ICARIA
Improving climate resilience of critical assets

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D6.4 Implementation Plan and Risk Contingency Plan

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D6.4: Implementation Plan and Risk Contingency Plan

Summary

This document is the third version of the Implementation Plan and Risk Contingency Plan. First, it indicates how the work of the project has been divided and organized as well as the way to evaluate if the project objectives are reached according to the schedule and within the budget. Additionally, it defines key steps to follow in order to initiate the project action. The second part lists a number of risks that could affect different aspects of the project outcome. It includes risk mitigation measures and a contingency plan for each case.

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D6.4	WP 6	
Deliverable lead beneficiary	**Deliverable author(s)**	**Contributor(s)**
Aquatec (AQUA)	Àlex de la Cruz (AQUA)	Barry Evans (UNEXE) Rita Brito (LNEC) Marianne Bügelmayer (AIT) Dennis Havlik (AIT) Andrea Cuartero (CET) Ahtanasios Sfetsos (DMKT)
Internal reviewer(s)	**External reviewer(s)**	
Angel Villanueva (AQUA) Beniamino Russo (UPC)	Athanasios Arvanitidis (CERTH-ITI)	
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27/06/2024	2.0	Àlex de la Cruz (AQUA)	Final version

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List of Acronyms and Abbreviations

CI	Critical Infrastructure
CoPs	Communities of Practitioners
CS	Case Study
CSF	Case Study Facilitators
CT	Coordination Team
D&E	Dissemination and Exploitation
DoA	Description the Action
DSS	Decision Support System
GA	Gran Agreement
GCM	General Circulation Model
KPI	Key Performance Indicators
NDA	Non-disclosure agreements
PMT	Project Management Team
PSB	Project Steering Board
PST	Project Steering Board
RAF	Resilience Assessment Framework
SSO	Strategic Subobjectives
TGM	Trial Guidance Methodology
UPC	Universitat Politècnica de Catalunya
WP	Work Package

Executive summary

The third version of the Implementation Plan and Risk Contingency Plan has been updated in the 18th month of ICARIA's project lifetime (June 2024). The first section summarizes the evolution of the implementation plan with the main goals achieved during the initial semester of the project. Next, it depicts key steps forward envisaged in the implementation strategy for the following 18 months.

Furthermore, this document presents an updated identification list of risks, prevention measures and contingency plans considering the new challenges and eventualities that will be faced in the coming months.

Finally, another section indicates the list of risks materialized since the beginning of the project and indicates the measures that have been taken to minimize their effect.

This Implementation Plan and Risk Contingency Plan will be updated in month 30 under the supervision of the Project Management Team (PMT).

1 Introduction to project ICARIA

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 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 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 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.

This project will be especially devoted to critical assets and infrastructures that are 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. 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, 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 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).

- 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 studies regions

- SSO3.- Quantify uncertainty and manage data gaps through model input requirements and innovative methods
- SSO4.- Increase the knowledge on climate related disasters (including interactions between compound events and cascading effects) by developing and implementing advanced modeling for multi-hazard assessment
- SSO5.- Better assessment of holistic resilience and climate-related impacts for current and future scenarios
- SSO6.- Better decision taking for cost-efficient adaptation solutions by developing a Decision Support System (DSS) to compare adaptation solutions
- SSO7.- Ensure the use and impact of the ICARIA outputs

2 Objectives of Deliverable 6.4

The present document is the third updated version of the Implementation Plan and Contingency Plan of the ICARIA (Improving Climate Resilience of Critical Assets) project corresponding to month 18 of its lifespan. Versions 1 and 2 were presented in February and June 2023 (ICARIA 2023a and ICARIA 2023b). This research project is being developed within the European Union Research and Innovation funding program Horizon Europe under the Grant Agreement (GA) number 101093806.

The document corresponds to Deliverable 6.4 of Work Package 6 (WP6) - Project Management. The general objective of WP6 is to ensure an efficient coordination and management of both the technical-scientific and the financial matters of the project to ensure the fulfillment of all objectives and milestones defined in the GA. The specific objectives of this WP are as follows:

- Quality assessment of project progress, results, and impact
- Timely submission of deliverables and reports to the European Commission
- Keeping the project within budget and schedule while achieving the objectives
- Risk mitigation and management
- Establishing effective communication channels Consortium –Commission

The main objectives of this third version of the Implementation Plan and Contingency Plan are as follows:

1. Update the implementation strategy according to the current status of the project
2. Forecast potential risks and challenges that might affect the project outcome and define prevention and contingency measures to avoid or reduce the probability of negative occurrence and consequences.

Given the fact that along the whole lifespan of ICARIA its characteristics and nature evolve, the first and the second version of the project Implementation Plan and Risk Contingency Plan delivered in M2 and M6 have been updated in M18. This version takes into account new risks that may arise during the second half of the project. An updated version of this document will be delivered in M30 focusing on the last steps of the project. All versions of the Implementation Plan and Contingency Plan can include input from the PMT as well as any member of the consortium.

In this third version of the document the “Materialized risks” section has been updated to highlight the risks that have materialized during the first eighteen months of the project, together with the actions undertaken in each case.

3 Implementation plan

3.1 Work developed between M6-M18

The present section presents a brief summary of the main activities developed in project ICARIA in the period between M6 and M18.

Table 1 summarizes the coordination activities undertaken in this period to ensure an adequate functioning of the project consortium and an adequate quality of the work delivered.
It should be noted that, after an amendment to the consortium GA, the ICARIA Coordination Team (CT), originally formed by CETAQUA and AQUATEC, has changed to the following structure:

- AQUATEC: Project coordinator
- Universitat Politècnica de Catalunya (UPC): Scientific and Technical leader

Table 1. Summary of the coordination activities between M6 and M18.

Coordination objective	Incentives takens
Establish effective and frequent communication within the ICARIA PMT	• Organize monthly PMT meetings and produce detailed minutes with specific tasks assignments and follow-ups • Hold bilateral WP-WP or WP-Case Study (CS) meetings to discuss relevant matters • Organize an Annual Technical Meeting in Naples in M7
Ensure a general status of coordination among all Tasks and WPs in ICARIA	• Organize a Plenary Meeting (face to face) in Vienna in M13 • Involvement of the CT in the supervision of all ongoing Tasks • Use the PMT meetings to foster communication among WPs and Case Study Facilitators (CSF) • Establish a fluent communication between the CT and the CSF as responsible for the work developed in each CS
Timely submission of deliverables	• According to the project Description of Action (DoA), a total of 23 deliverables have been submitted in the first semester. • The deadline for a total of 5 deliverables has been modified through the GA amendment (D1.2, D2.2, D3.1, D3.2 and D3.4).
Dialogue with relevant local stakeholders	• Organization of two Communities of Practice (CoP) meetings involving relevant stakeholders from each CS related to climate resilience and critical infrastructure management.
Adequate budget management	• Two internal financial reporting (at M6 and at M12) have been done to ensure an adequate progress of the expenses incurred. None of them were mandatory but were scheduled as useful exercises for partners with low experience, check initial important deviation and possible other problems.

Coordination objective	Incentives takens
	• Deviations have been notified to some partners to ensure that either an adequate justification is provided or that corrective measures are taken.

According to the project GA and its Gantt diagram (see Annex B), in M18 (June 2024) Milestone 2 has been achieved with the submission of the corresponding deliverables and the fulfillment of the KPIs due in the 18th month of the project.

Since the start of ICARIA, a total of 23 Deliverables have been submitted. These are listed below.

Table 2. Summary of the ICARIA project deliverables handed over between M1-M18.

Deliverable number	Deliverable name	Work package	Responsible partner	Due month
D1.1	ICARIA holistic modelling framework	WP1	PLINIVS	M11
D1.2	Climate projections and hazard data	WP1	FIC	M14
D1.3	Impact modeling data requirements and methods to treat data gap filling and data uncertainty	WP1	CERTH	M18
D1.4	WP1 lab testing results	WP1	CERTH	M18
D2.1	Holistic modeling framework for multi-hazards and related uncertainty analysis	WP2	AQUA	M12
D2.2	Multi-hazard scenario building methods	WP2	UNEXE	M14
D2.3	ICARIA multi-hazards modeling tools and application guidelines – Version 1	WP2	UNEXE	M18
D2.5	WP2 lab testing results	WP2	IREC	M18
D3.1	Tangible impacts methods	WP3	CET	M14
D3.2	Holistic resilience methods	WP3	LNEC	M14
D3.3	Portfolio of adaptation solutions	WP3	CET	M18
D3.6	WP3 testing results	WP3	AQUA	M18
D4.1	Trial design	WP4	AIT	M18
D5.1	Dissemination and communication Plan - Initial version	WP5	CET	M6
D5.4	Stakeholders engagement plan	WP5	UNINA	M6
D6.1	Project Management Manual	WP6	AQUA	M2
D6.2	Implementation plan and Risk contingency	WP6	AQUA	M2

Deliverable number	Deliverable name	Work package	Responsible partner	Due month
	Plan – Initial version			
D6.3	Implementation plan and Risk contingency Plan – Version 2	WP6	AQUA	M6
D6.4	Implementation plan and Risk contingency Plan – Version 3	WP6	AQUA	M18
D6.6	Innovation Management Plan	WP6	AQUA	M6
D6.8	Data Management Plan – Initial version	WP6	AQUA	M6
D7.1	OEI - Requirement No. 1 (Engagement of an external Ethics Advisor)	WP7	AQUA	M2
D7.2	OEI - Requirement No. 2 (Engagement of an external Ethics Advisor)	WP7	AQUA	M18

Remarkably, during the first half of the project, a total of 2 Milestones have been successfully achieved. The proofs of fulfillment are as follows:

Table 3. List of achieved milestones and means of verification.

Milestone number	Milestone name	Work package	Means of verification	Due month
1	Implementation plan	WP6	Delivered D6.1 and D6.2	M2
2	WP labs: tests done, and methods and tools validated in the first version	WP 1, 2 and 3	Delivered D1.4, D2.4 and D3.5 Partial achievement of SSO1 (KPI1.1 and 1.3), and full achievement of SSO2 (KPI2.1, 2.2 and 2.3)	M18

3.2 Next implementation steps

The Implementation Plan of ICARIA for the coming months aims to:

1. Ensure the adequate implementations of the models, tools and frameworks developed in WP1, 2 and 3 in all three CS within the activity of WP4.

2. Implement and validate the multi-hazard risk assessment framework of the project in all three CS

3. Develop a comprehensive multi-hazard risk assessment of the 3 CS of the project within the general scope of the project.

4. Organize and execute the validation process of the ICARIA results following the Trial Guidance Methodology (TGM) as described in Deliverable 4.1 and maintain alive and proactive local CoPs

5. Organize exploitation plans to ensure the usability of the ICARIA tools and main results after the end of the project.

This plan will be articulated according to the following guidelines that indicate the measures that will be adopted to ensure an adequate organization of the project:

1. **Consortium coordination and partners engagement**

- Monthly PMT meeting
- Annual plenary meetings
- Annual technical meetings (face-to-face PMT meetings)
- Regular internal WP meetings
- Regular bilateral WP and CSF meetings

2. **Technical matters**

- Development of cutting-edge single and compound hazard models
- Development of comprehensive multi-risk assessment models
- Development of holistic resilience models
- Evaluation of different adaptation scenarios
- Evaluation of the satisfactory fulfillment of project KPIs and milestones

3. **Results exploitability**

- Involvement of local stakeholders of CoP in key steps and critical decisions of the project:
    - Identification of main hazards and critical assets for the risk assessment
    - Design of the DSS functionalities
    - Identification of suitable adaptation solutions for specific scenarios and assets
- Involvement of following regions via specific workshops

4. **Project outreach and results dissemination**

- Keep an active dissemination strategy via the project website and social media actions
- Participation in thematic conferences at national and international level
- Involved project ICARIA in relevant research clusters
- Publish papers in technical journals presenting the developments and results achieved
- Engagement activities for the project follower regions
    - First workshop for presentation ICARIA's methods and tools (scheduled July 2024)
    - Second workshop for presentation of the project results and final solutions (scheduled November 2025)

5. Financial management and reporting periods

- Regularly assess the financial evolution of the project via internal reporting periods every 6 months
- Ensure an adequate management of information and document presentation during the first official reporting period in M18 by informing all partners of the administrative requirements and the documents that need to be prepared and supervising their delivery

4 Identification of risks, mitigation measures and contingency plan

In the context of project management, a "risk" is meant as a probable situation that can cause an unwanted change in the project objectives, schedule or planned activities. ICARIA involves a consortium of 15 partners and 3 case studies. Hence, a number of risks can potentially affect the desired outcomes of the project, some of them were even identified during the development of the project proposal. Therefore, it is essential to identify each risk and define appropriate contingency measures.

These risks can be associated with both internal and external factors. Internal risks derive from inadequate management and coordination of the consortium and results dissemination, while external risks are associated with matters beyond the control of the consortium (e.g., data availability, involvement of key external stakeholders, confidentiality issues).

As project coordinator, AQUATEC has conducted an identification and analysis of the risks that can threaten the adequate execution of project activities, paying special attention to those that directly affect the key steps for the project development. This analysis has been carried out through a participatory process that has involved the members of the PMT. The steps followed in the risk definition process are as follows:

1. Preliminary identification of risks done by the coordinators based on several sources:
    a. Risks included in the ICARIA proposal and DoA
    b. Further risks identified by different PMT members
    c. Further risks identified by any partner at any point in time
2. Definition of a specific list of risks and tailored risk-prevention measures with a contingency plan for each case.

Thanks to developing this process in a participatory manner, it was possible to amplify the points of view involved in the risk identification. These risks were also categorized in the following fields

- Project management
- Research
- Dissemination and exploitation

For each one of the identified risks, the affected WPs were identified, together with a proposal of mitigation measure(s) to avoid or reduce the probability of negative occurrence and a Contingency Plan to mitigate the consequences of its occurrence and increase the final project success.

Table 4. Identification of risks related to research activities and proposal of risk-prevention measures and contingency plan.

Description of the risk	WP involved	Proposed risk-prevention measures	Contingency plan	Impact	Probability
Definition of a common ground for climate scenario modeling	WP1	ICARIA future projections have been determined for statistical and dynamical downscaling, a large set of GCM and different horizons. Due to the large possible scenarios to be considered and the high computational cost to be provided, it is necessary to limit the number of simulations ensuring the treatment of uncertainty.	Meeting among climate downscaled projections experts and modelers. Analysis of other experiences from recent and ongoing projects (RESCCUE and ARSINOE)	High	Medium
Difficulties to implement the hazard and risk assessment methods to a specific CS	WP 4	The activity in WP1, 2 and 3 has set the framework, tools and methods for all CSFs to develop the risk assessment of interest for each CS. This work is gathered in high-quality deliverables providing guidelines for the implementation of such methodologies to any case of study.	All 3 CS count with expert partners in modeling and risk assessment, the CSF. Furthermore, the CSFs count with the support of several technical expert partners who will support them in the assessment of impacts in certain specific sectors, such as electricity distribution, water-related assets or economic impacts.	High	Medium
Difficulties to develop multi-hazard modeling methods	WP2	WP2 is organized in a manner that efforts on developing multi-hazard modeling methods are carried out throughout the whole project, starting with a literature review of single hazard modeling in D2.1 (M12), an initial strategy outline in D2.2 (M14) and D2.3 (M18) and a final methodological document to present the innovation generated in this field in	Competent partners with extensive expertise in hazard modeling have been placed as responsibles and contributors to this innovative task.	High	Low

Description of the risk	WP involved	Proposed risk-prevention measures	Contingency plan	Impact	Probability
		D.24 (M33).			
Difficulty to determine the most relevant multi-hazard scenarios for the CS	WP2	A Bayesian Networks-based approach has been used to correlate single-hazard events in multi-hazard scenarios. Furthermore, a workshop to establish a common understanding of this matter among the CSF has been celebrated.	If the results of the workshop on multi-hazard scenarios definition are unclear, more meetings on this topic will be celebrated. Eventually other projects focused on the topic of multi-hazard modeling could be contacted.	High	Low
Difficulties to implement the TGM to the context of ICARIA	WP 4	Bilateral meetings with the CSF and the TGM expert partners are scheduled to define and execute an implementation plan of this methodology to the needs of project ICARIA.	Mr. Uberto del Prato, an expert on resilience and with previous experience in TGM implementation, has been appointed as a new Project Advisory Board member to provide external support in this field.	Medium	Low
Complexity of developing an exploitable DSS	WP3	Bilateral meetings between the DSS developers (DRAXISS) and the CSFs are celebrated recurrently to ensure coordination and common understanding between the risk assessment modelers and the DSS developers. Bilateral meetings between the DSS developers and other ICARIA's tools developers were held during tools' development, mainly in WP3.	If progress is stuck due to a lack of coordination, an ad-hoc face-to-face meeting between DRAX and the CSF can be organized.	High	Medium
Difficulties in establishing	WP 1, 2, 3 and 4	Definition of a common framework for the project in WP1. The Consortium could utilize the methodology	If needed, specific workshops for each specific CS can be organized by the CSF	High	Medium

Description of the risk	WP involved	Proposed risk-prevention measures	Contingency plan	Impact	Probability
the baseline regional / critical infrastructure resilience and agreeing on how to address them		and tools developed in the RESILOC[1] project to facilitate this process.	and/or the trial and minitrial coordinators		
Delay of the activity or failure in achievements of milestones and KPIs	All	Monthly PMT meetings will pay careful attention to upcoming delivery deadlines and will also keep track of the evolution of all lines of work ongoing on the project in a continuous manner. If a potential delay is identified in a specific deliverable or milestone, a meeting between the coordination team, WP leader and Task/Deliverable responsible will be held. If necessary, the rest of the contributors to the deliverable will also attend the meeting. In that meeting, opportune measures for each specific case will be defined to ensure a timely delivery of the document.	In case an activity is delayed, the coordinator will notify the EC Project Officer to jointly try to solve the problem. In case an activity is repeatedly late, or some WPs are always delayed, the Coordinator, with the support of the EC, may take action in order to ensure proper completion of the tasks (e.g., redistribution of tasks, subcontracting)	Medium	Medium
Lack of data availability for	WP 1, 2, 3 and 4	ICARIA will devote many efforts to filling data gaps through the implementation of different novel	If a data gap cannot be filled, WP leaders have to notify the coordinator to follow one	High	Medium

[1] https://cordis.europa.eu/project/id/833671

Description of the risk	WP involved	Proposed risk-prevention measures	Contingency plan	Impact	Probability
modeling, risk and resilience assessment		techniques and strong background acquired by project partners (AIT specialist in the use of AI to achieve downscaled climate scenarios and hazards and CERTH specialist in the use of no-conventional methods to validate hazard and impact models). Guidelines will be produced to support identification of data characteristics and contributors for resilience assessment.	of the following foreseen strategies: 1. If there are problems collecting data from organizations, administrations and services operators that are ICARIA partners, the Coordinator will formally request them to provide the data. The signature of additional NDAs or the use of partially dummy data (with fake coordinates, for instance) can be explored. 2. If there are problems collecting data from organizations, administrations or services operators that are not ICAIRA partners, the Coordinator, case-study coordinators or other ICARIA partners will write a letter asking the corresponding authorities to ask for the collaboration of the organizations, administrations or service operators. 3. In case the previous measures do not work, alternative data sources will be identified.		

Description of the risk	WP involved	Proposed risk-prevention measures	Contingency plan	Impact	Probability
			Finally, in case an activity is compromised, the coordinator will notify the EC Project Advisor in order to adapt the WP implementation plan.		
Uncertainty chain affecting the reliability of results (climate projections, hazard and risk results and adaptation benefits)	WP 1, 2, 3 and 4	ICARIA will devote great resources to analyze uncertainty sources and propagation in Task 1.3 and specific uncertainties caused by different environmental drivers and humanitarian activities evaluated using generalized likelihood uncertainty estimation method or fuzzy set approach (Task 2.2).	If uncertainty causes a major issue in results reliability, extraordinary monographic meetings will be organized in order to identify the causes and define corrective actions. These measures could be redefinition of frameworks, changing methodologies or exploring different data sources.	High	Medium
Uncertainties and low performance of the hazard models	WP 2, 3 and 4	To increase the certainty and performance of models, a detailed calibration and validation of the models is needed. To calibrate and validate models recent data is required. It is expected that this data will be either gathered from members of the consortium who have access to it (mainly the Risk Owners) or from external parties who could be included in the local	In case that some of the data needed for the calibration and validation processes is not available, the generation of synthetic data will be considered.	High	Medium

Description of the risk	WP involved	Proposed risk-prevention measures	Contingency plan	Impact	Probability
		CoPs. If needed it could also be considered to deploy a set of sensors to carry field measurements.			
Uncertainties and low performance of the impact models	WP 3	To increase the certainty and performance of impact models, they must be calibrated using actual damages or impacts data. As this information can be very varied in terms of its nature (e.g., economic damage, affected assets, consequence on people safety), collection of such datasets is often complicated. For this reason, each case of study is expected to involve stakeholders in their CoPs who are able to provide this kind of data.	If a CSF is unable to obtain data for impact, it can ask the Coordinator to formally request this data to public authorities. If this measure was to fail, alternative data sources could be explored.	High	Low
Low quality of deliverables	All	The quality of deliverables is ensured by an internal and external peer-reviewed system. It involves two rounds of revision for each deliverable. The first one is done by a member of the consortium who has not been involved in the development of the document. The second one will be done by the scientific coordinator of the project, who will approve the final version to be delivered.	If a deliverable does not have the expected quality for a European research project, the Coordination will not submit it and ask the partner to improve its content and/or presentation. In case of delay, the Coordination will inform the Project Advisor in advance to explain the reasons for the delay.	High	Low
High	All	Given the interconnected and sequential approach	Given that some delays might occur due to	High	Medium

Description of the risk	WP involved	Proposed risk-prevention measures	Contingency plan	Impact	Probability
dependency of several tasks in previous tasks from other WPs		presented in ICARIA, the results of some tasks are highly dependent on what is previously done in other WPs. Therefore, a good coordination between WPs is needed, through the PMT meetings as well as bilateral WP meetings.	the problems in other WPs, the Gantt chart of the whole project will be updated to assess the advancements of the project, and also to determine the severity of the existing delays. Additionally, a flow diagram or table clearly showing the links and information flow between WPs and tasks will be prepared in order to identify, for each WP, the input and output needs and respective WPs, tasks and deliverables. This flow will facilitate the identification of dependencies and the definition of the more critical.		

Table 5. Identification of risks related to project management and proposal of risk-prevention measures and contingency plan.

Description of the risk	WP involved	Proposed risk-measures	Contingency plan	Impact	Probability
Lack of coordination among partners / WPs / tasks	All	AQUATEC has extensive experience in coordination of large research projects similar to ICARIA. Moreover, the governing structure of the project is designed to promote the interaction and participation of all members. Furthermore, a large number of consortium members have worked together previously in other research projects with satisfactory results. In case coordination problems are observed, the monthly PMT will assess and solve them. WP's' implementation plans will be prepared, with detailed interdependencies (inputs/outputs) between tasks in every WP and between WPs, identify which partner is doing what and when, ensure approval of such plan by each partner in the WP and by the coordination. Finally, the PMT and the project coordinator will promote bilateral technical meetings between WPs with close interaction.	Coordination meetings along the project will address all issues that might occur at every given time	High	Medium
Low collaboration among partners	All	The Project Management Manual (D6.1) will provide tools to foster partners' collaboration. Moreover, the schedule of regular meetings at all levels will promote the necessary collaboration to meet objectives. Finally, the Project Steering Board (PSB) will sit regularly to ensure	Additional specific coordination meetings between WP leaders, Task leaders and CSF to ensure strict monitoring.	High	Medium

Description of the risk	WP involved	Proposed risk-measures	Contingency plan	Impact	Probability
		the coordination and the flow of communication among WP.			
Withdrawing of a consortium member or key personnel from the project	All	All the partners were completely committed to this project at the project start, as indicated by their contributions to the Kick of Meeting. The level of satisfaction with project development and the risk of partner or key personnel withdrawing will be periodically assessed in PMT and PSB meetings if needed. According to the Consortium Agreement, partners have an obligation to transfer work so far completed to an alternate partner in case of withdrawal.	In case a partner or key personnel needs to withdraw for unforeseen reasons, the consortium will first look for a possibility to replace the necessary skills within the consortium. If this fails, an alternative partner with the necessary skills will be sought.	Medium	Low
Conflicts within the Consortium	All	Partners are aware that the Coordination Team is available at any time for any complaint or dissatisfaction with the working plan in order to find solutions that can be discussed in extraordinary meetings by using video conference. Partners can also express and discuss their concerns to find appropriate solutions in the plenary meetings.	If no resolution is achieved, the PSB will be involved to mediate and resolve the situation between conflicting parties. As the last resort and if the conflict provokes negative outcomes or changes in the project execution, the Coordinator will explain the problem and its causes to the Project Advisor, and find a solution according to the European funding principles.	Medium	Low
Financial deviations or	All	During the project proposal, an adequate budget was thoroughly developed between all partners considering	If a partner needs to change the allocation of financial resources, the	High	Low

Description of the risk	WP involved	Proposed risk-measures	Contingency plan	Impact	Probability
laxity of partners		the resources and efforts that will be required in each task. Moreover, partners will send internal technical and financial reports every six months to the Coordination Team so the evolution of expenses with respect to the total budget can be evaluated. This will allow the coordinator to detect any deviation in time to take measures if needed.	Coordination Team will discuss the situation and request the change to the Project Advisor.		
Extra costs in the process of purchasing equipment	All	In case extra costs for purchasing equipment are required, a deep analysis of the necessity will be analyzed by the affected partner and the Coordination Team so as to reduce it just to the strictly necessary.	Coordination involvement will be required by any partner who needs to charge extra-cost.	Medium	Low

Table 6. Identification of risks related to dissemination and exploitation (D&E) activities and proposal of risk-prevention measures and contingency plan.

Description of the risk	WP involved	Proposed risk-prevention measures	Contingency plan	Impact	Probability
Fulfillment of the KPI about scientific publication	WP5	Due to the relatively short duration of the ICARIA project and the long duration of the review process of high-level scientific journals, maybe KPI fulfillment will be quite difficult to accomplish.	Select a journal with a faster review process, special issues or, as a very last measure, change the KPI from published to submitted.	High	Medium
D&E activities raise little interest	WP 5	During the early stages of the ICARIA project, the communication team leading WP5 (led by CETAQUA) has developed a Dissemination and Communication Plan (D5.1) to define strategies to maximize the impact of ICARIA. This plan will also consider generating synergies with other EU projects such as MAIA, MIRACA, NATALIE and CLIMEMPOWER. This Plan will be updated by the end of the project to define how to manage D&E activities after the end of the project.	If a low interest in the project is detected, the reasons for this will be analyzed by the WP5 leader together with the PMT and an improved version of the Communication and Dissemination Plan will be developed.	High	Low
Difficulties to implement ICARIA results in other regions	WP 4 and 5	Along the project, a group of follower regions as well as the Project Advisory Board will actively participate in the project development. They will provide an external point of view from the perspective of an "outsider" region who could apply the results of ICARIA when developing their own risk assessments and resilience plans. Their input will serve as a reference to identify weak points in the replicability of the work produced. Furthermore, during the minitrials of climate scenarios,	Both during the Plenary Meetings and Technical Meetings, hence every 6 months, the project members will hold technical discussions regarding the implementation and replicability of the work delivered. These meetings will serve to identify issues in this sense and to define a common strategy to address them. Furthermore, 2 events	High	Medium

Description of the risk	WP involved	Proposed risk-prevention measures	Contingency plan	Impact	Probability
		the CSF will be able to assess if the work developed by other partners for the trials in other regions is applicable to their own case study.	for the project follower regions will be celebrated to present the project outcomes and results to potentially interested regions.		
Low impact of the project in potentially interested regions	WP 5	A dissemination and communication plan will be prepared in WP5. This document will define strategies to ensure the outreach of ICARIA results to specific groups of stakeholders who are of special interest in the project (e.g. policymakers, regional governments and metropolitan authorities). Moreover, WP5 action will include the mapping of specific potentially interested stakeholders who will be reached and engaged through the presentation of reports and the organization of conferences and workshops.	During the monthly coordination meetings and consortium plenary meetings, KPIs regarding the outreach of ICARIA results will be assessed. If the efforts made fall short, the situation will be assessed to identify the reasons causing that situation and adequate measures will be defined to improve the situation.	High	Medium
Low engagement with the CoP of the Case Studies	WP 5	Before forming the CoPs, Task 5.4 will predefine the profile of stakeholders who are relevant to the project aim, who have a specific interest and who can provide an add-on value to the development of the project. When the CoP is constituted, an initial meeting will be organized to define expectations, responsibilities and contributions expected from each stakeholder. Regular meetings/workshops will be organized to maximize the involvement of the CoPs in the project and	In case one or several members of a CoP do not contribute to the project in the expected terms, a meeting will be organized to identify the reasons and redefine the terms of their role to improve their participation.	Medium	Low

Description of the risk	WP involved	Proposed risk-prevention measures	Contingency plan	Impact	Probability
		incorporate their input into the work developed.			
Decreasing website visits	WP 5	The number of visits to the ICARIA website reflects the engagement with the project. In particular, the objective is to convert new visitors into returning ones and in this way to build a strong community interested in climate change and urban resilience topics.	In case of decreasing website visits, specific actions will be carried out to attract visitors to the website. This could include increasing the number of recurrent publications (news and blog entries), the creation of audiovisual and/or interactive media, or exploring new channels to share the link to the website, thus being social media, technical or general media and the project partners' websites.	Medium	Low

5 Materialized risks

The following table summarizes the risks that have materialized during the first 6 months of project ICARIA and mitigation measures that were adopted to minimize their effects.

Table 7. Risks materialized and mitigation measures taken in the first semester of project ICARIA.

Risk materialized	Contingency measures
Weak correlation between the data gap-filling efforts and the ICARIA multi-hazard risk assessment framework	Additional coordination meetings have been celebrated to ensure that the efforts on identifying and filling data gaps in multi-hazard risk assessment correlate with the project framework. This process has been reviewed by the expert partner PLINIVS. The initial data gap-filling efforts were essentially focused on climate data gaps and overlooked data concerning hazard, exposure and vulnerability assessments. This issue has been addressed by the development of a more comprehensive mapping of the data gaps encountered by the CSFs.
Delay in climate downscaling of climatic variables	The Deadline for D1.2 has been extended to M16 (April 2024) to ensure comprehensive and high-quality results for the climatic downscaling for the 3 CS.
Delay in the development of tangible impact assessment methods	The Deadline for D3.1 has been extended to M14 (February 2024) to ensure the development of tangible impact assessment methods for every hazard in ICARIA's scope.
Difficulties to find a common understanding on multi-hazard scenarios modeling	UNEXE has coordinated meetings to establish a common framework for all CSFs to select the most relevant multi-hazard scenarios to consider in the risk assessment models. This implies a definition of thresholds to consider an event as extreme, return periods of interest, assessment of duration of events and temporal framework for the modeled scenarios.
Difficulties to obtain data regarding CIs and drainage networks	Key stakeholders able to provide such data have been engaged in the project as CoP members so both their data and specific expertise can be used by the project. Specific Non-disclosure Agreements of Collaboration Agreements have been signed with these entities.
Difficulties to find reference values to monetize the impact of extreme events	Through the CoP activities, expert stakeholders in each region have provided support to find valid sources to quantify in monetary terms the impact of extreme weather events on certain critical assets or sectors (e.g. waste management plants, wastewater treatment plants, electricity distribution networks, urban drainage infrastructure, natural areas). If no economic data has been found for some specific risk receptors,

Risk materialized	Contingency measures
	alternative qualitative methods have been used to quantify the risk/impacts.
Adaptation of the TGM needs to the ICARIA context	Recurrent exchange between the TGM expert partners and the CSF have been held to define a plan to implement this results validation methodology to the needs and nature of the ICARIA Trials
Complexity of conceptualizing a DSS of the field of resilience against multi-hazard risks	Recurrent meetings between the CSF modelers and tools developers have been held to ensure consistent procedures and dataset formats to develop a tool that can be extrapolated to any European region.
Engagement of follower regions to the project outcomes	An event for the ICARIA follower regions has been set up for July 2024 to ensure their engagement with the project and to validate the preliminary project results with them. A second event involving the follower regions will be held in November 2025 to present the main project outcomes and results.

6 Conclusions

The first section of this document presents a summary of the achievements reached in project ICARIA during its first half. These can be summarized as follows:

- Initiating the project and promoting efficient communication within the consortium.
- Establishing a common conceptual framework for the project development and the case studies design.
- Definition of climate scenarios for the three CS via climate downscaling techniques.
- Gathering and development of hazard and impact assessment tools to assess the risk associated with multi-hazard extreme events.
- Development of the project tools Holistic Resilience Assessment Tool (ICARIA RAF) and the Portfolio of adaptation measures
- Partial development of the project tool DSS.
- Submission of 23 deliverables.
- Achievement of milestones 1 and 2.

Furthermore, the general guidelines that will be followed in the implementation of the project until M30 are indicated. These aim to ensure an adequate development of the project in the following directions:

- Consortium coordination and partners engagement
- Technical matters
- Results exploitability
- Project outreach and results dissemination
- Financial management and reporting periods

As the core of the Risk Contingency Plan, the 3rd section of the document describes the risks associated with the three main dimensions of ICARIA activities: research activities, project management and dissemination and exploitation of results.

The main identified active risks can be synthesized into the following list:

- Discrepancies within the consortium regarding technical matters
- Lack of coordination and/or cooperation between parties
- Data availability and uncertainty
- High complexity of the project due to the interconnections and interdependencies of the analyzed domains
- Low impact of dissemination initiatives
- Low interest of CoP members on participating in ICARIA
- Financial deviations or laxity of partners

Corresponding risk-prevention measures and contingency plans have been elaborated for all the risks identified and are presented in detail in this document.

The last section summarizes the main risks and difficulties that have occurred between M6 and M18 and explains the measures that were taken in each case to minimize the impact on the consortium. In this sense, a total of eight main risks have materialized over this period. Most of them relating to technical and scientific challenges of the project, but also related to effective communication of the preliminary outcomes of the project, delays on certain tasks due to unforeseen difficulties and general consortium coordination matters. In most cases, the issues have been solved with more active communication with the project members and, if needed, the rescheduling of some deadlines.

This Implementation Plan and Risk Contingency Plan will be updated in month 30 and will be thoroughly applied in the ICARIA project under the supervision of the Coordination Team.

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ICARIA (2023a). Deliverable 6.2 - Implementation Plan and Risk Contingency Plan Version 1. Available at: https://www.icaria-project.eu/downloads/#deliverables

ICARIA (2023b). Deliverable 6.3 - Implementation Plan and Risk Contingency Plan Version 2. Available at: https://www.icaria-project.eu/downloads/#deliverables

Annex A: Data Management Statement

Table A.1. Data used in preparation of ICARIA Deliverable 6.4

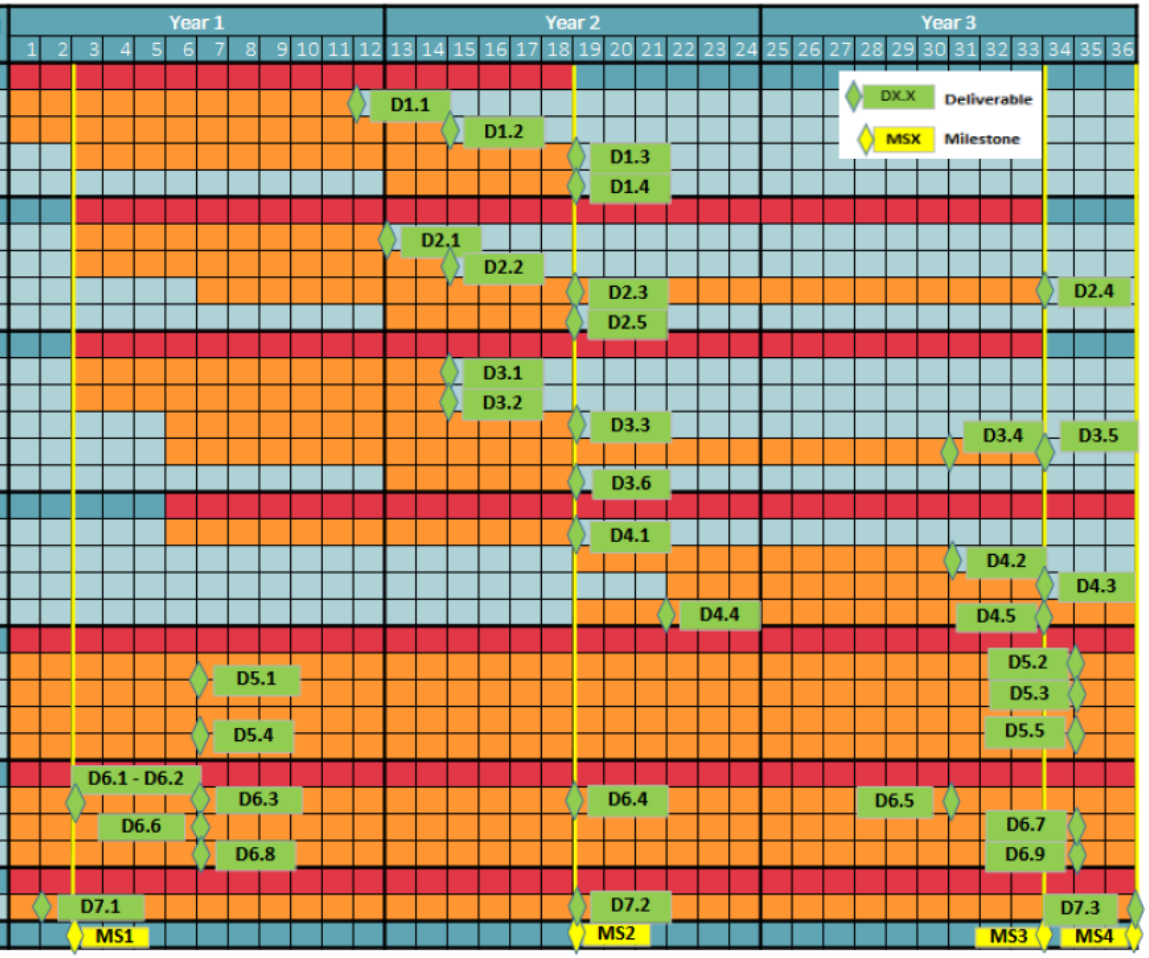
Dataset name	Format	Size	Owner and re-use conditions	Potential utility within and outside ICARIA	Unique ID
na	na	na	na	na	na

Table A.2. Data produced in preparation of ICARIA Deliverable 6.4

Dataset name	Format	Size	Owner and re-use conditions	Potential utility within and outside ICARIA	Unique ID
na	na	na	na	na	na

Annex B: Project ICARIA Gantt Diagram

WP	WP and task title	Start M	End M
WP1	Project framework, climate scenarios and modelling inputs	1	18
Task 1.1.	Risk/impact modelling framework	1	11
Task 1.2.	Climate scenario building	1	14
Task 1.3.	Modelling input requirements, data gaps and uncertainties	3	18
Task 1.4.	WP1 lab: testing of methods and tools	13	18
WP2	Modelling and multi-hazard assessment	3	33
Task 2.1.	Hazards dynamics and multi-hazards analysis	3	12
Task 2.2.	Extreme multi-hazards and modelling scenarios	3	14
Task 2.3.	Coupled hazard models: methodology and tool	7	33
Task 2.4.	WP2 lab: testing of methods and tools	13	18
WP3	Impacts evaluation and DSS	3	33
Task 3.1.	Tangible impacts assessment methods	3	14
Task 3.2.	Holistic resilience methods	3	14
Task 3.3.	Portfolio of Adaptation Solutions	6	18
Task 3.4.	Decision support system	6	33
Task 3.5.	WP3 lab: testing of methods and tools	13	18
WP4	Case studies: implementation, replicability and exploitation	6	36
Task 4.1.	Initial trial and exploitation design	6	18
Task 4.2.	Trial implementation and assesment	19	30
Task 4.3.	Replication	22	33
Task 4.4.	Sustainability and exploitation	19	36
WP5	Dissemination and exploitation	1	36
Task 5.1.	Communication tools and materials	1	36
Task 5.2.	Dissemination plan and activities	1	36
Task 5.3.	Strengthening ICARIA outreach	1	36
Task 5.4.	Stakeholders engagement	1	36
WP6	Project coordination and management	1	36
Task 6.1.	Overall coordination	1	36
Task 6.2.	Quality assurance and innovation management	1	36
Task 6.3.	Data management	1	36
WP7	Ethics	1	36
Task 7.1.	Ethics self-assessment	1	36
MILESTONES			



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