Deliverable Phase 1 – Climate risk assessment

Mersin Climate Ready: Multi-Risk Assessment for Urban, Coastal, and Rural Resilience (MCR-RA)

Türkiye, Mediterranean Region / Mersin Metropolitan Municipality

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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 harmonized Climate Risk Assessment approach

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Document Information

Deliverable Title	Phase 1 – Climate risk assessment
Brief Description	The first deliverable of the MCR-RA project presents the implementation of the CLIMAAX methodology for multi-risk climate assessment in Mersin. It includes the first analysis of heatwave, drought, flood, and wildfire risks to support regional adaptation planning.
Project name	Mersin Climate Ready: Multi-Risk Assessment for Urban, Coastal, and Rural Resilience (MCR-RA)
Country	Türkiye
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1.0	02/09/2025	Mersin Metropolitan Municipality	Final version

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Abbreviations and acronyms

Abbreviation / acronym	Description
AFAD	Turkish Disaster and Emergency Management Authority
B4P	Built4People (Horizon Europe Partnership on Sustainable Buildings)
CCAP	Climate Change Action Plan
CDP	Carbon Disclosure Project
CDS	Copernicus Data Store
CLIMAAX	Climate Adaptation and Risk Assessment Methodology
CORDEX	Coordinated Regional Climate Downscaling Experiment
ÇŞİDB	Ministry of Environment, Urbanization, and Climate Change
DRMKC	Disaster Risk Management Knowledge Center
ET_0	Reference Evapotranspiration
EUROHEAT	A European project for heat-health risk analysis (WHO/EU-wide)
GAEZ	Global Agro-Ecological Zones
GCM	Global Climate Model
GCoM	Global Covenant of Mayors for Climate and Energy
GIS	Geographic Information System
HDD/CDD	Heating Degree Days / Cooling Degree Days
IMS	Institute of Marine Sciences, Middle East Technical University
MapSPAM	Spatial Production Allocation Model (global dataset of crop area, yield, and production at ~10 km resolution)
METU CLIMATE	METU Center for Climate Change and Sustainability Policy
LST	Land Surface Temperature
MGM	Turkish General Directorate of Meteorology
MLGP	Multi-Level Governance Platform (EU4ETTR project context)
MMM	Mersin Metropolitan Municipality
NUTS	Nomenclature of Territorial Units for Statistics
RCP	Representative Concentration Pathways
SECAP	Sustainable Energy and Climate Action Plan
SPEI	Standard Precipitation Evaporatıon Index
SSP	Shared Socioeconomic Pathways
UHI	Urban Heat Island
UTCI	Universal Thermal Comfort Index
WASP	Weighted Anomaly of Standardized Precipitation
WP	Work Package

Executive summary

This deliverable presents the results of **Phase 1 of the Mersin Climate Ready project (MCR-RA)**, which applies the CLIMAAX methodology to establish a transparent and comparable baseline of multi-hazard climate risks for Mersin Metropolitan Municipality. The assessment focuses on **heatwaves, drought (relative and agricultural), wildfires, heavy rainfall, and coastal flooding**, reflecting Mersin's status as one of the four most climate-vulnerable provinces in Türkiye, with a composite climate risk score of **17/20** (Bütün Bayındır G.D., 2022).

Motivation

Mersin's Mediterranean location, dense urban centres, 835000 hectares of forest land, and highly productive agricultural plains make it particularly exposed to climate extremes. Intensifying heat, reduced rainfall, and increasing wildfire danger pose significant risks to public health, food security, ecosystems, and infrastructure. This deliverable was developed to quantify these risks, identify vulnerable groups, and provide the foundation for future adaptation strategies.

Main Results and Findings

- **Heatwaves**: Apparent-temperature heatwave days is projected to more than double, reaching ~37 days annually by 2050 (RCP8.5). Central districts, such as Toroslar, Akdeniz, and Yenişehir, face significant urban heat island effects, exposing elderly residents, refugees (~200,000), and outdoor workers to high health risks.
- **Drought**: Precipitation is projected to decrease by ~20% while evapotranspiration may double, leading to a 100% increase in irrigation demand. Without irrigation, yield losses are expected to reach 42% for bananas, 32% for lemons, 40% for grapes, and 45% for tomatoes.
- **Wildfires**: Fire Weather Index values are already exceeding extreme thresholds and may continue to do so for up to 150 days annually by 2050. Rural districts such as Gülnar and Mut are identified as hotspots where settlements directly border forests.
- **Floods**: 130-140 mm/24hr in 10-year return period is expected in most areas in Mersin, with 25-50% increase from the current situation, overwhelming existing storm water collection system in city centre. Coastal flooding risk, on the other hand, will remain relatively limited, with localized impacts in Silifke.

Contribution and Next Steps

Phase 1 established the **analytical and institutional foundation** for Mersin's resilience journey. It strengthened cooperation among municipal departments, universities, NGOs, and community representatives, while integrating CLIMAAX workflows into local decision-making processes.

- **Phase 2** will refine results using high-resolution datasets (e.g., LiDAR coastal maps, updated crop revenue data, socioeconomic vulnerability surveys).
- **Phase 3** will translate findings into a co-designed Climate Resilience Strategy, Action Plan, and Investment Plan, aligned with Mersin's SECAP and Türkiye's forthcoming Climate Law.

Phase 1 has delivered a **robust, evidence-based baseline** that enables informed decision-making and positions Mersin as a **demonstrator of climate resilience in the Mediterranean region**.

1 Introduction

1.1 Background

Mersin is a major metropolitan city located on Türkiye's Mediterranean coast, covering an area of 15,853 km² with a population of nearly 2 million. It combines dense urban centres, extensive agricultural land, and a 321 km-long coastline, making it one of the country's most diverse and climate-exposed provinces. Over 53% of its territory is forestland, while the Çukurova plain makes the region a critical agricultural hub for citrus, bananas, olives, and greenhouse vegetables. The city also hosts Türkiye's largest container port and significant tourism assets.

Mersin's geography and socio-economic structure increase its climate sensitivity. The city faces the combined risks of **heatwaves, drought, floods, wildfires, and coastal hazards**, ranking among the four most climate-vulnerable provinces in Türkiye. Average annual precipitation is around 600–650 mm, but evapotranspiration already exceeds 1300 mm, projected to rise to 2500 mm by 2050. Irrigation water demand is therefore expected to double, threatening agricultural productivity. Urban heat island effects are strong due to rapid construction, limited green space (2.86 m² per capita), and high humidity. Forest fire risk is extreme in rural districts, such as Gülnar and Mut, while coastal districts face exposure to floods and sea level rise.

Climate projections highlight worsening trends:

- **Heatwaves:** Frequency projected to increase from ~18 days today to ~37 days per year by 2050 under RCP8.5.
- **Drought:** Agricultural drought risk projected to intensify, with yield losses of up to 32% for citrus and 42% for bananas in irrigation deficit conditions.
- **Wildfires:** Fire Weather Index (FWI) regularly exceeds 30 in summer, with >40 critical fire danger days projected by 2050.
- **Floods and Coastal Risks:** 24-hour extreme rainfall (currently ~140 mm) is projected to increase by 25–50%, while low-lying coastal areas are at risk from sea level rise by 2050.

These hazards intersect with vulnerable groups, including ~200,000 refugees, ~300,000 earthquake-affected residents, elderly populations, children, small-scale farmers, fishermen, and low-income urban households. Climate change, therefore, poses risks not only to public health and ecosystems but also to food security, livelihoods, and Mersin's critical infrastructure.

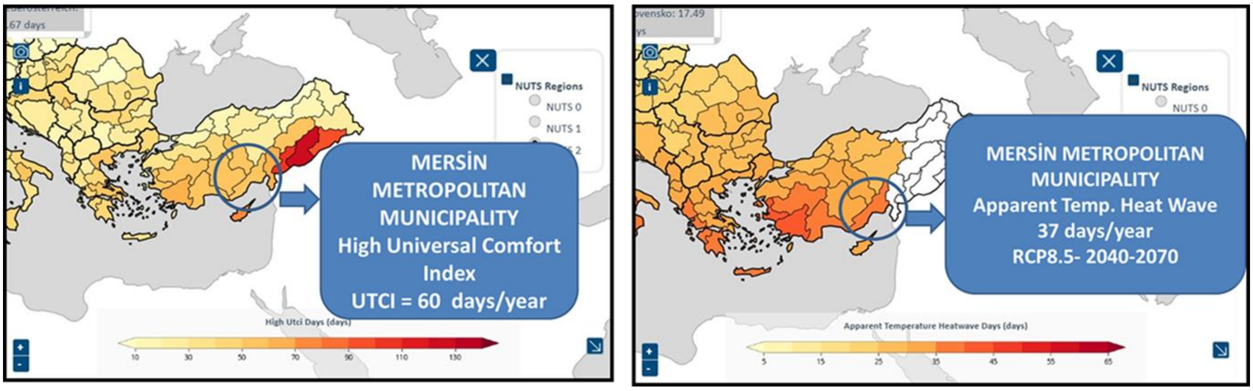


Figure 1-1 Geographic Location of Mersin and thermal stress in the region[1]

[1] https://climate-adapt.eea.europa.eu/en/metadata/indicators/apparent-temperature-heatwave-days

1.2 Main objectives of the project

The Mersin Climate Ready project (MCR-RA) applies the CLIMAAX methodology to deliver a multi-risk climate assessment across urban, coastal, and rural systems. The objectives are:

1. **Assess priority hazards** (heatwaves, droughts, wildfires, heavy rainfall and coastal floods) using open-source methods and workflows described in the CLIMAAX Handbook. The main objective is to develop a data-driven understanding of these risks and translate this knowledge into localized, evidence-based climate adaptation actions.
2. **Identify vulnerable populations and sectors**, including agriculture, forestry, tourism, urban infrastructure, and critical services.
3. **Strengthen adaptive capacity** by integrating results into Mersin's SECAP (Sustainable Energy and Climate Action Plan) and municipal strategies.
4. **Produce decision-support tools** (risk maps, datasets, and knowledge outputs) for municipal planners and stakeholders.
5. **Prepare for Phases 2 and 3**, where refined local data, high-resolution modelling, and co-designed adaptation strategies will be developed.

Applying the CLIMAAX Handbook ensures comparability with other European regions, improves data-driven planning, and connects Mersin to the European resilience community. The project also supports policy alignment with Türkiye's forthcoming Climate Law and EU Missions (Adaptation and Cities), positioning Mersin as a demonstrator of Mediterranean climate resilience.

During Phase 1, these objectives have already been **tested and validated in practice through stakeholder engagement**. In a dedicated stakeholder meeting, the project team presented the **wildfire workflow results**, which clearly illustrated the extreme risks faced by the **Gülnar and Mut districts and other rural municipalities where residential areas are located adjacent to forests**. Local representatives, including municipal officials and community organizations, emphasized the urgency of addressing wildfire risks and supported the integration of risk maps and early warning systems into their planning processes. This engagement demonstrated that the CLIMAAX approach is not only a scientific framework but also a **powerful communication and decision-support tool** for stakeholders, increasing ownership and awareness of adaptation priorities.

1.3 Project team

The project is led and implemented by the Mersin Metropolitan Municipality (MMM) through its Climate Change and Zero Waste Department, which is responsible for overall coordination, stakeholder engagement, and integrating results into municipal strategies and policies. Atalay Climate Consulting provides technical and methodological support, including workflow execution, stakeholder facilitation, and preparation of deliverables.

Table 1-1 Project Management and Core Team

Name	*Department*	*Expertise*	*Assignment in MCR-RA*	*Working Frequency*
Dr. Zafer Kuşatan	Climate Change and Zero Waste Dept.	Climate Change and Renewable Energy Division Manager	Project Manager (Contact Person), overseeing administrative work	High
Dr. İhsan Topallı	Climate Change and Zero Waste Dept.	Electrical and Electronics Engineer	CLIMAAX workflows' operations, workflow code adjustments, data transfer, and output analysis	Very High

Name	*Department*	*Expertise*	*Assignment in MCR-RA*	*Working Frequency*
Nursel Cansu Kaya Beyza A. Tor Bölükbaş	Climate Change and Zero Waste Dept.	Environmental Engineers	Local data collection, scheduling meetings, official documentation and reporting	Very High
Tamer Atalay	Atalay Climate Consulting	Environmental Engineer	CLIMAAX Handbook/Climatological training, result interpretation, and reporting.	High

In addition, scientific and institutional knowledge is being leveraged through collaboration with universities and organizations such as Mersin University, Tarsus University, and METU (Centre for Climate Change and Sustainability Policy – İKLİM, Institute of Marine Sciences – IMS), which contribute data, expertise, and feedback as relevant. Civil society groups such as the TEMA Foundation, farmer cooperatives, and representatives of vulnerable groups are engaged through workshops and consultations.

This setup ensures that MMM remains the single accountable institution for the project, while leveraging technical consultancy and stakeholder engagement to maximize the quality and impact of the climate risk assessment.

1.4 Outline of the document's structure

This deliverable follows the CLIMAAX template, presenting the Phase 1 results for Mersin:

- **Introduction:** Provides background, objectives, project team, and structure.
- **Climate Risk Assessment – Phase 1:** Details scoping, risk exploration, workflow selection, risk analysis, and preliminary findings.
- **Conclusions:** Summarizes outcomes of Phase 1 and implications for Mersin's climate resilience strategy.
- **Progress Evaluation and Future Contribution:** Reviews key performance indicators and outlines next steps for Phases 2 and 3.
- **Supporting Documentation:** Lists datasets, maps, and materials produced during Phase 1.

2 Climate risk assessment – phase 1

2.1 Scoping

The scoping process in Mersin is focused on:

- *Addressing the most significant climate hazards:* ***heatwaves, drought, floods (pluvial & coastal), and wildfires****.*
- *Defining the governance and policy context that will influence risk management strategies.*
- *Engaging municipal departments, district municipalities, community representatives, NGOs, universities, and vulnerable groups to foster a collaborative and evidence-based approach to adaptation.*

2.1.1 Objectives

Mersin Metropolitan Municipality (MMM) has established a long-term vision to enhance resilience to climate change while reducing emissions, aligning with Türkiye's 2053 net-zero target. To achieve this vision, MMM has adopted and begun implementing a **Sustainable Energy and Climate Action Plan (SECAP, 2024)**, structured around mitigation, adaptation, and energy poverty reduction.

The **Mersin Climate Ready (MCR-RA)** project addresses gaps in previous qualitative risk assessments by applying the **CLIMAAX common methodology** to deliver a quantitative, localized and science-based climate assessment. Until now, assessments have been fragmented and lacked sufficient spatial/temporal resolution, as well as integration of stakeholder perspectives. MCR-RA provides a standardized evidence base that can directly inform municipal decision-making and EU-aligned climate planning.

Objective, Purpose, and Expected Outcome

- **Objective:** Apply the CLIMAAX methodology for multi-risk assessment at the provincial (NUTS3) level, supporting Mersin's transition towards a climate-resilient Mediterranean city.
- **Purpose:** Generate high-resolution, data-driven, evidence-based insights into multi-hazard climate risks to guide adaptation planning and financing.
- **Expected Outcomes:**
    1. Enhanced understanding of Mersin's climate risks (heatwaves, drought, wildfires, heavy rainfall and coastal floods).
    2. Identification of vulnerable groups (elderly, children, refugees, earthquake-affected residents, farmers, fishermen, low-income households).
    3. Support for policy development and integration of risk assessment results into local plans (SECAP, land use planning, disaster risk strategies).
    4. Strengthened stakeholder engagement through training and dissemination activities.

Contribution to Policy and Decision-Making

The findings will directly support Mersin's Climate Change and Zero Waste Department and sectoral directorates in shaping strategies for:

- **Urban planning & public health** → urban heat mitigation, cooling infrastructure, social protection for vulnerable groups.
- **Agriculture & water management** → irrigation demand management, drought-resilient crops, MESKI's water resource planning.

- **Disaster risk management** → integration with AFAD's Integrated Disaster Risk Reduction Plan (IRAP).
- **Coastal protection & marine resilience** → supporting METU-IMS and port authorities in addressing sea level rise and storm surge.

Challenges and limitations

1. **Data Availability:** The lack of Türkiye-specific datasets, such as a national heatwave definition and limited historical max daily rainfall intensity data. Several recalculations are needed due to bugs and the adoption of more recent MapSPAM data in agricultural drought. Additionally, the crop coefficients of the most important regional crops (banana, lemon, grape, and tomato) were not included in the workflow's crop table. This challenge was coped with by modifying the crop table with **region-specific** crop coefficients[2]. Additionally, some code modules required adaptation to suit local needs.
2. **Stakeholder Engagement:** Coordination across a large metropolitan area and rural districts (13 districts in total) is challenging.
3. **Resource Constraints:** Limited technical staff in MMM's climate department; reliance on external consultancy for workflow implementation.
4. **External Influences:** Regional/national projects (Pathways2Resilience, Horizon Europe partnerships) will influence prioritization and funding.

2.1.2 Context

Assessment and Management of Climate Hazards in Mersin

Mersin has long faced multiple climate hazards — extreme heat, drought, flash floods, coastal flooding, and forest fires — due to its Mediterranean climate, urban density, and extensive rural and coastal ecosystems. The municipality has committed to **GCoM,** implemented its **SECA**P and **Climate Change Risk and Vulnerability Assessment (2024)**[3] and makes annual **CDP reporting**[4] **(A-rating in 2024),** related with climate risk assessment and adaptation actions. However, these qualitative assessments lacked sufficient data analysis, spatial resolution, and stakeholder validation. The MCR-RA project builds on this foundation by applying the CLIMAAX methodology, delivering a standardised, quantitative, and participatory risk assessment that aligns with EU and national frameworks.

Problem Statement and Broader Development Context

The Climate Change Risk and Vulnerability Assessment (2024) has prioritised heatwaves, drought, wildfires, and heavy rainfall hazards as the most significant climate risks, exposing sectoral vulnerabilities in public health, agriculture and food security, water scarcity, stormwater collection capacity, and the protection of forestland and residential areas. Vulnerability stems from the combination of:

- High exposure to **Mediterranean climate extremes** (heat, drought, flash floods, wildfires).

[2] https://www.tarimorman.gov.tr/TAGEM/Belgeler/yayin/Tu%CC%88rkiyede%20Sulanan%20Bitkilerin%20Bitki%20Su%20Tu%CC%88ketimleri.pdf

[3] https://www.mersin.bel.tr/uploads/files/mersinmmclimatechangeriskvulnerabilityassessmentreport77813272-23330.pdf

[4] www.cdp.net

- A large and diverse population (~2 million), including ~200,000 refugees and ~300,000 earthquake-affected residents.
- Economic dependence on **agriculture** (citrus, bananas, olives), with irrigation water demand projected to double by 2050.
- **Urbanization pressures**, with green space availability at only 2.86 m² per capita.
- Extensive **forest cover (835000 ha, 53% of territory),** making rural areas highly exposed to wildfire.
- Strategic **port infrastructure and coastal assets**, vulnerable to flooding and sea-level rise.

Governance Context

Mersin Metropolitan Municipality established its Climate Change and Zero Waste Department in 2022, responsible for implementing the Sustainable Energy and Climate Action Plan (SECAP)[5] and coordinating adaptation policies. Sectoral responsibilities are shared with:

- MESKI (Mersin Water Utility) – water supply and wastewater.
- AFAD (Disaster and Emergency Management Authority, Provincial Office) – disaster preparedness and emergency response.
- Directorates of Agriculture, Health, and Social Services – sectoral adaptation.

At the national level, climate action is guided by:

- Türkiye's National Climate Change Adaptation Strategy and Action Plan (2024–2030).
- The forthcoming Climate Law (2025), which will establish Climate Coordination Boards at the provincial level.
- Integrated Disaster Risk Reduction Plan (IRAP) of AFAD.
- Zero Waste Law, which also strengthens circular economy initiatives.

Internationally, Mersin is a signatory of the Global Covenant of Mayors (2023), participates in ICLEI, and is engaged in CLIMAAX, ensuring methodological alignment with EU climate resilience programmes.

Relevant Sectors and Potential Impacts of Climate Change

- Agriculture: Projected yield losses of up to 40–45% for citrus and bananas under irrigation deficit.
- Forestry & Wildfires: High wildfire exposure, especially in the Gülnar and Mut districts, where settlements are adjacent to forests. The Fire Weather Index (FWI) exceeds 70 on peak summer days.
- Urban & Coastal Infrastructure: Inadequate drainage capacity for the projected 25–50% increase in extreme rainfall; port and coastal areas exposed to flooding.
- Public Health: Elderly (212,000), children (513,000), refugees, and outdoor workers face disproportionate risks from extreme heat and poor air quality.
- Tourism: Beach tourism and cultural sites are threatened by rising heat, drought, and coastal risks.

External Influences on Climate Risks

- EU projects (CLIMAAX, P2R, Horizon Europe calls like Water4All and DUT): Opportunities for co-financing and methodological learning.
- National initiatives (Climate Law, Zero Waste Movement): Provide legal frameworks and financing pathways.
- Regional water stress: Pressures from GAP irrigation demand and over-extraction of groundwater.

[5] https://www.mersin.bel.tr/uploads/files/mersinsecapenglishfinal2021279126389-789558.pdf

- Earthquake recovery dynamics: A Large population of earthquake-affected residents increases vulnerability and competes for municipal resources.

Potential Adaptation Interventions

The MCR-RA project complements adaptation priorities outlined in MMM's SECAP and national strategies, focusing on:

1. Water management strategies: Demand management, modern irrigation, reuse schemes.
2. Urban heat mitigation: Expansion of green spaces, shaded public areas, and resilient settlement planning.
3. Wildfire prevention: Early warning systems, firebreaks, fuel management, and targeted action in districts like Gülnar and Mut.
4. Coastal resilience: Nature-based solutions (wetland restoration, dune protection) combined with resilient port infrastructure.
5. Community resilience: Awareness campaigns, training, and emergency preparedness for floods and wildfires.
6. Mainstreaming CLIMAAX tools: Embedding workflows into municipal decision-making and risk governance.

2.1.3 Participation and risk ownership

First Steps in Stakeholder Involvement

The MCR-RA project prioritizes a comprehensive stakeholder engagement strategy, ensuring diverse groups are actively involved in the climate risk assessment process. Initial stakeholder mapping identified actors from local government, academia, NGOs, the private sector, and community groups.

The engagement process began with a **large-scale stakeholder meeting in August 2025, hosted by MMM**[6], with participation from over 100 representatives of district municipalities, provincial directorates, universities, NGOs, and chambers of commerce. This was followed by a **wildfire-focused meeting in Gülnar District**, where the CLIMAAX wildfire workflow results were presented at the district level. The session clearly illustrated the extreme risks posed to rural and forest-adjacent settlements, demonstrating the practical value of CLIMAAX outputs as decision-support tools. These early engagements helped build trust among stakeholders and underscored the urgency of wildfire adaptation in particular.

Relevant Stakeholders for the MCR-RA Project

Table 2-1 Relevant Stakeholders for the MCR-RA Project

Stakeholder Group	*Role and Contribution*
Government Institutions	Mersin Metropolitan Municipality (lead); District municipalities (Gülnar, Erdemli, Silifke, Mezitli, Anamur); Provincial Directorate of Agriculture and Forestry; Provincial Directorate of Environment and Urbanization; Provincial Directorate of Health; AFAD (Disaster and Emergency Management Authority); MESKI (Mersin Water and Sewerage Utility).
Non-Governmental Organizations	Local and regional NGOs, including the Chamber of Environmental Engineers, the Chamber of Agricultural Engineers, the Chamber of Urban Planners, Regional Irrigation Unions, the Foundation for Combating Erosion (TEMA), other environmental groups, and community associations.

[6] CLIMAAX Results-Stakeholder Engagement Meeting Report-August 2025 https://www.mersin.bel.tr/dokumanlar/introduction-event-report-460278628

Stakeholder Group	*Role and Contribution*
Academia	Middle East Technical University – Institute of Marine Sciences (coastal risks), METU Center for Climate Change and Sustainability Policy (policy analysis), Mersin University, Tarsus University, Çağ University, Toros University (research support, student engagement).
Civil Society	TEMA Foundation, women's associations, environmental NGOs, farmer cooperatives, chambers of agriculture and fisheries.
Private Sector	Mersin International Port, Chamber of Shipping, Chamber of Industry and Commerce, agribusiness sector (including citrus, banana, and greenhouse producers), and tourism operators.
Community Representatives	1.9 million residents, ~35,000 registered farmers, ~200,000 Syrian refugees, ~300,000 earthquake-affected households, elderly (>212,000), children (>500,000), outdoor workers, small-scale fishers.
International Organizations	Collaboration with EU-funded projects, such as Pathways2Resilience (P2R), was applied for the second call, to share best practices and enhance capacity building.

Priority Groups and Vulnerable Areas

- Rural farmers and forestry workers are exposed to drought and wildfire risks.
- Elderly residents and children are highly vulnerable to extreme heat.
- Refugees and earthquake-affected households, with limited adaptive capacity and precarious housing conditions.
- Fishermen and coastal communities are threatened by flooding and sea level rise.
- Low-income households and outdoor workers are exposed to multiple hazards without sufficient protection.

Risk Ownership Regulation

- **MMM Climate Change and Zero Waste Department:** Overall coordinator, responsible for project management, risk communication, and integration into municipal policies.
- **MESKI and Sectoral Directorates:** Responsible for water, agriculture, forestry, health, and urban services.
- **AFAD (provincial level):** Leads emergency preparedness and disaster response.
- **District Municipalities:** Manage localized climate risks (e.g., wildfire prevention in Gülnar and Mut, flood risk reduction in Silifke).
- **Chambers and Civil Society Organizations:** Co-own risks in their sectors, supporting adaptation in agriculture, fisheries, and community resilience.

Acceptable Risk Levels

Preliminary consultations revealed that while stakeholders and communities accept a degree of **seasonal climate variability**, there is a very low tolerance for extreme heatwaves, prolonged droughts**, destructive wildfires, and heavy rainfall**, as these directly affect public safety, agriculture, and livelihoods. Heatwaves are perceived as increasingly dangerous, especially for the elderly and refugees, but are partly normalized due to Mersin's hot Mediterranean climate.

Communication Strategy

MMM communicates results through:

- Stakeholder meetings and thematic workshops.
- Risk maps and visual reports, shared with district municipalities and provincial directorates.
- Digital platforms such as MMM's website, social media (X, Facebook, Instagram), and press releases to reach broader audiences.

- Planned interactive dashboards and public campaigns from 2026 onwards, targeting schools, farmers, and coastal communities.

Figure 2-1 Stakeholder Engagement Meetings in Mersin (August 2025)

2.2 Risk Exploration

The risk exploration phase systematically assesses climate-related hazards, focusing on their underlying risks, exposure, and vulnerabilities within the Mersin region.

2.2.1 Screen risks (selection of main hazards)

For risk exploration, a qualitative hazard identification and climate risk and vulnerability assessment process was performed according to the methodology defined in the Global Covenant of Mayors for Climate and Energy (GCoM) Common Reporting Framework. Assessment results were reported in both the MMM Climate Change Risk and Vulnerability Assessment Report (2024) and the MMM SECAP Report. For the assessment, climate surveys and stakeholder consultations were conducted. According to the GFDRR's Think Hazard tool https://thinkhazard.org/en/report/3053-turkey-icel), Mersin (also known as İçel) faces a high risk of extreme heat, heavy rainfall, surface flooding, and wildfires. Mersin is recognised as one of the four most climate-vulnerable provinces in Türkiye, with a composite climate risk score of 17 out of 20. (Bütün Bayındır G.D., 2022)

Relevant Climate-related Hazards and Risks:

- **Heatwaves & Urban Heat Islands:** Mersin is among the hottest Mediterranean provinces, with projections of ~37 apparent temperature heatwave days annually by 2050 (RCP8.5)[7]. Vulnerable groups include the elderly, refugees, and outdoor workers.
- **Agricultural Drought:** Annual precipitation is around 600–650 mm while evapotranspiration (ET0) is around 1200, driving artificial irrigation dependency. In the current situation, an analysis was made in CROPWAT 8.0[8] represents that crops like citrus and bananas are highly dependent on artificial irrigation, with currently 16-20% yield losses in deficit conditions. (FAO-CROPWAT, 2025) (CLIMAAX agricultural drought workflow analysis represented that yield losses in case of rainfed-only will increase up to 40-45% by 2050)
- **Heavy rainfall:** Several extreme rainfall events (>150 mm/24h) have occurred in the past. Mostly, combined sewerage systems are already inadequate
- **Coastal Floods, erosion and sea level rise**: Mersin's coastline is vulnerable to erosion and saltwater intrusion, jeopardizing coastal infrastructure and tourism assets.

[7] https://climate-adapt.eea.europa.eu/en/metadata/indicators/apparent-temperature-heatwave-days

[8] https://www.fao.org/land-water/databases-and-software/cropwat/en/

- **Wildfires:** With 835000 ha of forest (53% of territory), Mersin is highly exposed. Fire Weather Index regularly exceeds 40 in the summer season. Districts such as **Gülnar and Mut** are particularly at intolerable extreme risk where settlements border forest edges.

Hazards covered in this CRA: Heatwaves, Drought (relative & agricultural), Heavy Rainfall, Wildfires, and Coastal Flood.

Table 2-2 Main Climate-Related Hazards and Potential Risks in Mersin

Climate Hazards	*Impact Description*	*Most Exposed Sectors*	*Vulnerable Population Groups Most Exposed*
Extreme Heatwave / Heat Stress	*Vital danger for chronic patients, the elderly, and outdoor workers due to extreme heat. İncrease in Forest fire risk.*	*Food-Agriculture-Forestry, Public Health, Energy and Water Supply, Industry-*	*Elderly>65 /children < 5 years old, Small-scale producers, Outdoor workers/farmers, Low-*
Drought	*Decrease in agricultural production and soil salinization due to excessive irrigation. Decrease in energy production and water reserves*	*Food-Agriculture-Forestry, Energy and Water Supply, Public Health, Industry*	*Elderly, Vulnerable health groups, Small-scale producers, Low-income households*
Wildfire	*Extreme fire risk in 835000 hectares of forestland in Mersin.*	*Forestland, biodiversity, wildlife and settlement next to forestland*	*Forest villages, pastoralists, low-income households, and elderly living near forestland.*
Heavy Rainfall and coastal flood	*Flash flood in residential and agricultural areas (especially greenhouse facilities). Interruptions of municipality services. Submersion of transportation lines. Vital risk.*	*Agriculture/Livestock, industry, transport, sewerage, waste management, energy and water supply, and residential areas.*	*Elderly, Small-scale producers, Low-income households*

Existing Data, Knowledge, and Gaps

Table 2-3 Existing Data, Knowledge and Gaps

Hazard	*Available Data*	*Data Gaps and Needs*
Heatwaves	*Daily Tmax/Tmin; Land Surface Temperature (Landsat); Population density; RCP4.5 & RCP8.5 projections*	*District-level urban heat island analysis; Socioeconomic vulnerability datasets (household cooling access, energy poverty).*
Drought	*Precipitation & evapotranspiration (MGM, Copernicus, FAO CropWat 8.0, ClimWat 2.0); Irrigation demand; regional Crop coefficients; Crop production stats*	*MapSPAM data for Grape is not available—high-resolution irrigation patterns.*
Floods	*Rainfall extremes; Land use/soil data; MESKI drainage system records*	*Local hydrological modelling; Coastal inundation mapping (LiDAR/topography).*
Wildfires	*Fire Weather Index (FWI) from CLIMAAX; Forest cover maps; Historical fire records*	*Settlement-level exposure maps; Data on suppression capacity, fire service resources, and early warning systems.*

2.2.2 Workflow selection

The MCR-RA project applies the CLIMAAX framework, utilizing six targeted hazards' workflows selected with input from MMM and stakeholders. These workflows represent the most pressing hazards in Mersin: **heatwaves, relative and agricultural drought, wildfires, heavy rainfall and coastal flooding**. Each workflow includes specific methodologies, datasets, and priority groups.

2.2.2.1 Heatwave Workflows

Objective: To assess the impacts of extreme heat and heatwaves on public health, urban systems, and vulnerable populations.

Methodology:

- 2 hazard assessment workflows; **EuroHeat** and **Xclim** were applied to calculate **heatwave frequency, duration, and intensity**.
- 2 risk assessment workflows; **Satellite-Derived Data Workflow** and **Climate Projections Workflow** were applied.
- EuroHeat workflow is based on the apparent temperature health-based thresholds and will evaluate heatwave frequency under historical and future climate conditions
- In the Xclime workflow, regional custom thresholds are defined at the 90th percentile of Tmax and Tmin (Tmax ≈ 36°C, Tmin ≈ 28°C for Mersin), with a minimum duration of 3 consecutive days.
- Satellite-Derived Data Risk Workflow utilizes high-resolution satellite images (e.g., Landsat) to map existing heatwave exposure and UHI impacts at a spatial scale of 30–100 meters. Key outputs include urban heat maps with high resolution and local exposure at the neighbourhood level.
- Climate Projections Workflow combines hazard projections and exposure and vulnerability information and facilitates anticipatory risk assessment. Deliverables are scenario-based risk maps that link climate and socioeconomic factors, as well as risk evolution over time, in relation to vulnerable populations and key sectors.
- Vulnerability assessed using **WorldPop datasets** (children under 5, elderly over 65, refugee distribution, population density).
- A 10×10 exposure–vulnerability matrix produced spatial risk maps for priority districts.

Vulnerable groups include the elderly (over 212,000), children (over 500,000), refugees (~200,000), outdoor workers (in construction/agriculture), and low-income households in high-density neighbourhoods.

Exposed Areas: Central urban districts of Mersin, characterized by limited green space (2.86 m² per capita), particularly Toroslar, Akdeniz, and Yenişehir.

Key Actions in the Workflow:

1. **Data Collection:** Regional climate thresholds, daily Tmax/Tmin, LST, population data.
2. **Hazard Assessment:** Calculate the number of heatwave days, frequency, and duration under RCP4.5 and RCP8.5 scenarios.
3. **Risk Assessment:** Produce exposure maps (UHI intensity), combine with vulnerability data, and generate spatial risk maps of affected populations.

2.2.2.2 Relative and Agricultural Drought Workflows

Objective: To evaluate relative and agricultural drought risk at the regional scale and estimate agricultural yield and revenue losses for key crops under irrigation deficit conditions.

Methodology:

- **Relative Drought Workflow:** Based on Copernicus CDS precalculated indicators, relative drought hazard in Turkiye's NUTS3 level is estimated as the probability of exceedance of severe precipitation deficits, compared between the historical baseline (1981–2015) and future projections (2050, 2080) under SSP1-2.6, SSP3-7.0, and SSP5-8.5.
- **Agricultural Drought Hazard Assessment Workflow:** Assesses potential yield losses using climate variables (temperature, precipitation, humidity, solar radiation, wind speed, soil water capacity) and calculates crop evapotranspiration. Focus on the main regional crops: **citrus, banana, grape and tomato**
- **Agricultural Drought Risk Assessment Workflow:** This workflow evaluates potential revenue losses due to reduced crop yields from precipitation scarcity in the absence of irrigation. Hazard quantified as evapotranspiration shortfall; exposure as crop production and revenue; vulnerability as irrigation coverage and water demand.

Vulnerable Groups: ~35,000 farmers, rural women, seasonal agricultural workers, and low-income households dependent on food security.
Exposed Areas: Irrigated agricultural lands of the **Çukurova plain** and coastal districts where banana and citrus production dominate.
Key Actions in the Workflow:

1. **Data Collection:** The data sets are downloaded from the EU Copernicus Data Store: Daily average precipitation flow; maximum and minimum temperature; 2-meter relative humidity; solar radiation; 10-meter wind speed; soil available water capacity; Elevation; Thermal climate zone.
2. **Hazard Assessment:** The hazard assessment was performed for the four main crops of the Mersin region (citrus, banana, grape and tomato) parameterized in the regional crop coefficients.
3. **Risk Assessment:** Generate maps of agricultural revenue loss projections

2.2.2.3 Heavy Rainfall and Coastal Flooding Workflows

Objective: Heavy rainfall and coastal flood workflows in the context of climate change can offer valuable insights into how the frequency and magnitude of extreme events may shift over time. These insights are crucial for making informed decisions and implementing effective preparedness measures to mitigate the impacts of pluvial and coastal flooding.
Methodology:

- **Heavy Rainfall Hazard Assessment Workflow:** Based on extreme rainfall events from EURO-CORDEX projections (25–50% increase in intensity by 2050). Hazard data combined with **land use, soil infiltration capacity, and MESKI drainage system maps**.
- **Coastal Floods Hazard Assessment Workflow:** Uses Copernicus sea-level rise and storm surge projections for the Eastern Mediterranean.
- **Coastal Floods Risk Assessment Workflow**: visualizes risks to residential areas and infrastructure caused by coastal flooding. The workflow utilizes pre-processed coastal flood maps from the Global Flood Maps dataset. It combines these with land use maps, as well as information on economic vulnerability (damage curves), to quantify the order of damages in economic terms.

Vulnerable groups include coastal residents, port workers, low-income households in flood-prone areas, and refugees in informal settlements.
Exposed Areas:

- **Pluvial:** Urban areas with poor drainage (Silifke, Tarsus).

- **Coastal:** Port of Mersin, Erdemli, and low-lying neighbourhoods along the Mediterranean coastline.

Key Actions in the Workflow:

1. **Data Collection:** Rainfall extremes, land use, MESKI drainage records, topography.
2. **Hazard Assessment:** Pluvial flood hazard (intensity, duration, return periods); coastal inundation zones.
3. **Risk Assessment:** Calculating damage maps based on flood maps. Exposure mapping of flood-prone urban neighbourhoods and port areas; overlaid with population density and social vulnerability.

2.2.2.4 Wildfire Workflows

Objective: The FWI Hazard workflow enables us to visualise spatial and temporal trends in FWI intensity and understand changes in fire weather season duration and onset based on FWI. Variations in seasonal FWI intensity determine how changing climate conditions are influencing the likelihood of wildfire development.

The FWI Risk workflow offers a straightforward tool for assessing which areas within a region are most suitable for wildfire development, based on climatic conditions and fuel availability. On the other hand, it informs users about which areas are most vulnerable to wildfire from a human, economic, and environmental perspective.

Methodology:

- **FWI Hazard Workflow:** provides a simple tool to visualise wildfire hazard using the Fire Weather Index (FWI) data available on the Copernicus Climate Data Store. The FWI is a climatic index that combines data on daily noon surface air temperature, rainfall intensity, wind speed, and relative humidity, accounting for the effects of fuel moisture and weather conditions on fire behaviour. It consists of a 0-100 score indicating how suitable the climate conditions are for the occurrence of wildfire.
- **FWI Risk Workflow:** Wildfire danger is first calculated as the combination of climatic danger, here represented by the seasonal FWI, and fuel availability given by the abundance of burnable vegetation. The two danger indicators are normalized and averaged to produce a spatialized fire danger index. This composite danger indicator will be combined with a range of wildfire vulnerability indicators to create a risk index. The vulnerability indicators used here are representative of the human, economic and ecological dimensions that wildfires could directly impact. To produce the risk index from the danger index and the vulnerability indicators, a Pareto analysis is conducted to identify the areas across the region with the highest overall risk, given the selected indicators.

Vulnerable groups include forestry workers, rural households, elderly individuals in isolated villages, and refugees in forest-adjacent rural settlements.

Exposed Areas: Gülnar (case study), Silifke, Anamur, and Erdemli — all districts with large forested areas adjacent to settlements.

Key Actions in the Workflow:

1. **Data Collection:** FWI datasets, forest cover, settlement maps. Fire Weather Index (FWI) data is available on the Copernicus Climate Data Store.
2. **Hazard Assessment:** Current vs. future FWI (number of high/extreme risk days).
3. **Risk Assessment:** To assess which areas of a region have the most suitable setting for wildfire development based on climatic conditions and fuel availability.

2.2.3 Choose Scenario

Mersin Metropolitan Municipality has set an overall target to become a "climate-neutral" and "climate-resilient" city by 2050. MMM applies medium and high-emission scenarios consistent with CLIMAAX workflows. The selected scenarios and temporal period include:

- Near Term –İnterim target by 2035
- **Medium-term resilient-carbon neutral target by 2050**
- **Scenarios selected:**
  - **SSP2-RCP4.5** (stabilization, "middle of the road").
  - **SSP5-RCP8.5** (pessimistic, highway to fossil world).
- **Socio-economic considerations:**
  - Population projected to grow modestly (~2.2 million by 2050).
  - Urban expansion continues, reducing green space per capita.
  - Agricultural irrigation demand projected to **double** by 2050.
  - Tourism pressures increase coastal vulnerability.

These scenarios provide a range of plausible outcomes for hazard intensity, exposure, and vulnerability. For Phase 2, high-resolution modelling at the **district scale** will refine projections, particularly for coastal flooding and wildfire exposure.

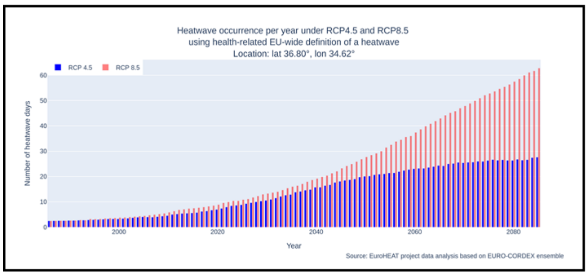
2.3 Risk Analysis

2.3.1 Workflow#1: Heatwaves

Table 2-4 Data overview Urban Heatwaves workflow

Hazard data	*Vulnerability data*	*Exposure data*	*Risk output*
EUROHEAT CDS data (Heat waves in Europe derived from climate projections) Xclim - CORDEX regional climate model data (Daily Tmax/Tmin, heatwave thresholds (90th percentile), Regional climate projections *Climate Projections under RCP4.5 and RCP8.5, processed through CLIMAAX workflows*	Population density (WorldPop Turkey-2021, 100 m. resolution), elderly female >65, children <5,	Land Surface Temperature (RSLab-Landsat8, 30m)	Hazard: Heatwave index, frequency, duration projection GRAPHS in RCP4.5 and RCP8.5 Risk: Spatially possible heat wave risk maps showing priority vulnerable neighborhoods. Climate Projection: Heatwave risk intensity maps for Mersin identified at the district level

Hazard Assessment Workflows: The heatwave index, frequency, and duration were calculated using both Euroheat and Xclim hazard assessment workflows. Euroheat Heatwave index is based on apparent temperature, while Xclime is based on thresholds of Tmax: 36 °C, Tmin: 28 °C and 3 consecutive days for Mersin.



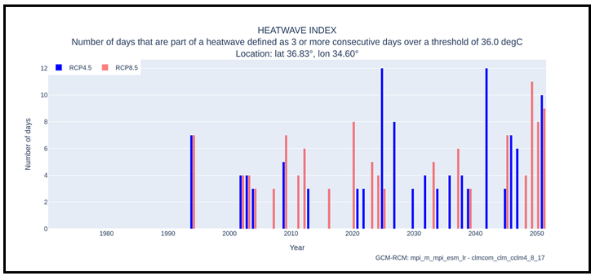


Figure 2-2 Heatwave Index graphs from EuroHEAT and Xclim

Risk assessment Workflows

- Exposure mapped using Landsat-based Land Surface Temperature (urban heat island hotspots).
- Vulnerability mapped via population density + age cohorts + refugee settlement data.
- Preliminary results show the highest risk in Toroslar, Akdeniz, and Yenişehir districts, where UHI effects combine with dense vulnerable populations.

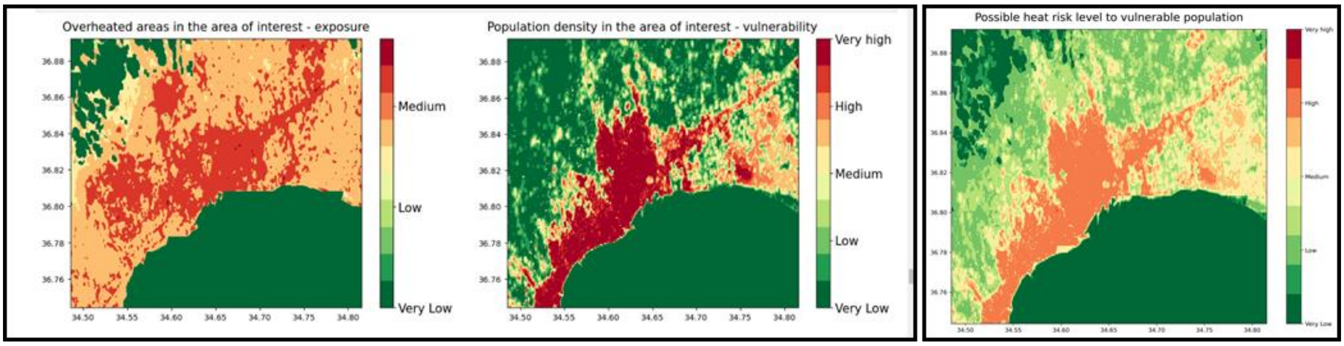


Figure 2-3 LST, Vulnerable Population Density and Heatwave Risk Maps of Mersin City Center

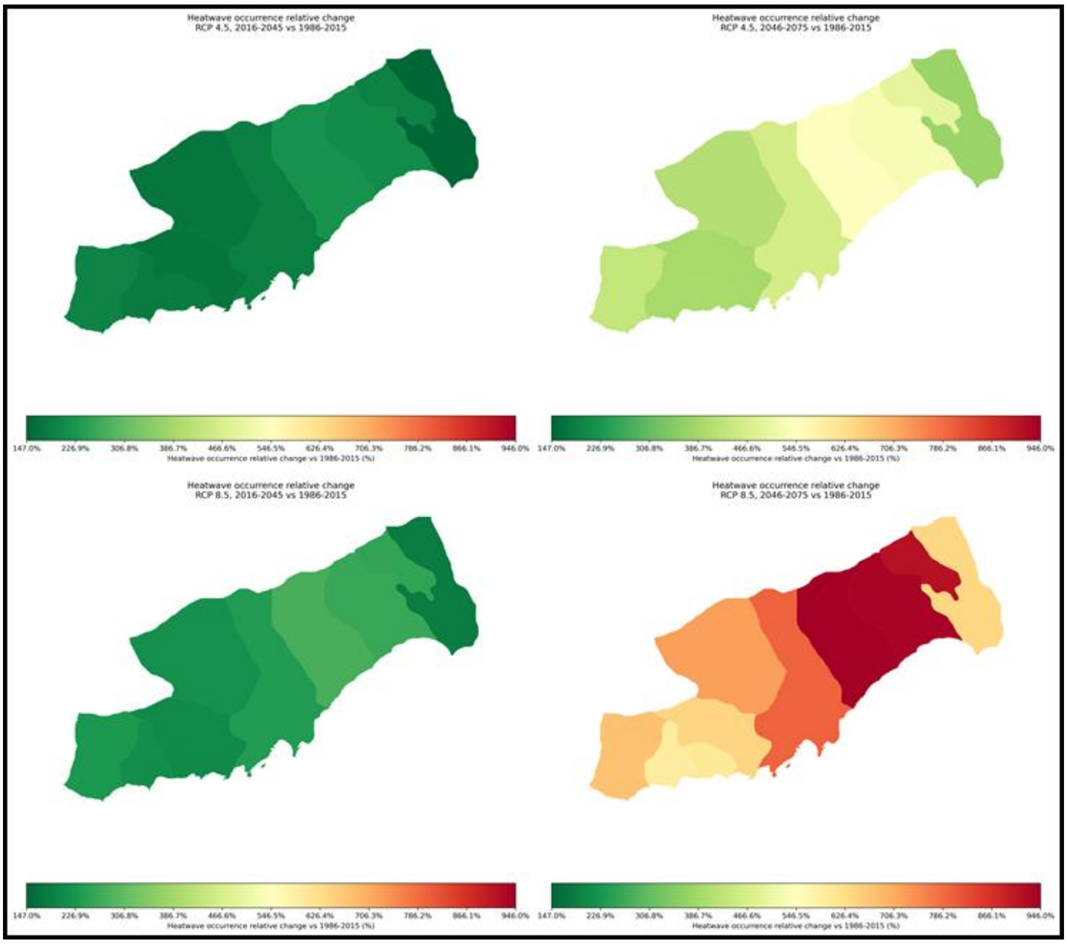


Figure 2-4 Relative change in heatwave occurrence in Mersin District- 1986-2015 vs 2016-2045 and 2046-2070 in RCP4.5/RCP8.5

2.3.2 Workflow #2: Relative Drought

Table 2-5 Data overview Relative Drought workflow

Hazard data	*Vulnerability data*	*Exposure data*	*Risk output*
***Relative Drought** Monthly precipitation (1981–2015) and projections under SSP1-2.6, SSP3-7.0, SSP5-8.5, averaged from five CMIP6 models at 0.5° resolution.*	*Rural population share, GDP per capita (from drought_vulnerability.csv)*	*Cropland, livestock, population, water stress (from drought_exposure.csv)*	*Relative drought risk classes (1–5), based on the combined hazard, exposure, and vulnerability*

Hazard Assessment: The hazard component for relative drought was analysed using the Weighted Anomaly Standardized Precipitation (WASP) index, which captures precipitation deficits while accounting for seasonal variation.

Risk Assessment: Using the CLIMAAX Relative Drought workflow, risk scores were derived as the product of hazard, exposure, and vulnerability, each normalized across NUTS3 regions. For Mersin, the risk was calculated using the WASP index (hazard), exposure indicators (cropland, population, and water stress), and vulnerability data (rural population share and GDP per capita). Current and future relative drought risks are demonstrated in the figures below. The relative drought risk score in the Mersin Region is currently 1 (low) out of 5 and is expected to increase to 2 in RCP8.5 scenarios by 2050.

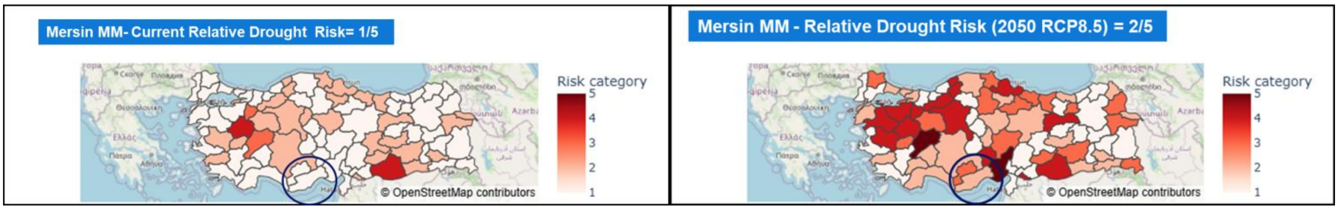


Figure 2-5 Current and Future Relative Drought Risk Level in Mersin

2.3.3 Workflow #3: Agricultural Drought

Table 2-6 Data overview Agricultural Drought workflow

Hazard data	***Vulnerability data***	***Exposure data***	***Risk output***
Daily precipitation, max/min temperature, 2m humidity, solar radiation, wind speed, soil water capacity, elevation, thermal zone; crop coefficients and growing season length for lemon, banana, grape and tomato	*Irrigation availability (GAEZ Ver.05) vulnerability based on irrigation system coverage*	*Crop production (MapSPAM 2020); Crop values (FAO GAEZ)*	*Maps showing crop yield loss and revenue loss due to irrigation deficit;*

Hazard Assessment: The agricultural drought hazard was assessed using climate projection datasets from the EU Copernicus Data Store for the RCP4.5 scenario covering the period 2041–2045. The analysis focused on cumulative seasonal precipitation, available soil water capacity, and standard evapotranspiration to evaluate the water balance affecting crop productivity in the Mersin region.

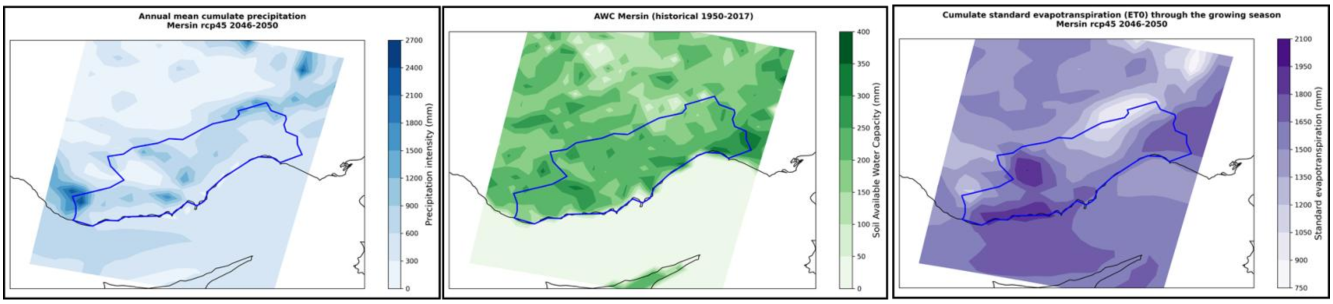


Figure 2-6 Maps of Annual Precipitation, Water Available Capacity and Standard Evapotranspiration in Mersin

The hazard assessment was performed for the four main crops of the Mersin region (Banana, Lemon, Grape, and Tomato), parameterized using regional crop coefficients. These coefficients were not originally available in the workflow's FAO list. The crop table was modified with more accurate regional crop coefficients supplied by the research institute (TAGEM) of the Ministry of Agriculture and Forestry. ([https://www.tarimorman.gov.tr/TAGEM/Belgeler/yayin/Tu%CC%88rkiyede%20Sulanan%20Bitkiler in%20Bitki%20Su%20Tu%CC%88ketimleri.pdf](https://www.tarimorman.gov.tr/TAGEM/Belgeler/yayin/Tu%CC%88rkiyede%20Sulanan%20Bitkilerin%20Bitki%20Su%20Tu%CC%88ketimleri.pdf)) (TAGEM, 2017)

Table 2-7 Regional Crop Table used in Agricultural Drought Hazard Assessment

FAO_Code	Crop	Clim	Kc_in	Kc_mid	Kc_end	lgp_f1	lgp_f2	lgp_f3	lgp_f4	Season start	Season End	RD1	RD2	DF	Type	Ky
33	**Grape**	4	0.69	0.78	0.4	0.104	0.238	0.367	0.368	67	298	0.7	1.35	0.5	0	0.9
322	**Lemon**	4	0.98	0.52	0.59	0.164	0.247	0.342	0.247	1	365	0.85	1.75	0.5	0	0.9
323	**Banana**	4	0.7	1.13	1.03	0.329	0.164	0.493	0.014	1	365	0.6	1.25	0.5	0	1.15
223	**Tomato**	4	0.41	1.1	0.75	0.216	0.216	0.388	0.173	97	236	0.45	0.8	0.5	1	1.05

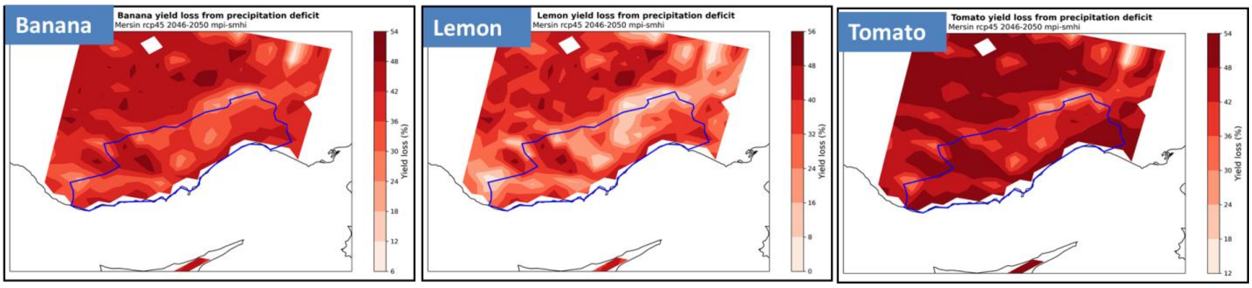


Figure 2-7 Banana, lemon and tomato yield losses in case of irrigation deficit

Risk Assessment: Revenue losses were calculated by combining yield loss percentages with crop-specific production and economic value data.

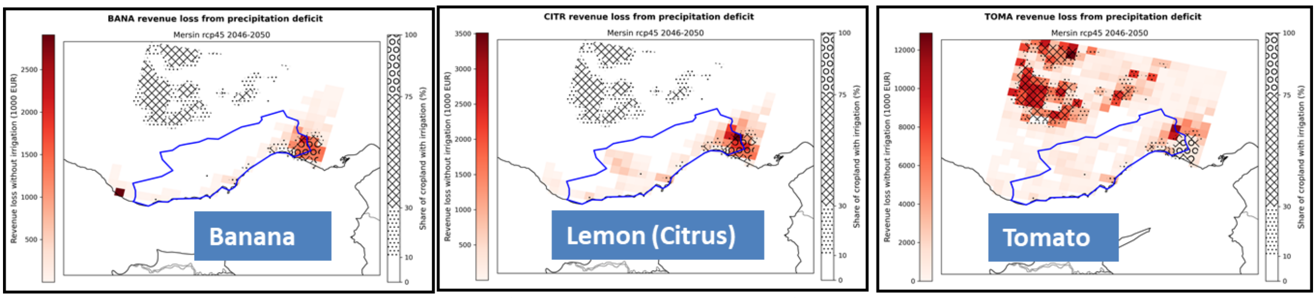


Figure 2-8 Maps of Revenue Loss in Main Crops (Banana, Citrus and Tomato) because of irrigation deficit

2.3.4 Workflow #4 Wildfire-FWI

Table 2-8 Data overview Wildfires workflow

Hazard data	*Vulnerability data*	*Exposure data*	*Risk output*
Fire Weather Index (FWI) day-of-year variation, days with FWI>30. FWI projections	*Rural households, forestry workers, the elderly, and refugees in forest-adjacent settlements*	*Forest cover (835000 ha, 53% province)*	*Ecosystem restoration cost index, fire danger index and the highest fire risk areas maps*

Hazard assessment

A detailed FWI analysis was conducted in the Mersin region. The day-of-year change graph shows that FWI is exceeding the highest forest fire risk level (FWI>30) in the summer season. In the 2050 projection, in some areas (especially Gülnar and Mut districts), FWI may increase by up to 80%. In 150 days of a year FWI exceeds 30. These assessments indicate that 835000 hectares of forest land in Mersin are under unavoidable excessive fire danger.

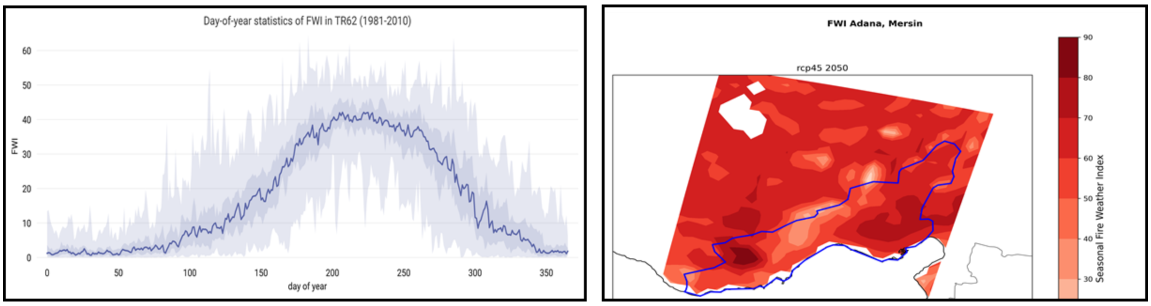


Figure 2-9 FWI in Mersin region: Day-of-year change and projection in 2050

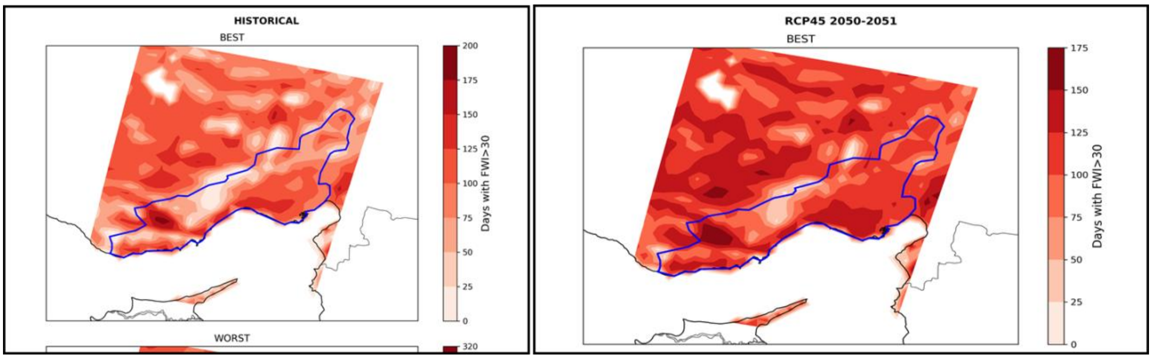


Figure 2-10 Number of days exceeding FWI>30: Current and 2050 situations

Risk assessment

The following maps were obtained from the wildfire risk workflow:

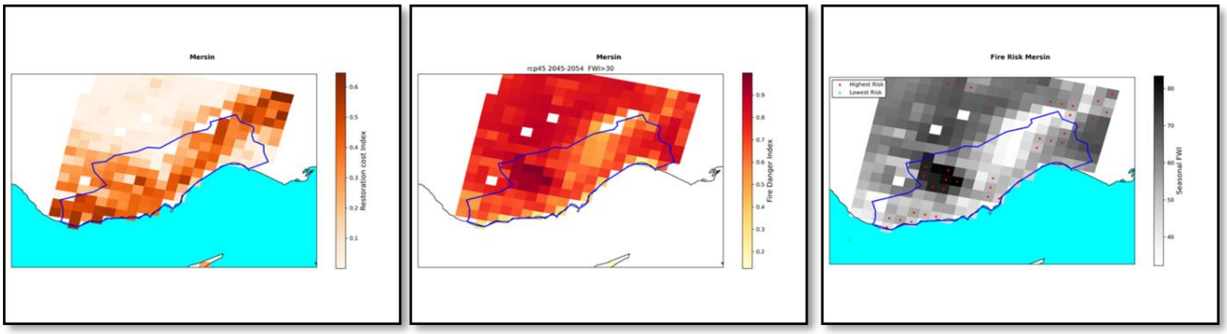


Figure 2-11 Ecosystem restoration cost index, fire danger index and the highest fire risk areas maps

2.3.5 Workflow #5: Extreme Precipitation and Coastal Flooding Workflows

Table 2-9 Data overview Heavy Rainfall workflow

Hazard data	*Vulnerability data*	*Exposure data*	*Risk output*
Heavy Rainfall : *Extreme rainfall projections underRCP8.5; 24h intensity & 10-year and 100-year return periods*	*Schools, hospitals, and critical infrastructure*	*Drainage capacity (MESKI), land use maps, elevation/topography, port infrastructure*	*The risk map of Projected Changes in Return Period (Frequency) of 100mm/24hr event*

A hazard assessment was conducted to analyze expected heavy rainfall for 3-hour and 24-hour durations for different return periods (5, 10, 50, 100, and 500 years) for both historic and future periods under RCP8.5. A return period of 10 years with 130-140 mm of rainfall per 24 hours is expected in most areas of Mersin, accompanied by a 25-50% increase from the current situation. The risk threshold for the Mersin region, determined as 100 mm/24h, will be exceeded in most areas within a 10-year return period by 2050.

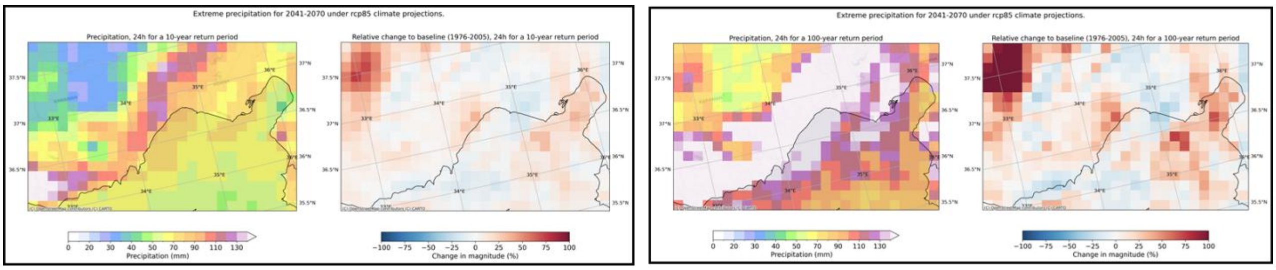


Figure 2-12 The map of expected precipitation for 24hr duration for 10-years and a 100-year return period for historical (1976-2005) and future (2041-2070) periods in the Mersin region

2.3.6 Workflow #6: Coastal Flooding

Table 2-10 Data overview Coastal Flooding workflow

Hazard data	*Vulnerability data*	*Exposure data*	*Risk output*
Coastal Flooding: Statistical indicators derived from water level time series for different return periods (10, 50, 100, 200, 500 years) and the NASA Sea Level Projection tool for future periods	*Global flood depth-damage functions (vulnerability curves) from JRC*	*Land use/land cover map from JRC (LUISA Base Map 2018)*	*Flood Risks to infrastructure, associated damage maps for extreme events in (5, 10,50 and 100 years)*

A risk assessment was conducted to visualise the risks to building infrastructure presented by coastal flooding in the region. The extreme water levels and additional sea level rise calculated in the hazard workflow were used for the potential water level rise. Land use/land cover maps developed and produced by the JRC (LUISA Base Map 2018) 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. In the Mersin region, only the Silifke district coastal zone will be affected by sea level rise and coastal flooding. Flood damage in all parts of the coastal area of Mersin appears to be insignificant.

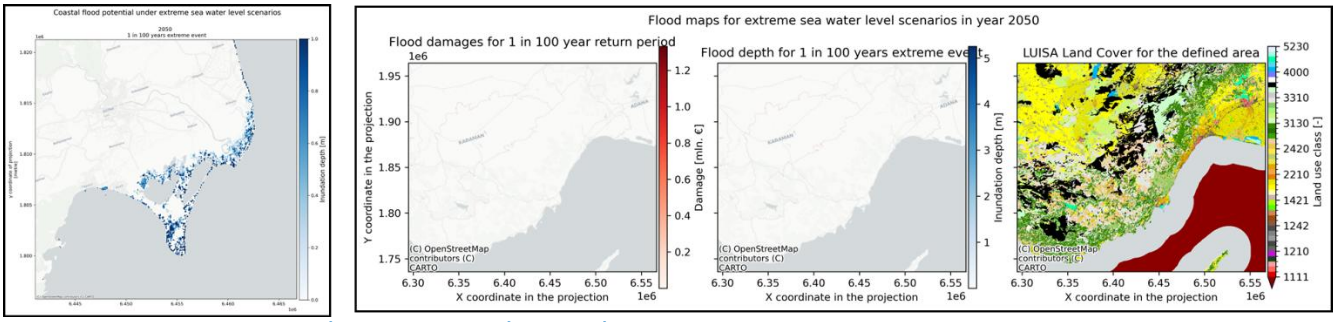


Figure 2-13 Sea level rise in Silifke and the risk of coastal flooding damage in the Mersin coastal region

2.4 Preliminary Key Risk Assessment Findings

2.4.1 Severity

Key Results from the Heatwave Risk Analysis:

- Apparent temperature heat wave ındex (Euroheat) is currently 17 days and will increase up to 40 days. by 2050 (RCP8.5)
- Extreme heatwave conditions (Tmax=36 ^{o}C, Tmin=28 ^{o}C and three consecutive days) were also analysed by means of Xclim. In extreme conditions, the heatwave index is expected to increase almost three times by 2050.
- Urban areas with high land surface temperatures and dense populations face severe public health risks. High-risk neighbourhoods have been identified and prioritized for adaptation.

Key Results from Relative and Agricultural Drought Risk Analysis:

- Mersin currently has a low relative drought risk (1 over 5). The risk score is expected to increase to 2 out of 5 in SSP5–8.5 scenarios by 2050.
- WASP index represents moderate long-term precipitation deficits.
- The region currently receives ~650 mm of seasonal rainfall but will face evapotranspiration rates of ~1900 mm in 2050, indicating heavy irrigation dependency.
- Yield losses in case of irrigation deficit were found as follows: Banana 30–42%, Lemon 16–32%, Grapes 24–40% and Tomato 36–48%
- Significant revenue losses were estimated in the eastern part of the Mersin region, such as for Banana and Citrus, up to 3 million euros per grid; for tomato, up to 8 million euros per grid. Revenue loss for grapes could not be estimated due to the unavailability of a dataset in MapSPAM-2020.

Key Results from Wildfire Risk Analysis:

- Day-of-year change graph represents that FWI is exceeding the highest forest fire risk level (FWI>30) in the summer season.
- In the 2050 projection, FWI will increase in all parts of the region, in some areas (especially Gülnar and Mut districts) FWI may reach up to 80!.

- In 150 days of the year, FWI exceeds the excessive fire risk threshold, which is FWI>30.
- The maximum Fire Danger Index was calculated in Gülnar and Mut Forestlands. All other parts also have a very high danger index.

Key Results from Heavy Rainfall and Coastal Flooding Risk Analysis:

- 130-140 mm/24hr in 10-year return period is expected in most areas in Mersin, with 25-50% increase from the current situation.
- In the Mersin region, only the Silifke district coastal zone will be affected by sea level rise and coastal flooding. Flood damage in all parts of the coastal area of Mersin appears to be insignificant.

Severity of the Identified Risks

Heatwaves: With a very high, frequent, and prolonged apparent temperature heatwave hazard, extreme Land Surface Temperatures (LST) in city centres pose a severe risk—especially in densely populated urban areas.

Drought: Although the relative drought score seems low in Türkiye, very low annual precipitation combined with high evapotranspiration will result in significant crop yield losses—up to 48% in the case of irrigation deficit.

Wildfire: 835000 hectares of forestland in Mersin are under excessive, intolerable, and immediate fire danger risk.

Heavy Rainfall: Severe rainfall events (130-140 mm/24hr in 10 10-year return period) are expected in most areas in Mersin

Coastal Flooding: Flood damage in the coastal region of Mersin appears to be insignificant. Only Silifke will be affected by sea level rise.

- Mersin already experiences **>40°C summer maxima**; heat index and UHI effects are intensifying in central districts.
- Apparent-temperature heatwave days is projected to more than double, reaching ~37 days annually by 2050 (RCP8.5),
- Central neighbourhoods with low green space (<3 m² per capita) show **very high health risks**, especially for elderly and refugees.

Drought (Relative & Agricultural)

- Mersin currently has a low relative drought risk (1 over 5). The risk score is expected to increase to 2 out of 5 in SSP5–8.5 scenarios by 2050.
- Precipitation is projected to decline by ~20% by 2050, while evapotranspiration may double.
- Modelled yield losses without irrigation: Banana 30–42%, Lemon 16–32%, Grapes 24–40% and Tomato 36–48%
- Irrigation demand is expected to **double by 2050**, threatening long-term agricultural viability.

Floods (Pluvial & Coastal)

- Extreme rainfall events (~140 mm/24h) already cause urban flooding in city centre.
- Climate projections suggest a **25–50% increase in rainfall intensity** by 2050.
- Coastal districts and the Port of Mersin are exposed to sea level rise and storm surges (~0.3–0.5 m by 2050).
- Potential cascading impacts include **port disruption, infrastructure loss, and economic damage**.

Wildfires

- Mersin has **835,000 ha of forestland (53% of land)**, with increasing summer FWI values.
- Extreme wildfire risk days with **FWI>70** are projected by 2050 under RCP8.5.
- Districts like **Gülnar, Mut, Silifke, and Anamur** face severe wildfire exposure due to settlement–forest interfaces.
- Risks include **ecosystem loss, agricultural land damage, and health/economic impacts**.

Overall Severity:

- Heatwaves and drought are persistent, high-impact risks with severe human health and food security consequences.
- Floods and wildfires present **episodic but extreme risks**, with potential cascading impacts on **infrastructure, economy, and ecosystems**.

2.4.2 Urgency

Heatwaves:

- Immediate hazard — occurring **every summer** with increasing severity.
- Urgent adaptation needed in urban cooling, green infrastructure, and public health measures.

Drought:

- Gradual but highly **persistent hazard**.
- Urgent measures are required to improve **irrigation efficiency, water demand management, and crop diversification**, as impacts could intensify by 2050.

Wildfire:

- **Sudden-onset hazard**, peaking in summer.
- Requires urgent investment in fire monitoring, suppression capacity, and community preparedness.

Heavy Rainfall and Coastal Floods:

- **Sudden-onset hazard** — flash floods can occur with little warning.
- Short-term urgency: upgrade drainage capacity and early warning systems.
- Coastal flooding risk measures are not urgent and need **long-term** adaptation planning

Overall Urgency:

- Heatwaves, wildfires and heavy rainfall demand **immediate short-term adaptation**, while drought and coastal flooding require **long-term but proactive measures**.

2.4.3 Capacity

Current Measures in Place:

- **Institutional:** Mersin MM has a Climate Change and Zero Waste Department and has already been implementing a Sustainable Energy and Climate Action Plan SECAP).
- **Financial:** Limited local funds, but opportunities exist via **Pathways2Resilience (P2R), Horizon Europe, LIFE, and EIB ELENA**.
- **Social:** Strong civil society (e.g., TEMA Foundation, farmer cooperatives) and active stakeholder engagement, including district municipalities such as Gülnar.
- **Human:** Technical staff supported by Atalay Climate Consulting; universities (Mersin, Tarsus, METU-IMS) provide scientific input.
- **Physical:** Drainage systems (MESKI) exist but are under-capacity; firefighting resources are limited compared to wildfire exposure.
- **Natural:** Rich agricultural base and forest resources, but highly stressed under climate change.

Capacity Gaps:

- **Water management:** Irrigation inefficiencies, groundwater over-extraction.
- **Urban planning:** Insufficient green areas and shading in high-density districts.
- **Disaster preparedness:** Limited wildfire suppression equipment and flood early warning systems.

Opportunities:

- Integration of CLIMAAX outputs into Mersin's SECAP and spatial planning.
- Use of EU and international finance to build water resilience, urban greening, and hazard protection systems.
- Strengthening local–academic–civil society collaboration for capacity building and awareness campaigns.

2.5 Preliminary Monitoring and Evaluation

Lessons Learned from Phase 1

The first phase of MCR-RA confirmed that Mersin faces **multi-hazard risks** that require an integrated assessment. Applying the CLIMAAX workflows showed that heatwaves, drought, flash floods, and wildfires interact across urban, coastal, and rural systems. The most valuable outcome was the ability to visualize risks through **district-level maps**, which helped stakeholders clearly see priority areas (e.g., wildfire exposure in Gülnar and Mut, urban heat in Toroslar).

The main challenges were:

- **Flood modelling:** Limited hydrological data and drainage maps prevented detailed pluvial flood simulations; coastal flood projections also require higher-resolution elevation data (LiDAR).
- **Agricultural drought analysis:** Unavailable crop coefficients in the crop table were found and modified with more accurate regional data, but the data set related to revenue loss for grapes is not available in FAO/MapSPAM.
- **Urban heat mapping:** Land surface temperature and UHI analyses highlighted hotspots, but more socioeconomic data (e.g., health-related issues, hospitality data) is needed to quantify vulnerability.

Despite these challenges, the Phase 1 analysis successfully produced **risk maps and preliminary quantitative estimates** that can be refined in the following phases.

Stakeholder Feedback

Feedback from workshops and the August 2025 stakeholder meeting was generally positive:

- Stakeholders valued the **evidence-based maps** and the ability to link results directly to municipal planning.
- The wildfire case study in **Gülnar** was especially impactful, as it demonstrated how risk assessment outputs can inform **district-level decision-making**.
- Stakeholders highlighted the need for **more inclusive participation** from the private sector (agribusiness, tourism, port operators) and stronger engagement with **local communities**, especially refugees and earthquake-affected households.
- Several requested more **training sessions** to learn how to interpret and use CLIMAAX results in their own institutions.

New Data and Further Needs

For the next phase, several new datasets and resources will be important:

- **Meteorological Data:** Updated regional projections from the Turkish State Meteorological Service (MGM).
- **Agricultural Data:** High-resolution yield and revenue data for bananas, citrus, olives, grapes and tomato; updated irrigation maps from MESKI and provincial directorates.
- **Flood Data:** LiDAR-based coastal topography and hydrological models for Silifke.

- **Urban Heat Vulnerability:** Socioeconomic surveys to identify households with limited cooling capacity and high exposure to energy poverty.
- **Capacity Building:** Expanded training for municipal staff, NGOs, and district municipalities to strengthen local ownership of results.

2.6 Work plan

Phase 2 – Refined Local Analysis (Months 7–16)

Building on the preliminary results from Phase 1, Phase 2 will focus on **refining local climate risk assessments** with high-resolution data and sectoral integration:

- **Data Integration:** Incorporate updated crop yield and revenue data (bananas, citrus, olives, wheat), irrigation maps from MESKI, LiDAR-based coastal elevation data, and updated socio-economic data on vulnerable groups.
- **Workflow Enhancement:** Customize the CLIMAAX Toolbox for Mersin's context, improving flood modelling (urban drainage + coastal inundation), wildfire simulation (district-level Fire Weather Index), and urban heat exposure mapping (energy poverty indicators).
- **Comparative Analysis:** Validate Phase 1 results against observed climate events (e.g., 2021 wildfires, 2023 floods) to improve credibility and local relevance.
- **Stakeholder Engagement:** Conduct thematic workshops (agriculture & drought, coastal & floods, wildfire preparedness, urban heat & health) with district municipalities, cooperatives, and NGOs.

Phase 3 – Adaptation Strategy Development (Months 17–22)

Phase 3 will move from risk analysis to **adaptation strategy co-design**:

- **Co-Development of Measures:** Work with stakeholders to design adaptation pathways, including urban greening and cooling, sustainable irrigation, flood defence systems, and wildfire preparedness.
- **Integration into Policy:** Align adaptation measures with Mersin's SECAP, Türkiye's National Climate Adaptation Strategy, and EU-level missions (Adaptation, Cities, Climate-Neutral).
- **Action Roadmap:** Produce a Climate Adaptation Roadmap for Mersin, including short-, medium-, and long-term actions, costs, and financing opportunities (EU, EIB, LIFE, GCF).
- **Dissemination & Uptake:** Expand stakeholder involvement to the private sector (agribusiness, port authorities, tourism sector) to ensure results influence real investment and resilience planning.

Scope Limitations

Specific hazards and sectors are **not included in this project** due to low relevance for Mersin:

- **Glacial/Permafrost Hazards** (not present in Mediterranean climate).
- **Avalanches, Landslides, and Typhoons** (not significant in the regional hazard profile).
- **Airborne/Vector-Borne Diseases** were noted but will not be quantitatively modelled under CLIMAAX Phase 2, as existing data is insufficient. These may be considered in future health sector studies.

3 Conclusions Phase 1- Climate risk assessment

The MCR-RA project's Phase 1 has successfully laid a **multi-hazard, data-driven foundation** for climate risk management in Mersin. By applying the CLIMAAX methodology, the project generated localized insights into hazard severity, exposure, and vulnerability across urban, coastal, and rural areas. These outputs provide a crucial foundation for targeted adaptation planning, policy alignment, and effective stakeholder engagement.

Key Findings

- **Heatwaves** are an immediate and severe threat in central Mersin. Land Surface Temperature (LST) analyses confirmed the presence of strong urban heat island effects in **Toroslar, Akdeniz, and Yenişehir**.
- Agricultural drought modelling shows severe yield losses without irrigation: banana 30–42%, lemon 16–32%, grapes 24–40% and tomato 36–48%. The Çukurova plain is particularly vulnerable due to its dependence on irrigation.
- **Floods** are a growing hazard. Extreme rainfall events are projected to increase by 25–50%, and intensities of up to 140 mm/24 hours are expected in a 10-year return period.
- **Wildfire risk** is rising in forest-adjacent districts. The Fire Weather Index (FWI) indicates that days with **extreme fire risk (FWI >30)** may double by 2050. Districts such as **Gülnar, Mut, Silifke, and Anamur** were identified as hotspots, where settlements are directly exposed to expanding wildfire fronts.
- **Vulnerable groups** face disproportionate risks: elderly populations, refugees (~200,000), earthquake-affected households (~300,000), and small-scale farmers are the most exposed. The wildfire case study in **Gülnar** demonstrated how CLIMAAX outputs can directly inform **district-level risk awareness and adaptation priorities**.
- **Risk mapping outputs** provided decision-support tools that were widely appreciated by stakeholders and will serve as the foundation for Phase 2 refinements.

Challenges Addressed

- Integration of diverse datasets (climate projections, socioeconomic indicators, stakeholder input) into CLIMAAX workflows.
- Identification of multi-hazard interactions (e.g., drought and heatwaves intensifying wildfire risk, floods affecting coastal settlements).
- Active stakeholder involvement, including workshops and thematic meetings, where risk maps were presented and discussed.

Challenges Remaining

- **Pluvial Flood modelling** remains constrained by limited hydrological ~~and LiDAR~~ data for drainage and coastal zones.
- **Agricultural datasets** (crop revenue, irrigation maps) still need refinement for grapes to improve accuracy.
- **Private sector engagement** (agribusiness, tourism, port operators) was limited in Phase 1 and requires expansion.
- **Capacity gaps** remain in firefighting resources, flood early warning systems, and municipal staff training.

Next Steps – Phases 2 and 3

- **Phase 2: Refinement of Risk Analysis**
  Extension of heatwave risk maps to all district's city centre. Integration of high-resolution datasets (LiDAR coastal maps, updated yield/irrigation data, heatwave-related hospitality data, socio-economic vulnerability surveys), improved workflow calibration, and validation with observed events (e.g., 2021 wildfires, 2023 floods).
- **Phase 3: Development of Adaptation Strategies**
  Co-design of adaptation measures with stakeholders, including urban greening for heat mitigation, water efficiency for drought resilience, flood defence systems, and wildfire preparedness plans. Outputs will include a **Climate Adaptation Roadmap** aligned with Mersin's SECAP, Türkiye's national strategies, and EU missions.

4 Progress evaluation and contribution to future phases

The Phase 1 deliverable of the **MCR-RA project** provides a comprehensive multi-hazard baseline for Mersin, covering **heatwaves, drought, floods, and wildfires**. By applying four CLIMAAX workflows, the project delivered risk maps and district-level analyses that will serve as the foundation for refined assessments and strategy development. This work has established a strong analytical basis and mobilized key stakeholders to engage in future phases.

Connection to Future Phases

Phase 2 – Refined Local Analysis (Months 7–16):

- Integration of **high-resolution datasets** (LiDAR coastal data, updated crop yield/irrigation maps, socioeconomic surveys on energy poverty and health).
- **Enhanced workflow calibration** for drought and flood modelling, incorporating local agricultural and hydrological data.
- **Validation of Phase 1 outputs** against observed recent events (2021 wildfires, 2023 floods).
- **Stakeholder workshops** focused on thematic risks (agriculture, coastal resilience, wildfire preparedness, urban heat mitigation).

Phase 3 – Adaptation Strategy Development (Months 17–22):

- **Co-development of adaptation measures** with district municipalities, cooperatives, NGOs, and the private sector (agribusiness, port, tourism).
- **Policy integration** into Mersin's SECAP and Türkiye's National Adaptation Strategy, aligned with EU Missions on Adaptation and Cities.
- **Roadmap preparation** for climate adaptation, including investment priorities, financing sources, and pilot actions.

Table 4-1 Overview key performance indicators

Key performance indicators	*Progress*
Risk assessment of 4 climate hazards (heatwaves, drought, floods, wildfires) at the NUTS3 level	*Six workflows were completed successfully: Heatwave, Agricultural Drought, Relative Drought, Wildfire, Heavy Rainfall, and Coastal Flooding.*
Identification of vulnerable groups and sectors	*Elderly individuals, children, refugees, earthquake-affected households, rural farmers, coastal residents, and port workers were identified.*
Engagement of stakeholders through dissemination/training	*One large stakeholder meeting (August 2025) and one thematic wildfire session (Gülnar district) have been completed; further workshops are planned.*
Provision of risk assessment data to decision-making institutions	*Outputs shared with MESKI, AFAD, Provincial Directorates (Agriculture, Environment, Health), and district municipalities.*
Execution of communication actions to inform stakeholders	*Three actions have been completed (stakeholder meeting, wildfire case presentation, and media outreach); more are planned for Phase 2.*
Engagement of municipalities in dissemination efforts	*District municipalities (Gülnar, Mezitii, Erdemli,, Silifke, Anamur) engaged; coastal municipalities to be further integrated in Phase 2.*

Table 4-2 Overview milestones

Milestones	*Progress*
M1: Document review and initial data collection completed	*Achieved (M1).*
M2: Initial risk assessment completed and first deliverable submitted	*Achieved (M6).*
M3: High-resolution local data integrated into the project	*Ongoing – datasets being compiled for Phase 2.*
M4: Refined risk assessment completed and second deliverable submitted	*Planned for Phase 2 (M16).*
M5: Adaptation strategies identified and proposed	*Planned for Phase 3 (M20).*
M6: Final deliverable prepared and project results disseminated	*Scheduled for M22.*

Phase 1 has achieved its primary goal: producing a **robust, stakeholder-informed multi-hazard climate risk baseline** for Mersin. The findings not only highlight critical risks (heatwaves, drought, floods, wildfires) but also demonstrate the practical value of CLIMAAX workflows through case studies such as **wildfire risk in Gülnar and Mut**. These results directly inform Phases 2 and 3, where higher-resolution analysis and co-designed adaptation strategies will ensure that Mersin's climate action remains **scientifically grounded, locally owned, and policy-relevant**.

5 Supporting documentation

Main Report
MCR-RA_MersinMM_Phase 1 Climate Risk Assessment Report (PDF/Word)
Comprehensive documentation of methodology, analysis, findings, and conclusions.

MCR-RA_Visual Outputs
1_MCR-RA_Visual Outputs_Heatwaves.zip
- 1_1_MERSIN_HEATWAVE_hazard_assessment_xclim.ipynb
- 1_2_ MERSIN_HEATWAVE_hazard_assessment_EuroHEAT.ipynb
- 1_3_MERSIN_HEATWAVE_risk_assessment.ipynb
- 1_4_ MERSIN_HEATWAVE_risk_projections.ipynb
- 1_5_MERSIN_APPARENT_TEMP_HEATWAVE_index.png
- 1_6_MERSIN_HEATWAVE_heatwave_index.png
- 1_7_MERSIN_HEATWAVE_heatwave_frequency.png
- 1_8_MERSIN_HEATWAVE_heatwave_duration.png
- 1_9_MERSIN_HEATWAVE_LST_hotspots.png
- 1_10_MERSIN_HEATWAVE_vulnerable_population_map.png
- 1_11_MERSIN_POSSIBLE_HEATWAVE_RISK_MAP.png
- 1_12_MERSIN_HEATWAVE_Projections.png

2_MCR-RA_Visual Outputs_Relative Drought.zip
- 2_1_MERSIN_ RELATIVE_DROUGHT_hazard_assessment.ipynb
- 2_2_ MERSIN_ RELATIVE_DROUGHT_risk_assessment.ipynb
- 2_3_MERSIN_RELATIVE_DROUGHT_risk_visualization.ipynb

- 2_4_MERSIN_DROUGHT_WASP_Index.png

3_MCR-RA_Visual Outputs_Agricultural Drought.zip

- 3_1_MERSIN_AGRICULTURAL_DROUGHT_hazard_assessment.ipynb
- 3_2_MERSIN_AGRICULTURAL_DROUGHT_risk_assessment.ipyn
- 3_3_MERSIN_AGRICULTURAL_DROUGHT_crop_table_regional.xlsx
- 3_4_MERSIN_AGRICULTURAL_DROUGHT_Yield_Loss_Spreadsheet.xlsx
- 3_5_MERSIN_AGRICULTURAL_DROUGHT_banana_yield_loss.png
- 3_6_MERSIN_AGRICULTURAL_DROUGHT_lemon_yield_loss.png
- 3_7_MERSIN_AGRICULTURAL_DROUGHT_grapes_yield_loss.png
- 3_8_MERSIN_AGRICULTURAL_DROUGHT_tomato_yield_loss.png
- 3_9_MERSIN_AGRICULTURAL_DROUGHT_banana_revenue_loss.png
- 3_10_MERSIN_AGRICULTURAL_DROUGHT_lemon_revenue_loss.png
- 3_11_MERSIN_AGRICULTURAL_DROUGHT_tomato_revenue_loss.png
- 3_12_MERSIN_wac_Precipitation_Evapotranspiration.png

4_MCR-RA_Visual Outputs_Wildfires.zip

- 4_1_MERSIN_WILDFIRE_FWI_day-of-year_graph.png
- 4_2_MERSIN_WILDFIRE_FWI_current.png
- 4_3_MERSIN_WILDFIRE_FWI_2050_RCP45.png
- 4_4_MERSIN_WILDFIRE_Fire_Danger_Index.png
- 4_5_MERSIN_WILDFIRE_Ecological_restoratıon_cost_index.png.png
- 4_5_MERSIN_WILDFIRE_Fire_Rısk_Area.png

5_MCR-RA_Visual Outputs_Heavy Rainfall.zip

- 5_1_MERSIN_HEAVY_RAINFALL_Hazard_Assessment.ipynb
- 5_2_MERSIN_HEAVY_RAINFALL_24hr-10years-RP_hazard_maps.png
- 5_3_MERSIN_HEAVY_RAINFALL_24hr-100years-RP_hazard_maps.png
- 5_4_MERSIN_HEAVY_RAINFALL_3hr-10years-RP_hazard_maps.png
- 5_5_MERSIN_HEAVY_RAINFALL_3hr-100years-RP_hazard_maps.png
- 5_6_MERSIN_HEAVY_RAINFALL_genextreme_24_dist.png
- 5_7_ MERSIN_HEAVY_RAINFALL_expected_prec_24h_2041-2070_Mersin_MM

6_MCR-RA_Visual Outputs_Coastal Flooding.zip

- 6_1_MERSIN_COASTAL_FLOOD_hazard_assessment.ipynb
- 6_2_MERSIN_COASTAL_FLOOD_risk_asessment.ipynb
- 6_3_MERSIN_SILIFKE_COASTAL_FLOOD_sea-level-rise-map.png
- 6_4_MERSIN_COASTAL_FLOOD_Result_map_Mersin_2050_rp0100.png
- 6_5_MERSIN_LUISA_Land cover map.png
- 6_6_MERSIN_Storm Surge.png
- 6_7_MERSIN_COASTAL_FLOODING_Vulnerability Curve.png

MCR-RA_Communication Materials.zip

- 1_MERSIN_StakeholderMeeting_Aug2025_Presentation.pdf
- 2_MERSIN_StakeholderWorkshop_Report.pdf

During Phase 1, communication and outreach activities were actively conducted. Media posts, stakeholder announcements, and institutional updates were shared through Mersin Metropolitan Municipality's channels and EU partners (EU4EnergyTR, CLIMAAX). Highlights included:

- A **district-level wildfire risk case** for Gülnar was shared on social media and the local press.
- Public dissemination of **heatwave and drought risk maps**.
- Statements from Mersin MM's Climate Change Department emphasizing the importance of EU cooperation.

MCR-RA_Datasets Collected.zip

- 1_MGM_Daily_Temperature_Max_Min.xlsx
- 2_MGM_Daily_Precipitation_xlsx

- 3_MGM_Montly_Precipitation.xlsx
- 4_MGM_Official Letter_Projections_data_link_pdf
- 4_TAGEM_Regional Crop Coefficients and growing periods.pdf

These datasets were provided through the **MGM-Turkish State Meteorological Service**, and **TAGEM-Local Agricultural Research Institute**. Formal correspondence was exchanged for climate and agricultural datasets.

Zenodo Repository Uploads

All Phase 1 outputs are structured in the Zenodo repository as follows, uploaded in ZIP format for clarity and reuse:

1. Main Report – MCR-RA Phase 1 Deliverable
2. Visual Outputs – Hazard/risk maps, notebooks, charts (Heatwaves, Relative Drought, Agricultural Drought, Wildfires, Heavy Rainfall, Coastal Flooding)
3. Communication Materials – Stakeholder presentations, workshop reports, outreach documentation
4. Datasets – Climate, hydrological, and agricultural datasets (Excel/pdf)

All Phase 1 outputs, including the final report, are uploaded to the **CLIMAAX Zenodo community** and will remain accessible for transparency and replication.

Zenodo community and are accessible via the CLIMAAX community at:

https://doi.org/10.5281/zenodo.17052027

6 References

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Zenodo CLIMAAX Community: Phase 1 Outputs – Mersin Climate Ready (MCR-RA), available at: https://zenodo.org/communities/CLIMAAX, 2025.