Deliverable Phase 1 – Climate risk assessment

Climate-Ready İzmir: Enhancing Resilience Strategies

Türkiye, İzmir

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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

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Document Information

Deliverable Title	Phase 1 – Climate risk assessment
Brief Description	The CRIZ-ERS project aims to strengthen İzmir's climate resilience by addressing risks like extreme weather, floods, droughts, and heatwaves. Through risk assessments, stakeholder engagement, and targeted interventions, it promotes a sustainable urban environment while aligning with international frameworks like the EU Green Deal and Horizon 2020.
Project name	Climate-Ready İzmir: Enhancing Resilience Strategies
Country	Türkiye
Region/Municipality	İzmir
Leading Institution	İzmir Metropolitan Municipality
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Abbreviations and acronyms

Abbreviation / acronym	Description
CRA	Climate Risk Assessment
CRIZ-ERS	Climate-Ready İzmir: Enhancing Resilience Strategies
GCAP	Green City Action Plan
IMM	İzmir Metropolitan Municipality
IRAP	İl Afet Risk Azaltım Planı (Provincial Disaster Risk Reduction Plan)
NGO	Non-Governmental Organization
SECAP	Sustainable Energy Climate Action Plan
CRA	Climate Risk Assessment
DSI	Directorate General for State Hydraulic Works
GCM	General Circulation Model
RCM	Regional Climate Model
TSMS	Turkish State Meteorological Services

Executive summary

The Climate-Ready İzmir: Enhancing Resilience Strategies (CRIZ-ERS) project has been developed to strengthen İzmir's adaptive capacity in response to increasing climate risks, including extreme weather events, floods, droughts, heatwaves, and sea level rise. As a rapidly urbanizing region, İzmir faces significant challenges related to climate change, requiring comprehensive and targeted adaptation strategies. The main objective of the CRIZ-ERS project is to enhance resilience by conducting thorough climate risk assessments, identifying vulnerable sectors, and developing evidence-based adaptation interventions.

The project is part of a broader effort aligned with international frameworks such as the EU Green Deal, Horizon 2020 program, and Turkey's commitments under the Paris Agreement. By integrating local and international perspectives, the project aims to position İzmir as a model city for urban climate resilience.

During the first phase, a comprehensive risk assessment was conducted to identify the most vulnerable sectors and communities within İzmir. An inclusive stakeholder engagement process was carried out, involving public institutions, private sector representatives, academia, civil society organizations, and local communities. This participatory approach allowed for collecting valuable insights and identifying critical risks and adaptation needs. Key sectors identified as particularly vulnerable include agriculture and food production, energy, tourism, manufacturing and industry, healthcare and public safety, water resources management, cultural heritage, and urban infrastructure.

Based on the assessment, a set of targeted adaptation interventions was proposed. These interventions include enhancing green and blue infrastructure through afforestation, improving water management practices, increasing the resilience of critical infrastructure, implementing sustainable urban planning initiatives, and protecting cultural heritage from climate-related damages. Additionally, the project emphasizes community development through awareness programs, improved emergency management capacities, and early warning systems to safeguard vulnerable populations.

Several challenges were encountered during the assessment, including data gaps related to localized vulnerabilities and limited coordination among some stakeholder groups. To address these issues, the project recommends continuous data collection, stakeholder capacity-building, and the development of integrated data systems. As new data and insights become available, adaptation measures will be regularly updated to reflect emerging risks and improve resilience planning.

In conclusion, the CRIZ-ERS project has made significant progress in identifying climate risks and proposing comprehensive adaptation interventions. By fostering multi-stakeholder collaboration and leveraging international frameworks, İzmir is well-positioned to enhance its resilience and adapt to the growing impacts of climate change.

1 Introduction

1.1 Background

İzmir Metropolitan Municipality (IMM) has initiated the "Climate-Ready İzmir: Enhancing Resilience Strategies (CRIZ-ERS)" project to address the city's growing vulnerability to climate change and climate-related risks. As a dynamic and rapidly urbanizing region, İzmir faces a range of climate hazards, including floods, heatwaves, droughts, and wildfires. While the Sustainable Energy and Climate Action Plan (SECAP) has outlined climate risks and vulnerabilities at the city level, it lacks precise, location-specific analyses that are critical for targeted intervention.

The CRIZ-ERS project aims to bridge this gap by conducting detailed, location-specific, and neighborhood-level risk assessments. Utilizing advanced tools and methodologies from the CLIMAAX framework, the project will enhance the accuracy and resolution of climate data, supporting more effective adaptation strategies. By integrating high-resolution data into routine climate planning, the project will contribute to the city's long-term resilience and adaptive capacity.

The project also emphasizes multi-stakeholder collaboration, involving municipal departments, academia, civil society organizations, and local communities. This inclusive approach ensures that the voices of vulnerable groups are considered in decision-making processes. Additionally, the project aligns with both national and international climate adaptation policies, enhancing its relevance and potential for broader application.

1.2 Main objectives of the project

The primary objective of the CRIZ-ERS project is to conduct comprehensive climate risk assessments at multiple spatial scales, including the provincial, metropolitan and district levels. This will enable the identification of priority areas and the development of tailored adaptation strategies. The project aims to improve the current Risk and Vulnerability Assessment of İzmir as outlined in SECAP by incorporating higher-resolution, geographically specific data through the CLIMAAX framework. It also seeks to conduct detailed risk assessments to address climate-related vulnerabilities in selected areas within the Konak district of İzmir. Another objective is to evaluate climate-related risks and adaptive capacities related to specific hazards, such as floods and heatwaves, within diverse population groups. The project intends to enhance the CLIMAAX outcomes by integrating local data related to vulnerability and socio-economic factors, thereby increasing accuracy and relevance. Strengthening stakeholder capacities, including municipal departments, NGOs, citizens, and disaster management authorities, is also a key goal, as well as improving communication and technical capacities among stakeholders to facilitate the effective implementation of climate adaptation strategies. By developing targeted adaptation action plans for prioritized areas and focusing on long-term resilience and sustainable urban planning, the CRIZ-ERS project will not only enhance the city's climate resilience but also establish a robust framework for data-driven decision-making and community engagement.

1.3 Project team

Project Team:

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    - M. Kemal Demirkol: Technical Advisor (Climate Adaptation, Risk Assessment)
    - Prof. Dr. Osman Balaban: Technical Advisor (City Planning and Climate Adaptation)
    - Assoc. Prof. Dr. Meltem Şenol Balaban: Technical Advisor (Disaster Risk Management)
    - Assoc. Prof. Dr. Selda Tuncer: Technical Advisor (Social Policies and Gender Equality)
    - Assist. Prof. Dr. Banu Gökmen: Technical Advisor (Urban Conservation/Cultural Heritage)
    - Dr. Çağrı Karaman: Technical Advisor (International Climate Analysis and Model Development Expert)
    - Dr. Emrah Alkaya: Technical Advisor (Environment and Urban Infrastructure)
    - Engin Koç: Technical Advisor (Ecosystem and Biodiversity)
    - Elif İrem Köse Kiper: Technical Advisor

1.4 Outline of the document's structure

This document is structured to provide a comprehensive climate risk assessment for İzmir province and Konak district. It begins with an introduction outlining the project's background, objectives, and stakeholders. The main section details the climate risk assessment, including hazard identification, risk analysis, and key findings. Preliminary conclusions summarize the severity, urgency, and capacity for adaptation. The document also includes a progress evaluation, highlighting key performance indicators and future milestones. Supporting documentation, references, and formatting guidelines are provided at the end.

2 Climate risk assessment – phase 1

2.1 Scoping

2.1.1 Objectives

Coastal cities are the places where the most severe impacts of climate change will be experienced in the current century. There are studies such as the “Mediterranean Region Supplementary Material” prepared by the 2nd Working Group within the framework of IPCC AR6, which discusses the possible risks that coastal cities in the Mediterranean basin may face. Since İzmir is a coastal city in the Mediterranean basin, most of the risks mentioned in such studies will most likely be felt in the city İzmir should be considered as one of the cities that are highly exposed to climate change-related risk and that require future plans for adaptation actions.

According to IPCC source referenced above detection and attribution of climate change impacts in the Mediterranean Basin are covered as follows (*IPCC: Mediterranean Region Supplementary Material, 2022, Table SMCCP4.1*):

- Water availability and quality
- Terrestrial and freshwater ecosystems.
- Wildfires
- Balance of marine ecosystem
- Food production and security
- Health and well-being (thermal discomfort such as heatwaves)
- Variations in storm regime
- Coastal and river flooding
- Impacts of sea level rise to cultural heritage, infrastructures and communities
- Inland ecosystems (loss of habitats and ecosystem and range shifts)
- Fisheries

It is important to evaluate the above possible threats from the perspective of İzmir. It is obvious that during the city-wide studies prepared in the past years, both Sustainable Energy and Climate Change Action Plan (SECAP) and Provincial Disaster Risk Reduction Plan (IRAP), historical records regarding heat waves, wildfires, drought and agricultural droughts, sea level rise and possible flood came to the fore. The threats and related risks mentioned were also highlighted in the stakeholder meetings held within the scope of this project.

The Climate Risk Assessment (CRA) for İzmir aims to evaluate the threats and risks posed by climate change across various sectors, including the environment, economy, and society. The primary objective is to provide a comprehensive understanding of how climate change may impact local communities and to develop effective adaptation strategies that enhance resilience. The study seeks to identify high-risk areas, prioritize risks, and formulate actionable strategies to mitigate these threats. These outputs will guide stakeholders in preparing for climate-related challenges and support the adoption of sustainable development practices.

The CRA also considers the variability of risks between the city center (metropolitan area) and the rural parts of the city, recognizing that climate impacts may differ across geographical areas. In the later stages of the project, separate evaluations will be conducted based on data quality to understand the diverse risk levels within the city. To ensure stakeholder involvement, meetings were held with public institutions, private sector representatives, and civil society organizations. Their feedback contributed to shaping the assessment and will help guide policy and decision-making processes.

The findings of the CRA are expected to support regional planning, infrastructure investments, emergency preparedness, and long-term sustainability policies. By delivering reliable, evidence-based information, the CRA directly contributes to policy formulation and decision-making, enabling both reactive and proactive responses to climate change.

However, the CRA faces several limitations, including challenges related to data availability and quality, particularly at the local level. Insufficient stakeholder engagement may also affect the effectiveness of the assessment, while resource constraints, including funding and technical expertise, may limit the depth of analysis. Additionally, uncertainties inherent in climate models and socio-economic scenarios can impact the predictability of long-term risks. Legal and institutional barriers may further hinder the implementation of adaptation measures, as existing regulations may not fully align with emerging climate realities. Despite these challenges, the CRA aims to establish a strong foundation for informed decision-making, providing a clear roadmap for climate risk management and sustainable policy development. By fostering collaboration and evidence-based planning, the CRA will support the region in building climate resilience and adapting to future challenges.

2.1.2 Context

Owing to its geographical positioning, İzmir is exposed to a range of climatic and natural disaster hazards, including earthquakes, tsunamis, floods, droughts, wildfires, and severe weather conditions. In response to these challenges, the municipal administration has implemented comprehensive strategic plans, including the Sustainable Energy and Climate Action Plan *(SECAP, 2019)* and the Green City Action Plan *(GCAP, 2020)*. Additionally, the Provincial Disaster Risk Reduction Plan (IRAP), prepared by AFAD and implemented with the involvement of the municipality, aims to strengthen the city's disaster resilience and mitigate potential losses through robust risk assessment and reduction strategies. Conversely, SECAP is dedicated to curbing greenhouse gas emissions and enhancing the city's adaptability to climate change.

Additionally, The Urban GreenUP Project *(Urban GreenUP, 2024)* funded by the European Union under Horizon 2020, identifies İzmir as one of the leading cities alongside Liverpool and Valladolid. Under this project, three pilot areas have been designated in the Karşıyaka and Çiğli districts, where green parklets, permeable surfaces, pollinator houses to support biodiversity, and new green corridors have been established.

The project "Green Re-vision: A Framework for Resilient Cities" is conducted by the İzmir Metropolitan Municipality. As part of this project, a climate model for İzmir has been developed, projecting conditions for the years 2050 and 2100.

To reduce carbon emissions in İzmir, the Sustainable Energy and Climate Action Plan (SECAP) outlines strategies such as increasing energy efficiency, expanding renewable energy sources, improving waste management, and enhancing green spaces.

İzmirThe Urban Heat Island and Social Vulnerability Assessment Report *(Karşıyaka Belediyesi, 2024)*, prepared by Karşıyaka Municipality, analyzes the spatial distribution of vulnerable populations and identifies areas most affected by heatwaves. The report emphasizes the need to increase green infrastructure applications in urban hotspots.

İzmir Metropolitan Municipality aligns its climate risk strategies with UN Agreements, the EU Green Deal, and Turkey's National Climate Policies. The city is part of the United Nations Resilient Cities Campaign and follows the Sendai Framework for Disaster Risk Reduction.

At the local level, the SECAP and GCAP, approved by the İzmir Metropolitan Municipality Council, aim to reduce greenhouse gas emissions by 40% by 2030 and make the city more resilient. These action plans include clean energy investments, sustainable transportation projects, and water management strategies.

The Climate Neutral and Smart Cities Mission, led by 112 cities chosen by the European Commission, aims for climate neutrality by 2030. As a Leading City, İzmir is committed to building an inclusive city alliance through an innovative and participatory governance model. The initiative fosters collaboration across various sectors, including energy, transportation, waste, industry, agriculture, and tourism, involving public, private, academic, NGO, and media stakeholders. Additionally, the Mission aims to guide cities aiming for climate neutrality by 2050 under the European Green Deal. With its diverse action plans and sectoral involvement, İzmir will become a key center of experience among leading cities.

As part of a stakeholder engagement initiative, an interactive survey was conducted during a series of meetings with both internal and external stakeholders. These discussions aimed to identify the key sectors in our region and assess their potential vulnerabilities to climate change. The sessions provided valuable insights into industry-specific concerns, adaptation strategies, and policy recommendations. Through this collaborative approach, stakeholders highlighted several critical sectors that are expected to be significantly impacted by climate change. The priority sectors resulting from the stakeholders' assessments are provided in Figure 2-1.

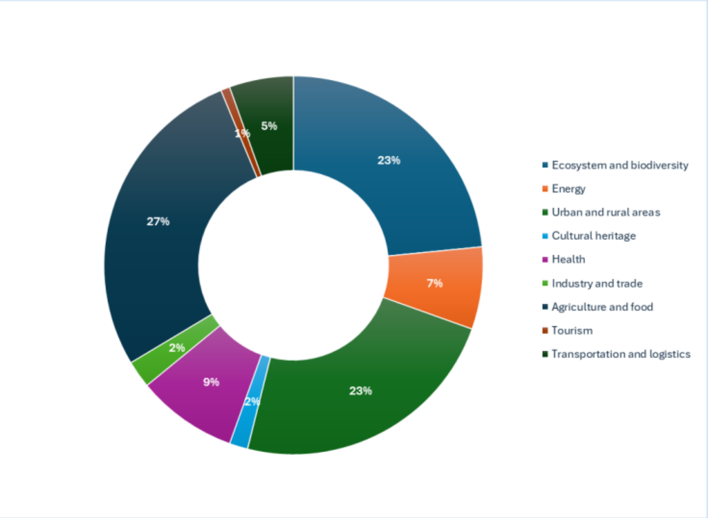

Figure 2-1 The Most Affected Sectors by Climate Change Across İzmir Province

Based on the survey results and stakeholder feedback, the following sectors emerged as the most relevant and vulnerable to climate change:

- **Agriculture and Food Production:** Climate change is expected to significantly impact agricultural productivity due to shifting rainfall patterns, increased temperatures, and extreme weather events. Stakeholders have highlighted concerns regarding soil degradation, water scarcity, and crop yield variability. Adaptation measures such as resilient crop varieties and sustainable irrigation techniques will be essential.
- **Energy Sector:** Rising temperatures and changing precipitation patterns may affect both renewable and non-renewable energy sources. Hydropower generation, in particular, is vulnerable to reduced water availability, while increased temperatures could elevate cooling demands, stressing energy grids. Stakeholders suggest investing in diversified renewable energy sources and smart grid solutions to enhance resilience.
- **Tourism and Hospitality:** The tourism industry may face disruptions due to changing weather patterns, rising sea levels, and increased frequency of extreme weather events.

Stakeholders emphasized the need for sustainable tourism practices, eco-friendly infrastructure, and policies to mitigate risks while maintaining sector growth.

- **Manufacturing and Industry:** Climate change can impact manufacturing through supply chain disruptions, energy demand fluctuations, and material resource shortages. Respondents highlighted the necessity for green manufacturing practices, energy efficiency improvements, and circular economy approaches to ensure long-term sector sustainability.

- **Healthcare and Public Safety:** Rising temperatures and environmental changes could lead to increased health risks, including heat-related illnesses, vector-borne diseases, and air pollution-related conditions. Stakeholders underscored the importance of strengthening healthcare systems, emergency response mechanisms, and climate-resilient urban planning.
- **Water Resources Management:** Water scarcity and quality issues were consistently raised by respondents as major concerns. Sectors reliant on water, such as agriculture, energy, and manufacturing, may face operational challenges. Strategic investments in water conservation, desalination, and efficient management policies were suggested as critical adaptation strategies.

The target areas for potential adaptation interventions within İzmir province, İzmir metropolitan area, and Konak district will be determined based on the results of the risk and vulnerability analysis. This analysis will identify high-risk areas for a range of sectors, assets and social groups. Therefore, the likely adaptation interventions and actions given in Table 2-1, will be diversified and specified for high-risk areas in different parts of the province.

Table 2-1 Adaptation Sectors and Interventions

Adaptation Sector	Adaptation Interventions
Green and Blue Infrastructure	• Afforestation efforts in suitable areas. • Creation of water-retaining parks within heat hotspots as part of the sponge city approach. • Replacement of impermeable surfaces with natural and permeable materials. • Increasing urban green spaces and enhancing connectivity between green areas. • Reopening covered rivers and streams where feasible. • Protecting groundwater resources and preventing illegal water usage through a monitoring system.
Critical Infrastructure	• Identifying and analyzing the resilience of critical infrastructure facilities against extreme meteorological events and climate-related disasters. • Implementing improvements and reinforcements based on risk analysis results.
Urban Infrastructure	• Implementing structural measures such as seawalls and drainage channels in coastal areas. • Reviewing and improving existing flood drainage facilities. • Enhancing structural infrastructure where nature-based solutions are insufficient. • Promoting water conservation and reuse through rainwater harvesting and storage systems. • Separating rainwater and sewage systems where necessary. • Ensuring regular maintenance of flood drainage channels.
Urban Built Environment	• Strengthening urban built environments in high-risk areas through urban transformation initiatives. • Implementing projects in unplanned settlements. • Renewing or evacuating vulnerable buildings in high-risk zones.
Disaster and Emergency Management	• Establishing early warning systems for high-risk areas. • Setting up emergency response centers for effective disaster intervention.

	• Creating shelter and temporary protection centers for vulnerable groups during disasters.
Risk Management	• Updating flood hazard maps based on climate projections and changes in precipitation patterns. • Updating landslide hazard maps in line with climate projections and precipitation regime changes.
Forestry	• Taking preventive measures against accidents and fires in industrial and energy facilities near forest areas. • Clearing vegetation and trees near power transmission lines and establishing a monitoring system. • Constructing firebreak roads and restricting access during high-risk periods.
Water Management	• Implementing water efficiency measures in agriculture and modernizing irrigation systems. • Improving industrial water use efficiency and promoting recycling and reuse.
Cultural Heritage	• Constructing erosion control structures and improving vegetation in cultural heritage sites. • Implementing natural water retention methods and enhancing drainage systems. • Revising conservation plans for heritage sites with respect to climate risks.
Community Development	• Organizing awareness and education programs for vulnerable social groups. • Implementing social policy measures to reduce vulnerabilities.

2.1.3 Participation and risk ownership

During the stakeholder engagement meeting, participants shared their perspectives on the most significant climate change-related events affecting the İzmir province, as well as the top hazards requiring urgent preventive measures to reduce negative impacts. The insights gathered during these discussions revealed critical areas of concern and highlighted priorities for adaptation efforts. The results obtained from the analysis are presented in Figure 2-2 and Figure 2-3. Accordingly, a risk assessment focusing on the relevant stakeholders has been conducted in this section.

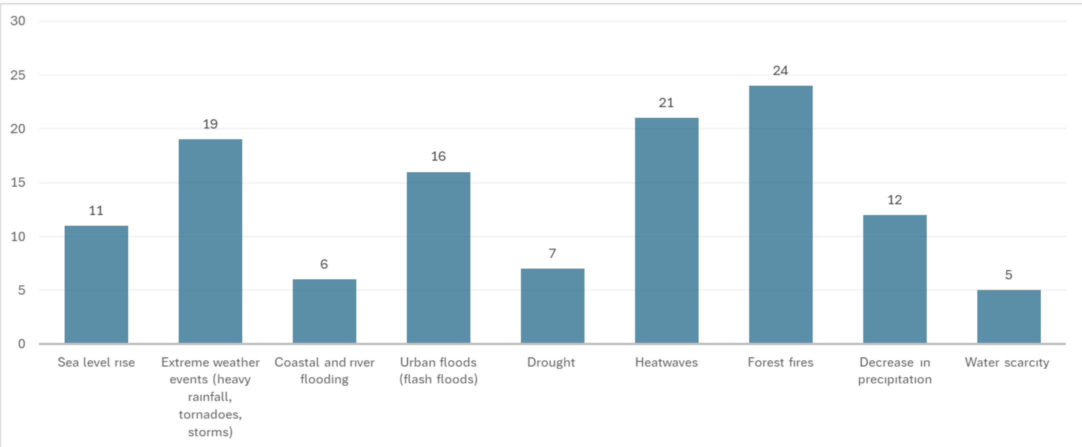

Figure 2-2 The Most Significant Climate Change-Related Events Affecting the İzmir Province

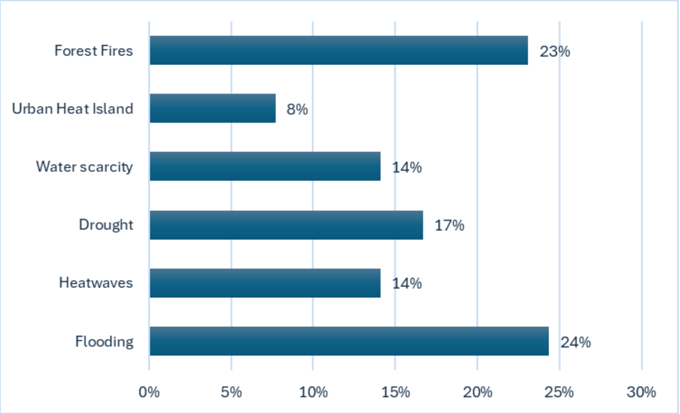

Figure 2-3 The Hazards That Require Urgent Preventive Measures to Reduce the Negative Impacts Of Climate Change In The İzmir Province

As seen in Figure 2-2, the three most significant climatic hazards mentioned by the participants are forest fires, heatwaves and extreme weather events. Considering the recent experiences in İzmir, the responses are not surprising. In relation to their perception of likely hazards, participants highlighted forest fires and flooding are the most pressing issues that require urgent adaptation measures.

The stakeholder categorization methodology developed for climate risk management in İzmir aims to ensure a comprehensive and inclusive approach by systematically identifying and grouping stakeholders. The methodology categorizes stakeholders into primary and secondary groups, considering their influence, vulnerability, data provision capabilities, and roles within the project framework. Internal and external stakeholders include those directly involved or significantly impacted by climate risks, while secondary stakeholders have indirect involvement or supportive roles. The primary and secondary stakeholders in question are illustrated in the impact-interest matrix shown in Figure 2-4.

The Impact-Interest Matrix is used as a strategic tool to classify stakeholders into four quadrants: Manage Closely (High Impact - High Interest), Keep Satisfied (High Impact - Low Interest), Monitor (Low Impact - High Interest), and Keep Informed (Low Impact - Low Interest). This categorization supports targeted engagement strategies, ensuring that key actors like regulatory authorities and essential service providers are actively involved, while others like local chambers and NGOs receive periodic updates *(PMI, 2017)*.

The methodology was developed through comprehensive research, expert consultations, and project documentation analysis. It addresses critical aspects such as identifying vulnerable groups, assessing risk ownership, and establishing communication strategies. By involving public institutions, private sector organizations, professional chambers, academia, civil society, and citizens, the approach enhances collaboration and strengthens climate risk management efforts in İzmir.

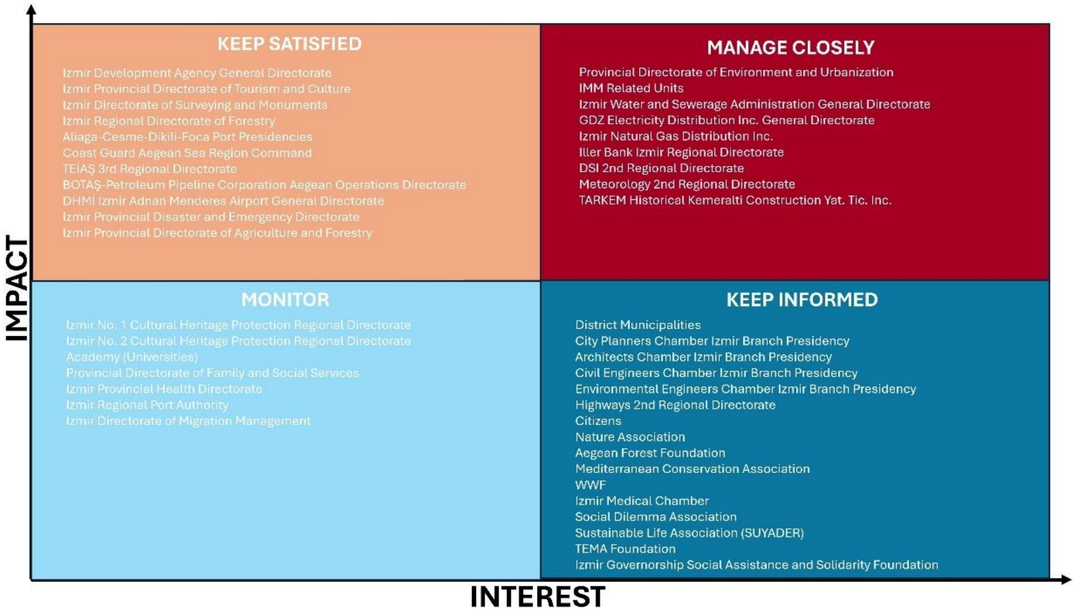

Figure 2-4 Stakeholder Analysis Impact-Interest Matrix

The RACI Matrix is a tool used to define roles and responsibilities in climate risk management for İzmir, ensuring accountability and effective communication. It categorizes stakeholders as Responsible (task executors), Accountable (ultimate decision-makers), Consulted (providers of expertise or input), and Informed (kept updated on progress). This clear role assignment helps streamline decision-making and coordination among stakeholders *(PMI, 2017)*. In the context of climate risk management in İzmir, the RACI Matrix, shown in Table 2-2, is used to streamline stakeholder engagement and role allocation. The primary goal is to enhance coordination and transparency by clearly defining who is responsible, accountable, consulted, and informed for each aspect of risk management. This approach helps reduce ambiguity and improves collaboration among diverse stakeholders, including public institutions, private sector organizations, academia, civil society, and the community.

To construct the RACI Matrix, stakeholders are identified based on their roles and responsibilities within the climate risk management framework. Tasks are broken down into key components like risk ownership regulation, risk level assessment, and communication strategies. Stakeholders are assigned roles according to their capacity, with İzmir Metropolitan Municipality and the Provincial Disaster and Emergency Directorate accountable for risk regulation, while academic institutions and professional chambers provide expertise. Public communication is handled by the municipality's communication units, and citizens and NGOs are kept informed about progress *(CLIMAAX , 2024)*.

The RACI Matrix helps ensure that all stakeholders are effectively engaged and that responsibilities are distributed in a way that maximizes efficiency. By aligning the roles of primary and secondary stakeholders according to their level of impact and interest, the matrix supports a systematic and coordinated approach to managing climate risks in İzmir.

Table 2-2 RACI Matrix

Task/Responsibility	Responsible (R)	Accountable (A)	Consulted (C)	Informed (I)
Risk Ownership Regulation	Provincial Directorate of Environment and Urbanization	IMM, Provincial Disaster and Emergency Directorate	Academic Expert	Citizens, NGOs

Acceptable Risk Level Assessment	Provincial Directorate of Health, İzmir Development Agency	IMM Related Units, Provincial Disaster and Emergency Directorate	Academic Expert, Chamber of Civil Engineers, Chamber of Architects	Citizens, District Municipalities
Communication and Reporting	Project Implementation Team	IMM Press and Public Relations Unit	Academic Experts, Media Representatives	District Municipalities, NGOs, Public

2.2 Risk Exploration

2.2.1 Screen risks (selection of main hazards)

İzmir, located in the Mediterranean climate zone, experiences hot and dry summers, and mild and rainy winters. On a provincial scale, the annual average temperature ranges between 14-18°C in coastal areas. The hottest months are July (27.3°C) and August (27.6°C), while the coldest months are January (8.6°C) and February (9.6°C). In summer, coastal temperatures are 1-2°C lower than inland areas due to the influence of the sea breeze. During winter, the average temperature is around 7°C, but it can drop at times due to maritime air masses coming from the north and northwest. There are significant differences in the distribution of precipitation across months and seasons in İzmir. The annual average precipitation is 700 mm, with more than 50% of it occurring in winter, 40-45% in spring and autumn, and only 2-4% in summer. The number of snowy days in low-lying areas is almost negligible, whereas in higher elevations, both the number of snowy days and the duration snow remains on the ground increase. The annual average sea surface temperature is 18.5°C. The coldest months for sea temperature are January (11°C) and February (10.7°C), while the warmest months are July and August (26.2°C). İzmir's climate is well-suited for agriculture, tourism, and urban living, with hot, dry summers and mild, rainy winters characteristic of the Mediterranean climate.

2.2.2 Workflow selection

İzmir faces significant climate risks, including rising temperatures, more frequent heatwaves, and prolonged droughts that threaten water resources, agriculture, and public health in urban areas due to urban heat island effect. Extreme precipitation events are increasing, leading to urban flooding, while sea level rise endanger coastal areas like Karşıyaka and Konak through erosion and saltwater intrusion. Likewise, the increase in frequency and intensity of such extreme events as heavy precipitation and storm surges may lead to inundation of urban infrastructure in coastal parts of the metropolitan area. Wildfire is becoming more common in forested regions such as Kemalpasa and Seferihisar, and storms are intensifying, damaging infrastructure and disrupting daily life. Agriculture is particularly vulnerable, with declining rainfall and soil degradation affecting key crops like olives and grapes. By screening the historical events, the following workflows were selected *(Turkish State Meteorological Service, 2025).*

2.2.2.1 Heavy Rainfall

Heavy rainfall in İzmir is becoming more frequent and intense due to climate change, increasing the risk of coastal, urban and riverine flooding. The city's rapid urbanization exacerbates this problem, particularly in low-lying areas such as Konak, Karşıyaka, Bornova, and Alsancak. Extreme rainfall impacts the stormwater infrastructure, leading to flash floods that disrupt transportation, damage buildings, and threaten public safety. On September 12, 2024, İzmir experienced heavy rainfall that led to significant flooding across the province. It is reported that the downpour affected 231 homes, 47 businesses, and 45 vehicles. The city reviewed 133 kilograms of rain per square meter over a 5-hour period. On July 12, 2024, İzmir experienced a severe thunderstorm particularly affecting central districts like Konak and Bayraklı. The heavy rainfall led to significant water accumulation on streets, causing difficulties for both drivers and pedestrians. During the heavy rain, two individuals lost their lives due to electric shock *(Yeni Asır, 2024)*.

2.2.2.2 Drought

İzmir faces an increasing risk of drought that has significant implications for agriculture, water resource management, and urban sustainability. İzmir experiences long, dry summers with limited precipitation, making it particularly vulnerable to prolonged periods of drought. In recent years, shifting climate patterns have led to reduced annual precipitation, prolonged dry periods, and increased temperatures, intensifying drought conditions across the region. In October 2024, İzmir faced significant drought conditions, with the Tahtalı Dam's water levels dropping to 16%, marking the second-lowest October level in its 25-year history making risk for the clean water resources for the city. This marked the second-lowest October level since the dam's completion in 1997, with the lowest recorded at 5.5% in 2008 due to drought conditions in the region. The drought conditions in 2022-2023 have led to 30% decrease in wheat and corn cultivation areas have decreased from 60,000 to 12,000 decares. In conclusion, drought functions as a crosscutting hazard in İzmir, as it makes significant impacts on key sectors of socio-economic structure. Drought in İzmir Province is not just altering agricultural production patterns but also adversely affects the tourism sector due to water shortage. The crosscutting impacts of drought underscore the importance of water management and sustainable farming and tourism practices.

2.2.2.3 Heatwaves

In recent decades, İzmir has experienced a steady increase in average temperatures and more frequent, prolonged heatwaves. Turkey has warmed by 1.46°C since 1950, placing it in one of the fastest-warming regions globally, heating at three times the world average. The frequency of heatwaves between May and September has increased ninefold, and their duration has extended sevenfold. Global warming is particularly intense in the Mediterranean Basin, where Turkey is located. In İzmir, the number of tropical nights—when temperatures remain above 20°C—has increased from a maximum of 70 per year in the 1950s to over 100 today. The number of days exceeding 30°C has also risen significantly. Additionally, in June 2024, İzmir experienced its hottest June day since meteorological records began in 1938, with temperatures reaching 41.4°C, breaking the previous record of 41.3°C set on June 28, 1982 *(Anadolu Ajansı, 2024)*. These reveals that heatwave risk in İzmir is a growing concern, requiring coordinated efforts. One heatwave related problem in urban areas of İzmir Province is the urban heat island (UHI) effect. The populous urban agglomerations within the province already suffer from UHI effect, which is expected to intensify in future especially during prolonged heatwave periods.

2.2.2.4 Coastal Flooding

İzmir is highly vulnerable to the impacts of flooding and rising sea levels due to its coastal location, rapid urbanization, and the effects of climate change. Between 2010 and 2021, İzmir was the second most flood-affected city in Turkey, experiencing 95 severe flood events. Alterations to natural water flow, such as canalizing riverbeds with concrete, have worsened flood risks. Additionally, the city has observed an increase in extreme weather events, including thunderstorms, hailstorms, and tornadoes. Coastal flooding is becoming a growing concern, as storms combined with rising sea levels cause seawater to intrude into residential and commercial areas. Coastal flooding, particularly in low-lying areas like Bostanlı, Mavişehir, Karşıyaka, and Konak, is becoming more frequent due to rising sea levels and extreme weather events like storm surges and heavy rainfall. Studies reveals that the effect of sea level rise endangers areas such as the İzmir Bay, Kordon, and popular tourist destinations like Alaçatı and Sığacık. Additionally, the Gediz Delta Bird Sanctuary is at risk of submersion *(EKOIQ, 2023)*.

2.3 Risk Analysis

2.3.1 Extreme Precipitation

Table 2-3 Data overview workflow #1

Hazard data	Vulnerability data	Exposure data	Risk output
Projected increase in heavy rainfall events (e.g., 100 mm/24h return period changes)	*Infrastructure vulnerability: Schools, hospitals, and critical infrastructure are in areas with a ≥10% decrease in the return period of 100 mm/24hr event*	*Population & Infrastructure - Schools and hospitals*	*The risk map of Projected Changes in Return Period (Frequency) of 100mm/24hr event*

2.3.1.1 Hazard assessment

For this analysis, the EURO-CORDEX (EUR-11) climate projections at a 12km spatial resolution were utilized. The workflow was implemented for the region under two emission scenarios (RCP4.5 and RCP8.5). The analysis was conducted for the western part of Turkey (Aegean region), while the time series were specifically generated for İzmir city extent. The 30-year frames of daily precipitation data were used for the analysis. The selected timeframes are 1976-2005 (baseline or historic simulations) and 2041-2070 (mid-century).

The KNMI-RACMO22E regional climate model (RCM), *(KNMI , 2017))*,, driven by the ICHEC-EC-EARTH general circulation model (GCM), *(EC-Earth, 2014)* has been selected for analysis due to its ability to provide finer-scale simulations for the European region. Hazeleger et al. (2012) highlighted that the ICHEC-EC-EARTH model effectively captures large-scale climate variability in the Mediterranean region, including Turkey, accurately representing seasonal temperature patterns and the influence of major circulation systems. Additionally, Seddiqe et al. (2023) examined climate projections over the Marmara region of Turkey using RACMO22E, driven by ICHEC-EC-EARTH, under RCP4.5 and RCP8.5 scenarios. Their findings indicate that the model successfully simulates seasonal precipitation patterns.

Climate change projections indicate an increase in the frequency and intensity of extreme rainfall events in the region. This trend poses significant challenges for İzmir and a change in the 3-hr and 24-hr precipitation and return periods of events (i.e. 100-year) is significant for the region. The map of expected precipitation for 24hr duration for 100-year return period for historical (1976-2005) and future (2041-2070) for based on RCP4.5 (not shown) and RCP8.5 scenarios are presented in Figure 2-5.

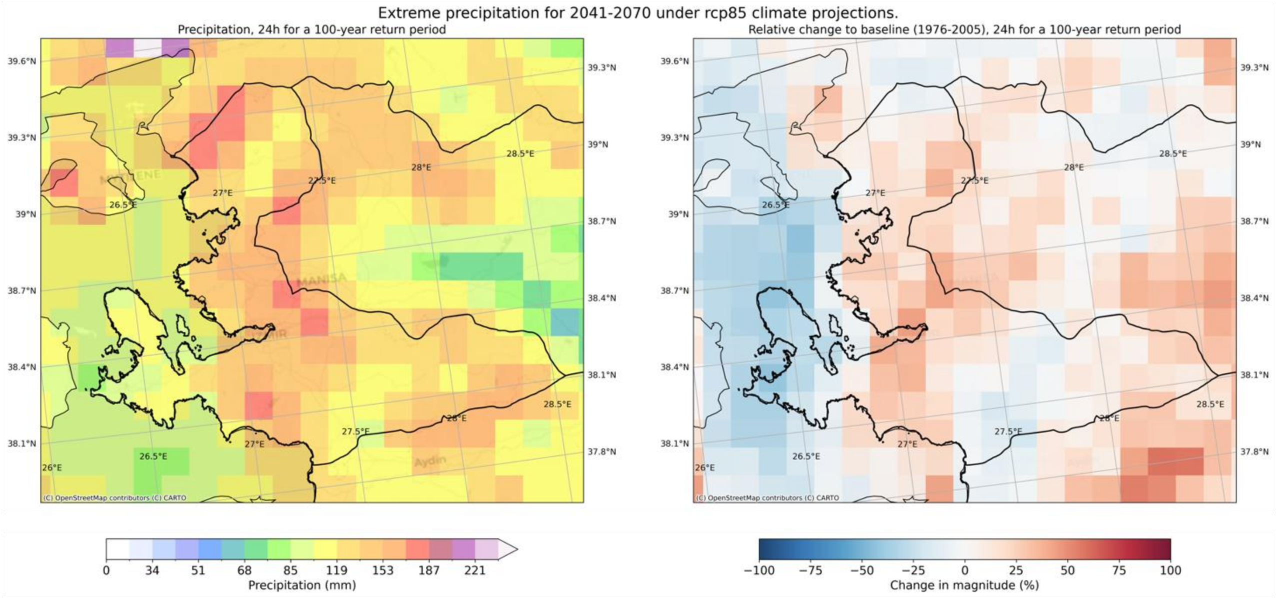

Figure 2-5 : The map of expected precipitation for 24hr duration for 100-year return period for historical (1976-2005) and future (2041-2070) periods in İzmir Region

The most pronounced increases in extreme rainfall are found in the **northeastern and southeastern** parts of İzmir, where precipitation is expected to rise by up to **25%**, signaling a substantial intensification of extreme weather events. In contrast, decreases of up to **25%** are observed in the **coastal and central-western areas**, including regions along the coastline, such as the popular **touristic destination of Çeşme**. This pattern indicates a shift in precipitation dynamics, with inland areas likely to experience more intense storms, while coastal regions may see a reduction in extreme rainfall events.

2.3.1.2 Risk assessment

In this region, extreme precipitation is defined by a 100 mm/24-hour rainfall threshold. This analysis focuses on how climate change may influence this critical limit, considering the rising frequency and impacts of such events. This analysis, covering all İzmir, aims to determine how climate change affects the return periods of the 100 mm/24-hour rainfall threshold. Figure 2-6 shows the current return periods for the 100 mm/24h rainfall threshold across İzmir, while the right map displays the expected return periods for the same threshold under the future climate scenario, RCP85 (2041-2070).

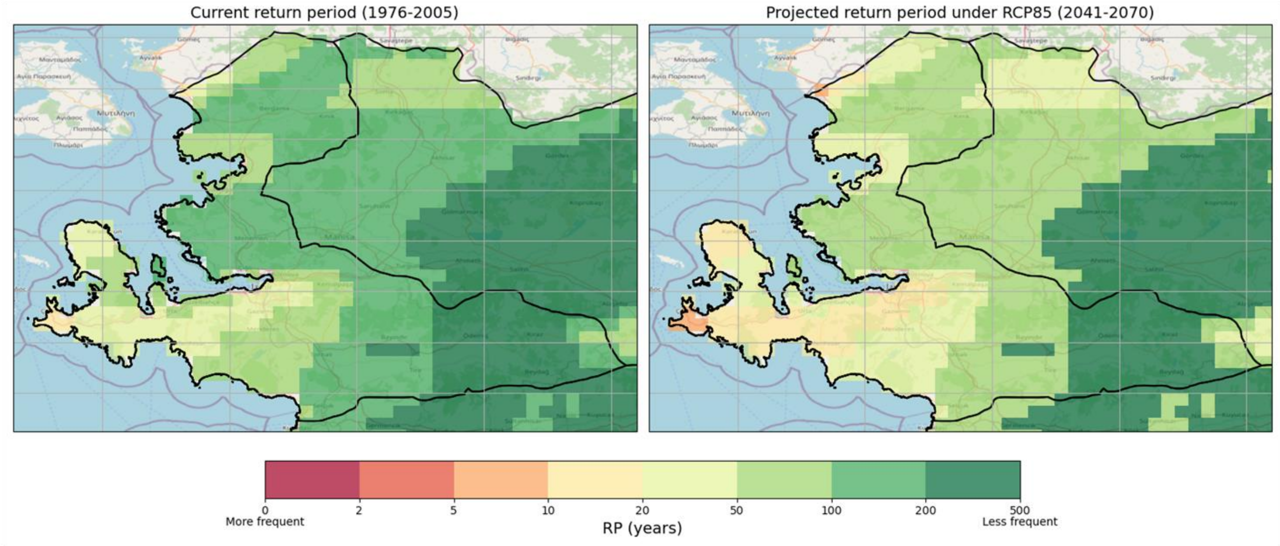

Figure 2-6 : Projected Changes in Return Period (Frequency) for 100mm/24h Events: 1976-2005 to 2041-2070 Model Chain: ICHEC-EC-Earth / RACMO22E | Scenario: RCP85

Future projections (2041-2070) under RCP8.5 shows a clear shift toward shorter return periods of the region, especially in the southern and coastal areas, where return periods decline nearly 50 years in many places. In coastal areas, a sharp decline in return periods was observed, with values dropping below 10 years. This means extreme precipitation events are expected to become far more frequent in these areas.

Figure 2-7 illustrates the percentage shift in precipitation within the İzmir region, highlighting the most significant changes in the frequency of 100 mm/24h events.

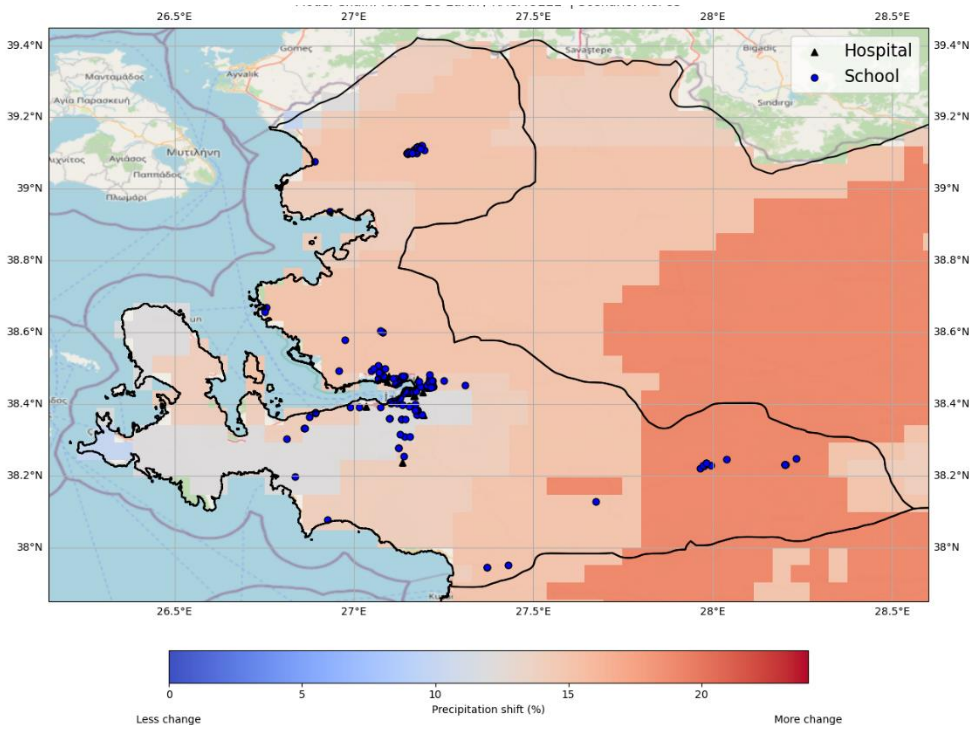

Figure 2-7 : Projected difference in return periods for 100mm/24h events in İzmir: 2041-2070 vs 1980-2010 Model Chain: ICHEC-EC-Earth / RACMO22E | left: RCP45 right: RCP85

In the RCP8.5 scenario, the return period for a 100mm/24h event decreases throughout the region. Coastal areas experience a 10% change, while inner regions experience up to a 20% decrease. This indicates that İzmir will face more frequent heavy rainfall events. Most schools and hospitals in the region are located where there is at least a 10% change in the return period for a 100 mm/24h event. This could lead to disruptions in education and healthcare services and potential damage to buildings in the future.

2.3.2 Heatwaves

Table 2-4 Data overview workflow #2

Hazard data	***Vulnerability data***	***Exposure data***	***Risk output***
Heatwave metrics such as frequency, average length, and total yearly heatwave days for the historical, and projected periods under RCP 4.5 and RCP 8.5. and Land surface temperature (LST) data from Landsat 8 Satellite	*Vulnerable population data (0-5 years and > 65 years)*	*Land Surface Temperature - areas that heat up most (UHI)*	*The heatwave risk map based on the exposure (LST - areas that heat up most) x vulnerability (density of vulnerable population).*

2.3.2.1 Hazard assessment

The heatwave hazard in İzmir City (27.16, 38.43) was evaluated using a workflow based on EURO-CORDEX EUR-11 (12km) climate projections from the KNMI-RACMO22E RCM (ICHEC-EC-EARTH GCM). The xclim library was used to define and calculate heatwave metrics *(Bourgault et al., 2023)*. Specifically, the frequency, average length, and total yearly days of heatwaves were determined for the historical (1976-2005) and projected (2006-2100) periods, under RCP 4.5 and RCP 8.5. Heatwaves were defined as periods of at least three days with daily maximum temperatures above 35°C and daily minimum temperatures above 20°C. The results of these calculations are visualized in Figure 2-8 (Number of the heatwave days and heatwave index are not shown).

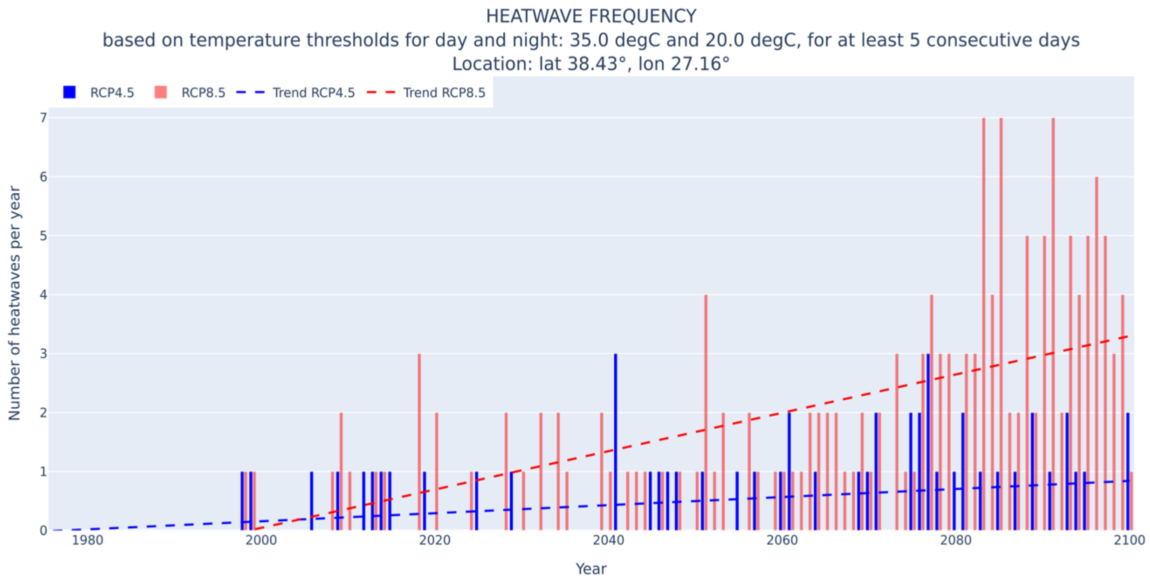

Figure 2-8 : Heatwave frequency based

The heatwave frequency projections for İzmir indicate a significant increase in the number of heatwaves per year throughout the 21st century, particularly under the **worst scenario. In the beginning of the century,** both **RCP4.5 and RCP8.5** scenarios show relatively few heatwaves per year, with minimal differences between them. However, as the century progresses, heatwave occurrences rise notably, especially under **RCP8.5**, where the frequency accelerates after **the mid-century** reaching 6-7 heatwaves per year. The results show that without mitigation measures, İzmir will experience **more frequent and prolonged extreme heat events.**

2.3.2.2 Risk assessment

Urban Heat Island (UHI) is a phenomenon where urban areas experience higher temperatures than their surrounding rural areas due to human activities, land cover changes, and urbanization and İzmir is significantly affected by the UHI effect. Therefore, the risk assessment workflow integrates Landsat8 Land Surface Temperature (LST) data with vulnerability population data to estimate the risk for the overheated areas *(Sayler, 2023).* The LST data is obtained for the period of 2022 to 2024 and only June and August months were selected. Final LST maps were produced taking the mean of all satellite data retrieved from this time *(Pezzuloet al., 2017).* The vulnerable population data were obtained from WorldPop data *(WorldPop, 2024)* for the age groups of 0-5 and > 65 in the region. Both LST and vulnerable population data were classified into 10 5 categories (Very low - Very high). Figure 2-9 shows LST (left) and the vulnerable population density in İzmir.

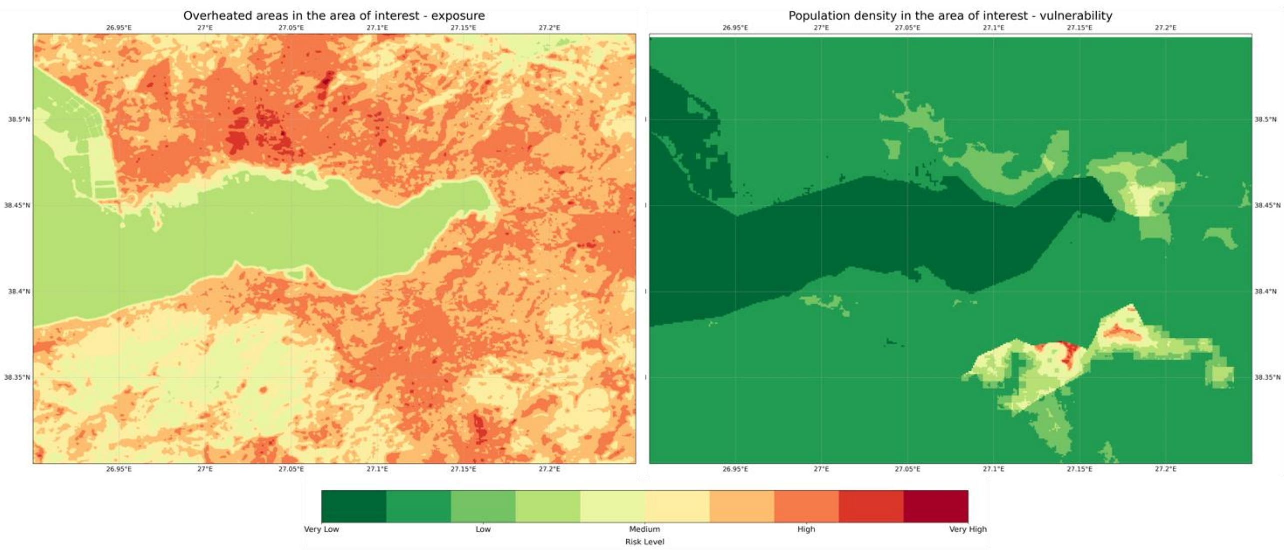

Figure 2-9 : LST (left) and vulnerable population density (right) maps in İzmir

The risk is based on the 10x10 risk matrix, which combines the LST with data from vulnerable population data. Figure 2-10 shows the heatwave risk map based on the exposure (LST - areas that heat up most) x vulnerability (density of vulnerable population).

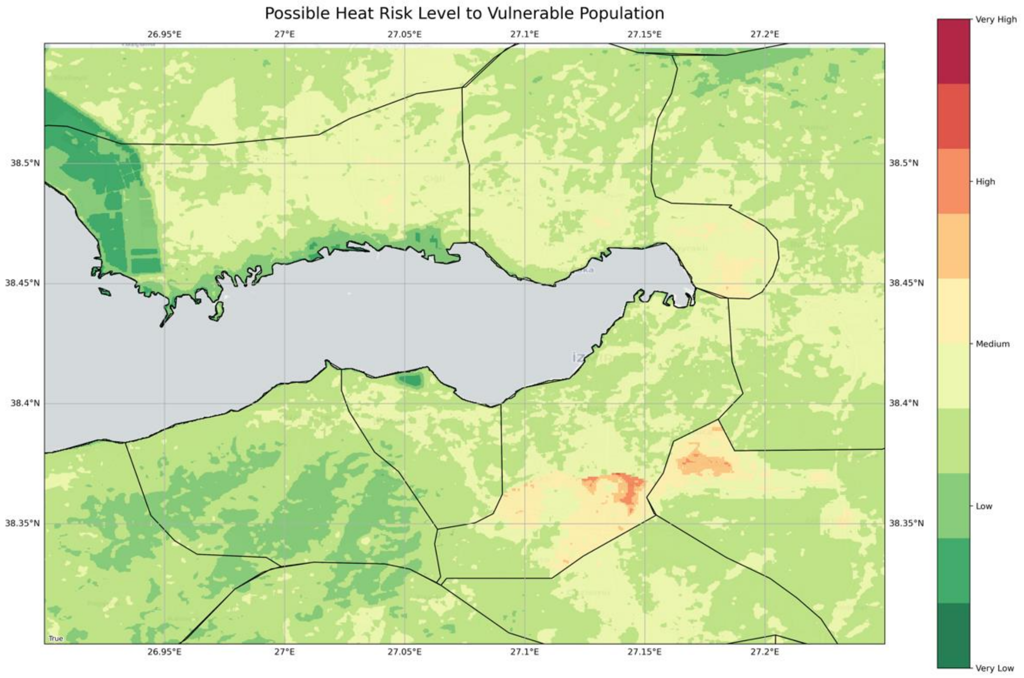

Figure 2-10 : Heatwave risk map to vulnerable population in İzmir

The western and coastal regions experience lower heat risk. In contrast, inland areas, the southern and southeastern parts of the city, show significantly higher risk. These areas have high population and urbanization densities, limited vegetation cover and more vulnerable groups, such as the young, elderly and people pre-existing health conditions. İzmir City continues to urbanize, the expansion of impervious surfaces without adequate measures (tree cover and reflective materials) will further amplify heat risks with the effect of the rising temperature due to the climate change in future. Without adaptation strategies, the combined effects of urbanization and climate change could make extreme heat one of the most pressing environmental hazards for İzmir's population.

2.3.3 Agricultural Drought

Table 2-5 Data Overview Agricultural Drought

Hazard data	Vulnerability data	Exposure data	Risk output
Precipitation deficit leading to yield loss in maize, wheat, sorghum, and barley. Daily mean precipitation, temperature, relative humidity, solar radiation, wind speed. Soil available water capacity, elevation, and thermal climate zone	*Share of cropland with irrigation systems.*	*Crop distribution and economic value data Global Agro-Ecological Zones (GAEZ).*	*Revenue losses from irrigation deficit expressed as 'lost opportunity cost' in thousand euros.*

2.3.3.1 Hazard assessment

In recent years, İzmir has experienced prolonged dry periods posing a threat to agricultural activities and potable water sources. Reduced precipitation, coupled with rising temperatures, has led to lower soil moisture levels and increasing the need for irrigation. Therefore, this workflow assesses the impact of water deficit on crop yields in İzmir region where the crucial crops for the dairy are maize, wheat, and potato. The EURO-CORDEX EUR-11 (12km) climate projections from the KNMI-RACMO22E RCM (ICHEC-EC-EARTH GCM) were used in this workflow of daily mean precipitation

flux, maximum and minimum temperature, 2 m relative humidity, surface downward solar radiation and 10 m wind speed as well as data on soil available water capacity *(Hengl et.al., 2019),* elevation *(Danielson et.al., 2011)* and thermal climate zone *(FAO et al., 2007).* The RCP4.5 (not shown) and RCP8.5 scenarios were evaluated for future periods, specifically focusing on two distinct time frames: 2046-2050 and 2066-2070.
In hazard assessment, the impact of precipitation deficits on yield loss for three key crops in the region is analyzed. Maize, wheat, and potato are the most important crops cultivated in the region, playing a crucial role in agriculture in İzmir. Figure 2-11 presents maize and wheat yield loss due to precipitation deficit in the region between 2046-2050 under the RCP8.5 scenario.

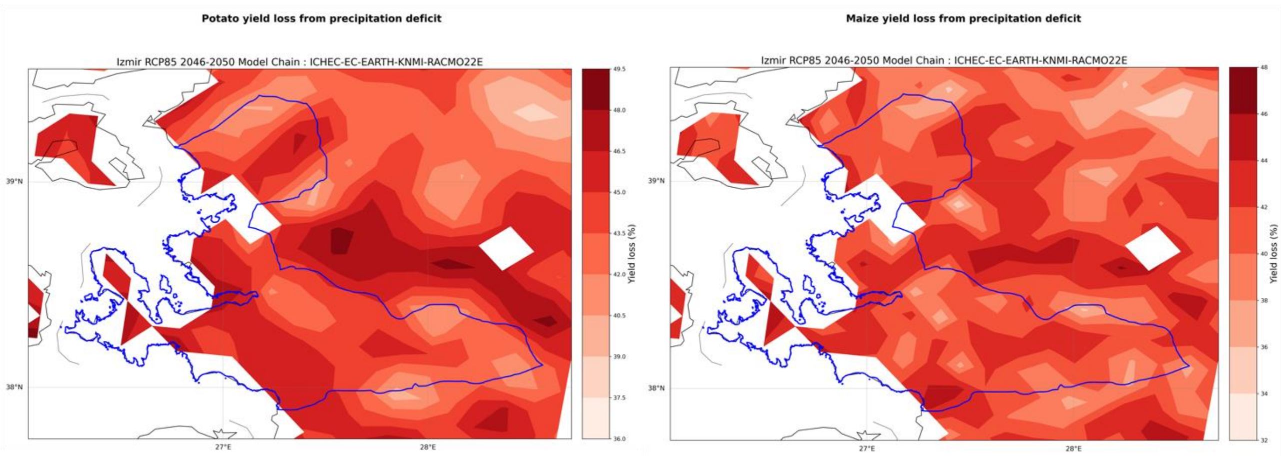

Figure 2-11 Potato (left) and Maize (right) yield loss from precipitation deficit in the region between 2046-2050 for RCP8.5 scenario.

For both maize and potato, the yield loss is projected to be substantial, and localized variations suggest differences in sensitivity to precipitation deficit. For **potato yield loss** approximately **40%** across the İzmir region is experienced. For **maize yield loss**, the yield reduction is slightly different but follows a similar pattern and loss is up to %50**.** Both maize and potato will experience severe yield reductions in İzmir due to precipitation deficits, with yield losses exceeding **40% in many areas**, posing a substantial challenge to future agricultural productivity in the region.

2.3.3.2 Risk assessment

The risk analysis the workflow is followed to investigate the potential revenue losses from irrigation deficit in İzmir region for the studied crops Losses are expressed as the 'lost opportunity cost' in thousands of euros if crops are grown under non-irrigated conditions. The maps also show the share of cropland in each grid-point with irrigation systems already implemented in 2010 as an indicator of vulnerability to rainfall scarcity. The Global production of crops from MapSPAM repository (International Food Policy Research Institute, 2019) and crop aggregated value [US$] from the FAO-IIASA Global Agro-Ecological Zones data repository (GAEZ) were used to determine the exposure of different crops to precipitation scarcity. Figure 2-12 presents potato and maize revenue loss due to precipitation deficit in the region between 2046-2050 under the RCP8.5 scenario.

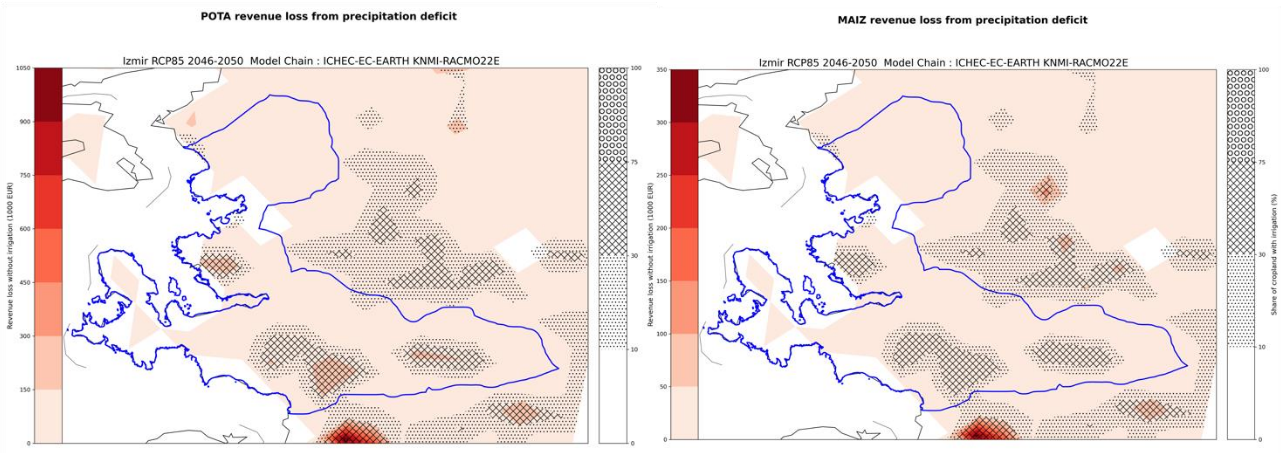

Figure 2-12 : Potato and maize revenue loss due to precipitation deficit in the region between 2046-2050 under the RCP8.5 scenario.

The map identifies regions where revenue losses are expected to be most severe, with some areas experiencing losses exceeding 1000 USD per hectare for potato and significant losses for maize. The highest financial impacts are primarily concentrated in the southern and southeastern parts of the region. In contrast, northern and coastal areas show relatively lower revenue reductions. Overall, the pattern indicates that precipitation deficits will lead to considerable economic losses, aligning with the trends observed in the yield loss maps.

2.3.4 Coastal Flooding

Table 2-6 Data Overview Coastal Flooding

Hazard data	*Vulnerability data*	*Exposure data*	*Risk output*
Statistical indicators derived from water level time series for different return periods (10, 50, 100, 200, 500 years) and NASA Sea Level Projection tool for future periods	*Global flood depth-damage functions (vulnerability curves) from JRC (Huizinga et al., 2017).*	*Land use/land cover map from JRC (LUISA Base Map 2018) for urban areas, agricultural fields, infrastructure, and water bodies.*	*Flood Risks to build infrastructure, flood and associated damages maps for extreme event in (5, 10,50 and 100 years)*

2.3.4.1 Hazard assessment

In the coastal flooding hazard workflow, a global dataset of statistical indicators derived from water level time series (ref) was utilized. This dataset provides extreme water levels for various return periods (5, 10, 50, and 100 years) relative to the mean sea level for the period 1979–2018 using reanalysis datasets. However, it only represents extreme water levels and does not account for the effects of sea level rise. To incorporate sea level rise projections, the NASA Sea Level Projection Tool was used to obtain data from the IPCC 6th Assessment Report (AR6). These projections, referenced to the 1995–2014 baseline, consist of multiple model outputs. In this workflow, the median values of these model outputs were selected. The analysis focused exclusively on the SSP5-8.5 scenario, assessing sea level rise by the year 2100. Extreme water levels for different return periods in İzmir coastal area were given in Table 2-7.

Table 2-7 Extreme water levels for different return periods in İzmir coastal area

Return Period	Extreme water level (m)
5	0.444
10	0.473
50	0.539
100	0.567

With extreme water levels reaching **0.567 m** for a 100-year return period, the risk of flooding is already significant under present-day conditions. However, these values only represent historical extremes and do not include the effects of sea level rise, which is expected to exacerbate coastal hazards. Sea level projections show 0.81 m rise in the region under the SSP5-8.5 scenario (median estimate). As a result, the additional rise in sea level will significantly amplify extreme water levels, posing serious risks to coastal infrastructure, urban areas, and overall flood resilience.

2.3.4.2 Risk assessment

Risk assessment was assessed to visualize risks to build infrastructure presented by coastal flooding in the region. The extreme water levels and additional sea level rise calculated in hazard workflow were used for potential water level rise. Land use/land cover maps developed and produced by the JRC (LUISA Base Map 2018, (Pigaiani et.al., 2021) were used for various types of urban areas, natural land, agricultural fields, infrastructure and waterbodies. Additionally, for risk analysis global flood depth-damage functions (vulnerability curves) were used by JRC *(Huizinga et al., 2017)*. The analysis was performed for 5-, 10-, 50- and 100-year return periods of extreme water levels in the region. Figure 2-13 show water depth maps for 1 in 100-year extreme events.

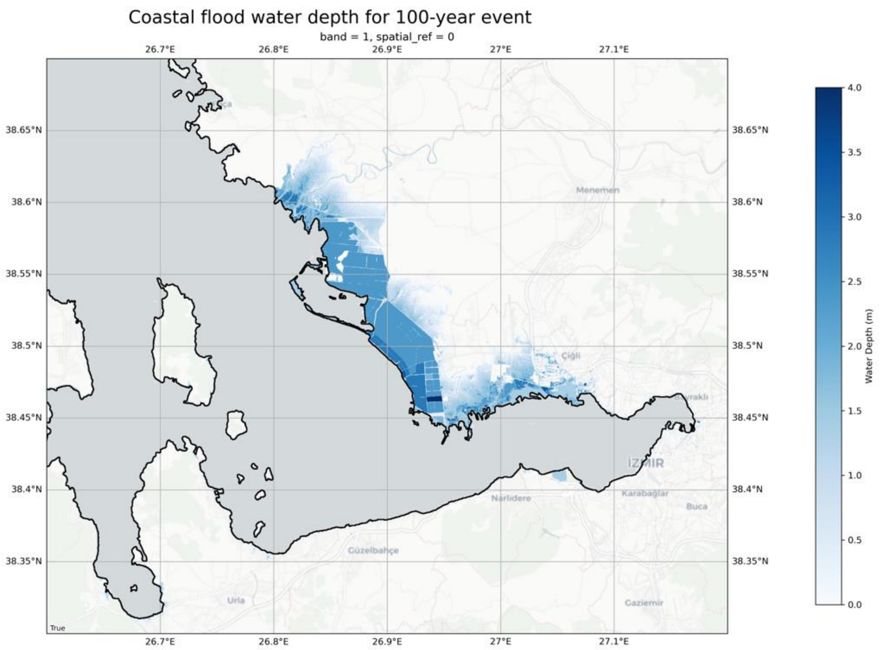

Figure 2-13 The water depth map of 1 in 100-year coastal flood event for SSP585 scenario in 2100 event in İzmir Metropolitan City

The effect of the coastal flooding on the infrastructure was assessed using the potential water depth map, flood depth-damage functions and land cover information. Figure *2-14* show flood damage for 1 in 100-year extreme event and land cover information in İzmir.

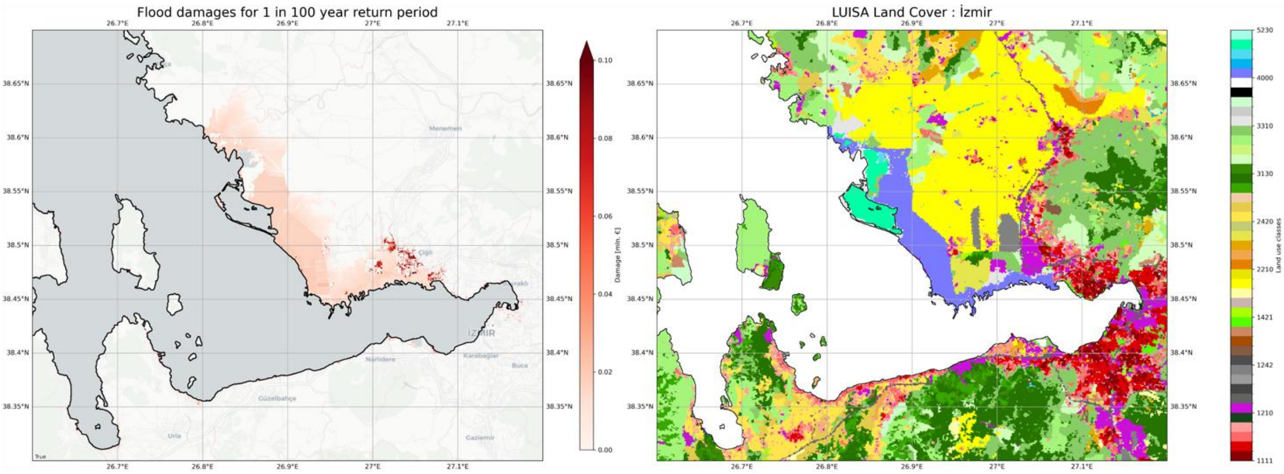

Figure 2-14 The flood damage map of 1 in 100-year coastal flood event for SSP585 scenario in 2100 event (left) and land cover classes in İzmir Metropolitan City

The analysis showed significant flood risks in low-lying coastal areas. The areas most affected by flooding and economic damages are concentrated around Çiğli and the northern coastal zones of İzmir, where urban development and infrastructure are highly exposed to rising water levels. Infrastructure such as **roads, ports, and industrial zones in Çiğli and Aliağa** could be significantly impacted by the flooding. Coastal areas closer to **Karşıyaka and İzmir city center** are affected to a lesser extent. The results indicates that densely populated and industrialized regions face higher financial losses due to flooding in İzmir.

2.4 Preliminary Key Risk Assessment Findings

2.4.1 Severity

The hazard and risk analysis indicates that İzmir is vulnerable to multiple climate-related hazards, including heavy rainfall and coastal flooding, agricultural drought, heatwaves. These hazards pose significant threats to both urban and rural areas, leading to infrastructure damage, disruptions in water and food security, and economic losses.

Among the risks, heatwaves pose the greatest threat to the region, with rising temperatures and prolonged extreme heat events expected to have severe consequences for public health, agriculture, and infrastructure. The combination of high urbanization and the urban heat island effect further intensifies the impact, particularly in densely populated areas. Additionally, increased energy demand for cooling may increase this effect on resources, making heatwaves the most pressing climate-related challenge for İzmir in the coming decades.

2.4.2 Urgency

Compared to other hazards, heatwaves require urgent adaptation measures in the short term, as their frequency and intensity are already increasing and are projected to worsen in the future. Increasing the urban green spaces, improving building insulation and cooling efficiency and strengthening healthcare response plans are critical to mitigating the risks. Heatwaves represent İzmir's primary climate challenge, threatening widespread health, economic, and infrastructural disruption without immediate and robust adaptation measures.

2.4.3 Capacity

İzmir has developed substantial capacity for climate adaptation through collaboration with local, national, and international stakeholders. The city actively participates in global initiatives like the Horizon 2020 program and CLIMAAX projects, aligning local efforts with the EU Green Deal and the Paris Agreement. Through multi-sectoral stakeholder engagement, İzmir has strengthened technical and institutional capacities to address climate risks, enhance resilience, and implement sustainable adaptation strategies.

2.5 Preliminary Monitoring and Evaluation

The first phase of the climate risk assessment provided valuable insights into the vulnerabilities of İzmir yet also revealed several challenges. One of the primary difficulties encountered was the lack of high-resolution, location-specific data, especially regarding socio-economic vulnerabilities and localized climate impacts. While comprehensive data was available at the provincial and metropolitan levels, neighborhood-specific assessments faced limitations due to data gaps and variability in data quality. Furthermore, integrating feedback from diverse stakeholders proved challenging, as their perspectives on priority risks and adaptation measures varied significantly.

Stakeholder feedback emphasized the need for more inclusive and continuous engagement processes to ensure that all relevant groups are adequately represented in the assessment. Some stakeholders expressed the importance of incorporating additional local actors, particularly those involved in critical infrastructure and community-based organizations. This will ensure that the next iteration of the assessment better reflects ground-level realities and practical implementation challenges. Since the initial assessment, new data has become available, including updated climate projections and enhanced datasets on urban heat islands and flood risks. However, there remains a need for more granular data on social vulnerabilities and infrastructure resilience, as well as improved analytical tools to model compound risks. To further strengthen risk understanding, future assessments should incorporate more interdisciplinary research, enhanced data collection efforts, and capacity-building initiatives for stakeholders.

3 Conclusions Phase 1- Climate risk assessment

The CRIZ-ERS project has made substantial progress in enhancing İzmir's adaptive capacity to climate change by conducting comprehensive risk assessments and proposing targeted adaptation interventions. The project successfully identified the most vulnerable sectors and developed tailored strategies to address critical risks, including agriculture, energy, tourism, manufacturing, healthcare, water management, cultural heritage, and urban infrastructure. Through an inclusive stakeholder engagement process, valuable insights were gathered, promoting a collaborative approach to climate resilience planning.

Despite these achievements, several challenges remain. One of the primary issues encountered was the lack of high-resolution, location-specific data, which posed difficulties in accurately assessing localized vulnerabilities. Additionally, integrating diverse stakeholder perspectives and ensuring continuous collaboration proved challenging in some instances. Addressing these gaps requires further capacity-building efforts and improved data collection practices to enhance the robustness of future assessments.

The key findings indicate that climate risks in İzmir are highly interconnected, requiring an integrated, multi-sectoral approach to adaptation planning. The development of sector-specific interventions, such as enhancing green and blue infrastructure, promoting sustainable urban planning, and improving disaster response capacities, will be crucial for building long-term resilience. Moving forward, the project will continue to leverage stakeholder feedback, integrate emerging data, and align local strategies with international frameworks such as the EU Green Deal and Horizon 2020 to maintain progress toward a climate-resilient İzmir.

4 Progress evaluation and contribution to future phases

In Phase 1 of the CRIZ-ERS project, preliminary analyses were conducted to identify primary climate risks affecting İzmir, such as extreme precipitation, heatwaves, agricultural drought, and coastal flooding, focusing on key sectors such as agriculture, energy, tourism, manufacturing, health, water management, cultural heritage, and urban infrastructure. This phase allowed for a comprehensive assessment of how these risks could affect various stakeholders, providing a basis for developing targeted adaptation strategies to enhance urban resilience.

An essential component of this phase was the stakeholder engagement meetings, held to validate findings and gather localized data. These meetings involved a diverse range of participants, including public institutions, private sector representatives, academic experts, civil society organizations, and local communities. The primary objective of these meetings was to cross-check the preliminary risk assessment with real-world conditions, ensuring that the analysis accurately reflects local realities and sector-specific challenges. Stakeholders provided valuable insights into vulnerabilities, adaptive capacities, and existing practices, which significantly enhanced the accuracy of the climate risk models.

To maximize stakeholder engagement, targeted questions were posed regarding climate impacts on critical infrastructure, community health, energy demands, agricultural productivity, and the vulnerability of cultural assets. Additionally, discussions explored existing adaptation measures already in practice and potential areas for improvement. The data and feedback collected during these meetings directly informed the development of localized adaptation strategies, fostering more resilient and context-specific solutions for climate risk management. Following the completion of Phase 1, the project will transition to Phase 2, where the focus will shift to developing detailed adaptation and risk management strategies based on the validated data and stakeholder input. These strategies will be tailored to address the most critical risks identified, ensuring practical and sustainable solutions to improve İzmir's climate resilience.

According to the technical specifications of the project, dissemination activities were planned to be conducted during Phase 1. However, due to unforeseen challenges and prioritization of other critical tasks, dissemination could not be carried out in this phase. To address this gap, comprehensive dissemination efforts are scheduled to take place during Phase 2.

Table 4-1 Overview key performance indicators

Key performance indicators	***Progress***
Multi-risk climate assessment successfully conducted by the end of Phase 1.	*Achieved*
Local data integration completed to refine the multi risk climate assessment by Phase 2.	*Phase 2*
Climate adaptation strategy developed and implemented by the end of Phase 3.	*Phase 3*
Workshop; conducted for stakeholders, including lead farmers, policymakers, relevant agricultural organizations, sector stakeholders, and local government representatives, to increase climate risk awareness and participation.	*Phase 2*
Policy Note; developed and shared with local governments to incorporate climate resilience into regional planning.	*Phase 2*
Scientific Article; published based on project findings to contribute to academic research.	*Phase 3*

Key performance indicators	*Progress*
Policy Brief; developed and shared with local governments to guide climate adaptation measures.	*Phase 2*
Press Release; issued to increase public awareness and highlight project progress and results.	*Phase 2*
Training Session; for agricultural consultants to enhance their capacity to support farmers in climate adaptation strategies.	*Phase 2*
Stakeholder Congress; organized to disseminate the project results and foster collaboration among key participants.	*Phase 3*

Table 4-2 Overview milestones

Milestones	*Progress*
M1: Completion of the multi-risk climate assessment by the end of Month 6.	*Achieved*
M2: Successful integration of local data into the climate assessment by the end of Month 16	*Phase 2*
M3: Workshop for stakeholders (including lead farmers, policymakers, agricultural organizations) completed by Month 16.	*Phase 2*
M4: Training session for agricultural consultants completed by Month 16.	*Phase 2*
M5: Policy Note developed and shared with local governments by Month 16.	*Phase 2*
M6: CLIMAAX workshop in Barcelona attended in June 2025	*Phase 3*
M7: Climate adaptation strategy developed and implemented by Month 22.	*Phase 3*
M8: Scientific article based on project findings submitted for publication by Month 21.	*Phase 2*
M9: Stakeholder Congress conducted by Month 21, bringing together 100 participants to discuss project results and foster collaboration.	*Phase 2*
M10: CLIMAAX workshop in Brussels attended in Dec 2026 to present final project results to policy and decision-makers.	*Phase 3*

5 Supporting documentation

The additional documents and datasets have been uploaded to the Zenodo platform (*https://doi.org/10.5281/zenodo.15105769*). The content of the files are as follows:

- Main Report (PDF or Word)

Visual Outputs (infographics, maps, charts)

- Heavy Rainfall (extreme precipitation) Workflow (Maps and Graphs)
  - Hazard Workflow Outputs
  - Risk Assessment Outputs
- Heatwaves Workflow (Maps and Graphs)
  - Hazard Workflow (xclim) Outputs
  - Risk Assessment (UHI) Outputs
- Agricultural Drought (Maps and Graphs)
  - Hazard Workflow Outputs
  - Risk Assessment Outputs
- Coastal Flooding (Maps and Graphs)
  - Hazard Workflow Outputs
  - Risk Assessment Outputs

Datasets Collected

- İzmir region boundary

Press Release

6 References

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