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Deliverable Phase 1 – Climate risk assessment

CLIMAAX for Aveiro Region: Planning for Future Resilience and Sustainability (CLIMAAX4CIRA)

Portugal, Comunidade Intermunicipal da Região de Aveiro

Version 1.0 | September 2025

HORIZON-MISS-2021-CLIMA-02-01 - Development of climate change risk assessments in European regions and communities based on a transparent and harmonised Climate Risk Assessment approach

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101093864. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

Document Information

Deliverable Title	Phase 1 – Climate risk assessment
Brief Description	Deliverable Phase 1 – Climate Risk Assessment represents the initial step of the CLIMAAX for Aveiro Region: Planning for Future Resilience and Sustainability (CLIMAAX4CIRA) project. Developed following the harmonized CLIMAAX framework, its primary objective is to strengthen climate resilience in the Aveiro Region through a systematic assessment of climate risks. This deliverable addresses the urgent need to understand the region's vulnerabilities to key climate hazards—such as heavy rainfall, floods, heatwaves, droughts, and wildfires—that are projected to intensify. It provides a comprehensive overview of the initial assessment process, including the scoping of objectives, regional climate context, applied methodology, and preliminary findings that will guide future adaptation planning.
Project name	CLIMAAX for Aveiro Region: Planning for Future Resilience and Sustainability (CLIMAAX4CIRA)
Country	Portugal
Region/Municipality	Intermunicipal Community of the Aveiro Region *Comunidade Intermunicipal da Região de Aveiro (CIRA)*
Leading Institution	*Comunidade Intermunicipal da Região de Aveiro (CIRA)*
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Deliverable submission date	05/09/2025
Final version delivery date	
Nature of the Deliverable	R – Report
Dissemination Level	PU - Public

Version	Date	Change editors	Changes
1.0	05/09/2025	Intermunicipal Community of the Aveiro Region	Deliverable submitted

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Abbreviations and acronyms

Abbreviation / acronym	Description
CESAM	Centre for Environmental and Marine Studies
CIRA	*Intermunicipal Community of the Region of Aveiro (Comunidade Intermunicipal da Região de Aveiro)*
CLIMAAX4CIRA	CLIMAAX for Aveiro Region: Planning for Future Resilience and Sustainability
CRA	Climate Risk Assessment
DAO	Department of Environment and Planning
DEM	Digital Elevation Model
EFFIS	European Forest Fire Information System
ENAAC	National Strategy for Adaptation to Climate Change (*Estratégia Nacional de Adaptação às Alterações Climáticas*)
EU	European Union
EuroHEAT	EuroHEAT: European and national heat spells
FWI	Fire Weather Index
GAEZ	Global Agro-Ecological Zones
GDP	Global Depth Maps
GFM	Global Flood Maps
IDF	Intensity-Duration-Frequency
INE	Statistics Portugal (*Instituto Português de Estatística*)
IPMA	Portuguese National Institute for Sea and Atmosphere (*Instituto Português do Mar e da Atmosfera*)
JRC	Joint Research Center
JRC RDH	Joint Research Centre Risk Data Hub
LUISA	Land Use
NGO	Non-Governmental Organization
NUT	Nomenclature for Territory Units (*Nomenclatura das Unidades Territoriais*)
OSM	OpenStreetMaps
PNEC	National Energy and Climate Plan (*Plano Nacional de Energia e Clima*)
RCP	Representative Concentration Pathway
SPEI	Standardized Precipitation-Evapotranspiration Index
WUI	Wildland Urban Interface

Executive summary

This Deliverable for Phase 1 – Climate Risk Assessment marks the initial stage of the CLIMAAX for Aveiro Region: Planning for Future Resilience and Sustainability (CLIMAAX4CIRA) project. The project's overarching goal is to enhance climate resilience across the Intermunicipal Community of Aveiro Region (hereafter referred to as the Aveiro Region) through a systematic and harmonized approach to assessing climate risks. This phase establishes the scientific foundation necessary to understand the region's exposure, sensitivity, and vulnerabilities to climate change impacts.

The assessment focuses on five critical climate hazards identified as priorities for the Aveiro Region: heavy rainfall, floods, heatwaves, droughts, and wildfires. These hazards are expected to increase in both frequency and severity under future climate scenarios, posing significant threats to human health, ecosystems, agriculture, infrastructure, and socio-economic stability. By addressing these risks, the project responds directly to the urgent need for evidence-based adaptation planning.

Phase 1 followed the harmonized CLIMAAX framework to deliver a comprehensive multi-risk assessment. This involved scoping regional objectives, analysing the current and projected climate context, and applying standardized methodologies for risk identification, characterization, and preliminary quantification. The integration of available climate, environmental, and socio-economic data allowed for the generation of an initial risk profile across multiple sectors.

Key findings of this phase include the identification of spatially variable vulnerabilities within the Aveiro Region, reflecting its complex geography and diverse land uses. Heatwaves and droughts emerged as widespread concerns, while floods, heavy precipitation events, and wildfire risks showed strong localized impacts. These results highlight the differentiated nature of climate risks and the necessity of tailored adaptation responses.

The assessment also revealed limitations related to data resolution and availability, underscoring the importance of acquiring higher-resolution, locally relevant datasets to enhance risk accuracy. These improvements will be addressed in Phase 2, which aims to refine the assessment with more granular data and advanced modelling techniques.

Preliminary stakeholder mapping was conducted during this phase to identify relevant actors across governance levels and sectors. This foundational work prepares for more structured and active stakeholder participation planned in subsequent phases. Inclusive and multi-level stakeholder involvement is recognized as essential for effective adaptation planning, ensuring that local knowledge complements scientific analysis.

In summary, Phase 1 delivers a foundational climate risk assessment for the Aveiro Region, providing essential insights to inform future risk reduction and adaptation efforts. The findings underline the urgency of implementing proactive adaptation measures and the need for continued collaboration, data integration, and methodological refinement. This deliverable lays the groundwork for Phases 2 and 3, which will focus on refining risk assessments and exploring targeted adaptation strategies to build a resilient and sustainable future for the Aveiro Region.

1 Introduction

1.1 Background

The Aveiro Region, located in central-north Continental Portugal, is geographically defined by its unique hydrographic features, including the *Ria de Aveiro*, a lagoon with more than six thousand hectares (see Figure 1-1) (Slingerland et al. 2018; Rodrigues et al. 2021; Coelho et al. 2018). This landscape, encompassing about 1693 km² and 11 municipalities, contributes to a distinct microclimate with mild temperatures year-round. The region's climate is classified as temperate with rainy winters and dry, mild summers (Csb) according to the Köppen-Geiger scale (Peel, Finlayson, and McMahon 2007). Key physical characteristics include a predominantly low-altitude coastal zone and higher altitudes in the interior, reaching 841m in Sever do Vouga. Historically, the region has experienced significant impacts from climate-related events, particularly floods due to the low-lying nature of the *Ria de Aveiro*. A slice and gate system, inaugurated in 1985, was implemented in Aveiro City to control water levels in the urban channels and mitigate these flood risks, demonstrating a proactive approach to environmental management. Current climate trends indicate a measurable increase in minimum, mean, and maximum temperatures in the Aveiro Region since the 1970s, alongside a general decrease in annual mean precipitation (IPMA 2023). Despite the overall reduction in precipitation, there has been an observed increase in the frequency and magnitude of extreme precipitation events. The region's population was approximately 367,455 in 2021(INE 2021), constituting about 3.5% of the national population, with varying densities across its municipalities.

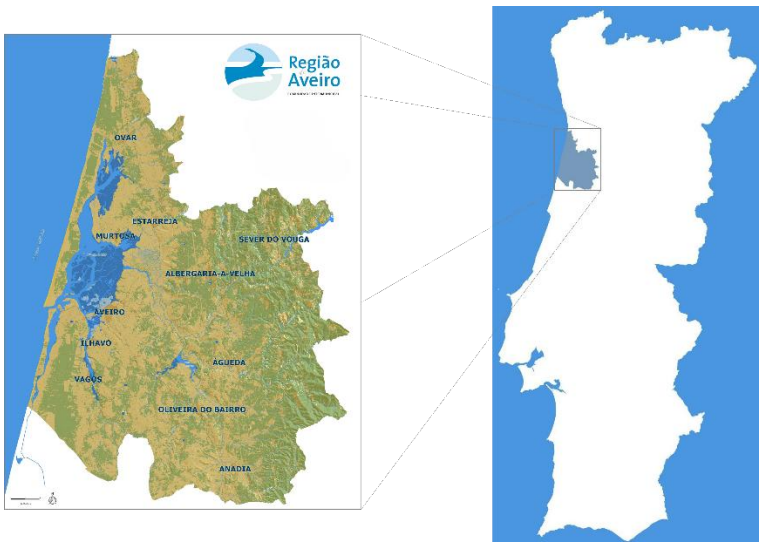


Figure 1-1 Aveiro Region location.

1.2 Main objectives of the project

The main objective of the CLIMAAX4CIRA project is to enhance climate resilience in the Aveiro Region by conducting a structured climate risk assessment. Using the CLIMAAX framework, the project will identify vulnerabilities to climate impacts such as heatwaves, floods, and droughts. The outcomes will support decision-makers in developing targeted adaptation strategies and improving community awareness, ultimately strengthening the region’s capacity to respond to climate change. Specific objectives of the CLIMAAX4CIRA project include:

- Apply the CLIMAAX common methodology to assess multi-hazard climate risks in the Aveiro Region;
- Refine the first climate risk assessment using local data to gain detailed insights into specific vulnerabilities;
- Engage local stakeholders to develop adaptation strategies tailored to regional needs;
- Supporting municipalities in integrating CRA results into local adaptation and risk management policies;
- Increase public awareness and preparedness through participatory approaches and knowledge-sharing initiatives;
- Strengthen the region's technical capacity by providing data and tools for long-term climate adaptation planning.

1.3 Project team

- Project Coordinator: Comunidade Intermunicipal da Região de Aveiro (CIRA)
    - José Eduardo de Matos - Executive Secretary
    - Patrícia Castro – Project manager
- External Consulting Services: University of Aveiro
    - Sílvia Coelho - Doctorate Researcher at CESAM and DAO
    - Bruno Augusto - Doctorate Researcher at CESAM and DAO
    - Myriam Lopes - Associate Professor at CESAM and DAO
    - Ana Isabel Miranda - Full Professor at CESAM and DAO

1.4 Outline of the document's structure

This document presents the first phase of the climate risk assessment for the Aveiro Region. It begins with an introduction that provides background information, outlines the project's objectives, introduces the project team, and describes the structure of the report. The second chapter focuses on the climate risk assessment, covering the initial scoping activities, the exploration of key climate hazards, and the detailed risk analysis through five thematic workflows. It also presents the preliminary findings on risk severity, urgency, and adaptive capacity, along with early monitoring and evaluation insights and an outline of the work plan. The document concludes with a summary of phase one results, an evaluation of progress to date, and reflections on how this phase informs future work. Supporting materials and references are included at the end.

2 Climate risk assessment – phase 1

2.1 Scoping

2.1.1 Objectives

The overarching objective, purpose, and expected outcome of this CRA is to enhance climate resilience in the Aveiro Region by conducting a structured multi-hazard assessment following the CLIMAAX framework. The project's outcomes are specifically designed to support decision-makers in developing targeted adaptation strategies and improving community awareness, thereby strengthening the region's capacity for long-term climate adaptation planning. This assessment directly aims to inform and integrate with upcoming local and regional development plans, strategies, and policies by providing a robust, data-driven understanding of climate risks and vulnerabilities. Limitations and boundaries for this CRA primarily include the availability of local, high-resolution data for refining the assessment in later phases. Other constraints may involve the extent of stakeholder involvement and various other relevant factors that could influence the depth and breadth of the assessment.

2.1.2 Context

In the Aveiro Region, climate hazards, impacts, and risks have been historically addressed and are currently being managed through established planning instruments and initiatives. The Intermunicipal Strategic Program for the Aveiro Region (Lopes et al. 2021, 2022) serves as an initial pillar for an integrated territorial approach, guiding strategic decisions and public investment, and positioning the region at the national forefront of climate change response. Several municipalities in the region have also developed their own Municipal Climate Change Adaptation Plans (Carlos, Rabaça, and Ré 2016; Laranjeira and Nunes 2023; Medina et al. 2024; Almeida and Nunes 2024; Cardoso and Nunes 2024; Barroso et al. 2025; Costa and Nunes 2024; Cardoso and Nunes 2021), reinforcing this commitment by integrating climate adaptation and resilience strategies into local urban planning frameworks.

The primary challenge that the CLIMAAX4CIRA project seeks to address is the Aveiro Region's increasing vulnerability to climate change impacts—particularly heavy rainfall, floods, heatwaves, droughts, and wildfires—which are projected to intensify in both frequency and severity. This issue is framed within the broader regional and national development agendas, with the aim of strengthening governance and enhancing long-term resilience. The governance context for climate risk assessment is shaped by national policies such as the National Strategy for Adaptation to Climate Change (ENAAC 2020), which promotes a cross-sectoral approach to adaptation. Additionally, all municipalities in the Aveiro Region have joined the Covenant of Mayors for Climate and Energy, demonstrating their commitment to the European Union's climate and energy objectives through the development of Sustainable Energy and Climate Action Plans ("Signatories | EU Covenant of Mayors").

Building on these efforts, several studies (e.g., Coelho et al. 2022; Coelho, Ferreira, et al. 2023; Ribeiro et al. 2021; Coelho, Rafael, et al. 2023) have identified key sectors in the Aveiro Region that are particularly relevant and highly vulnerable to climate change impacts, namely:

- Human Health: Increased heat exposure (e.g., heatwaves) poses risks of higher mortality and worsened chronic illnesses and allergies. Climate change may also influence the spread of pathogens and disease vectors.

- Agriculture and Forests: Threatened by reduced agricultural productivity, water stress, crop and livestock damage, and heightened susceptibility to wildfires, pests, and diseases.
- Water Resources: Expected declines in water availability and quality due to reduced precipitation and more frequent droughts, alongside challenges in surface runoff and aquifer recharge.
- Biodiversity and Landscape: Sensitive ecosystems, such as coastal wetlands (e.g., salt marshes and seagrass meadows), face biodiversity loss. These areas are vital for carbon sequestration and coastal protection.
- Infrastructure and Transport: Vulnerable to damage from extreme weather events, such as intense rainfall and strong winds, highlighting the need for climate-resilient design and maintenance.
- Coastal Zones: Highly exposed to sea-level rise, erosion, and wave action, with potential consequences for ports, fisheries, and coastal property.
- Economy and Tourism: While an extended summer season may benefit tourism, it also stresses water availability during peak periods.
- Energy: Susceptible to fluctuations in renewable energy generation (e.g., hydropower, biomass) and rising cooling demands due to higher temperatures.

External drivers influencing these challenges include EU funding mechanisms such as Horizon Europe, along with Portugal's national commitments to carbon neutrality by 2050, as outlined in the Roadmap for Carbon Neutrality 2050 (APA 2019) and the National Energy and Climate Plan (PNEC 2030).

Potential adaptation measures include promoting nature-based solutions (e.g., green and blue infrastructure), restoring natural water systems, enhancing urban drainage, implementing water reuse strategies, expanding green spaces, encouraging sustainable agriculture, increasing transport system resilience, and fostering urban regeneration (e.g., Ascenso et al. 2021; Rodrigues et al. 2020; Rafael et al. 2021).

2.1.3 Participation and risk ownership

The first steps of the CLIMAAX4CIRA stakeholder involvement process focused on identifying relevant actors across multiple governance levels and sectors, drawing on knowledge from previous regional planning efforts and climate projects. While the core engagement activities will take place in Phase 2, this early mapping provides a foundation for a structured and inclusive participation process. A multi-level engagement approach is being developed, incorporating structured interactions such as stakeholder meetings, workshops, and co-development sessions to assess climate risks and shape effective adaptation measures tailored to regional needs. The overarching aim is to enhance public awareness, strengthen governance, and foster collaboration in addressing climate change challenges. Stakeholders already identified represent a broad spectrum, including:

- **Governmental Bodies**: Municipalities within the Aveiro Region; central and local public administration agencies.
- **NGOs**: Environmental advocacy groups and community-based organizations.
- **Private Sector**: Local businesses, infrastructure and utility operators, and agricultural enterprises.
- **Regional Development Agencies**: Entities involved in strategic territorial planning and economic development.

- **Academia**: Notably, the University of Aveiro and other entities with expertise in climate science, risk modeling, and spatial planning.
- **Local Communities and Citizens**: Including residents, civic associations, and schools.

While an organigram mapping institutional interconnections is not available at this stage, the project's stakeholder strategy is designed to encourage collaboration across sectors and levels of governance.

Preliminary analysis also identified several priority groups, including children under 5, older adults over 65, unemployed individuals, low-income households, residents of older buildings (pre-1960), populations living in flood-prone areas, and workers in climate-sensitive sectors such as agriculture, forestry, and tourism.

Risk ownership is largely embedded within existing municipal and intermunicipal planning instruments, which already integrate climate risks into strategic decision-making. These instruments outline territorial priorities, investment strategies, and climate resilience actions aimed at improving environmental sustainability, public safety, and socio-economic development. The project employs a risk matrix to help local authorities prioritize risks based on projected frequency and severity, thereby shaping an understanding of what levels of risk are considered acceptable in the regional context.

To ensure broad and effective communication, project results will be disseminated through scientific publications, policy briefs, community outreach activities, local media, online platforms, and stakeholder meetings tailored to different audiences.

2.2 Risk Exploration

2.2.1 Screen risks (selection of main hazards)

Climate-related hazards and potential risks relevant for the Aveiro Region context, based on climate projections and regional/local vulnerability assessments, include:

- Increased temperatures: Projections indicate a generalized increase in mean, maximum, and minimum annual temperatures, with greater intensity in summer, particularly inland.
- Heatwaves: A clear trend of increased duration and frequency of heatwaves is expected.
- Droughts: Conditions are projected to worsen, evolving from "normal" to "extreme" category.
- Intense Precipitation/Flooding: Despite a general decrease in annual mean precipitation, an increase in the frequency and magnitude of extreme precipitation events is anticipated.
- Forest Fires: There is a projected increase in the number of days with high fire risk.
- Sea Level Rise and Coastal Erosion: Given the region's coastal and lagoon characteristics, sea-level rise is expected to lead to increased strong wave events and coastal erosion.

These hazards align with findings from the Copernicus Climate Change Service Atlas, which highlights rising temperatures, drought hotspots, flood-prone zones, and increased wildfire risk concentrated in the region's inland and coastal areas. Local studies and historical data confirm warming trends since the 1970s, with changes in precipitation patterns and extreme event occurrences.

Vulnerable groups, such as older adults, young children, low-income households, and residents in flood-prone or fire-prone areas, are disproportionately affected. Key sectors impacted include agriculture, forestry, urban infrastructure, and public health.

The CLIMAAX4CIRA project focuses specifically on these five hazards — heavy rainfall, floods, heatwaves, droughts, and fires — due to their significant current and projected impacts and their relevance to regional stakeholders' concerns.

Existing data and knowledge come from global and regional open platforms (such as Copernicus Climate Data Store (Copernicus CDS) and Euro-CORDEX (Jacob et al. 2014)), the Portuguese National Institute for Sea and Atmosphere (IPMA), and previous regional climate and vulnerability assessment projects. Further high-resolution data on local hazard exposure and socio-economic vulnerability are needed to improve risk assessments and inform adaptation planning.

2.2.2 Workflow selection

2.2.2.1 River and Coastal Floods, Flood Damage and Population Exposure

This workflow was applied to the Aveiro Region using high-resolution JRC flood hazard maps and LUISA land use data to assess the impacts of river and coastal floods. Damage estimates were calculated for five return periods (10, 50, 100, 200, 500 years) by linking inundation depth to vulnerability-damage curves and economic exposure (GDP/m²). The Aveiro Region's coastal and low-lying urban areas are particularly at risk. Vulnerable populations include those living in flood-prone zones. The workflow supports the identification of flood hotspots and helps quantify economic losses and population displacement risks.

2.2.2.2 Extreme Precipitation

The Aveiro Region is among the Portuguese regions most frequently affected by extreme precipitation, which can trigger flash floods and overwhelm urban drainage systems. This workflow uses climate projections and precipitation indices to analyze the frequency and intensity of such events. Urban infrastructure, transportation networks, and densely populated neighborhoods are especially exposed. Vulnerable groups include mainly residents in poorly drained areas. By identifying spatial patterns of precipitation extremes, this workflow supports the design of flood mitigation strategies and improvements in urban stormwater management.

2.2.2.3 Urban Heatwaves

The urban heatwave workflow combines hazard assessments (e.g., EuroHEAT) with climate projections to evaluate the frequency, duration, and severity of heatwaves in urban environments. In the Aveiro Region, increasing temperatures and urban heat island effects heighten the exposure of vulnerable populations, particularly elderly individuals, children, and those in low-income households without access to adequate cooling. Densely built areas with limited green space are especially affected. This workflow helps map high-risk zones, informing public health planning and urban greening strategies to reduce heat-related health risks.

2.2.2.4 Agricultural Drought

The agricultural drought workflow evaluates the impact of precipitation deficits and soil moisture anomalies on agricultural systems. In the Aveiro Region, drought conditions are expected to intensify, affecting key sectors such as crop farming, livestock, and forestry. Vulnerable areas include rainfed agricultural zones and those with limited irrigation infrastructure. Small-scale farmers and communities dependent on agriculture are particularly exposed. By identifying areas at

high risk of yield reduction, this workflow supports planning for more resilient agricultural practices, irrigation strategies, and drought preparedness.

2.2.2.5 Fire (FWI)

This workflow integrates the CLIMAAX Fire Weather Index (FWI) to assess wildfire risk, focusing on temperature, humidity, wind, and fuel availability. In the Aveiro Region, analysis identified fuel-rich forest areas and high-risk zones near forest-urban interfaces. While full machine learning applications were limited due to data constraints, preliminary risk maps highlight priority zones for fire prevention. Vulnerable groups include rural populations, forest workers, and residents near fire-prone areas. Collaboration with local municipalities aims to improve data availability and enhance future fire prediction and preparedness.

2.2.3 Choose Scenario

The scenarios incorporated in the CLIMAAX workflows, RCP2.6, RCP4.5, and RCP8.5, are relevant for the Aveiro Region, as they capture a range of possible climate futures from low to high greenhouse gas emissions. These scenarios, combined with different time horizons (reference/historical and short-, mid- and long-term future), align well with the region's needs for assessing climate risks over varying planning periods. In this phase, the primary objective was to run the standard CLIMAAX workflows and evaluate baseline results, using the scenarios and timeframes according to available data. For future analyses, scenario selection will be refined to focus on the most plausible socio-economic and climatic pathways for the region, considering factors such as population growth, economic activities, energy consumption, and sector-specific vulnerabilities.

2.3 Risk Analysis

This section presents the outcomes of the risk analysis phase, conducted using the standard CLIMAAX workflows applied to five primary climate hazards relevant to the Aveiro Region: (i) river floods, coastal floods, building damage and population exposure; (ii) extreme precipitation, (iii) urban heatwaves, (iv) agricultural drought, and (v) wildfires. Each workflow integrates available hazard, vulnerability, and exposure datasets to generate risk maps and impact estimates across different spatial and temporal scenarios. The results presented here provide an indicative, high-level risk profile, which will be refined in Phase 2 using local high-resolution data.

2.3.1 River and Coastal Floods, Flood Building Damage and Population Exposed

2.3.1.1 River Floods

The river flood hazard analysis was performed using the CLIMAAX standard River Flood workflow, which incorporates high-resolution hazard maps provided by the JRC. The workflow models inundation depth for different return periods (10, 50, 100, 200, and 500 years) under current and future climate scenarios (baseline ca. 1980 and projections for 2030, 2050, and 2080 using RCP 4.5 and RCP 8.5). The simulations rely on LUISA land cover data and DEM-based flood propagation models. The detailed data overview can be found in Table 2-1.

Table 2-1 Data overview for River Floods workflow.

Hazard data	***Vulnerability data***	***Exposure data***	***Risk output***
JRC high-resolution river flood maps (RPs: 10, 50, 100, 200, 500 years) Flood maps for extreme flood events in the baseline climate (ca. 1980) and in the future climates (2030, 2050, 2080 for EURO-CORDEX RCP 4.5 and RCP 8.5 climate scenarios) Aqueduct Floods dataset (2030, 2050, 2080; RCP 4.5, RCP8.5; NorESM1-M, GFDL-ESM2M, HadGEM2-ES, IPSL-CM5A-LR, MIROC-ESM-CHEM)	JRC damage curves for land use (LUISA)	LUISA land cover 2018 (100m), with adjusted GDP for Aveiro Region	Potential economic damage to infrastructure and damage maps from river floods

2.3.1.1.1 Hazard assessment

Flood hazard maps (see Supplementary Materials) reveal significant exposure in municipalities such as Águeda, Estarreja, Albergaria-a-Velha, and Sever do Vouga. The Baixo Vouga region, intersected by multiple river systems and drained by canals connected to the Ria de Aveiro, consistently shows high inundation potential.

While these spatial patterns of flood depth are informative, the resolution of the available flood data remains insufficient for operational planning or detailed micro-zoning. This limitation will be addressed in Phase 2 through the integration of local, high-resolution datasets

2.3.1.1.2 Risk assessment

Following the hazard workflow, risk and exposure maps were produced, using the included LUISA land cover which are suitable for a rough analysis. GDP per capita was the only update to the standard workflow. The value for the Aveiro region (21.023€ in 2021 (INE 2022)) was used.

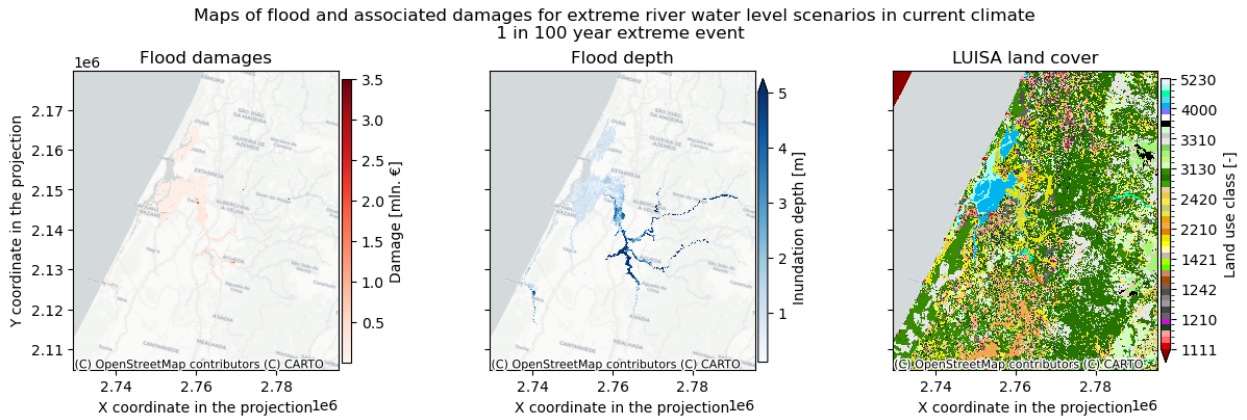


Figure 2-1 Maps of flood (inundation depth [m]) and associated damages (mln. €) for extreme river water level scenarios in current climate (LUISA land cover 2018), for Aveiro Region.

Figure 2-1 show the potential flood depths and the associated economic damage. This overview helps to see which areas carry the most economic risk under the flooding scenarios. Preliminary results highlight that economic damage increases particularly near Aveiro and Águeda. Industrial parks and transport infrastructure near river basins face consistent exposure.

2.3.1.2 Coastal Floods

The coastal flood hazard analysis uses Microsoft Planetary Computer's Global Flood Maps (GFM) based on MERIT DEM (90m) and projections for sea-level rise. Future conditions (RCP 8.5, year 2050) were compared with baseline scenarios across return periods from 10 to 500 years. The detailed data overview can be found in Table 2-2.

Table 2-2 Data overview for Coastal Floods workflow.

Hazard data	***Vulnerability data***	***Exposure data***	***Risk output***
Microsoft Planetary Computer - Global Flood Maps: GFM - MERIT DEM 90m - 2050 slr - 0250-year return level GFM DEM 90m – 2018 GFM DEM 90m – 2050 (RCP8.5) RPs: 10, 50, 100, 200, 500 years	JRC damage curves for land use (LUISA)	LUISA land cover 2018 (100m), with adjusted GDP for Aveiro Region	Potential flood depths and the associated economic damages
Copernicus Climate Data Store water levels and daily maximum surge levels for 2015 CDS water level statistics, computed over the period of 1979-2018 based on reanalysis (ERA5) atmospheric data			

2.3.1.2.1 Hazard assessment

For the coastal flood workflow, the same procedure applied to river flooding was followed. The hazard maps (see Supplementary Materials) show increasing flood extent along the coastline of Ílhavo, Vagos, and Murtosa, including parts of the Ria de Aveiro system. The projected expansion of flood zones under 100- and 250-year events is substantial, confirming existing concerns about saltwater intrusion, dune system instability, and lagoon overtopping. Looking ahead, sea-level rise, storm surges, and land subsidence are expected to act in synergy, further aggravating flood risk in these coastal ecosystems.

2.3.1.2.2 Risk assessment

Following the hazard workflow, risk and exposure maps were produced, using the included LUISA land cover which are suitable for a rough analysis. GDP per capita was the only update to the standard workflow. The value for the Aveiro region (21.023€ in 2021 (INE 2022)) was used.

Risk assessment results (Figure 2-2 and Figure 2-3) indicate a substantial increase in flood exposure by 2050, with coastal buildings and key transport infrastructure, facing heightened vulnerability. Under the 250-year return period scenario based on RCP 8.5 projections, expected damages are estimated to exceed several million euros. The most critical hotspots identified include the urban fringes of Aveiro, the coastal settlement of Torreira in the municipality of Murtosa, and the highly exposed Praia da Barra–Costa Nova corridor.

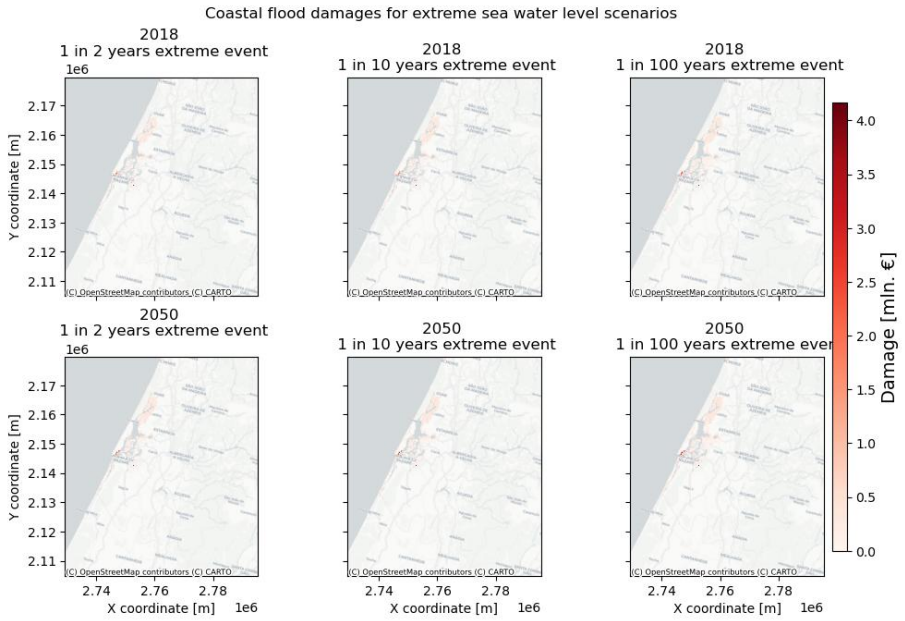


Figure 2-2 Coastal flood damages (mln. €) for extreme river flow scenarios in 2018 (to different return periods: 10, 50 and 100 years), and 2050, for Aveiro Region.

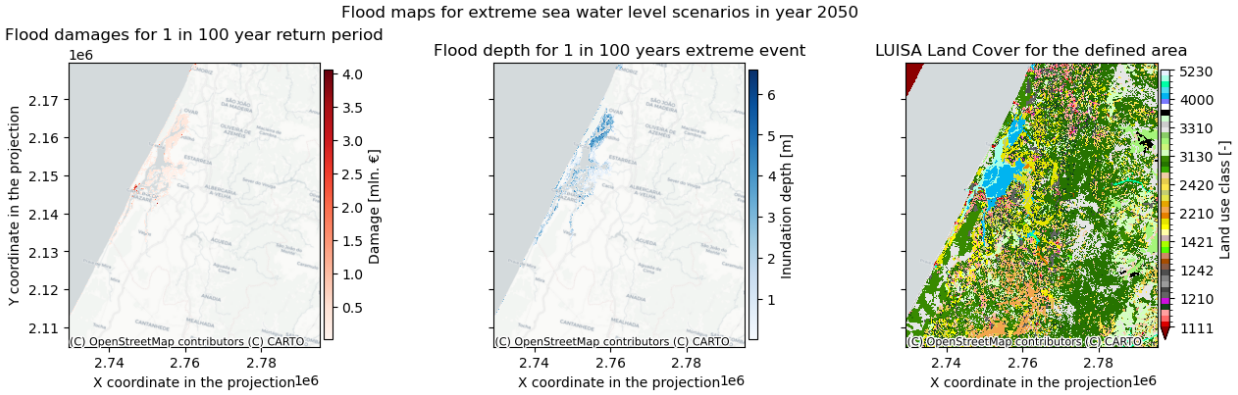


Figure 2-3 Maps of coastal flood (inundation depth [m]) and associated damages (mln. €) for extreme costal water level scenarios in current climate (LUISA land cover 2018), for Aveiro Region.

2.3.1.3 Flood Building Damage and Population Exposed

This workflow used fine-resolution hazard maps combined with OpenStreetMap (OSM) building data and Copernicus demographic information to evaluate structural and population exposure across different flood scenarios. Inundation depth data was analyzed for 10-, 50-, 100-, and 500-year return periods, covering both present and future conditions. The detailed data overview can be found in Table 2-3.

Table 2-3 Data overview for Flood Building Damage and Population Exposed workflow.

Hazard data	***Vulnerability data***	***Exposure data***	***Risk output***
JRC 3 arc-seconds grid spacing river flood extent and flood depth (RPs: 10, 50, 100, 500 years)	…	Population data from JRC methodology Combined damage function is applied based on Residential, Commercial, and Industrial JRC depth-damage values Building data from OpenStreetMap	Total damage for the region of interest € (RP: 10,50, 100, 500) Displaced population

2.3.1.3.1 Hazard assessment

A map showcasing the difference in flood depths between two return periods was produced (see Supplementary Materials). The analysis confirmed the vulnerability of densely built low-lying areas, particularly in Aveiro city, where commercial and residential zones overlap with flood hazard areas. As with the river and coastal flood workflows, the resolution of the data should be improved to enable more detailed analysis.

2.3.1.3.2 Risk assessment

Following the hazard assessment, and focusing on the Aveiro location, the Flood Building Damage and Population Exposure workflow was applied. The workflow utilizes OSM building data, and population data to assess the damage to buildings (Mil €), exposed population, and displaced population due to floods (Figure 2-4 and Figure 2-5).

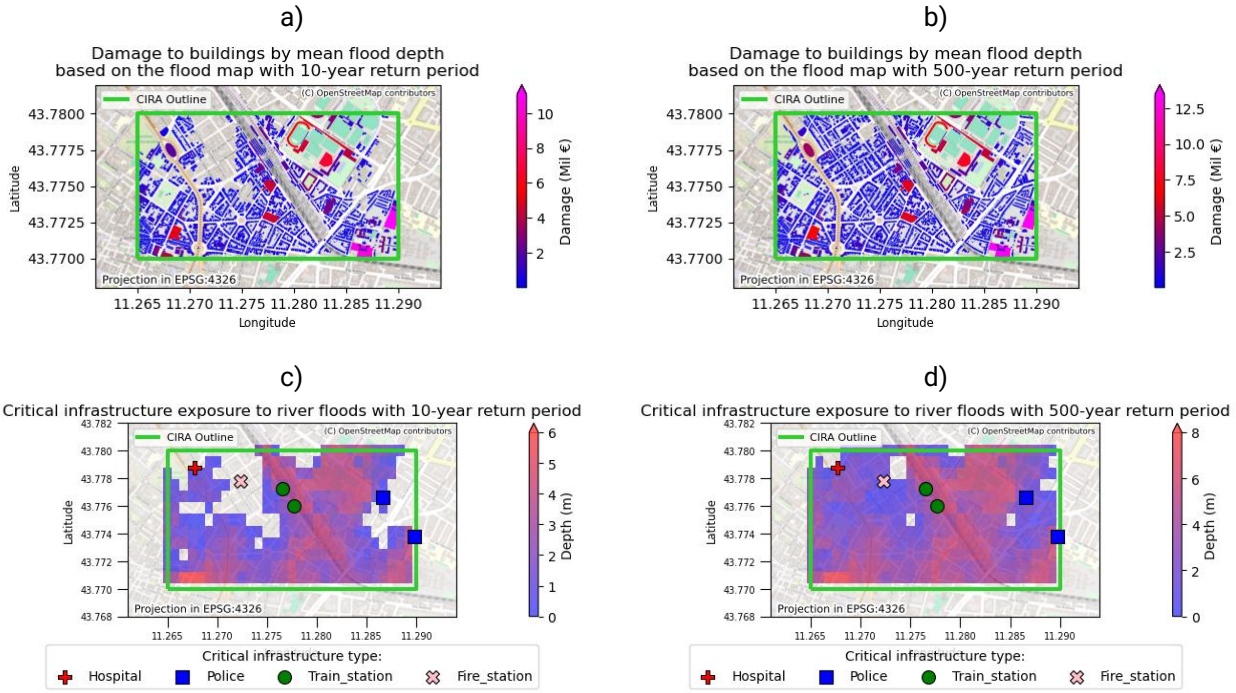
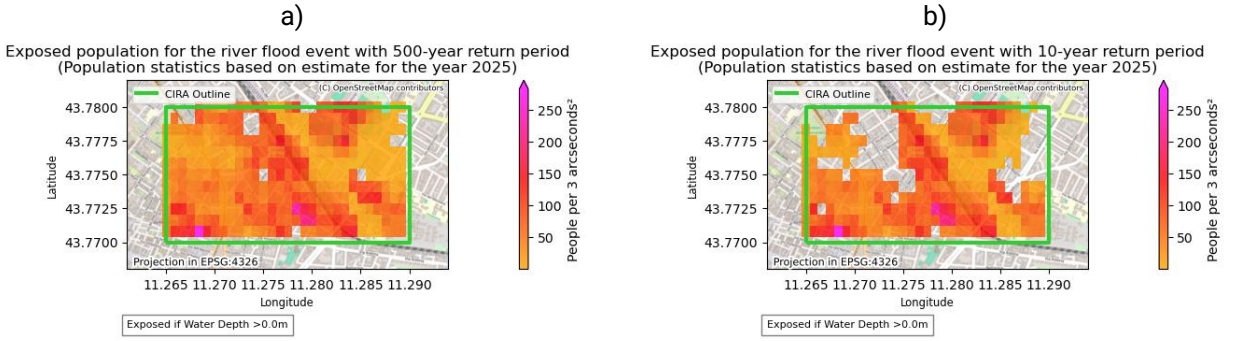


Figure 2-4 Damage to buildings by mean river flood depth (m) for an event with a return period of 10 years (a) and 500 years (b); Critical infrastructure exposed to river flood for an event with a return period of 10 years and 500 years.



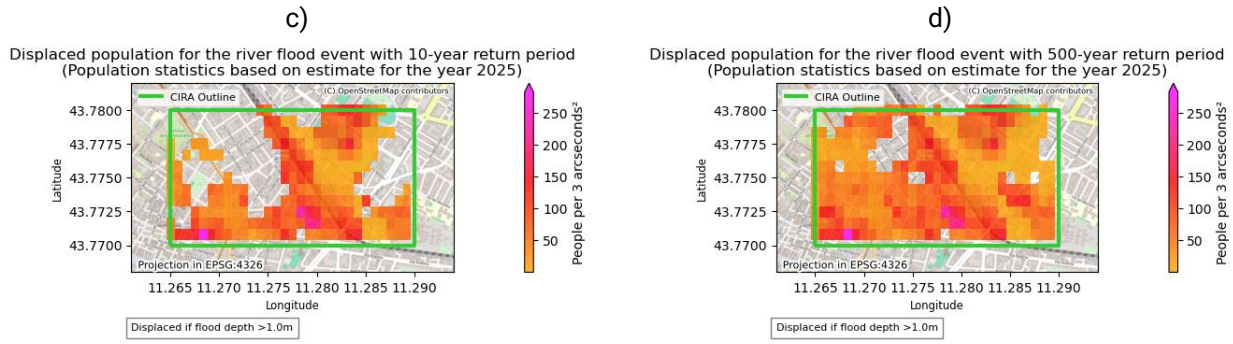


Figure 2-5 Population exposed to river flood for an event with a return period of 10 years (a) and 500 years (b); Displaced population due to river flood event with a return period of 10 years (c) and 500 years (d).

Lastly, the workflow provides with estimated damage to buildings, exposed population, and displaced population, based on flood events for multiple event return periods. The number of displaced residents and the volume of property loss rise sharply between the 10- and 500-year scenarios.

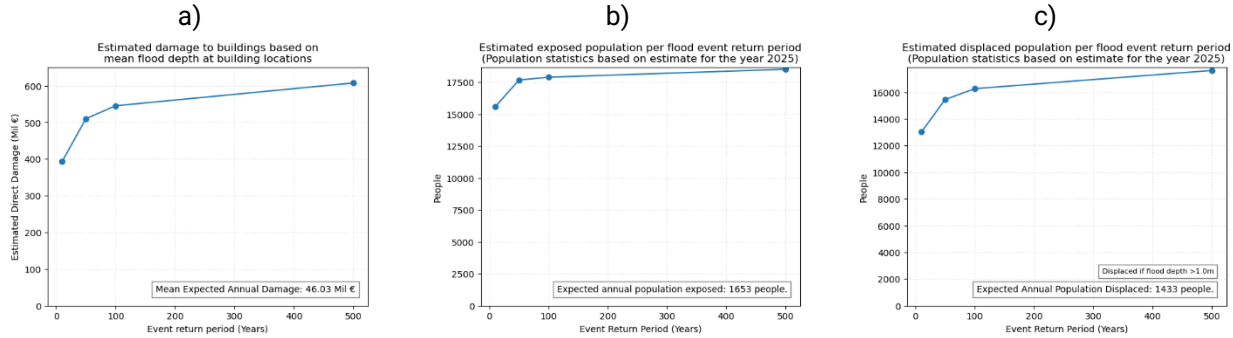


Figure 2-6 Estimated damage to buildings (a), exposed population (b), and displaced population (c), based on flood events for multiple event return periods.

2.3.2 Extreme Precipitation

In this first phase of the project, the workflow was applied with the standard methodology. The application of the extreme precipitation workflow focused on the bounding box with coordinates – "8.8661, 40.3631, -8.2329, 40.9323", representing Aveiro Region. The extreme precipitation hazard assessment is based on EURO-CORDEX climate projections for 3-hour and 24-hour durations, which provide precipitation flux data at a 12x12 km spatial resolution for both historical (1976–2005) and future (2041–2070) climate, under RCP 8.5 scenario. The detailed data overview can be found in Table 2-4.

Table 2-4 Data overview for Extreme Precipitation workflow

Hazard data	***Vulnerability data***	***Exposure data***	***Risk output***
EURO-CORDEX from the Climate Data Store: two different 30-year frames (1976-2005 [baseline or historic simulations] and 2041-2070 [climate projections] timeframes RCP 8.5 EURO-CORDEX precipitation datasets (temporal series of annual maximum precipitation for sub-daily and daily resolution)			

2.3.2.1 Hazard assessment

Hazard assessment provided by extreme precipitation workflow worked well and produced relevant data that, in its present state, it's already usable in refine management plans, even considering that

only RCP 8.5 was used. Hazard maps (see Supplementary Materials). show future increases in precipitation intensity and frequency, which are expected to overwhelm urban drainage systems and increase surface flooding. Although the workflow results are already meaningful for planning purposes, some thresholds could not be extracted for local quantification due to dataset limitations. These gaps will be addressed in Phase 2.

2.3.2.2 Risk assessment

Although the hazard component of this workflow produced relevant and actionable information, risk quantification could not be fully completed due to limitations in the return-period calibration. As a result, exposure thresholds for specific drainage infrastructure or neighborhoods could not be directly determined. Future work will try to focus on integrating local rainfall and runoff datasets to better define high-risk areas, especially those with historic flooding incidents. Nonetheless, the current output already provides a valuable baseline for guiding improvements to stormwater infrastructure, early-warning systems, and resilience-based urban planning.

2.3.3 Urban Heatwaves

Urban heatwave hazard was assessed through the application of the EuroHEAT methodology combined with downscaled temperature projections from EURO-CORDEX under RCP4.5 and RCP8.5. The detailed data overview can be found in Table 2-5.

Table 2-5 Data overview for Urban Heatwaves workflow.

Hazard data	***Vulnerability data***	***Exposure data***	***Risk output***
Health-related dataset from EuroHEAT: European and national heat spells, for period 1986–2085, considering RCP4.5 and RCP8.5 scenarios.	…		

2.3.3.1 Hazard assessment

Hazard assessment key indicators included the number of heatwave days per year, for specific points. The results (see Supplementary Materials) were obtained for the most urbanized area of each municipality of Aveiro Region. Inland municipalities, specially Águeda, Anadia and Sever do Vouga, are the ones with higher intensification of heatwave occurrence in the future, when considering scenario RCP8.5.

2.3.3.2 Risk assessment

Urban heatwave risk assessment combines the hazard Euroheat data with the population vulnerability data for the risk estimation for the current and projected climate (RCP4.5 and RCP8.5), for the short- (2016-2045) and mid-term (2046-2075) future. Figure 2-7 and Figure 2-8, show the magnitude of change in the heatwave occurrence classified from 1 to 10 (1-very low change, 10-very high change) and the potential increase in the risk to vulnerable population groups, respectively.

Although Vagos, Oliveira do Bairro, Anadia, Águeda, and Sever do Vouga are the municipalities expected to face a higher impact in the mid-term future, Ovar, Ílhavo, and Aveiro have the greatest heatwave risk for vulnerable population groups.

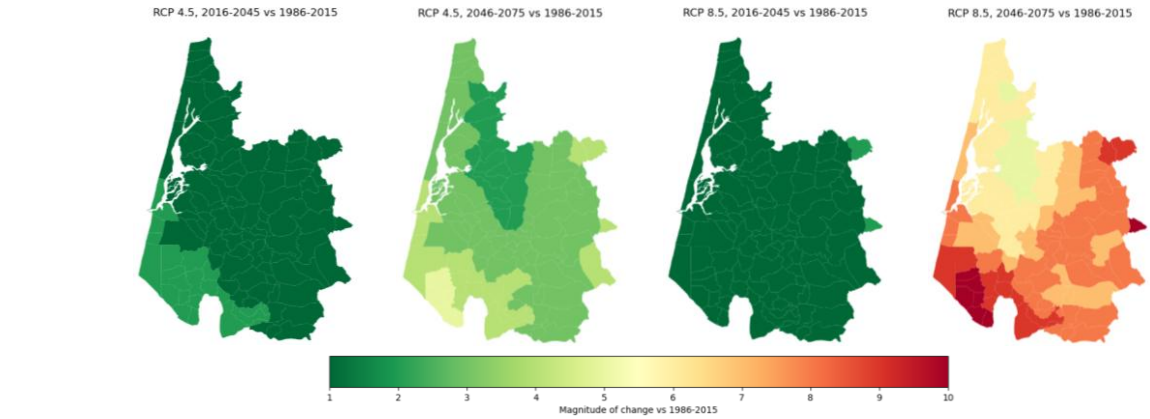


Figure 2-7 Magnitude of the potential projected increase of the heatwave occurrence, from 1 to 10 (1-very low change, 10-very high change), for the short- (2016-2045) and mid-term (2046-2075) future, under RCP4.5 and RCP8.5, in Aveiro Region.

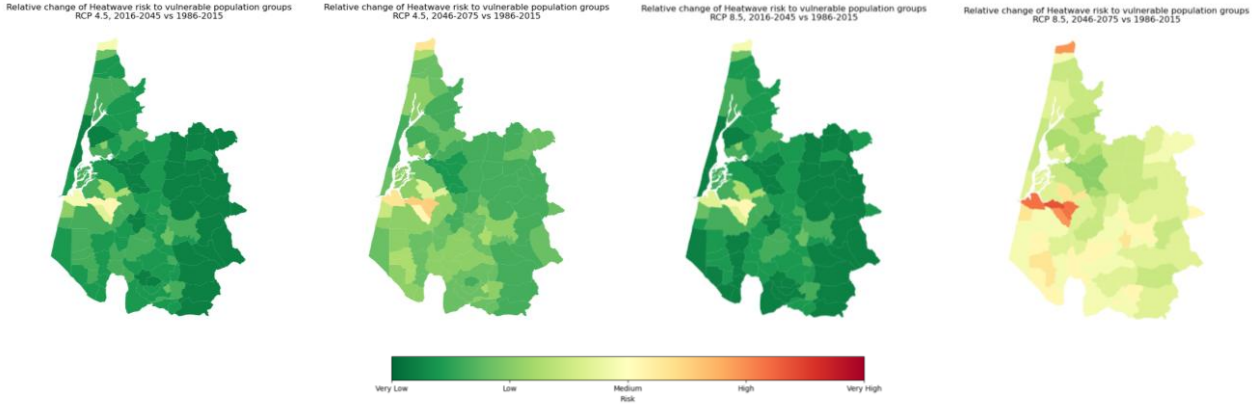


Figure 2-8 Potential projected increase of the heatwave risk to vulnerable population groups, for the short- (2016-2045) and mid-term (2046-2075) future, under RCP4.5 and RCP8.5, in Aveiro Region.

2.3.4 Agricultural Drought

Agricultural drought hazard was assessed using indicators of soil moisture deficit and precipitation anomalies, derived from regionalized drought indices including the Standardized Precipitation-Evapotranspiration Index (SPEI). The detailed data overview can be found in Table 2-6.

Table 2-6 Data overview for Agricultural Drought workflow.

Hazard data	***Vulnerability data***	***Exposure data***	***Risk output***
Daily mean precipitation, maximum and minimum temperature, 2m relative humidity, surface downward solar radiation, and 10m wind speed, derived from EURO-CORDEX EUR-11 climate projections (MPI-SMHI) for future periods (2036–2065) under RCP8.5 scenario	*Soil available water capacity*	*Crop distribution and economic value data (e.g., Global Agro-Ecological Zones (GAEZ), MapSPAM repository)*	*Revenue losses from irrigation deficit expressed as 'lost opportunity cost' in thousand euros*
Precipitation deficit leading to yield loss in key regional crops (e.g., maize, wheat, sorghum, barley, potato)	*Share of cropland with irrigation systems*		
	Thermal climate zone		
	Elevation		

2.3.4.1 Hazard assessment

Based on the results of the available water capacity in the soil, together with the accumulated precipitation intensity and standard evapotranspiration, throughout the growing season, it was possible to obtain the yield losses in the crops of beans, corn, legumes and rice (see Supplementary Materials) in the Aveiro region. Bean yield is expected to suffer the greatest production losses due to precipitation deficit, exceeding 50-60% reduction across almost the entire Aveiro Region.

2.3.4.2 Risk assessment

Risk assessment combined hazard maps with land use classification, crop type distributions, and farm-level vulnerability indicators. The findings highlight that potato and rice crops will have the higher revenue losses from the precipitation deficit (Figure 2-9). In general, farms with minimal irrigation infrastructure, and water-dependent crops are expected to face the greatest risk of reduced productivity. Although not shown in the results, drought is also expected to adversely impact livestock farming through reduced forage and increased heat stress. This emphasizes the need for improved water efficiency measures, drought-tolerant crop varieties, and insurance mechanisms tailored to smallholder farmers and cooperatives.

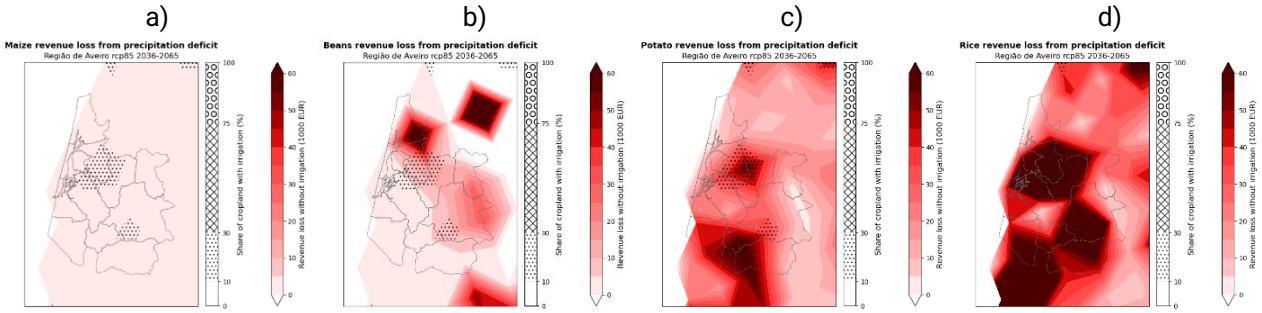


Figure 2-9 Maize (a), beans (b), potato (c) and rice (d) revenue loss from precipitation deficit, for the period 2036-2065, considering the RCP8.5 scenario., in Aveiro Region.

2.3.5 Fire (FWI)

In this first phase of the project, the workflow was applied with the standard methodology. For Fire workflow, only the FWI approach was possible to apply, due to the large amount of data required for the Machine Learning approach. The application of Fire workflow focused on NUT II (PT16), representing the Centre Region of Portugal, where Aveiro Region is located. Unfortunately, at this stage, it was not possible to reach the NUT III level, which would have focused only on the Region of Aveiro. The detailed data overview can be found in Table 2-7.

Table 2-7 Data overview for Fire (FWI) workflow.

Hazard data	***Vulnerability and Exposure data***	***Risk output***
Copernicus Climate Data Store – Fire Weather Index (FWI), Seasonal FWI, EURO-CORDEX scenarios: historical and RCP scenarios (2.6) Burnable areas (EFFIS)	European Forest Fire Information System (EFFIS) – fire danger categorization (it as the combination of wildfire danger and vulnerability) Joint Research Centre Risk Data Hub (JRC RDH) includes several datasets mainly at NUTS 2 level Pan-European Wildfire Risk Assessment – vulnerability indicators (Population at the Wildland Urban Interface (WUI), Protected areas fraction, Ecosystems Irreplaceability, Population density, Restoration cost)	Pareto analysis of risk (highlights which areas in the region have the highest wildfire risk)

2.3.5.1 Hazard assessment

For the FWI approach, the application focused on historical data and RCP 2.6. Historical and best, mean and worst scenarios were successfully produced. Some examples of the results produced can be found in the supplementary materials document. The inland municipalities emerge as wildfire hotspots, particularly in forested and rural landscapes with limited fuel management.

2.3.5.2 Risk assessment

After the hazard assessment, it was possible to use the Risk Assessment workflow. The results (Figure 2-10) were as follow, and include the Fire Danger Index, Seasonal FWI, Burnable vegetation (%) for RCP 2.6 (2046-2050) FWI>20, Vulnerability indicators: People living in WU interface (%), Protected land area (%), Irreplaceability Index, Vulnerability indicators: Population density (people/km^2), and Restoration cost Index, for Aveiro Region.

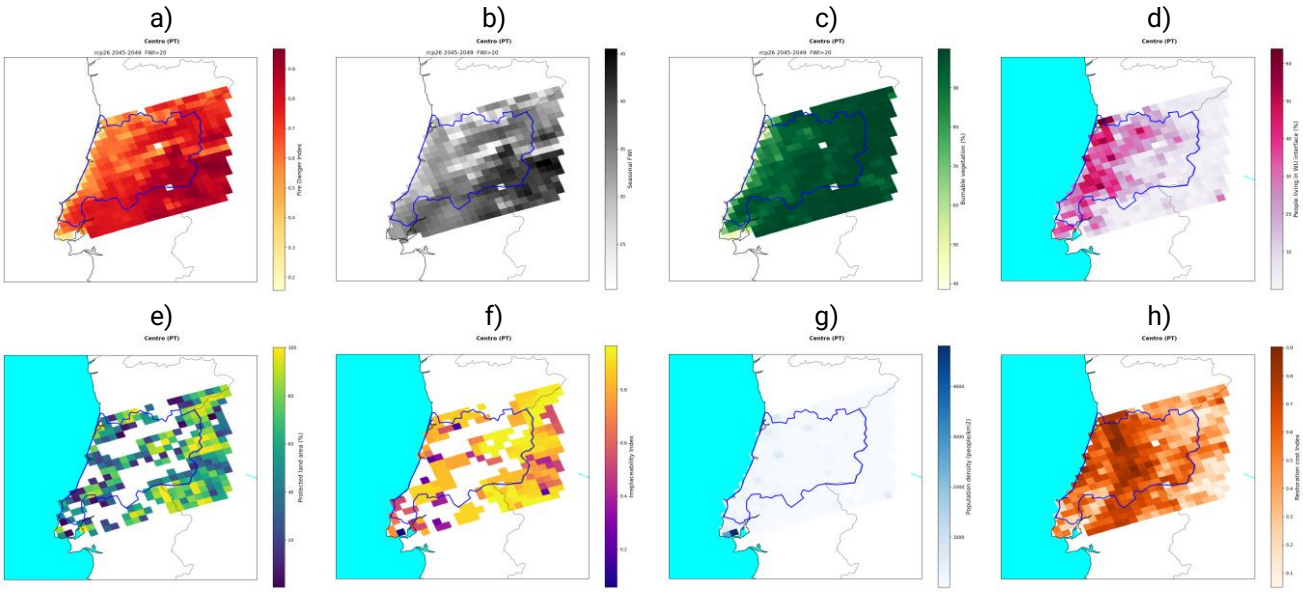


Figure 2-10 Fire Danger Index (a), Seasonal FWI (b), and Burnable vegetation (%) for RCP 2.6 (2046-2050) FWI>20 (c), Vulnerability indicators: People living in WU interface (%)(d), Protected land area (%)(e), and Irreplaceability Index (f); Vulnerability indicators: Population density (people/km2) (g), and Restoration cost Index (h), for Aveiro Region.

Lastly, the workflow allowed to perform the Pareto analysis, resulting in Figure 2-11, which reveals the areas in the region that have the highest wildfire risk given the specified vulnerability parameters. Again, inland municipalities emerge as the ones with higher fire risk.

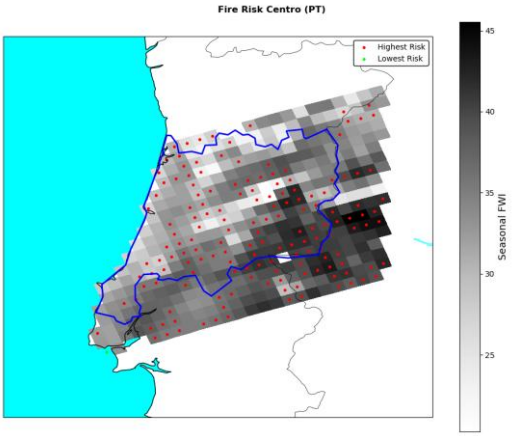


Figure 2-11 Fire risk (Seasonal FWI), for Aveiro Region.

2.4 Preliminary Key Risk Assessment Findings

2.4.1 Severity

The hazard and risk analysis for the Aveiro Region indicates its vulnerability to multiple climate-related hazards, including heatwaves, intense precipitation leading to river and coastal floods, droughts, and wildfires. These hazards pose significant threats across various sectors, impacting human health, agriculture, infrastructure, and natural ecosystems.

Among these, heatwaves are identified as a highly severe risk, with projected increases in frequency, duration, and intensity, posing significant public health concerns, particularly in densely populated urban areas and for vulnerable groups. The combination of rising temperatures and the urban heat island effect is expected to exacerbate these impacts, leading to higher mortality rates and worsening chronic illnesses.

Intense precipitation events leading to river and coastal floods also represent a high-impact risk. While the current resolution of river flood models shows limitations in capturing localized flash flood behaviour, historically documented events in the region confirm their destructive potential for urban infrastructure and property. Coastal flooding, particularly near the port area, shows measurable inundation, posing significant disruption to critical infrastructure like transportation routes and municipal car parks, especially under sea level rise scenarios.

Droughts are projected to worsen significantly, impacting agricultural productivity through reduced crop yields and increased water stress. This can lead to substantial economic losses for farmers and affect local food security. Wildfires also pose a severe threat, with a projected increase in high fire risk days, endangering forest areas, rural populations, and the wildland-urban interface. The potential for cascading effects from these hazards is high, including economic disruption, strain on public services, and long-term environmental degradation.

2.4.2 Urgency

The Aveiro Region faces urgent needs for climate adaptation across all identified primary risks.

Heatwaves represent an immediate and rapidly intensifying threat. Their frequency and intensity are already increasing and are projected to worsen in the near future, demanding urgent short-term actions. These include implementing effective early-warning systems, enhancing cooling infrastructure in critical locations (healthcare facilities, elderly care homes, schools), and promoting passive cooling solutions in urban planning and building design.

River and coastal flooding events require both rapid response and strategic medium-to-long-term planning. Sudden-onset floods from intense rainfall necessitate immediate civil protection enhancements, robust early-warning, and evacuation systems, and securing critical infrastructure. For the medium to long term, comprehensive structural interventions (e.g., improved drainage networks, flood barriers) combined with nature-based solutions (e.g., restoration of natural floodplains) are crucial to build enduring resilience against progressively worsening flood risks associated with increased precipitation intensity and sea-level rise.

Agricultural droughts have persistent and compounding impacts, requiring immediate attention to water management practices. Measures to promote resilient agricultural practices, efficient irrigation, and drought preparedness are crucial in the short term. The continuous decline in water availability means these risks have the potential to persist and worsen over time, making long-term planning for water conservation and alternative water sources highly urgent.

Wildfires also demand immediate preventive measures, especially given the projected increase in high fire risk days. This includes forest management, early detection systems, and community preparedness in fire-prone areas.

In conclusion, the urgency evaluation highlights that immediate, proactive action combined with strategic, forward-looking planning is essential across all primary hazards.

2.4.3 Capacity

The current capacity for climate adaptation in the Aveiro Region is characterized by a mix of existing planning instruments and ongoing initiatives, but also by limitations in high-resolution data and comprehensive stakeholder engagement. While there is a recognized commitment to climate action at municipal and intermunicipal levels, there is a need to strengthen technical capacities, improve data availability, and enhance collaborative frameworks. The CLIMAAX4CIRA project aims to build upon existing capacities by providing a robust framework for climate risk assessment and by fostering greater participation from diverse stakeholders. Addressing the identified gaps in data and coordination will be crucial for developing and implementing effective adaptation measures. The Aveiro Region already has:

- Financial Capacity: Existing planning instruments and participation in EU funding mechanisms (like Horizon Europe) indicate some financial capacity, though more targeted investments are needed.
- Human Capacity: There is awareness and knowledge among municipal and intermunicipal entities, but specific training for climate data interpretation and advanced assessment methods is required.
- Physical Capacity: Efforts like the slice and gate system in Aveiro City demonstrate a proactive approach to infrastructure, but further improvements in urban drainage and critical infrastructure resilience are necessary.
- Social Capacity: The project is designed to enhance social inclusion through multi-level stakeholder engagement, aiming to build broad community awareness and support.
- Natural Capacity: Recognition of the importance of coastal wetlands and other ecosystems for carbon sequestration and protection highlights an understanding of natural capacity, but restoration and nature-based solutions require further implementation.

Specific interventions implemented or planned include the already developed Climate Change Adaptation Plans. The CLIMAAX4CIRA project itself is a significant intervention aimed at strengthening these capacities through data-driven risk assessment and collaborative adaptation strategy development.

2.5 Preliminary Monitoring and Evaluation

Preliminary monitoring and evaluation during Phase 1 concentrated on tracking progress in the climate risk assessment process, while direct evaluation of adaptation measures and full stakeholder engagement are planned for later phases. Key performance indicators included successful application of the CLIMAAX framework and identification of primary climate hazards and vulnerabilities.

Limitations in high-resolution local data affected the precision of vulnerability mapping, and challenges were encountered in integrating diverse data sources. These issues will be addressed in subsequent phases to improve risk assessment accuracy.

Initial stakeholder mapping identified relevant actors across governance levels and sectors, providing a foundation for more structured engagement planned in Phase 2 and beyond. Early feedback highlighted the importance of involving a broader range of local stakeholders to ensure inclusiveness.

Data availability on climate risks and socio-economic vulnerabilities remains limited, indicating a need for enhanced data collection, resources, and interdisciplinary expertise in future phases.

Ongoing monitoring will focus on evaluating adaptation effectiveness, tracking climate indicators, and assessing socio-economic impacts to ensure adaptation plans remain responsive to evolving conditions.

2.6 Work plan

The work plan for the subsequent phases of the CLIMAAX4CIRA project will build upon the foundational work completed in Phase 1. Phase 2 will focus on refining the climate risk assessment by incorporating more localized, high-resolution data and conducting in-depth analyses of specific vulnerabilities. This will involve detailed mapping of exposed assets and populations, and further engagement with local communities to gather granular insights. Phase 3 will then concentrate on developing targeted adaptation strategies based on the refined risk assessment. This will include co-designing solutions with stakeholders, integrating adaptation measures into regional and municipal planning, and developing robust monitoring and evaluation frameworks for long-term resilience. The project will continue to emphasize multi-stakeholder collaboration, knowledge sharing, and capacity building throughout all phases to ensure sustainable and effective climate adaptation in the Aveiro Region.

3 Conclusions Phase 1- Climate risk assessment

Phase 1 of the CLIMAAX4CIRA project has successfully established a foundational climate risk assessment for the Aveiro Region, following the harmonized CLIMAAX framework. This initial phase provided a comprehensive overview of the region's climate vulnerabilities, identifying heat waves, intense precipitation, floods, droughts, and wildfires as critical and urgent risks—each affecting specific areas within the region. These findings align with existing knowledge that the region's complex geography poses significant challenges for climate change adaptation.

The assessment highlighted an increasing frequency and intensity of these hazards, underscoring the urgent need for proactive adaptation measures. While the standard CLIMAAX workflows offered a valuable baseline, the analysis revealed the necessity of incorporating higher-resolution local data to refine risk assessments and enhance the precision of adaptation planning in future phases.

Preliminary results confirm the region's susceptibility to climate change impacts across multiple sectors, including human health, agriculture, infrastructure, and natural ecosystems. Additionally, the stakeholder engagement process initiated during this phase has laid a solid foundation for a collaborative climate adaptation approach, emphasizing the importance of multi-level governance and community involvement.

In summary, Phase 1 successfully addressed the challenge of establishing a scientific basis for understanding climate risks in the Aveiro Region and identified key climate hazards and sectoral vulnerabilities. However, it also highlighted remaining challenges, notably the need for improved local data resolution to support targeted resilience strategies. This phase sets the stage for developing focused and effective adaptation measures in subsequent project phases.

4 Progress evaluation and contribution to future phases

The progress achieved in Phase 1 of the CLIMAAX4CIRA project has been substantial, laying a solid foundation for subsequent phases and contributing significantly to the overall project objectives. The successful application of the CLIMAAX framework for a multi-hazard climate risk assessment in the Aveiro Region represents a key milestone. This initial assessment has provided critical insights into the region's climate vulnerabilities, identifying priority hazards and at-risk sectors.

Phase 1 has directly contributed to future phases by:

- Establishing a baseline: The comprehensive risk profile developed in Phase 1 serves as a crucial baseline against which future changes and the effectiveness of adaptation measures can be evaluated.
- Identifying data gaps: The assessment highlighted the need for more localized, high-resolution data, particularly for refining risk analyses at a finer spatial scale. This insight will guide data collection efforts in Phase 2, ensuring that subsequent analyses are more precise and tailored to local conditions.
- Guiding adaptation strategy development: By identifying the most severe and urgent climate risks, Phase 1 has provided clear guidance for the development of targeted adaptation strategies. This will enable the project to focus resources on the most impactful interventions.
- Enhancing regional capacity: The process of conducting the CRA has contributed to building technical capacity within the Aveiro Region, both in terms of understanding climate risks and applying advanced assessment methodologies. This enhanced capacity will be vital for long-term climate resilience planning.

Table 4-1 Overview key performance indicators

Key performance indicators	***Progress***
1 workflow successfully applied in Phase 1	Phase 1: achieved on 07/21/2025
1 workflow successfully applied in Phase 2	Phase 2: to be achieved by 30/06/2026
1 climate risk assessment reports developed and shared with decision-makers	Phase 2: to be achieved by 30/06/2026
2 stakeholder engagement activities conducted	Phase 3: to be achieved by 31/12/2026
3 communication actions taken to share results with local communities and the general public	Phase 3: to be achieved by 31/12/2026
1 policy recommendations document produced based on project findings	Phase 3: to be achieved by 31/12/2026
1 scientific publication or dissemination activity related to the project outcomes	Phase 3: to be achieved by 31/12/2026

Table 4-2 Overview milestones

Milestones	***Progress***
M1: Subcontracting done	Phase 1: achieved on 17/03/2025
M2: Attend the first CLIMAAX workshop held in Barcelona	Phase 1: achieved on 11/06/2025
M3: CLIMAAX CRA successfully applied to Aveiro Region	Phase 1: achieved on 31/07/2025
M4: Stakeholders meeting & dissemination of CLIMAAX CRA results	Phase 2: to be achieved by 31/10/2025
M5: CLIMAAX CRA successfully refined with Aveiro Region local data	Phase 2: to be achieved by 31/05/2026
M6: Stakeholders meeting on adaptation options and local actions	Phase 3: to be achieved by 30/09/2026
M7: Adaptation options and local actions successfully defined	Phase 3: to be achieved by 30/11/2026
M8: Attend the final CLIMAAX workshop held in Brussels	Phase 3: to be achieved by 31/12/2026

5 Supporting documentation

The additional documents and datasets have been uploaded to the Zenodo platform (https://doi.org/10.5281/zenodo.16995692). The contents of the folder are as follows:

- Communication Materials
    - Executive Summary (in Portuguese)
    - Newsletter (in Portuguese)
- Phase 1 Deliverable
    - Main report
    - Supplementary materials
- Workflows Outputs
    - Floods Workflows
        - River Floods
        - Coastal Floods
        - Flood Building Damage and Population Exposed
    - Heavy Rainfall Workflow
        - Extreme Precipitation
    - Heatwaves Workflow
        - Hazard Assessment (EuroHEAT)
        - Risk Assessment (climate projections)
    - Droughts Workflow
        - Agricultural drought Workflow
    - Fire Workflow
        - Wildfire (FWI) Workflow

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