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D6.6 Innovation Management Plan

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D6.6: Innovation Management Plan

Summary

This Innovation Management Plan presents a description of the different lines of work that will be followed in project ICARIA together with the methods and tools that will be used as the starting point to develop the tangible results beyond the current state-of-the-art in the field of risk analysis and resilience assessment of critical assets against single and compound extreme weather events associated with climate change.

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28/06/2023	1.5	Alex de la Cruz (AQUA)	Final version

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List of Acronyms and Abbreviations

BAU	Business as Usual
CoPs	Communities of Practitioners
DoA	Description of the Action
DSS	Decision Support System
EAD	Expected Annual Damage
EO	Expected Outcomes
ESM	Earth System Models
GA	Gran Agreement
ICARIA	Improving Climate Resilience of Critical Assets
IP	Impact pathways
IPCC	International Panel of Climate Change
KPI	Key Performance Indicators
RCMs	Regional Climate Models
RES-SCI	Scientific Results
RES-TEC	Technical Results
SSO	Specific Subobjectives
SSPs	Shared Socio–Economic Pathways
UNDRR	United Nations Office for Disaster Risk Reduction
WP	Work Package

Executive summary

The Innovation Management Plan defines the main expected innovative outcomes of project ICARIA together with the current knowledge that will be used as a starting point and the strategy that will be followed to generate results beyond the state-of-the-art. It also specifies how the project aim and results have been subdivided and classified in a way that they become specific, measurable, achievable and timebound. General guidelines for the exploitation of project results are also given.

A final Innovation Management Report will be delivered in month 34. That deliverable will include all evidence gathered from monitoring the implementation process of ICARIA outputs.

This deliverable is the first result of T6.2 Quality Assurance and Innovation Management.

1 Introduction

1.1 ICARIA in short

The number of climate-related disasters has been progressively increasing in 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 of the number of recorded disaster events by 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 (UNDRR, 2020 and IPCC, 2021). For the future, by mid-century, the world stands to lose around 10% of total economic value from climate change if temperature increase stays on the current trajectory, and both the Paris Agreement and 2050 net-zero emissions targets are not met (Guo et al., 2021).

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

Special regard is devoted to critical assets and infrastructures particularly susceptible to climate change, in a sense that its local effects can result in significant increases in cost of potential losses for unplanned outages and failures, as well as maintenance – unless an effort is undertaken in making these assets more resilient. Therefore, ICARIA aims to understand how future climate might affect life-cycle costs of these infrastructures and 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. This requires forward planning that considers a comprehensive multi-risk assessment and the uncertainties associated with climate change, rather than reliance on models solely based on past events and single climate hazards.

1.2 Scope and Objectives

The present document corresponds to the Deliverable 6.6 Innovation Management Plan (IMP) of Work Package 6 (WP6) - Project Coordination and Management.

The overall aim of the deliverable is to define, at an initial stage of the project, the following matters: **(1) a description of the relevant results (tools and methods) to be achieved within ICARIA; (2) indicate the background state of the art knowledge provided by recent research projects and how it will contribute to ICARIA project**. This document should serve to ensure that a satisfactory degree of innovation is achieved during the entire project lifetime in all research directions. This document corresponds to the actions taken in Task 6.2: Quality assurance and innovation management.

2 Innovation Management Strategy

2.1 ICARIA Specific Subobjectives

Considering the overall objective of the ICARIA project, Seven strategic Subobjectives (SSO) have been defined. Each one represents a specific field of work where efforts will be devoted to generate tangible results that represent a progress beyond the current state of the art. According to the typology of the work that will be developed in each case, these seven SSO have been classified in four categories as shown below:

- **Scientific:** corresponding to research activities for advances beyond the state of the art.
- **Technological:** suggesting and/or developing novel solutions, integrating state-of-the art and digital advances.
- **Societal:** contributing to improved dialogue, awareness, cooperation and community engagement as highlighted by the European Climate Pact.
- **Dissemination and exploitation:** aimed at sharing ICARIA results to a broader audience and number of regions and communities to maximize project impact.

The following table summarises the seven SSOs and indicates their classification

Table 1. Summary of ICARIA SSOs and their categories

Number	Title	Category
SSO 1	Achievement of a comprehensive methodology to assess climate related risk produced by complex, cascading and compound disasters	Scientific
SSO 2	Obtaining tailored scenarios for the case studies regions	Scientific
SSO 3	Quantify uncertainty and manage data gaps through model input requirements and innovative methods	Scientific
SSO 4	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	Scientific
SSO 5	Better assessment of holistic resilience and climate-related impacts for current and future scenarios	Scientific
SSO 6	Better decision taking for cost-efficient adaptation solutions by developing a Decision Support System (DSS) to compare adaptation solutions	Technological
SSO 7	Ensure the use and impact of the ICARIA outputs	Societal and dissemination and exploitation

2.2 ICARIA background projects

In the Description of Action (DoA) of the project, a comprehensive description of the objectives and the current state-of-the-art knowledge and methods that will contribute to each SSO has been provided. The following figure depicts the main recent EU research projects that will provide the required background to project ICARIA to achieve its innovation expected results.

Figure 1. ICARIA Background EU research projects.

2.3 ICARIA expected results

In order to clearly picture the tangible outcomes that project ICARIA will deliver by fulfilling the SSOs, a set of 10 results have been defined. All these results are specifically associated with a SSO and a WP. The following figure depicts these results together with their classification between Scientific Results (RES-SCI) and Technical Results (RES-TEC).

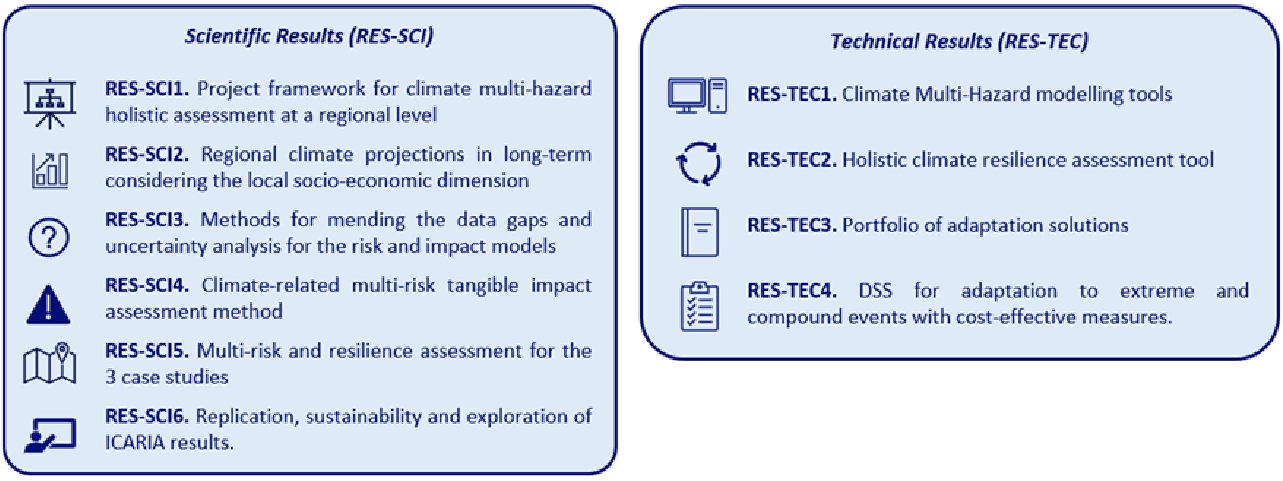

Figure 2. ICARIA Progress beyond: Expected results.

Regarding the mid term horizon, three Expected Outcomes (EO) have been defined according to the HORIZON-MISS-2021-CLIMA-02-03 topic. Specifically, these outcomes will focus on the Objective 2 of the Implementation Plan of Climate ChangeAdaptation Mission (Accelerating transformations to climate resilience).

Table 2. Summary of the mid-term pathway Expected Outcomes.

Mid-term Expected Outcomes (EO)
EO1. Beyond state-of-the-art asset-level models for critical infrastructures will allow for a better assessment of adaptation options
EO2. Public authorities will be enabled to compare different adaptation approaches on the basis of a model information system on critical infrastructure
EO3. An analysis of gaps in European data regarding the assessment of direct and indirect economic consequences of damages to critical infrastructures.

Furthermore, ICARIA addresses all Impact Pathways (IP) envisaged by Climate Change Adaptation Mission through a regional approach rooted in research and innovation and based on the above mentioned results and outcomes.

Table 3. Summary of the long-term Impact Pathways

Long-term Impact Pathways (IP)
IP1. Mobilize all actors, such as EU Member States, regional and local authorities, research institutes, investors and citizens to create real and lasting impact
IP2. Provide general support to European regions and communities to better understand, prepare

Long-term Impact Pathways (IP)
for and manage climate risks and opportunities. Accelerate transformations to climate resilience: cooperate with at least 150 regions and communities to accelerate their transformation to a climate resilient future, supporting them in the co-creation of innovation pathways and testing of solutions **IP3.** Demonstrate systemic transformations to climate resilience: deliver at least 75 large-scale demonstrations of systemic transformations to climate resilience across European regions and communities. **IP4.** Foster the development of a balanced portfolio of solutions across the different climate risks, the different innovation areas as identified in the Mission Implementation Plan and the different biogeographical regions, as defined by the European Environment Agency

In order to measure the fulfilment of both the SSOs and the expected results, a number of Key Performance Indicators (KPI) have been defined in the project DoA. Each KPI is linked to a specific SSO and to a deliverable, which correlates it with a tangible result. A table with the full list and description of the KPIs is provided in Annex I.

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

3 Description of SSOs and development beyond state of the art

To achieve this aim, ICARIA has identified 7 Strategic Subobjectives (SSO), each one related to one or several work packages. They will be SMART: Specific (related to WPs), Measurable (by relevant KPIs), Achievable (the WPs in which they will be achieved are listed), Realistic (since they are referred and explained in the methodology section), and Timebound (each KPI is related to a deliverable and a month of achievement). The SSOs have also been classified according to different categories: scientific, corresponding to research activities for advancing beyond the state of the art (SSO1, SSO2, SO3, SO4, SO5); 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 dissemination and exploitation, aimed at sharing ICARIA results to a broader audience and number of regions and communities to maximize project impact (SSO7).

The following points depict the aim of each SSO and how will each one extend the current state-of-the-art.

3.1 SSO1.- Achievement of a comprehensive methodology to assess climate related risk produced by complex, cascading and compound disasters

a) SSO1 description

A harmonized Risk/Impact modeling framework for climate-related hazards will be developed, based on an innovative multi-risk analysis methodology encompassing modeling, spatial visualization and visual analytics of hazards, exposure, vulnerability and the expected socioeconomic impacts related to targeted extreme events and long-onset changes, aimed at supporting national to local integrated adaptation actions in a sustainable and resilient planning perspective.

b) State of the art and progress beyond

The framework developed will outline a harmonized service-oriented modeling approach aimed at maximizing exploitation of satellite/remote sensing data and methods to handle modeling uncertainties. It will be designed to consider 1) the impact of adaptation measures on the local hazard conditions, exposure and vulnerability, and 2) the postprocessing of modeling results through cost-benefit and multi-criteria analysis tools as DSS components. To this aim, specific areas of improvement are targeted with respect to current state of the art and terminology (IPCC, 2014):

- *Hazard*: model the contextual features (e.g. forest fire) and precursor conditions that aggravate them (e.g. heat waves, drought) as well as their relations to identify the trigger mechanisms of cascading events.
- *Exposure*: classify the geographic distribution of elements at risk according to specific parameters like age, asset typologies.
- *Vulnerability*: develop vulnerability functions (including dynamic vulnerability aspects linked to compound events and cascading effects) for strategic assets and services.
- *Risk*: comprehensive risk assessment including tangible direct and indirect impacts.

- *Adaptation and resilience*: linking quantitative impact modeling results with post-processing tools for multi-criteria analyses (in synergy with SSO5) within DSS (by integrating methods developed by EU RESCCUE (Velasco et al., 2018) and CLARITY (Zuccaro & Leone, 2021) projects based on quantitative and qualitative parameters), aimed at prioritizing adaptation strategies that concurrently bring social, environmental and economic co-benefits, as well as holistic climate resilience assessment of critical services and infrastructures (building on previous EU projects EU CIRCLE (Sambor & Krzysztof, 2017), SNOWBALL (Zuccaro et al., 2018) and RESCCUE (Velasco et al., 2018) methods and tools).

c) Methods contributing to SSO1

Considering that the overall aim of SSO1 is to generate a methodology to assess climate related risks that supports the process of planning adaptation measures at regional scale, three broad work directions can be differentiated.

Firstly, future climate scenarios will have to be built based on historical data and taking into consideration the effects of climate change by considering different Shared Socio–Economic Pathways (SSPs) defined in the IPCC 6th report (IPCC, 2021). This will involve the gathering of historic data from local and regional climate agencies as well as from EU-level sources such as Copernicus Climate Data Store or CORDEX. In order to make projections usable locally so they can represent urban and land use characteristics of each region, local downscaling methods will be applied. Given the expertise of the ICARIA consortium members, both statistical and dynamic downscaling approaches will be used parallelly. This strategy has proved to be successful in previous similar projects such as RESCCUE (Velasco et al., 2018), CLARITY (Zuccaro & Leone, 2021) and CRISI-ADAPT II (Rubio et al., 2018) , where downscaling to 500 m resolution was reached.

Secondly, a methodology for hazard and impact assessment will be established following the precedent set by projects CLARITY (Zuccaro & Leone, 2021) and RESCCUE (Velasco et al., 2018) for single hazard scenarios. Furthermore, since ICARIA will specifically address multi-hazard risk assessments, a novel methodology for these scenarios will be developed based on the theoretical framework from project SNOWBALL (Zuccaro et al., 2018).

The vulnerability assessment will take the work developed in CLARITY (heat-related impacts) (Zuccaro & Leone, 2021) and RESCCUE (water-related impacts) (Velasco et al., 2018) as a starting point and develop new vulnerability and damage functions to represent the full range of climatic hazards and critical assets considered. This development will enable a quantitative impact assessment of both the single and multi-hazard scenarios .

Thirdly, the results of the risk assessment modeling framework will incorporate the possibility to modify the baseline conditions of the model to incorporate different adaptation scenarios. This will transform the models from a forecasting tool to a decision-making support as it will enable the assessment of adaptation measures when planning or designing critical assets.

d) Specific results achieved within SSO1

RES-SCI1. Project. framework. ICARIA will provide a climate-change multi-hazard framework to ensure a holistic assessment at regional level that considers also potential cascading effects and compound events. This framework will cover any hazard impacting in any service or CI, although in the ICARIA project it will be developed and implemented for some selected single or compound hazards impacting on specifics assets and services.

3.2 SSO2.- Obtaining tailored scenarios for the case studies regions

a) SSO2 description

Near- and long-term climate projections (up to 2100) of Copernicus Climate Change Service will be (statistically and dynamically) downscaled for the three ICARIA case studies on the basis of the last emission scenarios used in the IPCC Sixth Assessment Report (IPCC, 2021). ICARIA will consider emissions scenarios without climate policies (baseline scenario) and with climate policies (mitigation scenarios). Climate change projections and socio–economic scenarios will be estimated at a local scale to evaluate climate-related impacts (business as usual scenarios) and adaptation/mitigation measures (adaptation scenarios). Moreover, as a feedback, climate projections will consider changes in local socio-economic scenarios leading to different land uses and then impacting on some climate variables (e.g. urban heat island and wind encased).

b) State of the art and progress beyond

Downscaling of climate projections of Earth System Models (ESM) is usually performed by either using statistical approaches such as analogue stratification and transfer functions or parametric quantile-mapping, better representing local features (e.g. micro-climate, urban heat), or using Regional Climate Models (RCMs) for dynamically downscaling the global projections, thereby better representing physical processes related to regional characteristics (e.g. topography, land use). Within ICARIA, these approaches will be further improved by smartly mixing different climate model simulations. The future climate scenarios are currently produced under the new emission scenarios, derived from the SSPs (IPCC, 2021). To progress beyond the state-of-the-art, ICARIA will work in local socioeconomic scenarios to project future land uses to improve climate projections.

c) Methods contributing to SSO2

Initially, the most relevant climate hazards for each CS critical assets will be identified through a participation process involving local stakeholders. Taking these considerations into account, the related climate variables will be pinpointed and their historical climatic data will be analyzed. This will serve to calibrate and verify the statistical climate models and characterize possible local climate features to produce local scale climate scenarios for the three case study regions for the short (2015-2040), mid (2041-2070) and long (2071-2100) term horizons. In this process, two downscaling approaches will be used in a parallel and smart way: a statistical and a dynamical downscaling. The statistical one will work with weather observations and 10 CMIP6 Global Circulation Model to produce, through analogue stratification and transfer functions, local climate projections.

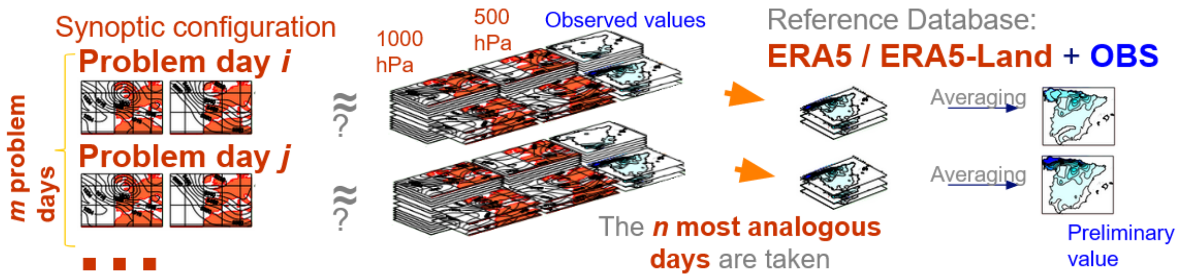

Figure 3. Example of some of the steps taken for the statistical downscaling methodology applied.

Meanwhile, the dynamical will use 2 CMIP6 Global Circulation Model input data and 2 RCMs for dynamical downscaling. The climate model simulations will be further post-processed using AI weighting to decrease the uncertainties related to climate projections of different models and therefore to better represent the regional future climate.

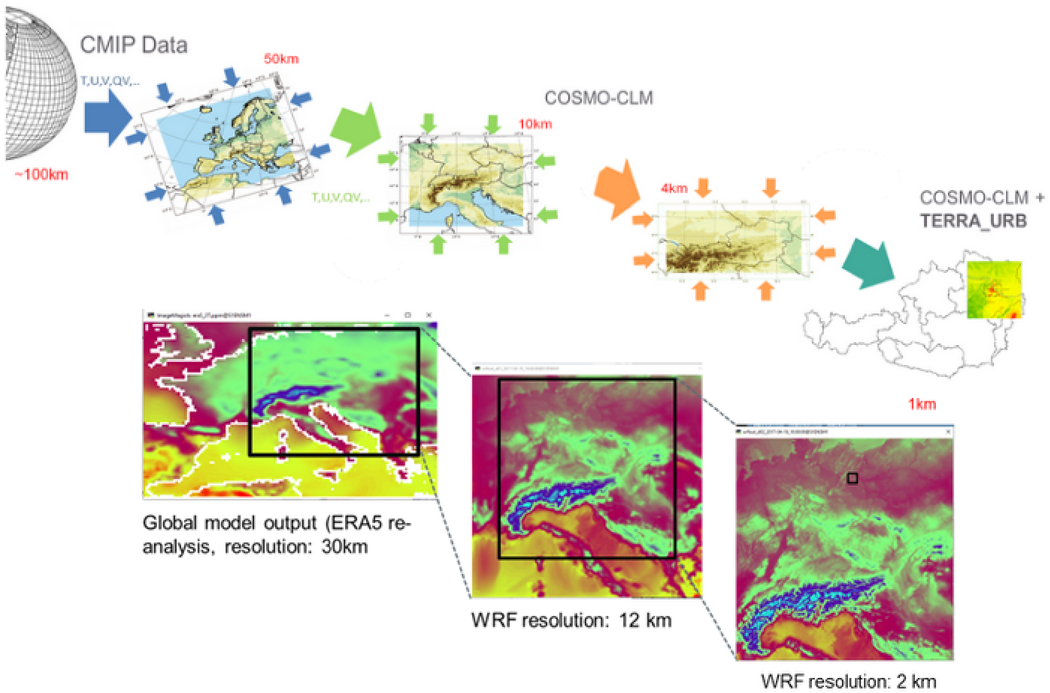

Figure 4. Example of the processes applied for the dynamical downscaling.

As a result, highly detailed hazard specific projections will be generated for each case study. The later combination of both methods will allow a reduction of projection uncertainties.

d) Specific results achieved within SSO2

RES-SCI2. Climate scenarios methods and results. Two downscaling methods will be proposed and merged to generate from near to long-term climate projections considering different emission scenarios at large scale and socio-economic ones at local scale. Taken into account the specific characteristics of each CS (area to be studied, variables, needs and requirements from stakeholders), both methods will be applied and their merging tested in the Austrian (Salzburg) and Greek (Syros, Naxos, Kos and Rhodes

Aegean islands) case studies, whereas the Spanish case (Barcelona Metropolitan Area) will only consider the statistical one. Both methodologies applied will produce tailored local climate projections that will be achieved up to the year 2100 in three specific 30-year time periods.

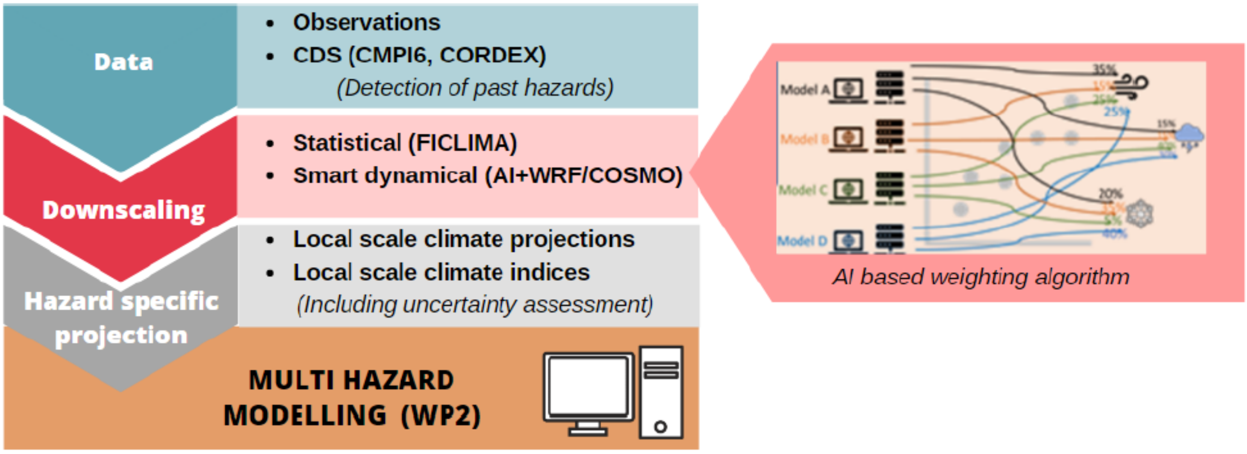

Figure 5. Scheme of the steps followed for the obtention of the future climate projections, including both downscaling methodologies and their merging for the multi hazard modeling.

3.3 SSO3.- Quantify uncertainty and manage data gaps through model input requirements and innovative methods

a) SSO3 description

ICARIA Trials (implementation) and Mini-Trials (replications) in the case studies will be carried out to define the minimum requirements in terms of input data needed to comprehensively analyze climate related multi-hazard and risks on critical infrastructure and the effects of possible adaptation measures, as well as to determine how such data can be obtained, substituted or generated. ICARIA Trials will be carried out in "best case study scenarios", with good data availability, well-known climate hazards and impact assessment methods. Hence this stage will serve to identify all the dada required to assess the impact and the risk of a specific hazard event on a given critical asset. During the replication phase, key aspects of one Trial will be reproduced in other regions (Mini-Trials), with suboptimal data availability (e.g., coarse climate data, poor asset and economic data). Therefore, in the execution of the Mini-Trials will be required to apply data gap filling methodologies. In this sense, novel and robust approaches for filling data gaps and augmentations (e.g. geographical and temporal downscaling, data substitution) will be applied within the replication context, such as uncertainty propagation analysis.

b) State of the art and progress beyond

Data gaps refer to data or values that are unavailable, but that are necessary to improve the accuracy and reliability of the output and remove the potential of a bias. It is a common challenge in many applications, likewise for climate change-related modeling tasks (e.g. impact, exposure). There are principally two types of missing data: complete lack of data (where ICARIA Trials are not likely to suffer from such a situation) and lack of site-specific data (i.e. temporally, and/or geographically representative) including low-resolution data, especially for the Mini-Trials case studies. Different approaches are leveraged to address the gaps, ranging from crowdsourcing approaches to create real data to advanced ones focusing on Artificial Intelligence and Machine Learning methods. For the lack of site-specific data, data-messing measured methods blended with the application of secondary data as surrogates will be explored, evaluating the completeness of the available datasets describing heatwaves, droughts, and forest fires. Data-centric approach will be used as a key way to significantly increase model accuracy. Furthermore, techniques such as data augmentation can be applied to artificially increase the amount of data, which can improve the size and quality of training datasets so that they can be used to create a more generalizable, portable and accurate model. exploring the suitability of methodologies ranging from noise injection to deep-generative models and automated data-augmentation. ICARIA will exploit this current state of not only technology, but also an increasing availability of different data sources, to research, adjust and create data gap services (e.g. models, approaches) best suitable to the regional context of the foreseen case studies.

c) Methods contributing to SSO3

As an initial step, each case study responsible will elaborate an exhaustive list of all the input data requirements for all the models that will be used in the project. The list will indicate the necessary data resolution/quality and the sources available (if any) to obtain this information. This will provide a good picture of the data availability and the major gaps and uncertainties to be addressed. A trivial scheme for handling data gaps will include i) the description of the chosen methods, ii) the evaluation of the completeness of the datasets (for missing site-specific data in each case study), and iii) the proposal of tools and secondary surrogate data (if applicable) to fill the data gaps. Methodologies will include but are not limited to regression models, extrapolation methodologies, linear-scaling of available compositional data and fitting of statistical distribution to a sample data frame. The relevance and importance of data gaps should be assessed depending on the contained impact methods and the weight of data missing value, respectively. It should be considered that the Trials setup aims for the highest possible quality of data so the results can be used “as they are” for operative/planning decision-making. On the other hand, the Mini-Trials replication foresees the use of suboptimal and/or limited datasets sourced both from open databases and national (local) authorities.

The model's sensitivity to data lack and uncertainties will be estimated by cross-validation measuring the effects of existing and/or introduced data gaps.

Given ICARIAs resources and constraints, the bridging of data gaps will be based on inexpensive methodologies which are either well documented or in literature or well known by the team members rather than developing novel data gap bridging techniques. Existing techniques that could be used for this purpose are: data augmentation, crowdsourcing and Artificial Intelligence tools.

d) Specific results achieved within SSO3

RES-SCI3. Methods for mending the data gaps and uncertainty analysis. Methods to mend the data gaps and define the uncertainty cascade related to the inputs, methods used and missing and quality of data will be defined and tested in Trials and Mini-Trials by cross validations measuring the effects of considering different scenarios related to regional data availability (from best case where all data is provided and worst-case scenario where minimum data is used).

3.4 SSO4.- Increase the knowledge on climate related disasters by developing and implementing advanced modeling for multi-hazard assessment

a) SSO4 description

This SSO aims to increase our understanding of climate-related disasters and the interconnectedness of multiple hazards. To achieve this, within this objective the primary goals will be to identify the triggering mechanisms behind cascading catastrophes and develop a holistic modeling framework that can be utilized to analyze both the likelihoods and consequences of such events.

b) State of the art and progress beyond

Multi-hazard events where one hazard either triggers and/or influences the effect of a subsequent hazard can arise from a variety of hazard type combinations such as:

- Storm surge coinciding with pluvial flooding commonly associated with tropical and extratropical cyclone events that result in increasing the magnitude of flooding experienced within coastal regions,
- landslides triggered by pluvial flooding during intense rainfall events,
- periods of drought leading to increased likelihood and severity forest fires,
- intense rainfall within a region that has previously experienced forest fires whereby as the ground is now charred, barren, with less capacity to absorb water, it creates conditions that can lead to flash flooding.

Modelling multi-hazard events can be challenging due to the differences in their spatial and temporal scales whereas some hazards such as flooding can be extremely localised both in space and time where other hazards such as droughts can be experienced regionally and countrywide over prolonged periods. The modelling of multi-hazards is complicated further in that the influence that one hazard has on another can be simultaneous or persist long after the first hazard has occurred. For instance the combination of storm surge and pluvial flooding occurs simultaneously whereas the flood risks in regions that have previously experienced a forest fire can remain to be significantly higher up to 5 years after the original forest fire event until vegetation affected by the fire is restored[1]. Therefore when considering multiple consecutive hazards ICARIA will look to establish how the effect of one hazard upon subsequent hazards within the same region propagates over time.

In terms of mitigating against multi-hazard risks, decision makers typically rely on designed events based on historical observations. The work within ICARIA aims to establish an integrated modelling approach to quantify the probability of individual hazards and the joint probability of multi-hazard, considering their spatiotemporal interactions and triggering mechanisms of cascading effects. Bringing together a multidisciplinary team of experts, ICARIA will establish an integrated modelling approach to quantify the probability of individual hazards and also the joint-probability of multi-hazards based on their spatiotemporal interactions, and the triggering mechanisms of the cascading effects.

The capacity of infrastructure and the impact of climate-related hazards on their serviceability will be analyzed to quantify the likelihoods of failures or reduced operational capacity, which will lead to

[1] https://www.ready.gov/sites/default/files/Flood_After_Fire_Fact_Sheet.pdf

cascading disasters. More importantly, the assessment framework will be an interactive procedure to fully reflect the mutual influences between different hazards. The uncertainties involved in the assessment, including the inputs that are specified in SSO3 and the modeling chain, will be analyzed in order to build scenarios of future climate-related multi-hazard.

c) Methods contributing to SSO4

The development of a holistic multi-hazard risk assessment framework is a key aspect for enhancing disaster risk reduction management (Ward et al., 2022). Within the scope of ICARIA the hazards identified for analysis across case studies include floods, storm surges, heat waves, droughts, forest fires, and storm winds. One of the first stages within this SSO4 will be to review pre-existing models and methodologies developed across previous EU research projects including but not limited to RESCCUE (flooding, droughts, and storm Surge) (Velasco et al., 2018 and Russo et al., 2020), CLARITY (wind, heatwaves) (Zuccaro & Leone, 2021), EU-CIRCLE (forest fires) (Varela et al., 2019) for single hazard assessment and develop an approach integrate them to allow for multi-hazard assessment.

In WP2, investigations will be conducted, analysing historical multi-hazard events and determining the underlying mechanisms driving their occurrence. Subsequently, coupled multi-hazard modelling chains will be developed to define the physical mechanisms responsible for hazard interactions where the joint probability of coincident or consecutive extreme events will be assessed using extended regional frequency analysis and dynamic Bayesian network analysis. In cases where multi-hazard events exhibit complex joint probability estimation, "what if" scenarios will be employed to assess their potential consequences and identify the most critical events requiring resource allocation.

The impacts of climate hazards on critical infrastructures will be qualified via damage curves, fragility curves, or probability distribution functions. These elements will be integrated in the framework in a way that they can reflect the dynamic vulnerability of assets and the effects of different adaptation scenarios.

Further than the hazard-asset impact assessment, ICARIA also intends to assess cascading effects between assets (risk receptors) based on the precedent set by RESCCUE (Velasco et al., 2018). The outputs of the hazard/risk models will be used to feed subsequent models simulating the cascading effects and service failure between the critical assets considered in the project.

d) Specific results achieved within SSO4

RES-TEC1. Multi-Hazard modeling tools. A modeling chain tool will be developed for temporal and spatial coupling of several climate-related hazards reflecting the probability for one hazard triggering others under certain conditions. This will allow the assessment of impacts of combined or compound events.

3.5 SSO5.- Better assessment of holistic resilience and climate-related impacts for current and future scenarios

a) SSO5 description

The aim is to increase the knowledge on multi-risk and resilience assessment of assets/critical infrastructures (including interaction between compound events, their climate drivers, cascading effects, tangible direct and indirect impacts) with the present state and future improvements under different socio-economic and climate scenarios for short-term impact mitigation planning and long-term adaptation strategy development.

b) State of the art and progress beyond

One of the main RESCCUE project outputs was the set of methodologies to assess tangible and intangible direct impacts produced by extreme water events on the water sector and the cascading and collateral indirect impacts on other urban services, and the RAF App framework and tool, to assess city and urban service's resilience and to support resilience planning (Velasco et al., 2018, Russo et al., 2020 and Cardoso et al., 2020). Also, one of EU-CIRCLE project (Sambor & Krzysztof, 2017) key outputs was the Resilience Assessment Tool, which was used a) to assess the climate resilience of interconnected infrastructures and assets considering the service flow continuum element and b) to use the delivered assessment in a new approach that shifts from cost-benefit climate and risk-based to resilience based adaptation options. In this sense, both projects recently provided advances in the resilience assessment of urban environments and interconnected critical infrastructures. Furthermore, in the framework of the XRE4S project[2], electrical network failures due to extreme weather events are being studied and related to specific thresholds of meteorological variables according to the vulnerability curves of the exposed assets. CLARITY (Zuccaro & Leone, 2021) developed a Heat Wave model for urban areas able to quantify health impacts on population taking into account local microclimate variables, as well as the effect of potential adaptation measures. SNOWBALL (Zuccaro et al., 2018) developed a theoretical framework for cascading effects analyses, based on an "event tree" logic and probabilistic assessment of hazard transitions from a triggering event. ICARIA will progress beyond the current state of the art through the conceptualization and practical development of comprehensive and cutting-edge multi-risk assessment methodologies related to different climate-related extreme events considering tangible direct and indirect losses related to affected assets and critical infrastructures. Regarding resilience assessment, ICARIA aims to improve the approaches used by RESCCUE RAF (Resilience Assessment Framework) (Cardoso et al., 2020) and EU-CIRCLE Resilience Assessment Tool (Sambor & Krzysztof, 2017) considering a wider range of climate-related hazards (single and compound events), widening the scope from local to regional and including several strategic infrastructures and services (water, mobility, waste energy…). Joint background acquired within RESCCUE (Velasco et al., 2018) and XRE4S projects will also help to improve the impact analysis of cascading effects produced by potential failures of electrical infrastructures due to extreme climate events.

[2] https://xre4s.cat/downloads/

c) Methods contributing to SSO5

Given the inherent interconnectivity between critical assets and services in an urban area, an adequate resilience assessment has to keep a holistic perspective considering all interactions and interdependencies (hence potential cascade failures) between assets. Project RESCCUE (Velasco et al., 2018) set a methodological precedent analyzing the cascading effects of flooding situations on certain assets.

In ICARIA, both direct and indirect tangible impacts on assets will be assessed. These impacts will be expressed in monetary and/or "% of service disruption" terms by using hazard-damage and hazard-disruption curves. These curves will be developed and validated using historical data from relevant stakeholders (e.g. insurances, facility operators, public administration or expert entities). The monetization of impacts under adaptation and "business as usual" scenarios will allow estimating the benefits of implementing risk reduction measures.

Furthermore, an upgraded framework for holistic resilience assessment will be developed and integrated in a novel "resilience assessment shell" that will be built on the work done in the RESCCUE RAF (Cardoso et al,. 2020) and EU-CIRCLE Resilience Assessment Tool (Sambor & Krzysztof, 2017).

d) Specific results achieved within SSO5

RES-SCI4. Climate-related multi-risk tangible impact assessment method. Based on RESCCUE (Velasco et al., 2018) and other relevant recent projects, ICARIA will provide an improved comprehensive method to consider direct and indirect tangible losses for assets and CI affected by different climate-related extreme events. The losses will include the reconstruction costs, the costs of not providing the service and the knock-on effects on other systems. Expectedly, the models developed within this result will be included as a major project outcome in the existing EU Adaptation Platform.

RES-TEC2. Holistic climate resilience assessment method. ICARIA will develop and test a method that combines the approaches and metrics used in RESCCUE (Velasco et al., 2018) and EU-CIRCLE (Sambor & Krzysztof, 2017) projects to assess resilience of complex systems focusing on main services and critical infrastructures. The method will have the versatility to be adopted in a wide range of scopes (from district/city to regional/national level) and will consider different climate related stressors as single or compound events. It will be materialised in a shell combining the upgraded tools and in a roadmap for resilience assessment. Similarly, to the multi-risk tangible impact models, the holistic assessment tool will be implemented in the EU Adaptation Platform.

3.6 SSO6.- Better decision taking for cost-efficient adaptation solutions by developing a DSS to compare adaptation solutions

a) SSO6 description

Development of a DSS that allows authorities to compare several adaptation solutions to improve climate planning on critical infrastructures. The final output will be a system of existing and improved modeling and assessment software and methods that share a common language, allowing interconnections to maximize the potential multiplier effect of their results. The DSS will offer a detailed asset level approach, and a holistic approach to support decision making at appropriate scale. Having as a basis the hazard modeling and the climate projections from WP1 and WP2, the DSS will integrate as its inputs the impact and resilience assessment, as well as the adaptation solutions from WP3. The users (case studies and CoP, decision makers, authorities, and CI managers) will be able to access the results of the impact/resilience assessment for every risk target studied in the project. Importantly, they will be able to understand the co-benefits (e.g. financial, environmental) of each adaptation solution in comparison to the scenarios under current conditions. Various visual elements, such as hazard maps, will enable users to easily understand the results of the assessments.

b) State of the art and progress beyond

ICARIA DSS will be built upon results from previous projects. Regarding the holistic approach, the resilience assessment module will feed from existing resilience assessment apps, the RAF App tool from the RESCCUE (Cardoso et al,. 2020) project and the EU-CIRCLE RAT (Sambor & Krzysztof, 2017). The detailed approach at asset level will include: i) climate models upgraded from previous projects (RESCCUE (Velasco et al., 2018), CLARITY (Zuccaro & Leone, 2021), EU-CIRCLE (Sambor & Krzysztof, 2017)), with the novelty of the downscaling of the shared socioeconomic pathways to the regional level of the study areas by combining statistical and dynamical downscaling; ii) adaptation modeling of critical infrastructure, improving innovative multi-hazard modeling, vulnerability functions and tangible direct and indirect damage assessment methodologies (e.g. developed in RESCCUE (Velasco et al., 2018) for floods, droughts and storm surge impacts in CLARITY (Zuccaro & Leone, 2021) for heat impacts): iii) qualitative and quantitative results under different adaptation scenarios. The main objective is to secure successful connections among the tools, facilitating a similar syntax between inputs and outputs that guarantees agility in the flow of tools. ICARIA DSS will be a web toolbox where the outputs of the different tools will be uploaded, and the final comparison of solutions will be facilitated. The DSS will mainly rely on precalculated impacts including economic and other impacts with and without adaptation. Detailed information on all adaptation solutions assessed in the project, including the information necessary to model the impacts, will be published through the Portfolio of Adaptation Solutions, for use in ICARIA and beyond. ICARIA portfolio will integrate RESCCUE web-based Adaptation Platform[3], RECONECT NBS portfolio[4], CLARITY Catalogue of adaptation options[5] and the DRIVER+ Portfolio of Crisis Management solutions[6]. Furthermore, preferred synergies with the recently funded KNOWING and MAIA projects (where AQUATEC and AIT will participate) will be established in order to coordinate new developments in this field avoiding overlaps.

c) Methods contributing to SSO6

Compared to other existing similar tools, the ICARIA DSS will consider a broader number of risk receptors than only critical infrastructures, as it will include people, housing, tourism and natural areas. As a result, the DSS will enable a more holistic assessment of the impact of any given adaptation measure on a larger set of assets. This tool will be designed as a toolbox of detailed and holistic approaches, composed of the most relevant adaptation modeling existing tools and methods. The DSS development

[3] https://resccue.ncg.ingrid.pt/accounts/login/?next=/resccue/studies
[4] http://www.reconect.eu/reconect-selection-of-nbs-tools-and-models/
[5] https://github.com/clarity-h2020/
[6] https://pos.driver-project.eu/en/PoS/solutions

will ensure data transferability with other EU services like C3S and Climate-ADAPT. Furthermore, it will be assessed how to integrate this tool in the EU Adaptation Platform. The consortium will secure a common syntax to allow the outputs of the modeling tools to serve as inputs of the assessment tools. A user-friendly web-based platform and interface will allow decision-makers to easily visualize impacts from single and compound hazards and the most cost-effective adaptation scenarios. The DSS will be developed, used and tested in a strong interaction with the stakeholders, namely the case study owners, to ensure its adequacy and friendliness.

In terms of usability, the DSS will allow the estimation of risk in monetary terms (expected annual damage or EAD) with respect to different extreme climate single and compound events. Also, a set of adaptation solutions collected from existing tools with the state-of-the-art upgrades will be available to assess current and future risks scenarios. The outputs of the detailed approach, consisting in the estimated EAD of the baseline (present), business as usual (BAU), future without adaptation measures) or adaptation scenarios (present or future scenarios after implementing the selected sets of adaptation solutions for each hazard), will feed a GIS platform displaying risk maps.

d) Specific results achieved within SSO6

RES-TEC3. Portfolio of adaptation solutions. Existing portfolios from previous projects will be expanded to include natural areas and integrate relevant solutions for the hazards studied within ICARIA, with a special focus on NBS. Portfolio will include the description of the solutions, their effects and co-benefits on relevant assets, construction and maintenance costs and a modeling guidance.

RES-TEC4. ICARIA DSS. ICARIA will develop a web based DSS based on resilience indicators, Cost Benefit Analyses and Multi Criteria Assessment to compare several adaptation measures and strategies to cope with extreme climate and compound events and their cascading effects on strategic assets and services, and thus facilitating the planning process by helping decision makers to choose the most cost-effective solutions.

3.7 SSO7.- Ensure the use and impact of the ICARIA outputs

a) SSO7 description

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

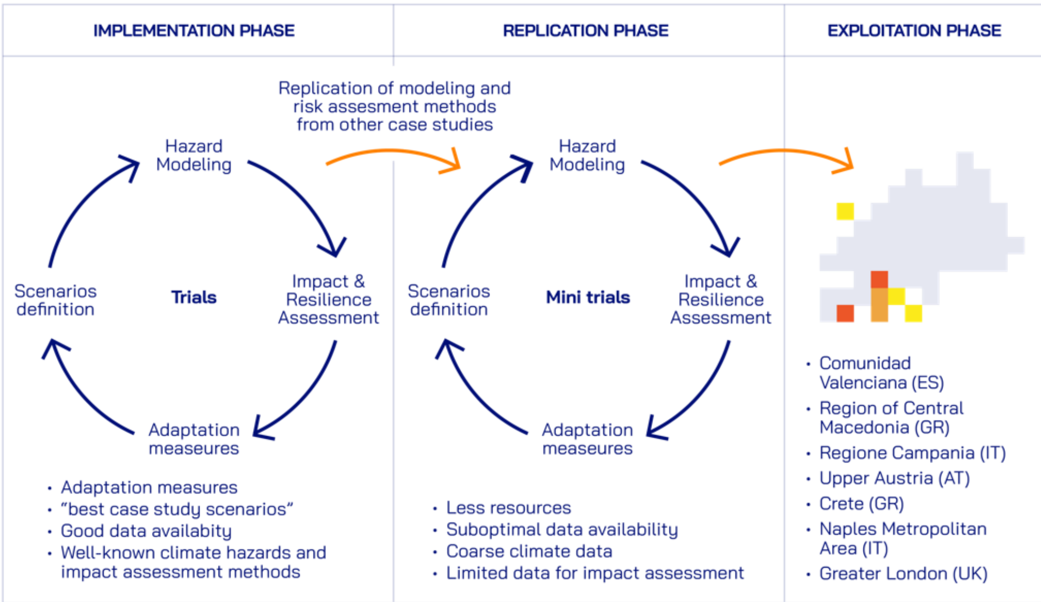

Figure 6. Scheme of the implementation, replication and exploitation phases of project ICARIA

b) State of the art and progress beyond

Based on successful past experience of collaboration in the field of past projects like BINGO (Van Alphen et al., 2021) and ESPREssO (Abad et al., 2020) , collaboration and communication channels (involving scientific experts, problem owners, local stakeholders, communities and citizens) will be proposed through the Communities of Practice (CoPs) of the three case studies to facilitate dialogue and cooperation, improve governance, coordination and knowledge transfer related to multi-risk management and long-term resilience planning. Participatory process will also be fostered during the local workshop using engagement tools and exercises to identify gaps and needs, to achieve a better understanding about risk awareness and to ensure co-creation of adaptation solutions. On top of this, synergies with the recently funded EU MAIA project will be established taking advantage from the participation of AIT and AQUATEC, as well as with other projects from this call. For these SSOs, the progress beyond the state of the art will be provided in the field of citizen science and, particularly, about citizen engagement according to Haklay classification (Haklay 2018) and 3D representations of pluvial flood and storm surges to improve risk perception.

c) Methods contributing to SSO7

Both the models and the DSS resulting from project ICARIA will be validated by three case studies representing very different geographical areas. In addition, both the Trials and the minitrials will be developed following the DRIVER+ Trial Guidance Methodology (Fonio et al., 2023), which enables a systematic and active participation of stakeholders in the Trials preparation, execution and results evaluation.

The three trials will be structured under a common multi-risk assessment framework and will follow shared strategies to assess specific climate hazards and asset vulnerabilities. Hence, ICARIA itself will enable the implementation of a common approach in three different regions. Furthermore, the exploitation of results will be ensured in two main ways: (1) involving local stakeholders, facility operations, local government, meteorological services and regional climate agencies to introduce an end-user perspective to the design of the DSS and other projet results; (2) a total of 7 european regions have been associated to ICARIA as “following regions”. These regions will provide external advice on how to enhance the replicability of ICARIA results in other geographical contexts.

d) Specific results achieved within SSO7

RES-SCI5. Multi-risk and resilience assessment for the 3 EU case studies. The previous ICARIA results (mainly methods and tools) presented in this table will be tested, implemented and replicated in the three case study regions for different hazards and assets to show the versatility and adaptability of the results. For the three regions a set of adaptation solutions will be chosen as the most cost-effective ones in relation to the hazards and assets evaluated.

RES-SCI6. Replication, sustainability and exploitation of ICARIA results. Results previously implemented in one of the case studies for some hazards and assets will be replicated in other regions with other hazard-assets combinations choosing again the most cost-effective adaptation measures but, this time, with less data and resources. Replication guidelines will be elaborated and a sustainability and exploitation plan will be also delivered to detail how these results are envisaged to be improved, used by the case studies and extended to other European regions in the next coming years to accomplish with the general Mission goal to help at least 150 European regions and communities towards climate resilience by 2030

4 Exploitation of ICARIA results

During the project, 4 main actions will be carried out in order to guarantee the proper exploitation of ICARIA results: (1) Implementation and assessment of ICARIA models and DSS in three case studies; (2) Validation of the replicability and relevance of ICARIA methods and software for assets level modeling; (3) Maximize the outreach of results through various means and tools (e.g. project website, development of communication materials, publication of technical papers, participation conferences and organization of a project final event) through which contacts with target audience will be established and (4) Identification and examination of novel developments that can be considered exploitable results describing the: innovation, potential customers, benefits to the customer, time-to-market, investment costs until exploitation, price, potential competitors, partners needed, IPR issues detected.

4.1 Implementation and replicability strategy

During the time span of project ICARIA, the methodological and technical developments generated will be implemented in the three case studies following a two step approach.

Firstly, a “full implementation” of the developments will be done in the Trial phase, where each case study will evaluate both the impacts and adaptation measures for their best known climate hazards. This step will represent “best case study scenarios", with good data availability, well-known climate hazards and impact assessment methods for all three case studies. In the second step, the so-called Mini-Trials, the replicability of the ICARIA development will be tested. The methods and tools applied in the Trials will be reproduced in other regions to assess the impacts and adaptation scenarios of less studied climatic events. These scenarios will count with suboptimal data availability.

The following Table depicts how the expected results will be implemented and replicated in the project case studies.

Table 4. Implementation and replicability in project ICARIA Trials and Mini-Trials.

Results	Implementation in the Trials	Replication in the Mini-Trials
RES-SCI1. Project framework	A multi-hazard framework to ensure a holistic risk assessment at regional level that considers also potential cascading effects and compound events will be implemented in the Trial phase to assess climate hazards under “optimal” data and knowledge conditions	In the Mini-Trials phase, the holistic framework will be applied to assess climate hazards under “suboptimal” conditions in each CS. The methods used to assess climate hazards in Mini-Trials will incorporate the “learnings” from the Trial phase. This step will also serve to test methods and tools to bridge the data gaps encountered in the Mini-Trials
RES-SCI2. Climate scenarios methods and results	The different climate projections will generate one of the key inputs for the hazard models for both the Trials and the Mini-Trials.These will serve to assess the impacts that will affect critical assets under different future climatic scenarios. The use of such projections will be similar in both the implementation and the replication phase.	

Results	Implementation in the Trials	Replication in the Mini-Trials
RES-SCI3. Methods for mending the data gaps and uncertainty analysis	Theoretically, Trial scenarios will be run with full data availability. Hence, the need for methods to mend data gaps will be limited. Nevertheless, the uncertainty assessment will be used to identify the most sensitive parameters of the impact and risk models.	Data gaps mending will be an essential part of the Mini-Trials given that limited data availability is expected. Therefore, a thorough assessment of the uncertainty of both the models and the input data will be key to assess the validity of the results.
RES-TEC1. Multi-Hazard modeling tools	A novel methodology will be developed to enable the modeling of the hazard posed by multi-hazard events, involving two simultaneous or consecutive extreme weather events. The methods developed in the Trial phase to assess such events will involve sectorial detail hazard models.	In the Mini-Trial phase, the Trial hazard models will be replicated. Nevertheless, since data and resource limitations are expected, this replication expects significant simplifications of the Trial methods and models. In this sense, data gap bridging method will be used.
RES-SCI4. Climate-related multi-risk tangible impact assessment method	A methodology will be developed to quantify in monetary terms the impact incurred in a wide range of critical assets. Such quantification will be based on the outcome of the hazard assessment.	Given that the outcomes of hazard assessment in the Mini-Trials will be limited, the impact assessment methods will be adapted to provide adequate results under this limitation.
RES-TEC2. Holistic climate resilience assessment method	A shell will integrate the results of the hazard and risk assessment to assess the holistic resilience of the CS regions against climatic hazards associated with several climatic scenarios. A deeper assessment can be made depending on the case studies' results	This result will serve to assess the regional resilience against less known climate hazards that still pose a relevant threat to the region.
RES-TEC3. Portfolio of adaptation solutions	Such portfolio, will serve to identify the most cost-effective solution to improve the regional resilience based on the risk assessment results.	Similarly to other outcomes of the project, the portfolio will have to be adapted to assess the adequacy of adaptation solutions against climate hazards that are assessed with data and methods limitation.
RES-TEC4. ICARIA DSS	Use and validation of the DSS by all the case studies for Trials. Case studies will use the platform to monitor risk targets, visualize impacts and compare different adaptation solutions.	Use and validation of the DSS by all the case studies for Mini-Trials. Case studies will use the platform to monitor risk targets, visualize impacts and compare different adaptation solutions.

Results	Implementation in the Trials	Replication in the Mini-Trials
RES-SCI5. Multi-risk and resilience assessment for the 3 EU case studies	Project ICARIA has three case studies where the tools and methods presented before will be tested, implemented and replicated. Furthermore, the resilience assessment will serve to determine the most cost-effective solutions for each region to improve their resilience against multi-hazards events.	Similarly to the Multi-hazard modeling tools (RES-TEC 1), the implementation of Multi-risk assessment methods in the Mini-Trials will face data gaps. Again, simplification and data gap bridging methodologies will be required.
RES-SCI6. Replication, sustainability and exploitation of ICARIA results	As presented in this section, the replicability of the methods and tools developed in the Trials will be tested in the Mini-Trials phase. This will serve to evaluate and improve the capacity of such methods to perform adequate risk assessments under data limitations. The exploitation of ICARIA results will be fostered by several means. These are presented in Section 4.2.	

4.2 Exploitation strategy

The exploitation strategy of project ICAIRA aims at ensuring that the developments and outcomes generated, reach potentially interested end users beyond the consortium. To this end, the following actions will be taken:

1. For each case study a local Community of Practitioners (CoP) will be established to enhance the stakeholder engagement during the development phase, ensuring that the tools generated in the project match their current and future needs, and to generate interest in using project results among potential end users such as policy/decision makers in terms of regional adaptation plans and critical infrastructure operators.

2. A total of seven European regions are involved in project ICARIA as “follower regions” (third parties). They will be the first candidates for results exploitation beyond the project. As extreme climate events and climate change consequences have an important impact on socio-economic inequalities and these differences could increase the gap across EU regions, case studies and follower regions have been selected in order to include less developed, transition and more developed regions. The figure below depicts both the location of the three Case Studies and the seven follower regions.

3. Publication of papers in technical and scientific peer-reviewed journals and participation in relevant conferences and workshops to comunica ICARIA’s expectations, methods and results to the scientific and technical community.

4. Involving project ICARIA in european level research clusters such as IC4water and coordination actions lice project MAIA to foster synergies and co-creation with other research activities.

Additionally, Deliverable 5.1 “Dissemination and Communication Plan”, delivered in M6 and updated in M36, presents a detailed explanation of all the activities planned and materials developed (e.g. a project website) to organise and implement dissemination and exploitation activities.

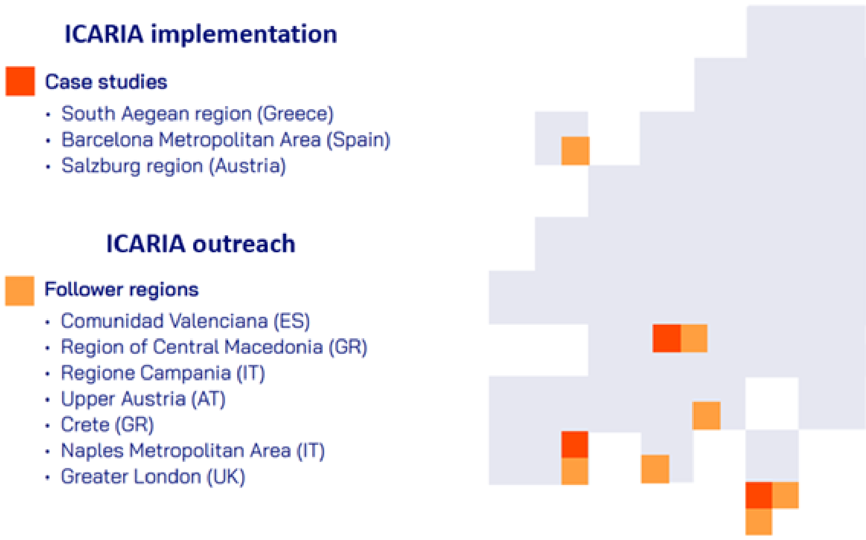

Figure 7. ICARA Progress beyond: Expected results

5 Conclusions

This report provides a detailed description of the specific results and developments that project ICARIA aims to produce beyond the current state-of-the-art and previous EU Research projects that serve as the basis for ICAIRA. Hence, this deliverable will serve as a guidance for the consortium and will be updated along the project development if needed.

Also, innovation management aims at ensuring that the outcomes of the project are aligned with the needs and expectations of its end users, and that the specific tools developed are easily exportable to other regions than the project case study. To this end, the project has been structured in three separate phases (Implementation, Replication and Exploitation) that ensure that all tools and methods developed in the project are tested in different regions with different conditions and data availability.

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Annex I: ICARIA project KPIs

KPI*	SSO*	Corres. deliv.*	Dead-line	Description	Probability of timely achievement
KPI 1.1	SSO 1	D1.1	M9	Framework (aligned with EC technical guidance on climate proofing of infrastructure 2021-2027) presented, at least, in 1 international conference and 1 open access scientific journal	Medium
KPI 1.2		D4.3	M33	Testing methodology in all ICARIA implementations (3 Trials) and replications (3 Mini-Trials)	High
KPI 1.3		D1.3	M18	Four data collection templates (1. hazard, 2. exposure, 3. vulnerability, 4. socio economic impact)	High
KPI 2.1	SSO2	D1.1	M12	Finalized concept of combination of the different approaches (at least 2) to obtain downscaled scenarios with uncertainty measurement for the near and long term	Medium
KPI 2.2		D1.2	M12	Number of CMIP6 climate models (at least 10 using the statistical approach, at least 2 using the dynamical approach**) downscaled at a local*** scale (points) to feed asset risk assessment	Medium
KPI 2.3		D1.2	M12	The method and results will be discussed within at least 1 open-source publication and 1 conference	High
KPI 3.1	SSO3	D1.3	M18	Use of data gap filling and data uncertainty methods recommended in D1.3 in all the three ICARIA case studies during the replication phase (Mini-Trials)	High
KPI 3.2		D4.3	M33	Satisfactory validation (75% satisfaction in Communities of Practice (CoP) poll results) of data gap and uncertainty methods recommended in D1.3 in the ICARIA case studies during replication phase (Mini-Trials)	High
KPI 4.1	SSO4	D4.2	M30	Successful implementation and assessment of ICARIA modeling framework through 3 trials	High
KPI 4.2		D4.2	M33	Successful replication of ICARIA modeling framework in at least 3 mini-trials	High
KPI 4.3		D4.3	M33	More than 3 publications on analyzing the interactions between multi-hazards and critical infrastructures, the knock-on effects of compound/cascade disasters, and the ICARIA modeling framework applications	Medium

KPI*	SSO*	Corres. deliv.*	Dead-line	Description	Probability of timely achievement
KPI 4.4		D4.3	M33	Presenting the methods and results in, at least, 15 specialized journals / forums / conferences	Medium
KPI 5.1	SSO5	D4.2 & D4.3	M36	More than 3 scientific publications on peer-reviewed indexed and open access journals about the holistic resilience assets and tangible impact assessment methods and their implementation within ICARIA case studies	Medium
KPI 5.2		D4.3	M33	Successful implementation and replication of the multi-risk and resilience assessments in the 3 ICARIA sites (average of 75% satisfaction on poll results among CoPs)	High
KPI 6.1	SSO6	D3.3	M18	For each of the asset categories that are investigated in the project, a minimum of 3 relevant adaptation solutions of ICARIA portfolio, applied and assessed in at least one of the case studies	High
KPI 6.3		D3.5	M33	Satisfactory implementation of the DSS (75% satisfaction on CoP poll results)	High
KPI 6.3		D3.5	M33	Use of DSS in all the 3 ICARIA case studies for Trials and Mini-Trials	High
KPI 7.1	SSO7	D5.3	M36	Availability of ICARIA website with more than 250 visits/month from M12 to M36	Medium
KPI 7.2		D5.5	M36	Minutes of the CoPs workshops during the project (3 minutes for each case study)	High
KPI 7.3		D5.5	M36	More than 10 regions (including followers) interested in ICARIA demos participating in final event	Medium
KPI 7.4		-	M36	Organization of Final Conference on climate-proofing infrastructures with more than 200 attendances	Medium

* KPI: Key Performance Indicator; SSO: Specific sub-objective; Corres. deliv.: Corresponding deliverable
** Dynamically downscaled climate projections based on at least 2 different CMIP6 and 2 different RCM models
*** High-level, hazard climate projection based on statistical approaches and AI-improved dynamical projections

ICARIA

Improving climate resilience of critical assets

More info: **www.icaria-project.eu**

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