface to support the contextualisation, co-design and validation of ICARIA’s multi-hazard risk and impact assessment workflow and its associated decision-support services.

Across five documented workshops (2023–2026), the CoP progressed from exploratory risk framing and stakeholder scoping to the discussion of modelling outputs and data gaps, followed by resilience assessment tools and a trial-oriented, hands-on evaluation of the Decision Support System (DSS). In addition, a 5th Salzburg CoP Workshop is scheduled for 4 March 2026 that took the form of the National event for the Salzburg case study in which all the main results of the project have been presented and discussed with all the stakeholders and new public institutions and governmental representatives potentially interested in the implementation of adaptation measures or policies (**table 18**).

Table 18. Salzburg Region (SLZ) CoPs.

<i>Salzburg Region (SLZ) CoPs</i>		
Workshop n.	date	Format/localisation
1	5 July 2023	Wirtschaftskammer Bezirksstelle Zell am See (Schulstraße 14, 5700 Zell am See)
2	23 April 2024	SinnZENTRUM Salzburg (Berchtesgadnerstraße 11, 5020 Salzburg)
3	20 November 2024	SinnZENTRUM Salzburg (Berchtesgadnerstraße 11, 5020 Salzburg)
4	18 November 2025	SinnZENTRUM Salzburg (Berchtesgadnerstraße 11, 5020 Salzburg)
5	4 March 2026	Online – Microsoft teams

5.4.1 Description of workshops

Workshop 1 – CoP launch and initial risk framing

The 1st Salzburg (SLZ) CoP Workshop combined an ICARIA overview and introduction to CoP functioning with an extended interactive session focused on identifying risks and challenges, discussing available models and data, and collecting expectations and next steps. The workshop documented early stakeholder concerns regarding access and dissemination of future risk maps (with a preference for integration into existing public dashboards and potentially Salzburg’s GIS environment, SAGIS) as well terminological issues regarding the definition of “risk” in a multi-hazard setting, including questions about compound events and the scope of protection objectives (**table 19**).

Table 19. Agenda of 1st CoP Workshop for the Salzburg CS.

<i>1st CoP Workshop –Salzburg CS</i> July the 5 th 2023	
Hour	Development
09:45 – 10:00	Welcome & round of introductions
10:00 – 11:00	Project overview & introduction to CoPs
11:00 – 11:20	Coffee break
11:20 – 13:00	Identification of risks and challenges & Next steps & Expectations for the project

Workshop 2 – Methodology, initial results, data gaps, and structured participatory validation

The 2nd Salzburg CoP Workshop began with a review of prior CoP activities with a presentation of methodology, initial results and data gaps, followed by an interactive session and an outlook focused on the DSS and adaptation measures. The interactive work was organised into four structured parts: (i) mapping locations of recent extreme events to support flood-model validation; (ii) assessing affectedness of electricity assets, properties and transport under intensified heavy precipitation/storm scenarios; (iii) discussing recovery dynamics under consecutive events; and (iv) eliciting DSS use cases and desired customisation/functionality (**Table 20**).

Table 20. Agenda of 2nd CoP Workshop for the Salzburg CS.

<i>2nd CoP Workshop –Salzburg CS</i> April the 23 rd 2024	
Hour	Development
13:00 – 13:15	Welcome & round of introductions
13:15 – 13:30	Project overview & overview of past CoPs
13:30 – 14:10	Presentation of the methodology, initial results and data gaps

14:10 – 14:30	Coffee break
14:30 – 15:30	Interactive session
15:30 – 15:50	Outlook: Decision Support System & Adaptation Measures
15:50 – 16:00	Next steps & farewell

Workshop 3 – Consolidation of results and onboarding to DSS/RAF/RAT

The 3rd Salzburg CoP Workshop presented updated methodological elements and initial modelling outputs (including climate indicators and first flood-modelling results) and explicitly introduced the DSS alongside the Resilience Assessment Framework (RAF) and the Resilience Assessment Tool (RAT). The workshop also identified concrete involvement pathways, including the indication that RAF/RAT would be tested with the community of Mittersill in the period December 2024–February 2025. In addition, it recorded persistent constraints affecting impact assessment credibility and feasibility, particularly challenges in estimating damage costs and the scarcity of robust empirical linkages between flood depth and damage (**Table 21**).

Table 21. Agenda of 3rd CoP Workshop for the Salzburg CS.

3 rd CoP Workshop –Salzburg CS November the 20 th 2024	
Hour	Development
13:00 – 13:15	Welcome & round of introductions
13:15 – 13:30	Project overview & overview of past CoPs
13:30 – 14:30	Project goal "Decision Support System" & current results
14:30 – 14:45	Coffee break
14:45 – 15:30	Interactive session
15:30 – 15:50	Resilience Assessment Framework & Tool
15:30 – 15:45	Next steps & farewell

Workshop 4 – DSS trial session

The 4th Salzburg CoP Workshop functioned as a trial session for the DSS. After presenting risk assessment results and reviewing progress, participants conducted a guided test run of the DSS in two blocks, operating in groups with scripted guidance and observer monitoring to capture usability-oriented feedback. Trial tasks included calculating wind risk for electricity infrastructure, exploring climate risk maps, and testing the RAF component, thereby assessing both analytical content and interaction workflows within the DSS environment. No limitations or difficulties were encountered and anticipated a subsequent CoP (noted as potentially online) in spring 2026, supporting continuity of engagement beyond the in-person trial (**Table 22**).

Table 22. Agenda of 4th CoP Workshop for the Salzburg CS.

<i>4th CoP Workshop –Salzburg CS</i> November the 18 th 2025	
Hour	Development
13:00 – 13:15	Welcome & round of introductions
13:15 – 13:45	Project overview, review of past CoP, results & decision support system
13:45 – 14:45	Test run of decision support system
14:45 – 15:00	Coffee break
15:00 – 15:45	Test run of decision support system
15:45 – 16:00	Next steps & farewell

Workshop 5 – National final event

A 5th Salzburg CoP Workshop was held as the National final event online, using Microsoft Teams platform. The main objectives of the 5th CoP workshop included the presentation of the final results of the project as well as a focus on the national outcomes. This has been achieved presenting the results of the risk assessment for the area of Mittersill, carried out during the project. The event also included the presentation of the DSS functionalities (**table 23**).

Table 23. Agenda of 5th CoP Workshop for the Salzburg CS.

<i>5th CoP Workshop –Salzburg CS</i> March the 4 th 2026	
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Hour	Development
13:00 – 13:25	Welcome, Project overview, Presentation of Impact assessment results for Salzburg/Mittersill
13:25 – 13:45	Presentation of Decision support system
13:45 – 14:00	Discussion & Goodbye

DRAFT

5.4.2 Attendees and stakeholder profiles

The Salzburg Region CoP coordinated by AIT with Verbund (Risk Owner for electricity/hydropower), included municipal actors (e.g., Mittersill, Salzburg), regional programs (KEM, KLAR!), and Salzburg Provincial Government departments (hydrology, forestry, disaster management) (**Table 24**).

This blend linked strategic planning/regulatory views with technical-operational ones (e.g., hazard management, infrastructure).

Participation broadened over time to include additional expert and sectoral perspectives relevant for a multi-domain understanding of risk, impacts and response. Workshop 3 added GeoSphere Austria, torrent/avalanche control, chamber of commerce, and Paracelsus Medical University for multi-domain risk insights.

Workshop 5 included Linz (Upper Austria) as an external stakeholder, signalling growing external interest and enhancing validation legitimacy and tool transferability.

This progressive diversification increases the legitimacy of validation activities and strengthens claims on usability and potential transferability of tool-supported workflows beyond a single institutional viewpoint.

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Table 24. Salzburg Region (SLZ) attendees list.

Salzburg region CS CoPs							
Stakeholder	Description	Category	1 workshop participants	2 workshop participants	3 workshop participants	4 workshop participants	5 Workshop participants
AIT	AIT is the Case study coordinator	ICARIA consortium member	3	3	3	4	3
City of Mittersill	Mittersill is a town in the province of Salzburg. With 6267 inhabitants, it is the largest town in Ober Pinzgau and often affected by flooding.	CoP 3rd party	1	1	-	-	1
KEM Saalfelden Leogang	The "Climate and Energy Model Regions" program, funded by the Austrian Climate and Energy Fund, supports Austrian regions in making optimal use of their local renewable energy resources, exploiting the potential for energy savings and operating sustainably.	CoP 3rd party	1	1	-	-	1
KEM Nationalparkregion	The "Climate and Energy Model Regions" program, funded by the Austrian Climate and Energy Fund, supports Austrian regions in making optimal use of their local renewable energy resources,	CoP 3rd party	1	-	-	-	-

	exploiting the potential for energy savings and operating sustainably.							
KLAR! Pinzgau	The "Climate and Energy Model Regions" program, funded by the Austrian Climate and Energy Fund, supports Austrian regions at an early stage with its " Climate Change Adaptation Model Regions (KLAR!) " funding programme. This helps to reduce damage and exploit opportunities.	CoP 3rd party	1	-	-	1	1	
Office of the Salzburg Provincial Government Forest department	The forest department takes care of forestry and timber industry matters	CoP 3rd party	1	1	1	1	-	
City of Salzburg	Capital City of the case study country	CoP 3rd party	1	-	-	1	1	
Verbund	Verbund is one of the largest producers of electricity from hydropower in Europe.	ICARIA consortium member and Risk Owner	2	2	1	1	1	

KEM Saalachtal	The "Climate and Energy Model Regions" program, funded by the Austrian Climate and Energy Fund, supports Austrian regions in making optimal use of their local renewable energy resources, exploiting the potential for energy savings and operating sustainably.	CoP 3rd party	-	1	-	-	-
Office of the Salzburg Provincial Government Catastrophe funds	The Climate Protection, Sustainability and Waste Management Department deals with the coordination of the climate and energy strategy and adaption goals.	CoP 3rd party	-	1	-	1	-
Office of the Salzburg Provincial Government Hydrological Service	The hydrological service observes, researches, analyses and keeps evidence of the basic data of the quantitative water cycle.	CoP 3rd party	-	1	2	2	-
Local Railway	The local railway (Pinzgauer Lokalbahn) operates the local railroad.	CoP 3rd party	-	2	-	-	-
Office of the Salzburg Provincial Government Geology department	Geological experts work for <ul style="list-style-type: none"> Disaster service in the province of Salzburg 	CoP 3rd party	-	-	1	-	-

	<ul style="list-style-type: none"> • Processing of subsoil identification (drilling) for the public sector • Official expert for geothermal systems (deep probes) • Preparation of drilling data in the Salzburg subsoil register, which is publicly accessible • Groundwater data for provincial construction sites in coordination with the hydrographic service 						
Salzburg Institute for Urban Planning and Living	Communal and regional development, climate adaptation, energy and climate planning	CoP 3rd party	-	-	1	1	1
Geosphere Austria	GeoSphere Austria is responsible for distributing warnings to the public as well as advising the federal government on topics related to the fields. In addition, GeoSphere Austria provides an important base for a prevention-oriented approach to climate change and the sustainable development of Austria.	CoP 3rd party	-	-	1	-	3
Torrent and Avalanche Control	Take care of floods, mudslides, landslides, rockfalls and avalanches which pose a high security risk for the population, their	CoP 3rd party	-	-	1	-	-

	living, settlement and economic areas and infrastructure.						
Chamber of commerce		CoP 3rd party	-	-	1	-	1
PMU Salzburg	Paracelsus Medical University	CoP 3rd party	-	-	1	-	-
City of Linz	Linz is the capital town of the province of Upper Austria and interested in the ICARIA methodology.	External stakeholder	-	-	-	-	2

During the workshop, stakeholders reflected about the escalation of impacts under intensified heavy precipitation/storm scenarios, focusing on electricity assets, properties and transport, explicitly exploring recovery timelines under consecutive events, thereby capturing a time-dimension of vulnerability and disruption that is often underrepresented in static assessments (**Figure 18**).

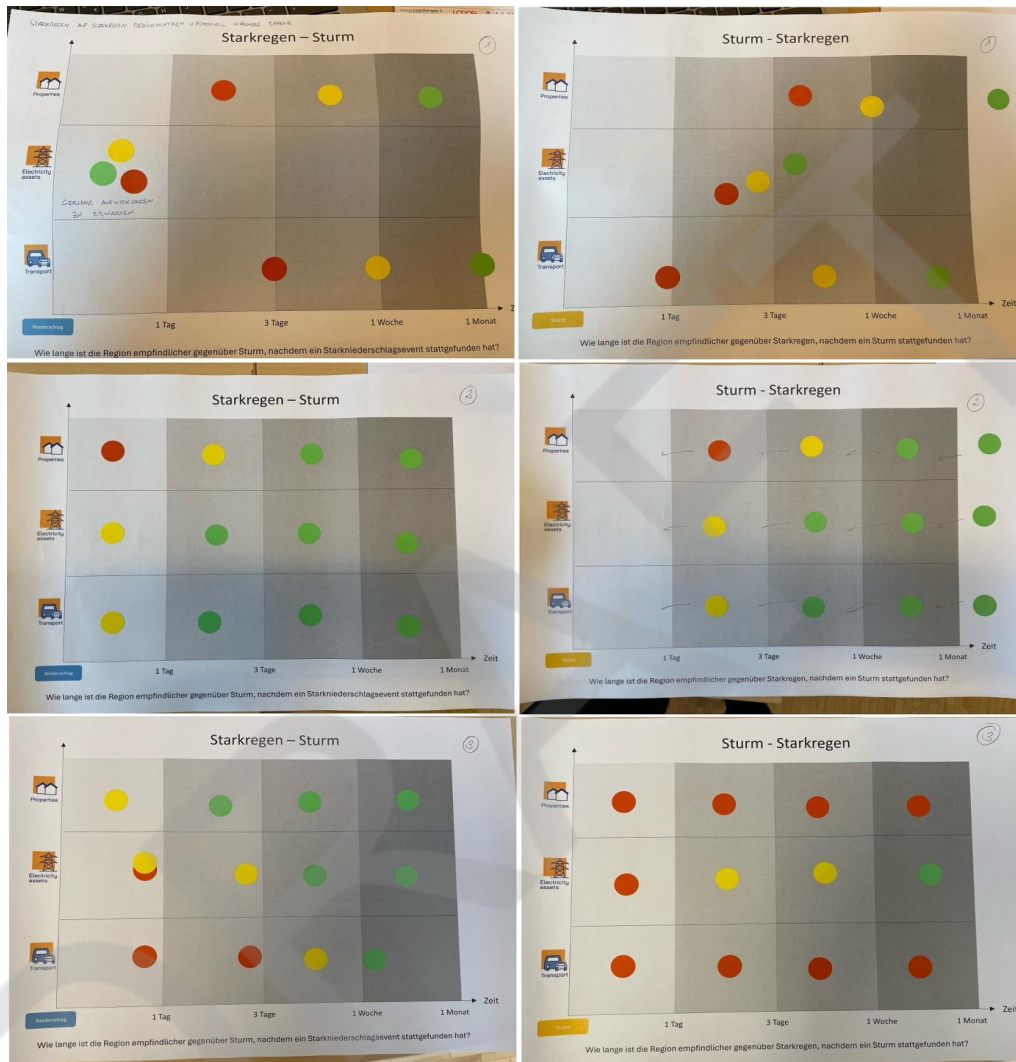


Figure 18: SLZ workshop 2: participative activity - Time series

In parallel, the workshop recorded a discussion on threshold values relevant to operational disruption (e.g., rainfall intensity over a defined duration), supporting the translation of hazard modelling results into decision-relevant triggers (**Figure 19**).

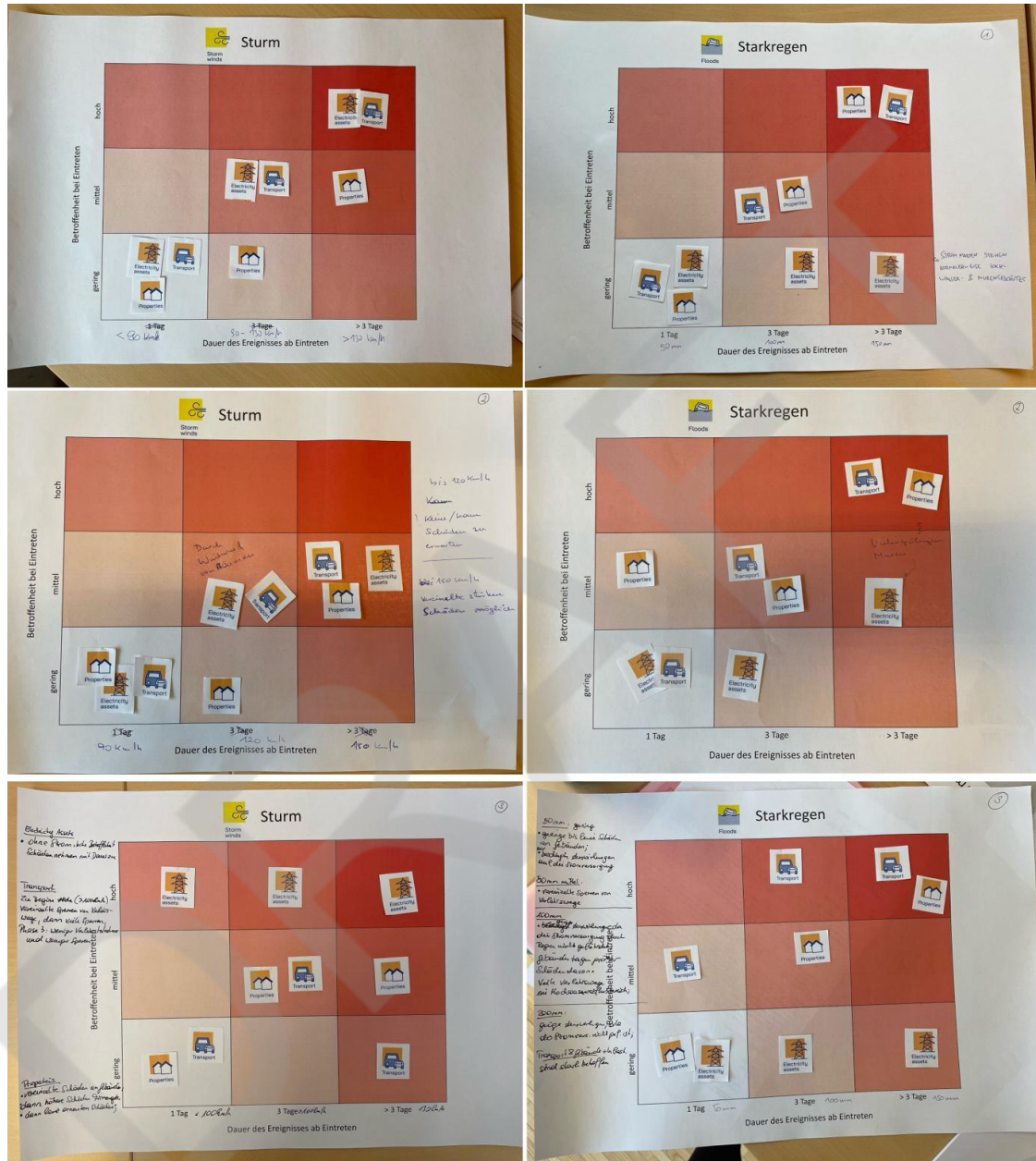


Figure 19: SLZ workshop 2: participative activity – risk mapping

The DSS-focused feedback activity generated a broad set of prospective use cases and adaptation themes. Stakeholders discussed possible applications for education and training, awareness raising and lessons-learned processes, as well as policy instruments linked to spatial planning and building regulation adjustments, complemented by technical measures such as retention areas, protective structures, and river widening/renaturation, and considerations related to insurance. Notably,

stakeholders emphasised that a large share of adaptation leverage is linked to spatial planning, seemingly highlighting that ICARIA outputs must be interpretable and usable for planning and regulatory audiences (**Figure 20**).

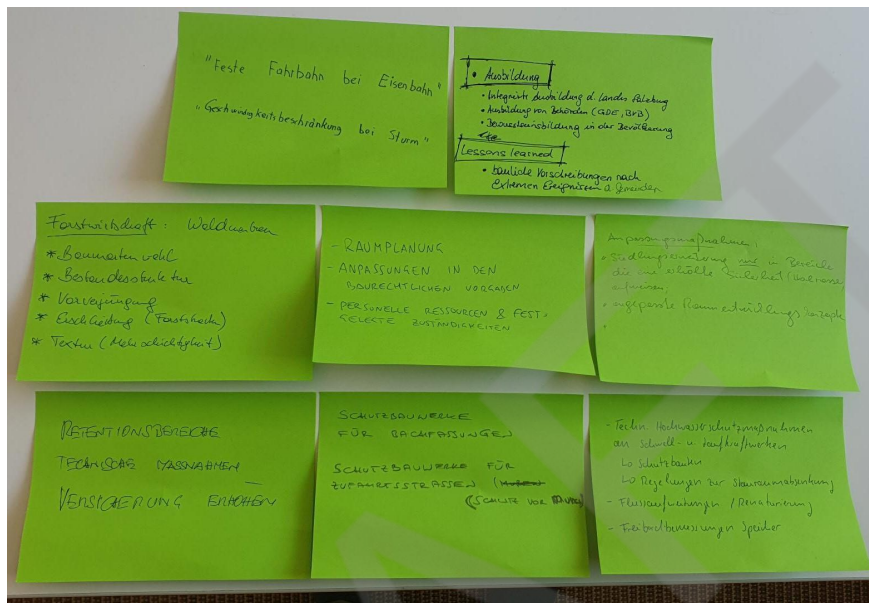


Figure 20: SLZ workshop 2: participative activity – DSS

Implementation realism and data constraints for impact assessment (Workshop 3)

Workshop 3 consolidated the transition from methodological discussion to tool onboarding by presenting the DSS together with RAF and RAT, and by identifying a concrete pilot pathway for resilience assessment tool testing with the community of Mittersill (December 2024–February 2025). The workshop also documented critical limitations affecting impact assessment: stakeholders stressed the difficulty of estimating damage costs due to building-specific variability and the limited availability of datasets linking flood height to damage costs.

DSS trial: feasibility of end-user interaction (Workshop 4).

Workshop 4 operationalised stakeholder engagement through a hands-on DSS trial session, in which participants tested core functionalities (including wind risk for electricity infrastructure, map-based exploration of climate risk information, and the RAF component). The participants were divided into two groups and carried out the test run of the DSS, which was guided by a script. The wind risk for electricity infrastructure was calculated, the map view for the climate risk maps was explored, and the DSS was tested (**Figure 21**). The trial design provided an explicit, replicable evaluation approach that can be reused in subsequent workshops and in replication contexts, supporting quality assurance and traceability of usability feedback. No limitations or difficulties were encountered and identified preparation for a subsequent CoP as a next step, reinforcing continuity and iterative refinement beyond the trial event.

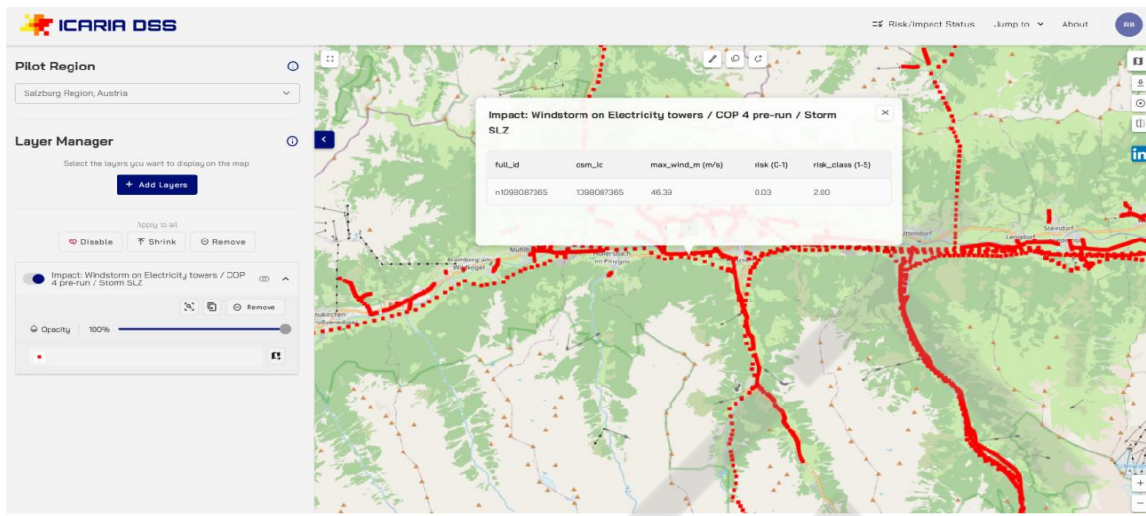


Figure 21: SLZ-Workshop 4: participative activity – DSS testing

national dissemination (Workshop 5)

Workshop 5 concluded the cycle of CoPs workshop for the Salzburg case study, highlighting both the technical advancements of the project and the pressing practical needs of regional decision-makers. In addition to the results of the impact assessment, a central topic concerned the accessibility of the Decision Support System (DSS) which confirmed to be of high interest for stakeholders also in future different uses. Technical experts provided deep insights into the underlying methodology, e.g. detailing the use of SFINCS (Super-Fast INundation of CoastS) for high-resolution flood modelling. The innovative focus on compound events stimulated further interest in exploring hazard combinations beyond the current focus on wind and precipitation. Overall, the stakeholders recognised the potential of the tool, emphasising its capacity to make flood protection planning more systematic and strongly data driven. The presentation of the Mittersill area worked as the occasion for stakeholders to require such an innovation, pointing out that the region has faced three extreme flood events within the last 16 years that are reshaping local risk perceptions and generating considerable concern among residents (Figure 22).

Fire Weather Index

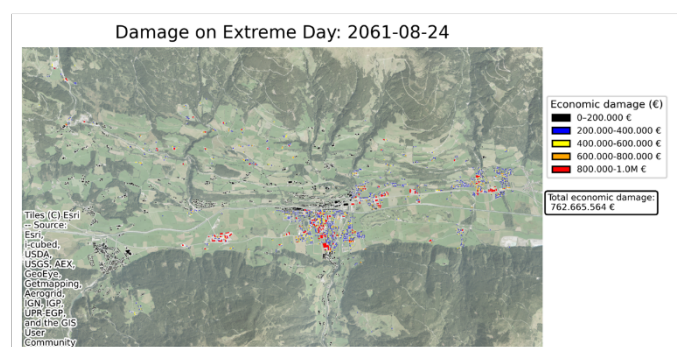
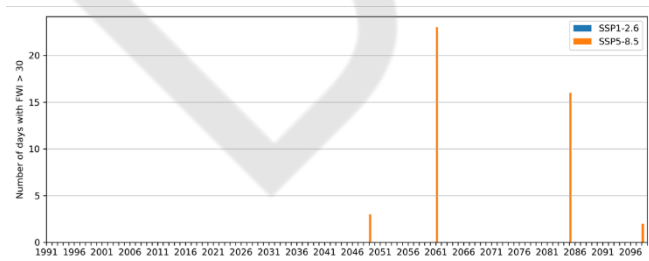


Figure 22: SLZ workshop 5: presentation of the results of the Fire Weather Index for the Mittersill area

5.5. ICARIA Final Event

The ICARIA Final Event represents the culminating dissemination activity of the ICARIA project. The event (realized at M39) synthesized the project outcomes to promote replication in follower regions and inform policy, aligning with EU Climate Change Adaptation Mission goals for cost-efficient adaptation and stakeholder uptake (**Figure 23**). After post-trials and mini-trials, the event was structured around keynote contributions, CS presentations, and a moderated round table, addressing vulnerabilities in Mediterranean hotspots and alpine areas and emphasizing cascading effects on strategic services.



ICARIA FINAL EVENT

Sala d'actes José Antonio Torroja, Barcelona School of Civil Engineering - UPC & online

13TH MARCH

- 9:30** *Registration and welcome coffee*
- 10:00** **Institutional welcome**
Esther Real (Barcelona School of Civil Engineering - UPC)
- 10:10** **Introduction to the event**
Beniamino Russo (Barcelona School of Civil Engineering - UPC)
- 10:20** **Keynote speech on the damage caused by the DANA in Valencia**
Francisco Espejo (Consortio de Compensación de Seguros)
- 10:50** **Highlights from the three pilot regions**
Àlex de la Cruz (Veolia)
Marianne Bügelmayer-Blaschek (Austrian Institute of Technology)
Thanasis Sfetsos (National Centre for Scientific Research "Demokritos")
- 11:50** *Coffe break*
- 12:10** **Round table discussion**
Moderator: Mattia Leone (Università di Napoli Federico II)
Guests: Ana Romero (Barcelona Metropolitan Area)
Mara Iaccarino (Comune di Napoli)
Lorenzo Chelleri (Universitat Internacional de Catalunya)
- 12:50** **Event closure**
Àlex de la Cruz (Veolia)
- 13:00** **Visit to the UPC Hydraulics Laboratory**
Beniamino Russo (Barcelona School of Civil Engineering - UPC)
- 14:00** *Lunch*



Figure 23: ICARIA Final Event's Agenda

By bridging scientific modelling with practitioner needs, it advances multi-risk assessment and socio-economic impact evaluation for resilient urban futures. The event included also a keynote lecture on the damage caused by the DANA event in Valencia in 2024, thereby situating the discussion within a concrete extreme-weather case study. Subsequently, representatives of the three CS presented key results and lessons learned, offering a comparative overview of methodologies, impacts, and adaptation strategies developed within the project. A central round table, involving experts from metropolitan authorities, municipal administrations, and academia, provided a forum for critical reflection on multi-level governance, risk management, and the transferability of ICARIA outcomes to broader European contexts. As the culmination of WP5's Stakeholder Engagement Plan (D5.4), the event followed the iterative workshops of the CoPs in AMB, SAR, and SLZ, which engaged stakeholders through workshops for co-creation, validation, and feedback integration. The round table moment was structured to foster high-level dialogue among end-users (e.g., AMB, Napoli, UIC), enabling priority alignment, risk perception refinement, and exploitation pathways, thus transitioning from local trials to scalable adaptation strategies

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6 Analysis of outcomes

6.1 Cross-case synthesis of main findings

The cross-case synthesis was conducted through a structured qualitative comparison of the three ICARIA case studies described in Section 5. Evidence was extracted from workshop agendas, as well as from workshops' reports (participant profiles, key findings, limitations, and next-step sections), with emphasis on identifying recurring themes (see Annex A and B).

Recurring vulnerabilities and interdependency logic

Across cases, stakeholders valued the prospect of integrated decision support - especially where it enables scenario comparison and map-based visualisation - but expressed that utility depends on alignment with real workflows, interpretable outputs, and reduced barriers in data preparation.

In AMB, DSS testing and follow-up discussions emphasised the usefulness of comparing hazard/adaptation scenarios and visualising outputs, while also identifying data preparation for risk/impact assessment as a key barrier requiring clearer guidance for non-experts. In SAR, stakeholders concluded the DSS would significantly support regional/adaptation planning, yet stressed language/terminology barriers and the need for expert-prepared data packages and CI characteristic information. In SLZ, stakeholders stressed the necessity to proceed to decision-relevant framing through thresholds and scenarios and pointed to the difficulty of producing credible damage-cost estimates where empirical datasets are scarce.

Types of measures perceived as effective

Across case studies, where adaptation was discussed, stakeholders emphasised measures embedded in spatial planning and regulation, alongside technical protection and preparedness/training measures. SLZ stakeholders explicitly highlighted spatial planning and building regulations as major adaptation levers, complemented by technical measures (retention areas, protective structures, river widening/renaturation) and insurance considerations. SAR's CoP similarly framed DSS value in terms of supporting regional planning, while highlighting the need for CI characteristic data to evaluate adaptation options credibly.

6.2 Identified gaps, needs and opportunities

Key differences between cases

Key differences between cases included, among others, the emphasis on different hazards that led to different models and socio-economic and institutional settings that shape stakeholder priorities and feasibility conditions. Regarding the socio-economic and institutional settings, AMB operates within a dense metropolitan governance environment with many interdependent operators and a strong need for cross-service coordination at scale. SLZ reflects an Alpine regional setting where hazard governance interfaces with spatial planning instruments and where the pace of planning cycles was perceived as slow relative to climate-change dynamics. SAR is an archipelagic setting where dispersion across islands and operational responsibilities (emergency services, maritime authorities, health services and utilities) create coordination complexity and strong dependence on hybrid engagement for feasibility.

Geography and settlement patterns drive operational constraints. The metropolitan setting in AMB creates dense interdependencies and high data complexity at scale, making integration and interoperability critical. The Alpine context in SLZ amplifies the relevance of heavy precipitation, flood dynamics, slope-related hazards, compound processes, and increases the value of threshold-based interpretation for emergency and planning decisions. The insular/archipelagic nature of SAR increases reliance on hybrid engagement, accentuates heterogeneity of exposure across islands, and elevates the operational relevance of emergency response coordination and service continuity for health, maritime and energy systems. This reflects also on the type of critical assets and service interdependencies requirements for the project tools.

In all three cases, stakeholders consistently requested outputs that can be interpreted for service continuity and cascading impacts, and tools that enable scenario comparison for planning decisions. Stakeholder composition influences both the breadth of needs and the feasibility of validation. For instance, in SAR's CoP, the participation of risk owners such as fire services, coast guard and hospitals reinforces a "response-and-continuity" logic that places strong demands on clear, actionable outputs and reliable data. In SLZ, the prominence of planning instruments and regional governance links tool requirements to regulatory feasibility and the ability to update evidence more frequently than traditional plan review cycles. AMB's CoP included multiple sector operators and expanded during DSS evaluation to additional operational actors, supporting a diverse usability testing environment.

What worked well across cases

- Progressive engagement sequencing from scoping to tool interaction proved to be one of the main successes of the CoPs planning and execution. All cases demonstrate that starting with hazard/asset scoping and expectations and then progressing toward methodological discussion and tool interaction supports both legitimacy and usability.
- The use of hybrid formats for the realization of the workshop worked as an inclusion and continuity enabler. SAR explicitly reported the hybrid setup as a positive outcome and reused it, enabling cross-island participation and continuity, overcoming geographical and economic obstacles to participation. AMB used a hybrid configuration for the final results-sharing CoP, enabling wider participation while maintaining a structured agenda. SLZ also chose online engagement for the last, national, workshop, indicating hybridisation as a practical sustainability mechanism and fostering the involvement of stakeholders beyond the ones already chosen.
- Regarding the participatory sessions, all three cases reported that hands-on DSS sessions with scripts/working groups support meaningful feedback. AMB's DSS participatory

evaluation used scripts, grouping and triangulated feedback (survey, observation, discussion), generating actionable usability insights. SAR's working groups enabled hands-on experience and structured discussion of usability, with outcomes explicitly recorded on language/terminology barriers and data preparedness needs. SLZ's DSS trial similarly used group-based scripted operation and observer monitoring, supporting practical feasibility testing with end-users.

Challenges and limitations observed

Across cases, stakeholders reported different challenges; AMB highlighted challenges in accessing/providing datasets even when stakeholders are data owners and stressed the complexity of data preparation for DSS workflows. SLZ emphasised the scarcity of empirical data linking hazard intensity (e.g., flood depth) to damage costs, limiting calibration and robustness of impact estimates. SAR underlined limited data availability for some CI, the time needed to consolidate wildfire impact information, and the continued need for CI characteristic data to enable meaningful DSS use. Data gaps, data readiness and the need to involve multiple stakeholders are the dominant cross-case limitations.

Across AMB, SAR and SLZ, stakeholders consistently identified constraints related to data access, completeness, and suitability for tool ingestion—especially empirical vulnerability/damage information. These limitations affect not only modelling quality but also the feasibility of DSS use by non-expert stakeholders, implying that guidance, templates and curated example datasets are critical enablers for uptake.

Regarding usability by non-expert stakeholders, across cases expertise thresholds and terminology barriers constrain appeared as fundamental limitations for replication and usability. AMB and SAR explicitly documented barriers linked to understanding terminology and preparing data for DSS workflows, with stakeholders requesting clearer, non-expert-friendly guidance and, in SAR, highlighting language/terminology issues. This has been resolved producing a common taxonomy guide, diffused to the stakeholders, and step-by-step guidelines for some of the tools, like the RAF. SLZ's emphasis on operational thresholds and the difficulty of damage-cost estimation similarly indicates that interpretability and evidence credibility are necessary conditions for sustained use in planning and governance contexts.

Contribution to project objectives and WPs

Cross-case CoP insights directly support project objectives by improving the fit between modelling outputs and decision contexts: stakeholder inputs provided validation material and helped identify where methodological credibility is sensitive to missing empirical evidence. The same insights inform resilience assessment and DSS development by documenting concrete usability barriers (terminology, data preparation burden) and high-value functionalities (scenario comparison, map-based exploration).

Furthermore, the engagement evidence supports adaptation strategy design and dissemination by clarifying what makes outputs actionable for stakeholders—namely, interpretability, alignment with planning/regulatory practices, and delivery in accessible formats (maps/graphs plus structured discussion about future opportunities).

CoP discussions provided context-specific validation inputs—such as stakeholder-identified hazard hotspots and event narratives (SAR and SLZ specifically), operational thresholds and compound-event considerations (SLZ), and metropolitan-scale hazard/receptor priorities (AMB)—which

collectively support refinement of hazard and impact assessment assumptions and improve interpretability of outputs.

DSS-oriented workshops generated direct usability evidence, including terminology barriers, data preparation constraints, and the value of scenario comparison and map-based exploration, informing how resilience assessment components (RAF/RAT) and DSS workflows should be structured for non-expert adoption.

Stakeholder inputs repeatedly emphasised the centrality of spatial planning and regulatory instruments, the need for curated adaptation options and clearer decision pathways, and the importance of presenting results in accessible format

The cross-case insights therefore contribute to directly advance ICARIA's objectives by systematically integrating stakeholder inputs into the core technical Work Packages (WPs), enhancing methodological robustness, usability, and alignment with decision-making contexts.

In WP1 (Project framework, climate scenarios and modelling inputs), CoP participants supplied data requirements, gap-filling strategies, and local-scale inputs for climate projections, while providing validation through hazard hotspots, event narratives (e.g., SAR and SLZ cases), and sensitivity to empirical evidence gaps.

For WP2 (Modelling and multi-hazard assessment), local risk knowledge shaped hazard interaction models and cascading effect simulations, incorporating operational thresholds and compound-event considerations identified in CoP discussions.

WP3 (Impacts evaluation and DSS) benefited from feedback refining resilience tools (e.g., RAF/RAT adaptations), tangible impact methods, and contributed to the second version of the Decision Support System (DSS), including features—such as scenario comparisons, map-based exploration, and prioritization—addressing usability barriers like terminology and data preparation.

Stakeholder contributions to WP4 (Case studies implementation, replicability and exploitation) informed trials, mini-trials, metropolitan-scale priorities (e.g., AMB), and replication guidelines, emphasizing curated adaptation options and regulatory alignment for EU-wide transferability.

WP5 (Dissemination and communication) leveraged CoPs for inclusive dialogue, with final workshops clarifying actionable formats (e.g., maps, graphs) and interpretability needs, thereby strengthening exploitation pathways.

Cross-case evidence further supported holistic resilience assessments and DSS workflows by documenting usability constraints and high-value functionalities, while highlighting spatial planning integration and stakeholder priorities for cost-effective adaptation.

6.3 Lessons learned for future engagement

CoP engagement generated the most decision-relevant outcomes when it was treated as an iterative pathway i.e., progressing from shared problem framing (hazards, receptors, governance constraints) to method clarification/validation, and finally to hands-on sessions on the tools (RAF, RAT and DSS demonstration and testing).

This kind of structured and repeated participation allows stakeholders to recognise their priorities in the analytical framing (improving legitimacy), to discuss assumptions and thresholds before judging outputs, and to gain familiarity before providing usability feedback.

Data constraints repeatedly emerged as the dominant determinant of feasibility and adoption; therefore, data readiness must be framed as a core engagement output not as an issue to be addressed only by technical teams offline. In addition, across cases, “usability” depended as much on availability of curated inputs and as on clear guidance.

In this sense, hands-on sessions produced more practical evidence than discussion-only meetings, making some barriers visible (terminology, workflow complexity, data upload steps) and allowing feedback to be translated into concrete requirements for tool refinement.

Geographic dispersion (SAR) and the need to concentrate stakeholder time (AMB, SLZ) lead to short, structured sessions that often rely on guided workflows and expert-prepared inputs, which is effective for feasibility but may limit the depth of unguided exploration. This suggests an opportunity to complement single-session trials with follow-up iterations (where feasible) to capture learning curves and longer-term usability, and to progressively shift from expert-prepared to stakeholder-prepared data workflows

Finally, hybrid arrangements should be considered as a standard engagement option for continuity and inclusiveness (especially in geographically dispersed regions), rather than a fallback; SAR, for instance, explicitly valued and reused hybrid configuration to overcome geographic and economic barriers. AMB and SLZ used hybrid effectively for final dissemination.

7 Conclusions

Deliverable D5.5, *Stakeholders Engagement Events Report*, narrates and analyses the realization of the stakeholder's participatory program embedded into ICARIA project, consisting in case study specific iterative workshops, spanning from month 7 through month 39 of the project, concluding in March 2026.

The CoPs workshops have been organized to accompany the stakeholders in the evaluation process of the project tools and outputs. The workshops followed temporal architecture that ensured a logical progression that mirrored the project's technical workflow:

- Workshop 1 for launch, stakeholder scoping, and expectation alignment.
- Workshop 2 for risk assessment validation and tool requirement elicitation.
- Workshop 3 for resilience tool implementation planning and DSS conceptualization.
- Workshop 4 for hands-on participatory evaluation of the DSS prototype.
- Workshop 5 for comprehensive result dissemination and forward-looking strategy formulation.
- Workshop 6 project final event to disseminate main results and ICARIA tools to follower regions and other end-users

CoPs serve as participatory forums in each case study region (Barcelona, South Aegean, Salzburg), engaging scientists, risk owners, stakeholders, and citizens to co-create knowledge on multi-risk management and adaptation, directly feeding into project methodologies.

The Communities of Practices within the ICARIA project, comprehensively advanced all seven Strategic Sub-Objectives (SSOs), with particular emphasis on SS07, which mandates replicable exploitation of results and enhanced societal impact via inclusive stakeholder dialogue, as exemplified by the European Climate Pact.

This advancement was achieved by systematically integrating stakeholder inputs from the CoPs into the core technical Work Packages (WPs) of the project. Specifically, contributions from CoPs:

- directly informed WP1 (Project framework, climate scenarios and modelling inputs), where stakeholders provided data requirements, gap-filling methods, and inputs for local-scale climate projections.
- WP2 (Modelling and multi-hazard assessment), where local risk insights shaped the modelling of hazard interactions and cascading effects.
- For WP3 (Impacts evaluation and DSS), CoP feedback refined resilience assessment tools, tangible impact methods, and the Decision Support System's adaptation prioritization.
- WP4 (Case studies implementation, replicability and exploitation) benefited from CoP input on trials, mini-trials, and guidelines for replication across EU regions.

- Finally, WP5 (Dissemination and communication), where the last workshop of the CoPs and the final event served to foster inclusive dialogue with society.

The cross-case synthesis highlights both convergences and nuances in stakeholder priorities, underscoring the adaptability of ICARIA's holistic framework to diverse socio-ecological contexts:

- Hybrid modalities—combining in-person sessions for rapport-building with virtual formats for scalability—enhanced participation and fostered trust during sensitive infrastructure disclosures. Thus, hybrid modality should be adopted as a default strategy to ensure sustained inclusivity, particularly in dispersed contexts.
- Geographical dispersion (e.g., SAR) and stakeholder time constraints (e.g., AMB, SLZ) necessitated concise, facilitated encounters with pre-configured materials, which proved practical but potentially limited open-ended inquiry; supplementary cycles are thus recommended to evaluate learning trajectories, shift data handling from expert-led to participant-driven approaches, and deepen engagement.
- Attendance gradients, with higher participation from technicians than executives, were effectively addressed through executive summaries and targeted roundtables, thereby securing strategic-level involvement
- Data limitations consistently posed the primary barrier to feasibility and uptake, emphasizing the imperative to integrate data preparedness as a core Community of Practice (CoP) deliverable rather than just a technical issue
- Lexical disparities between modellers and non-expert stakeholders were mitigated via visual aids (e.g., hazard classification visuals and maps) and dual-language lexicons.

The ICARIA Communities of Practice (CoPs) have demonstrated efficacy in operationalizing stakeholder engagement across its three demonstrator case studies—the Barcelona Metropolitan Area (AMB), South Aegean Region (SAR), and Salzburg Region (SLZ)—effectively bridging the gap between advanced scientific modelling and practical resilience-building for critical infrastructures vulnerable to multi-hazard climate risks.

Through a rigorous, phased implementation aligned with the Trial Guidance Methodology (TGM), these CoPs have not only validated core project outputs, including the Resilience Assessment Framework (RAF), Resilience Assessment Tool (RAT), and Decision Support System (DSS), but have also cultivated a dynamic co-creation ecosystem that embeds end-user insights into every stage of development, from hazard scoping to policy-relevant dissemination. These considerations present the CoPs workshops' thematic and temporal architecture as a scalable, Horizon Europe-compliant, blueprint for participatory risk governance method.

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9 Annexes

Annex A: CoP workshops agenda

<i>XX CoP Workshop – CS</i>	
Date:	
Hour	Development
10:00 – 10:15	
10:15 – 10:45	
10:45 – 11:30	
11:30 – 12:00	
12:00 – 12:45	
12:45 – 13:00	
13:00 – 13:15	

Venue:

Tot. duration:

*(please, rearrange the table according to the XX Workshop Agenda; also, specify the **venue** and the **total duration** of the event)*

Annex B: CoPs workshops report template

2nd CoP Workshop

Report

Barcelona Metropolitan Area CS

30.01.2024

(please, specify the CS Region and the date of the event)



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1 Agenda

<i>XX CoP Workshop – CS</i>	
Date:	
Hour	Development
10:00 – 10:15	
10:15 – 10:45	
10:45 – 11:30	
11:30 – 12:00	
12:00 – 12:45	
12:45 – 13:00	
13:00 – 13:15	

Venue:

Tot. duration:

*(please, rearrange the table according to the XX Workshop Agenda; also, specify the **venue** and the **total duration** of the event)*

2 Participants

Table 2. Overview of Stakeholders involved in the 2nd CoP Workshop for the Barcelona Metropolitan Area CS.

2 nd Workshop – <i>Barcelona Metropolitan Area CS</i> January, 30th 2024			
Stakeholder	Description	Category	Workshop participants (n.)
Aigües de Barcelona (AB)	AB is the public-private operator of the majority of the drinking water services and infrastructures in the AMB.	ICARIA consortium member	
AQUATEC	AQUATEC is a private company with a research and development department focused on urban climate resilience and flooding risk assessment.	ICARIA consortium member and Case study coordinator	
Àrea Metropolitana de Barcelona (AMB)	The Barcelona Metropolitan Area (AMB) is the public administration of the metropolitan area of Barcelona, which encompasses 36 municipalities with more than 3.2 million inhabitants.	ICARIA consortium member and Risk Owner	
CETAQUA	CETAQUA is a research private company with extensive expertise in EU research projects related to a wide variety of topics.	ICARIA consortium member	
Consortio de Compensación de Seguros (CCS)	CCS is a public business organisation that is attached to the Ministry of Economic Affairs and Digital Transformation. It performs many functions within the insurance field among which those related to coverage of extraordinary risk, compulsory vehicle insurance, combined agricultural insurance and liquidation of insurance companies stand out.	CoP 3rd party	
ECOPARC 1	ECOPARC 1 is a waste management facility belonging to the Barcelona Metropolitan Area authority. It joins the CoP as a local representative of waste facility operators.	CoP 3rd party	
ENDESA	ENDESA is the largest company in the electric sector in Spain. It is responsible for the electricity distribution network and related infrastructures (e.g., substations) in the context of the Barcelona Metropolitan Area CS.	CoP 3rd party	
Oficina Catalana del Canvi Climàtic (OCCC)	OCCC is the technical unit of the Government of Catalonia, being in charge to promote the establishment of climate change strategies, plans and projects in Catalonia. Hence, the OCCC is also responsible for submitting to the Government proposals relating to the mitigation of emissions and climate change adaptation.	CoP 3rd party	

<p>Servei Meteorològic de Catalunya (SMC)</p>	<p>SMC is a public company ascribed to the Government of Catalunya. It is the organisation responsible for the weather observation system and meteorological forecast in Catalonia.</p>	<p>CoP3rd party</p>	
<p>Institut de Recerca en Energia de Catalunya (IREC)</p>	<p>IREC is a publicly owned research centre specialized in the field of energy, sustainability and development.</p>	<p>ICARIA consortium member</p>	

*(please, rearrange the table according to the Stakeholders involved (see D5.4 list for each CS); also, specify the **number of participants** for each stakeholder)*

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4.3 Workshop summary

*(please, provide a brief summary of the Workshop, at max. 10-15 lines, with a **general introduction and opportunities** of the 2nd Workshop)*

3.1 Objectives of the 1st Workshop

*(please, organize the **objectives** of the 2nd Workshop in bullet points)*

- ...
- ...
- ...
- ...
- ...

3.2 Methodology

(please, provide a brief introduction to the methodology applied in the 2nd Workshop, at max 10-15 lines)

Table 3. Initial roadmap of the 2nd CoPs' Workshops described in D5.4.

Workshop (month)	Theme	Topics to be covered	Matters to be considered
Workshop 2 (M13)	Discussion and validation of the Risk Assessment approach	<ol style="list-style-type: none"> 1. Present the solutions project is developing and get feedback on needs, expectations etc. <ul style="list-style-type: none"> • Expected DSS features • Evaluation of Portfolio of Adaptation Measures • Validation of risk assessment methods developed 2. Present data/knowledge gaps and define possible solutions gaps of the models. 3. Present the Trial methodology and organisation. <ul style="list-style-type: none"> • Assess the trial gaps, objectives and research questions • Assess the proposed scenarios and discuss the roles of CoP members in these scenarios/trials 5. Assess how to measure the trials are success 	<ul style="list-style-type: none"> • Prepare a concise presentation of the following: <ul style="list-style-type: none"> ◦ Overall framework (Task 1.1) ◦ Hazard assessment methods (Task 2.2) ◦ Impacts assessment method (Task 3.1) • Participatory process to identify needs and expectations of the DSS and Portfolio tools. • Prepare a presentation of the TMG methodology.

Title of the Workshop. Add subtitle if needed

3.2.1 Step 1

*(please, provide a brief summary of Step 1, at max. 15-20 lines, regarding: **development, materials/tools used and their functioning, collected data** (if collected))*

*(also provide 1 – 2 **figures** describing Step 1)*



Figure 1: ...

3.2.2 Step 2

*(please, provide a brief summary of Step 2, at max. 15-20 lines, regarding: **development, materials/tools used and their functioning, collected data** (if collected))*

*(also provide 1 – 2 **figures** describing Step 2)*



Figure 2: ...

3.2.3 Step 3

*(please, provide a brief summary of Step 3, at max. 15-20 lines, regarding: **development, materials/tools used and their functioning, collected data** (if collected))*

*(also provide 1 – 2 **figures** describing Step 3)*



Figure 3: ...

(please, add or remove sub-sections to section 3.2 according to the number of steps/phases of the 2nd Workshop)

4 Key-findings

(please, organize the key-findings of the 2nd Workshop in bullet points)

- ...
- ...
- ...
- ...
- ...

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5 Limits and difficulties (if present)

5.1 Methodological limits

*(please, provide a brief summary of Steps 1/2/3, at max. 10-20 for each of them, regarding: **methodological limits** observed during the 2nd Workshop)*

5.2 Interaction limits

*(please, provide a brief summary of Steps 1/2/3, at max. 10-20 for each of them, regarding: **Interaction limits** observed during the 2nd Workshop)*

5.3 Data limits

*(please, provide a brief summary of Steps 1/2/3, at max. 10-20 for each of them, regarding: **data limits** observed during the 2nd Workshop)*

6 Next steps

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CETAQUA
WATER TECHNOLOGY CENTRE

AQUATEC

Aigües de Barcelona

AIT
AUSTRIAN INSTITUTE
OF TECHNOLOGY

AMB : Àrea Metropolitana
de Barcelona

iti CENTRE FOR RESEARCH & TECHNOLOGY - HELLENIC
Information Technologies Institute

DEMOKRITOS

DRAXIS
ENVIRONMENTAL TECHNOLOGIES

fic
Instituto para la Investigación del Agua

IREC
Shaping Energy for a Sustainable Future

LNCC LABORATÓRIO NACIONAL
DE ENGENHARIA CIVIL

cegean islands
Regional of South Aegean

University of Exeter

CENTRO STUDI PLINIVS

Verbund



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Annex C: Data Management Statement

Table C.1. Data used in preparation of ICARIA Deliverable 5.5

Dataset name	Format	Size	Owner and re-use conditions	Potential Utility within and outside ICARIA	Unique ID
Workshops (1-5) reports	.doc	Variable	AMB	n/a	n/a
Workshops (1-4) reports	.doc	Variable	SAR	n/a	n/a
Workshops (1-5) reports	.doc	Variable	SLZ	n/a	n/a
Final event agenda	.pdf	1,2 MB	AMB	n/a	n/a
Attendee lists (workshop 1-5)	.jpeg	Variable	AMB	n/a	n/a
Attendee lists (workshop 1-4)	.jpeg	Variable	SAR	n/a	n/a
Attendee lists (workshop 1-5)	.jpeg	Variable	SLZ	n/a	n/a
PowerPoint presentations used during workshops (1-5)	.ppt	Variable	AMB	n/a	n/a
PowerPoint presentations used during workshops (1-4)	.ppt	Variable	SAR	n/a	n/a
PowerPoint presentations used during workshops (1-5)	.ppt	Variable	SLZ	n/a	n/a
PowerPoint presentations used during final event	.ppt	Variable	SLZ; AMB; SAR	n/a	n/a

More info: www.icaria-project.eu

