ŞANLIURFA METROPOLITAN MUNICIPALITY

Climate Change Risk Analysis and Adaptation Strategies

(Revision II)

(Existing "Şanliurfa MM Climate Change Risk and Vulnerability Assessment Report-2022" was revised according to new P2R and and Clımaax Projects activities)

TARİHİN SIFIR NOKTASINDA SIFIR KARBON HAREKETİ

CLIMAAX climate ready regions

P2R PATHWAYS2RESILIENCE

ŞANLIURFA BÜYÜKŞEHİR BELEDİYESİ

Şanlıurfa Metropolitan Municipality

Climate Change and Zero Waste Department

April 2025

SANLIURFA METROPOLITAN MUNICIPALITY

Climate Change Risk

Analysis and Adaptation Strategies Report (Revision II)

Published by:

Mehmet DEMİR
Climate Change and Zero Waste Department Chairman

İbrahim Etem AKSOY
Climate Change Branch Manager

Dilek ERKAN- Abdullah İzzeddin KARABULUT
Environmental Engineer, Climate Change Branch

Tamer ATALAY- Hakan DUMAN- Soner ATALAY- İhsan TOPALLI
Project Consultants – ATALAY İklim-Plan Çevre Dan. Ve Müh. Hizm. Ltd. Şti
www.atalayconsulting.com

http://doi.org/10.5281/zenodo.15805274

ŞANLIURFA- April 2025

Table of Contents

Figures

Tables

Abbreviations and acronyms

AFAD	Turkish Disaster and Emergency Management Authority
CCAP	Climate Change Action Plan
CDP	Carbon Disclosure Project
CDS	Copernicus Data Store
CLIMAAX	Climate Adaptation and Risk Assessment Methodology
CRAS	Climaax Risk Assessments Implementation for the Şanlıurfa Region
ÇŞİDB	Ministry of Environment, Urbanization, and Climate Change
DRMKC	Disaster Risk Management Knowledge Centre
ET_0	Reference Evapotranspiration
GAEZ	Global Agro-Ecological Zones
GAP	Southeastern Anatolia Project
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
LST	Land Surface Temperature
MGM	Turkish General Directorate of Meteorology
NUTS	Nomenclature of Territorial Units for Statistics
P2R	Pathways to Resilience
PMP	Project Management Professional
RCP	Representative Concentration Pathways
SECAP	Sustainable Energy and Climate Action Plan
SMM	Şanlıurfa Metropolitan Municipality
SPEI	Standard Precipitation Evaporatıon Index
SSP	Shared Socioeconomic Pathways
UTCI	Universal Thermal Comfort Index
WASP	Weighted Anomaly of Standardized Precipitation
WP	Work Package
WHO	World Health Organization

EXECUTIVE SUMMARY

Climate Hazards, Risk and Vulnerability Analysis

Climate Hazards, Risk and Vulnerability assessment has been performed by means of surveys to define the climate hazards which have the most serious potential impact to the city services and inhabitants (Figure 1).

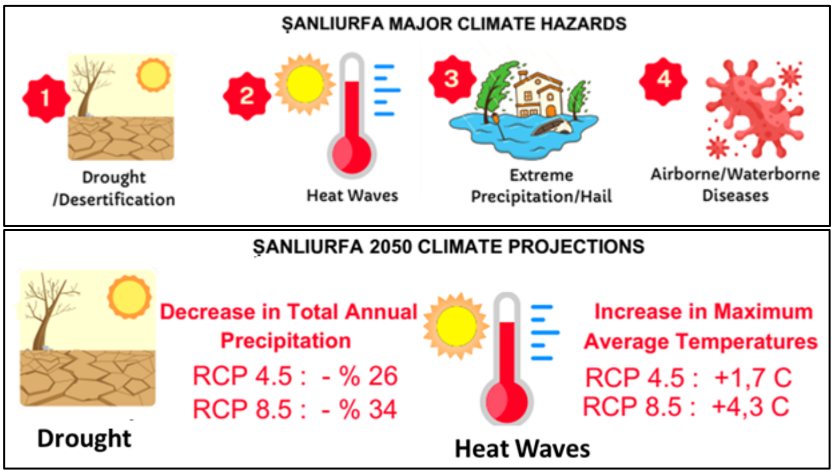

Figure 1: Şanlıurfa Major Climate Hazards and Şanlıurfa 2050 Climate Projections

Services or sectors with low adaptive capacity to potential future climate impacts in Şanlıurfa are shown in the chart below. In the chart, red areas indicate **vulnerable services** or sectors, and green areas indicate **resilient services** or sectors.

Climate Projections

To evaluate the future situation of drought and heat waves during the preparation of Şanlıurfa Climate Change Action Plan; HadGEM2-ES global data set family and RegCM4.3.4. regional climate model and Representative Concentration Pathways (RCP) scenarios were used. Among these scenarios, RCP 4.5 refers to the medium level of radiative forcing and global warming. RCP8.5 refers to the highest possible radiative forcing and the worst global warming scenario to be encountered in the future.

According to these projections, temperature increases of 2.1 - 2.7 ºC in the average monthly highest temperatures between 2050-2060, are expected, in line with the RCP4.5- RCP8.5 scenarios (according to the 2016-2021 base period). In the highest temperatures of the year, temperature rise will be around **1.7 - 4.3 ºC**. These situations will increase the frequency and severity of heat waves. if no adaptation action programme is implemented, heat waves may result catastrophic impacts on many sectors, especially on public health.

According to the RCP 4.5- RCP 8.5 scenarios, a decrease of **26% - 34%** is expected in the annual total precipitation. Decrease in the amount of precipitation may lead to increase drought hazard in the GAP region. Soil salinization may reach even more serious levels in the region if efficient irrigation systems are not implemented. Excessive irrigation will also increase the water consumption and energy needs.

Quantitative Risk and Vulnerability Analysis: CLIMAAX-CRAS Project

With a population exceeding 2.1 million and temperatures reaching a record 61°C, Şanlıurfa is one of the hottest and most climate-vulnerable regions in Türkiye. Covering approximately 19,000 km²—nearly half the size of the Netherlands—the province is in the Southeastern Anatolia Region and hosts up to 350,000 refugees. The region faces compounding challenges from heatwaves, agricultural drought, and socioeconomic fragility. This deliverable summarizes the Phase 1 results of the CRAS project, which applied the CLIMAAX common methodology to assess these interconnected climate risks and identify priority areas for adaptation.

The assessment focused on three CLIMAAX workflows: (1) urban heatwaves, (2) relative drought, and (3) agricultural drought. These workflows provided a structured analysis of risk severity, exposure, and vulnerability despite limitations in regional data availability. Şanlıurfa's location outside the Euro-CORDEX domain required methodological adaptation using Mediterranean climate model data and localized crop coefficients. Although detailed site-specific analysis will follow in Phase 2, the current phase offers a solid foundation for understanding the region's climate risk profile.

Key findings include:

Şanlıurfa has one of the highest heat stress values in Europe with an average of 130 UTCI days per year. According to the heat wave index, the city currently experiences approximately 80 heat waves, and this period is expected to increase to 100 days by 2050. The frequency of heat wave events is recorded as 8 to 10 times per year, and this frequency is expected to increase in the coming years. This trend, especially in densely populated urban areas, combined with high surface temperatures poses serious risks to public health. On the other hand, Şanlıurfa is also in a remarkable position in terms of drought risk. The relative drought risk is 4 out of 5, which is one of the highest levels in Turkey. While the WASP index reveals long-term precipitation deficiencies in the region, the annual evapotranspiration value of approximately 1650 mm, compared to an average annual precipitation of 350 mm, shows that agricultural production is largely dependent on irrigation. Heat waves pose a direct threat to public health with their sudden onset and temperatures exceeding 40°C in the summer months. Therefore, along with the identification of high-risk neighborhoods, urgent adaptation measures, especially solutions such as increasing green areas, should be put into effect. Drought is a risk that develops more slowly but has a long-lasting effect and is expected to create serious pressures on water resources and agricultural production, especially until 2050. It is predicted that yield losses of 32–40%, 33–42%, 10–25% and 24–36% may occur in products such as cotton, corn, wheat and pistachios when irrigation is not applied, respectively. In this context, it is of great importance to take early and decisive steps to increase water management and irrigation efficiency. Traditional surface irrigation methods should be abandoned and pressurized irrigation systems and digital agricultural technologies should be adopted. In addition, establishing effective drainage systems to remove accumulated salt in the soil, regularly monitoring irrigation water quality and informing farmers on these issues are among the main strategies recommended for sustainable agricultural production.

1. Climate Change Action Plan and City Context

1.1 Structure and Organization of CCAP Management

The preparation process of the Şanlıurfa Climate Change Action Plan (CCAP) began in February 2022 with CCAP Working Group training and was completed in October 2022 after an 8-month effort. The CCAP Working Group has been involved in all stages of the process and has managed the project. They have played roles in data collection for the greenhouse gas inventory, communication with stakeholders, conducting surveys for risk and vulnerability analyses, and organizing the stakeholder consultation workshop. The CCAP Report, prepared by Şanlıurfa Metropolitan Municipality with contributions from all city stakeholders and includes:

- The base year greenhouse gas inventory
- Risk and vulnerability assessment of current and future climate hazards
- Greenhouse gas and climate projections
- Mitigation scenario analyses
- Adaptation and mitigation action programs

The Greenhouse Gas Inventory studies were completed in April 2022, with inventory calculations performed separately for the years 2018, 2019, 2020, and 2021 using the GPC Protocol and CIRIS calculation tool. The detail level of the inventory is Basic+, and 2021 was chosen as the base year for the inventory.

For risk and vulnerability analyses, three separate surveys were conducted using the analysis method recommended by the Global Covenant of Mayors (GCoM). In the climate projections study, maximum temperatures and total annual precipitation parameters were obtained from the Turkish State Meteorological Service for the reference period covering 1970-2000 and the projection period covering 2016-1998. During the two-day stakeholder consultation meeting held in May, greenhouse gas inventory and climate risk and vulnerability analyses were evaluated, and action proposals for mitigation and adaptation were developed. A total of 152 mitigation action proposals and 75 adaptation action proposals were submitted by 94 stakeholder representatives from 37 different institutions (Table 1; Figure 2).

Table 1: CCAP Stakeholder Consultation Meeting Results

Şanlıurfa CCAP Stakeholder Engagement Workshop			
Workshop Roundtable Group	**Number of Participants**	**Mitigation Proposals**	**Adaptation Proposals**
Climate-Resilient Settlements and Living Spaces	14	33	15
Healthy Urban Life	13	6	5
Efficient Agriculture and Food Security	14	43	13
Clean Energy-Green Industry	13	7	7
Sustainable Water and Waste Management	13	24	6
Energy Efficient Carbon Zero Buildings	13	8	12
Green and Smart Urban Transportation	14	31	17
Total	**94**	**152**	**75**

Figure 2: Stakeholder Engegament Workshops - May 2022- February 2025

A new organizational change was made to manage the CCAP processes within the Şanlıurfa Metropolitan Municipality, establishing the Climate Change Branch under the Department of Climate Change and Zero Waste.

1.2 City Information

General city data related to CCAP processes are provided in the table 2 below:

Table 2: General Inventory Information of Şanlıurfa

City	ŞANLIURFA
Region	South-eastern Europe
Inventory Year	2021
Geographical Boundary	Geographical Boundaries of Şanlıurfa Province
City Area	19.220 km^2
Population[3]	2.143.020
Gross Domestic Product (GDP)[3]	42.770.000.000 TL (2020) ; 6,22 billion USD; 2901 $/capita
Economic Structure of the City[3]	Industry (19%), Services (17%), Agriculture (26%), Public (26%)
Land Use (Share of Turkey)	65% Agricultural Land (4.5% of Turkey's total)
City's Climate Classification[1]	Csa (Hot-summer Mediterranean climate)
Heating Degree Days (HDD)[2]	(2021) HDD = 1138 (T≤15ºC)
Cooling Degree Days (CDD)[2]	(2021) CDD = 1270 (T>22ºC)

2. Qualitative Risk and Vulnerability Assessment

2.1 Applied Methodology

The Global Covenant of Mayors for Climate and Energy - Common Reporting Framework was used for assessing climate risks. The Global Covenant of Mayors for Climate and Energy (GCoM) is the world's largest alliance of cities and local governments with a shared long-term vision to combat climate change and promote voluntary actions towards a low-emission, climate-resilient future.

Three surveys were conducted to assess potential climate hazards, current and future potential climate risks, their sectoral impacts including vulnerable populations. The survey forms were sent to the CCAP Working Group, all departments of the Metropolitan Municipality, and participants of the CCAP Stakeholder Workshop (online via Google Forms). The results were initially evaluated by the CCAP Working Group and subsequently at the CCAP Stakeholder Workshop held on May 25-26. The survey studies have aimed at the following objectives:

Survey 1: Şanlıurfa Climate Hazards: Identification of current and potential future climate hazards.

Survey 2: Climate Impacts: Evaluation of the adverse effects of climate hazards on urban service sectors and vulnerable community segments.

Survey 3: Vulnerability Analysis: Assessment of future climate hazards identified as critical for Şanlıurfa; adverse effects on service sectors, existing adaptive capacity, and sectoral vulnerabilities.

According to the survey results, risk and vulnerability analysis is presented in Tables 1, 2, and 3.

Climate Hazards and Impacts

Climate Hazards and Impacts Considering past events related to numerous climate hazards, potential risks for Şanlıurfa have been identified, excluding less probable hazards such as sea level rise, monsoon rains, and typhoons.

Evaluated Climate Hazards: Drought, Water stress, Increased water demand, Fire weather (risk of wildfires), Urban flooding, River flooding, Coastal flooding (incl. sea level rise), Hurricanes, cyclones, and/or typhoons, Extreme wind, Storm, Heavy precipitation, Mass movement, Biodiversity loss, Loss of green space/green cover, Soil degradation/erosion, Other forms of climate-induced landscape shift/degradation, Infectious disease

Evaluated Sectors or Services: Agriculture, Forestry, Fishing, Mining and quarrying, Manufacturing, Electricity, gas, steam and air conditioning supply, Water supply, Sewerage, waste treatment and remediation activities, Waste management, Administrative and support service activities, Public administration and defence; compulsory social security, Conservation, Construction, Wholesale and retail trade; repair of motor vehicles and motorcycles, Transportation and storage, Accommodation and food service activities, Information and communication, Financial and insurance activities, Real estate activities, Professional, scientific and technical activities, Education, Human health and social work activities, Arts, entertainment and recreation

Evaluated Vulnerable Community Segments: Women and girls, Children and youth, Elderly, Indigenous peoples, Marginalized/minority communities, Vulnerable health groups, Low-income households, Outdoor workers, Frontline workers, People with disabilities, migrants, small-scale producers Efforts have been made to determine the potential impacts of these hazards on sectors and vulnerable community segments. The potential impacts of evaluated climate hazards are described in the following table 3.

Table 3: Climate Hazards and Potential Impacts

Climate-Related Hazards	Impact Description	Most Exposed Sectors	Vulnerable Population Groups Most Exposed
Extreme Rainfall and Floods	Submersion of transportation lines, residential areas, and agricultural lands due to surface flooding caused by excessive rainfall	Food-Agriculture-Forestry, Transportation, Waste-Wastewater, Housing-Residential	Low-income households, Small-scale producers
Storms - Tornadoes	Roof damage to buildings due to excessive wind and storms. Damage to seedlings during flowering season	Transportation, Food-Agriculture-Forestry, Housing-Residential	Vulnerable health groups, Small-scale producers
Cold Wave / Frost Threat	Disruption of transportation due to severe winter conditions. Disruption in energy/water supply. Decrease in agricultural yield due to spring frosts	Food-Agriculture-Forestry, Transportation, Education, Public Health	Vulnerable health groups, Small-scale producers, Elderly
Extreme Heatwave / Heat Stress	Vital danger for chronic patients, elderly, and poor due to extreme heat. Forest fires due to extreme heat. Decrease in agricultural and livestock production	Food-Agriculture-Forestry, Public Health, Energy and Water Supply, Industry-Trade-Tourism	Elderly, Small-scale producers, Vulnerable health groups, Low-income households
Drought	Decrease in agricultural production, soil salinization due to excessive irrigation. Decrease in energy production and water reserves	Food-Agriculture-Forestry, Energy and Water Supply, Public Health, Industry-Trade-Tourism	Elderly, Vulnerable health groups , Small-scale producers, Low-income households
Soil Degradation / Desertification	Decrease in agricultural yield. Excessive fertilizer consumption	Food-Agriculture-Forestry, Energy and Water Supply, Industry-Trade-Tourism	Small-scale producers, Low-income households, Small-scale producers
Insect Infestation	Decrease in agricultural yield due to locust infestation	Food-Agriculture-Forestry, Public Health, Housing-Residential	Small-scale producers, Low-income households
Air and Waterborne Diseases	Vital danger for chronic patients and elderly due to diseases transmitted through air or water	Public Health, Food-Agriculture-Forestry, Emergency Management, Education	Elderly, Vulnerable health groups
Vector-borne Diseases	Vital danger for chronic patients and elderly due to diseases transmitted by insects and flies	Public Health, Emergency Management, Food-Agriculture-Forestry	Elderly, Vulnerable health groups
Wildfires	Decrease in forest areas. Fire and vital danger for settlements near forests. Decrease in bee and other insect populations. Vital danger for wild animals	Food-Agriculture-Forestry, Emergency Management, Energy and Water Supply, Housing-Residential	Vulnerable health groups
Hailstorms	Impact on fruit and vegetable production during flowering season due to excessive hail. Damage to vehicles due to excessive hail	Food-Agriculture-Forestry, Transportation	Small-scale Producers, Low-income households
Fog	Interruption of air traffic due to excessive fog	Transportation	Vulnerable health groups
Landslides	Disruption of transportation. Risk of collapse for buildings in landslide-prone areas	Buildings-Residential	Low-income households
Avalanches	Vital danger for residents or tourists. Disruption of transportation	Transportation, Tourism, Buildings-Residential	People with Disabilities

2.2 Climate Hazards and Current Risk Assessment

The potential climate hazards and their current risks in Şanlıurfa have been assessed through Survey 1. Accordingly, Drought, Extreme Heat Waves / Heat Island Effect, Soil Salinization / Desertification, Heavy Rainfalls and Floods, Hailstorms, and Airborne and Waterborne Diseases have been identified as the first priority climate hazards with serious or very serious impacts (Table 4; Figure 3).

Table 4: Climate Hazards Risk Assessment

Climate Hazards	Current Impact	Hazard Severity (m: 1-5)	Hazard Probability (p: 1-5)	Risk (m x p)
Heavy Rainfalls and Floods	Currently affecting the city	3 - Moderate	3 - Moderate	(9) Significant/Moderate
Storms and Tornadoes	Not currently affecting, potential future impact	2 - Low	1 - Low	(2) Not Serious/Low
Cold Wave / Frost Threat	Not currently affecting, potential future impact	2 - Low	2 - Low	(4) Not Serious/Low
Heat Wave / Heat Island Effect	Currently affecting the city	4 - High	5 - Very high	(20) Very Serious/High
Drought	Currently affecting the city	5 - Very high	4 - High	(20) Very Serious/High
Soil Salinization / Desertification	Currently affecting the city	4 - High	4 - High	(16) Very Serious/High
Insect Infestation	Not currently affecting, potential future impact	3 - Low	1 - Low	(3) Not Serious/Low
Airborne and Waterborne Diseases	Currently affecting the city	2 - Low	3 - Moderate	(6) Significant/Moderate
Vector-borne Diseases	Not currently affecting, potential future impact	3 - Moderate	1 - Very low	(3) Not Serious/Low
Fires	Not currently affecting, potential future impact	2 - Low	2 - Low	(4) Not Serious/Low
Hailstorms	Currently affecting the city	3 - Moderate	2 - Low	(6) Significant/Moderate
Fog	Not currently affecting, unlikely future impact	1 - Very low	1 - Very low	(1) Not Serious/Low
Landslides	Not currently affecting, unlikely future impact	2 - Low	1 - Very low	(2) Not Serious/Low
Avalanches	Not currently affecting, unlikely future impact	1 - Very low	2 - Low	(2) Not Serious/Low

Climate hazards have been assessed considering their severity and probability, and the assessment results are shown in the figure 3 below.

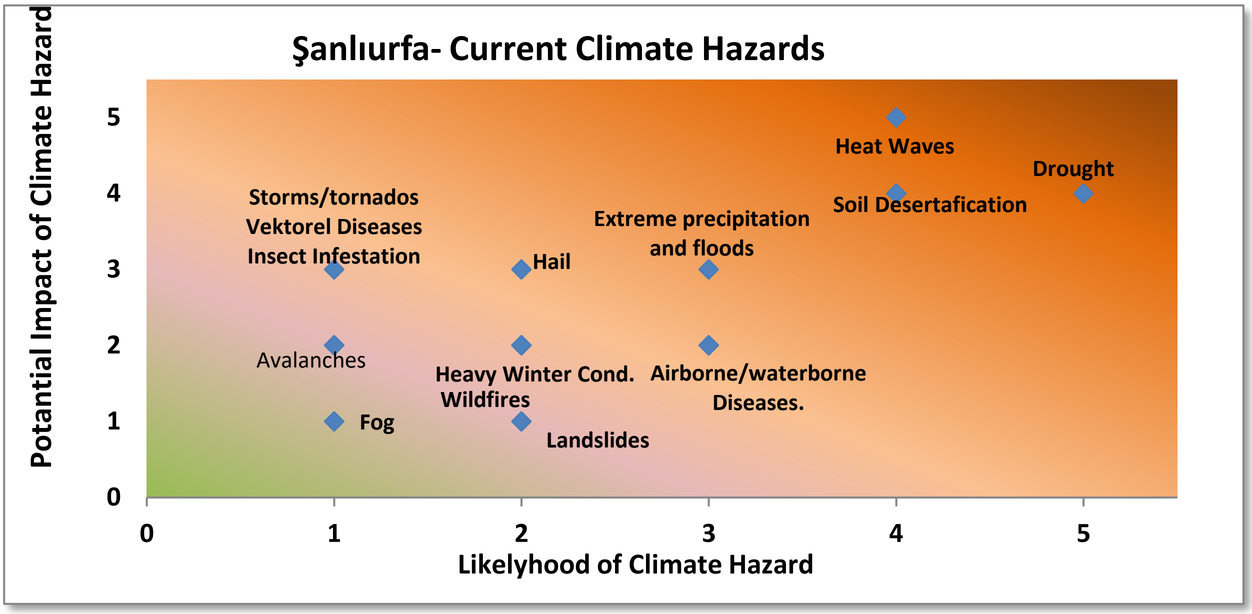

Figure 3: Current Status Climate Hazards Graph

2.3 Future Risk Assessment of Climate Hazards

The future status of climate hazards and their impacts on service sectors have been evaluated through Survey 1 and Survey 2 studies. The extent to which the primary climate hazards could affect service sectors is shown in the table 5 below.

Table 5: Sectoral Impacts of Climate Hazards

Primary Climate Hazards	Future Status of Hazard Severity	Future Status of Hazard Likelihood	Probable Time Scale of Hazard	Top 5 Most Affected Sectors	Future Potential Impact Severity
Drought	Expected to Increase	Expected to Increase	Medium-term (2026-2050)	Food, Agriculture, Forestry	Very Severe/High
				Energy and Water Supply	Severe/Medium
				Public Health	Not Severe/Low
				Industry-Trade-Tourism	Not Severe/Low
				Waste-Wastewater	Not Severe/Low
Extreme Heat Waves / Heat Island Effect	Expected to Increase	Expected to Increase	Medium-term (2026-2050)	Public Health	Very Severe/High
				Food, Agriculture, Forestry	Very Severe/High
				Energy and Water	Severe/Medium

				Supply	
				Industry-Trade-Tourism	Not Severe/Low
				Education	Not Severe/Low
Soil Salinization / Desertification	Expected to Increase	Expected to Increase	Medium-term (2026-2050)	Food, Agriculture, Forestry	Very Severe/High
				Energy and Water Supply	Not Severe/Low
				Industry-Trade-Tourism	Not Severe/Low
				Public Health	Not Severe/Low
				Education	Not Severe/Low
Heavy Rainfalls and Floods	Expected to Increase	Expected to Stay the Same	Medium-term (2026-2050)	Food, Agriculture, Forestry	Severe/Medium
				Transportation	Severe/Medium
				Waste-Wastewater	Severe/Medium
				Energy and Water Supply	Severe/Medium
				Housing-Settlements	Severe/Medium
Hailstorms	Expected to Increase	Expected to Stay the Same	Medium-term (2026-2050)	Food, Agriculture, Forestry	Severe/Medium
				Transportation	Severe/Medium
				Waste-Wastewater	Not Severe/Low
				Energy and Water Supply	Not Severe/Low
				Housing-Settlements	Not Severe/Low
Airborne and Waterborne Diseases	Expected to Increase	Expected to Stay the Same	Medium-term (2026-2050)	Public Health	Severe/Medium
				Housing-Settlements	Severe/Medium
				Emergency Management	Severe/Medium
				Food, Agriculture, Forestry	Not Severe/Low
				Education	Not Severe/Low

Sectoral Vulnerability Analysis Against Climate Hazards

The adaptive capacities of service sectors against primary (major) climate hazards were evaluated through Survey 3. Sectors resilient or vulnerable to these prioritized hazards were identified and shown in the table 6 and figure 4 below. The assessment was based on the potential future impacts

(PI) of climate hazards on the service/sector and the current adaptive capacity (AC) of the service or sector. The evaluation criteria are defined as follows:

Potential Impact (PI)

- **PI1** - Very Low: Sector/Service is Not Affected.
- **PI2** - Low: Sector/Service May interrupt Temporarily
- **PI3** - Medium: Sector/Service Shows Tendency to Deteriorate.
- **PI4** - High: Sector/Service Disrupt.
- **PI5** - Very High: Sector/Service Collapse. Unmanageable.

Adaptive Capacity (AC)

- **AC1** - Very High: No Improvement Needed for Adaptation.
- **AC2** - High: Additional Improvement May Be Necessary.
- **AC3** - Medium: Additional Investment Required for Adaptation.
- **AC4** - Very Low: High Investment Required for Adaptation.
- **AC5** - None: Very High Investment Required for Adaptation.

Table 6: Sectoral Vulnerability Analysis

Primary Climate Hazards	**Most Affected 5 Sector/Service**	**Potential Impact on Sector** **PI1 - PI5 (Low - High)**	**Sector's Adaptive Capacity** **AC1 - AC5 (Low – High)**
Drought	Food, Agriculture, Forestry	PI3 - Sector/Service Shows Tendency to Deteriorate.	AC5 – Very High investment required.
	Energy and Water Supply	PI3 - Shows a tendency to deteriorate.	AC2 - Additional investment needed for adaptation.
	Public Health	PI2 - Low: Sector/Service May interrupt Temporarily	AC2 - Additional improvements may be necessary.
	Industry-Trade-Tourism	PI2 - Sector/Service May interrupt Temporarily	AC2 - Additional improvements may be necessary.
	Waste-Wastewater	PI1 - Service not affected.	AC2 - Additional improvements may be necessary.
Heatwaves / Heat Island	Public Health	PI5 - Service stops. Unmanageable.	AC4 - High investment required.
	Food, Agriculture, Forestry	PI4 - High: Sector/Service Disrupt.	AC3 - Additional investment needed for adaptation.
	Energy and Water Supply	PI3 - Shows a tendency to deteriorate.	AC2 - Additional improvements may be necessary.
	Industry-Trade-Tourism	PI2 - Low: Sector/Service May interrupt Temporarily	AC2 - Additional improvements may be necessary.
	Education	PI2 - Low: Sector/Service May interrupt Temporarily	AC4 - Additional improvements may be necessary.
Soil Salinization / Desertification	Food, Agriculture, Forestry	PI4 - High: Sector/Service Disrupt.	AC4 - High investment required.

	Energy and Water Supply	PI2 - Low: Sector/Service May interrupt Temporarily	AC2 - Additional improvements may be necessary.
	Industry-Trade-Tourism	PI1 - Sector not affected.	AC2 - Additional improvements may be necessary.
	Public Health	PI1 - Service not affected.	AC1 - No need for improvement.
	Education	PI1 - Service not affected.	AC1 - No need for improvement.
Heavy Rainfall (rain / snow) and Floods	Waste-Wastewater	PI5 - Service stops. Unmanageable.	AC4 - High investment needed for adaptation.
	Food, Agriculture, Forestry	PI4 - High: Sector/Service Disrupt.	AC2 - Additional improvements may be necessary.
	Transportation	PI3 - Shows a tendency to deteriorate.	AC2 - Additional improvements may be necessary.
	Energy and Water Supply	PI2 - Low: Sector/Service May interrupt Temporarily	AC3 - Additional investment needed for adaptation.
	Residential Areas	PI3 - Shows a tendency to deteriorate.	AC3 - Additional investment needed for adaptation.
Hail	Food, Agriculture, Forestry	PI4 - High: Sector/Service Disrupt.	AC2 - Additional improvements may be necessary.
	Transportation	PI3 - Shows a tendency to deteriorate.	AC2 - Additional improvements may be necessary.
	Waste-Wastewater	PI2 - Low: Sector/Service May interrupt Temporarily	AC2 - Additional improvements may be necessary.
	Energy and Water Supply	PI1 - Service not affected.	AC2 - Additional improvements may be necessary.
	Residential Areas	PI1 - Service not affected.	AC1 - No need for improvement.
Airborne and Waterborne Diseases	Public Health	PI4 - High: Sector/Service Disrupt.	AC3 - Additional investment needed for adaptation.
	Residential Areas	PI4 - High: Sector/Service Disrupt.	AC2 - Additional improvements may be necessary.
	Emergency Management Methods	PI3 - Shows a tendency to deteriorate.	AC2 - Additional improvements may be necessary.
	Food, Agriculture, Forestry	PI1 - Sector not effected.	AC1 - No need for improvement.
	Education	PI2 - Low: Sector/Service May interrupt Temporarily	AC2 - Additional improvements may be necessary.

The low adaptation capacity (vulnerable) services or sectors to future potential climate impacts in Şanlıurfa are shown in the following graph. In the graph, red areas represent **vulnerable** services or sectors, while green areas indicate **resilient** services or sectors (Figure 4).

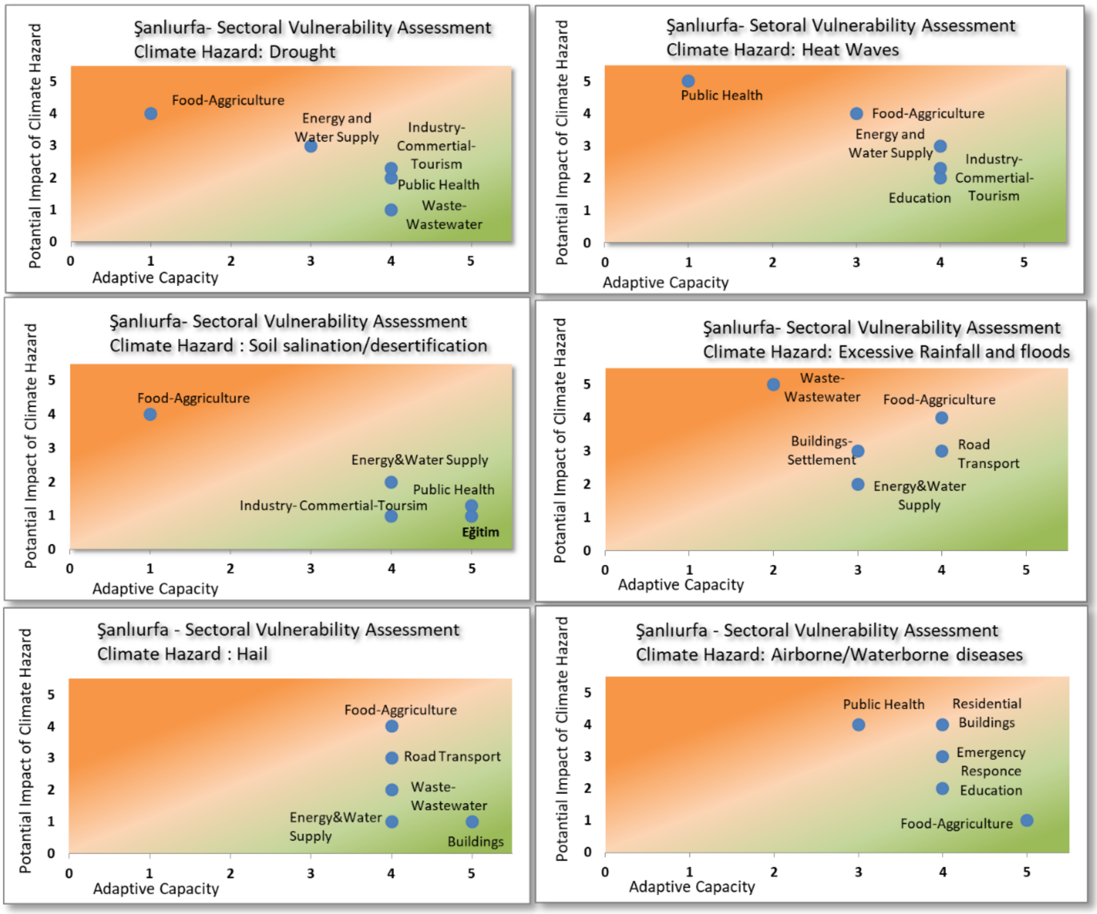

Figure 4: Şanlıurfa Sectoral Vulnerability Assessment Climate Hazards

2.4 Şanlıurfa Climate Projections

To be prepared for the consequences of climate change and to minimize its adverse effects, it is essential to predict how observed changes and trends in climate will unfold in the future, and to determine their impacts on natural and human systems. Understanding observed and past climates and forecasting future climates involves utilizing models that mathematically represent components of the climate system, their interactions, and feedback.

In preparing the Şanlıurfa Climate Action Plan, data from the HadGEM2-ES global dataset family, along with the RegCM4.3.4 regional climate model and Representative Concentration Pathways (RCP) scenarios, were used to evaluate future conditions of drought and heat waves. Among these scenarios, **RCP4.5** represents moderate radiative forcing and global warming levels, while **RCP8.5** represents the highest likely radiative forcing and worst-case global warming scenario.

For climate projection, data were obtained from the General Directorate of Meteorology according to the following scope:

Dataset:

- Global Climate Model: HadGEM2-ES
- Regional Climate Model: RegCM4.3.4
- Scenario: RCP4.5, RCP8.5

Parameters:

- Maximum Temperature (°C)
- Total Precipitation (mm)

Period:

- 2016-2098 (Future Period)
- 1971-2000 (Reference Period)

The averages of model data for a total of 48 coordinate points within the boundaries of Şanlıurfa province are shown in the table 7 and 8 below:

Table 7: Climate Projection Data for Reference Period and Future Period

Reference Period Parameter Data						
Reference Period	**Monthly Average Max. Temperatures,T °C**		**Highest Temperatures of the Year, T °C**		**Annual Total Precipitation, mm**	
1971-1980	21,07		41,27		465,7	
1981-1990	21,28		41,16		384,2	
1991-2000	21,50		41,46		471,6	
Future Period Parameter Data						
Future Period	**Monthly Average Max. Temperatures, T °C**		**Highest Temperatures of the Year, T °C**		**Annual Total Precipitation, mm**	
	RCP4.5	**RCP8.5**	**RCP4.5**	**RCP8.5**	**RCP4.5**	**RCP8.5**
2016-2021	22,38	22,64	43,07	42,47	500,7	489,1
2021-2030	23,14	23,25	43,81	43,71	401,0	424,6
2031-2040	23,97	24,15	44,51	44,78	337,9	386,9
2041-2050	24,17	24,74	44,80	45,42	363,9	344,9
2051-2060	24,45	25,38	44,78	46,78	377,7	329,9
2061-2070	25,15	26,50	45,59	46,67	304,4	295,9
2071-2080	24,91	26,83	45,33	47,97	387,1	355,5
2081-2090	25,18	27,47	46,52	48,50	369,3	382,4
2091-2099	25,57	28,27	45,81	50,00	281,1	323,7

Table 8: Climate Projections

1990-2000 Period Projections (Increase or Decrease)						
Future Period	**Increase in Average Monthly Maximum Temperatures T °C**		**Increase in Annual Maximum Temperatures T °C**		**Decrease in Annual Total Precipitation %**	
	RCP4,5	**RCP8,5**	**RCP4.5**	**RCP8.5**	**RCP4.5**	**RCP8.5**
2016-2021	+0,88 °C	+1,14 °C	+1,61 °C	+1,01 °C	+% 6,2	+%3,7
2021-2030	+1,64 °C	+1,75 °C	+2,35 °C	+2,25 °C	-%15,0	-%10,0
2031-2040	+2,47 °C	+2,65 °C	+3,05 °C	+3,32 °C	-%28,4	-%18,0
2041-2050	+2,67 °C	+3,24 °C	+3,34 °C	+3,96 °C	-%22,8	-%26,9
2051-2060	+2,95 °C	+3,88 °C	+3,32 °C	+5,32 °C	-%19,9	-%30,0
2061-2070	+3,65 °C	+5,00 °C	+4,13 °C	+5,21 °C	-%35,5	-%37,3
2071-2080	+3,41 °C	+5,33 °C	+3,87 °C	+6,51 °C	-%17,9	-%24,6
2081-2090	+3,68 °C	+5,97 °C	+5,06 °C	+7,04 °C	-%21,7	-%18,9
2091-2099	+4,07 °C	+6,77 °C	+4,35 °C	+8,54 °C	-%40,4	-%31,4

The modelling study shows projections for temperature and precipitation parameters between the Reference Period 1991-2000 and the Future Period, as presented in Table 7 and Table 8. Between 2050-2060, average monthly maximum temperatures are expected to increase by **2,1 – 2,7°C** under **RCP4.5** and **RCP8.5** scenarios compared to the 2016-2021 period. Similarly, annual maximum temperatures are projected to increase by **1,7 – 4,3°C**. These temperature increases are likely to significantly increase the frequency and intensity of heat waves, potentially leading to severe adverse effects across various sectors, particularly public health, if no preventive measures are taken.
In terms of annual total precipitation, a decrease of approximately **26% - 34%** is expected under **RCP 4.5** and **RCP 8.5** scenarios. This reduction in precipitation could exacerbate the risk of drought in the Sanliurfa region, lead to a greater need for irrigation, transition to efficient irrigation systems, and escalate the seriousness of soil salinization and desertification due to less water availability. Moreover, it may further increase water consumption and energy demand (Figure 5).

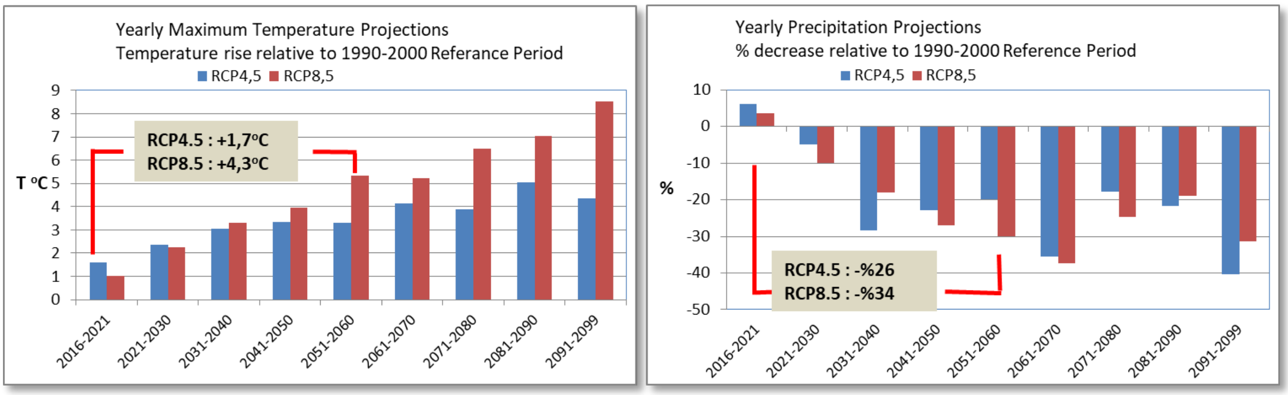

Figure 5: Extreme Temperature and Drought Projections

3. Quantitative Risk Assessment: Climaax- CRAS Project

3.1 Background

Şanlıurfa is near the Syrian border in the Southeastern Anatolia Region of Türkiye. Covering an area of approximately 19,000 km² (nearly half the size of the Netherlands), it has a population exceeding 2.1 million, including up to 350,000 Syrian refugees. Şanlıurfa is characterized by rapid population growth, low GDP per capita (€2,700), and limited access to technical and financial resources. These socioeconomic challenges heighten the region’s vulnerability to climate risks, particularly heatwaves, drought, and sporadic floods.

The region's hot and dry desert climate (Köppen-Geiger climate classification Csa) exacerbates its exposure to extreme weather events. Average summer temperatures often exceed 40°C. Annual HDD and CDD values were realized as 1122 and 1383, respectively, in 2024. The region has the worst Universal Thermal Comfort Index in Europe (High UTCI days is around 130 per year) (Figure 6). Şanlıurfa region has a Relative Drought Risk of 4 over 5, which means the highest drought risk in Türkiye. SPEI12 Index of Şanlıurfa indicates that the region has encountered several extreme drought seasons over the past two decades. Turkish General Directorate of Meteorology’s (MGM) projections indicate that annual precipitation is expected to decrease by 26% (in RCP4.5) to 34% (in RCP8.5) by 2050-2060. Additionally, Şanlıurfa’s agricultural sector, comprising 26% of its economy, is highly susceptible to climate variability, threatening food security, livelihoods and natural resources.

The Climaax Risk Assessments Methodology Implementation for the Region Şanlıurfa (CRAS) project aims to address these pressing challenges by applying the CLIMAAX common methodology framework. The project will focus on conducting a multi-risk climate assessment with a specific emphasis on the two most significant climate hazards for the region:

1. **Heatwaves:** Increasing temperatures severely threaten public health, agricultural productivity and urban infrastructure. Vulnerable groups, such as refugees, outside workers, low-income populations and elderly residents, are particularly at risk due to cooling energy poverty and limited green spaces (4.6 m² per capita, compared to the WHO's minimum recommendation of 9 m² per capita).
2. **Drought:** The region has experienced extreme drought conditions four times between 2008 and 2017, with a 13% reduction in rainfall compared to the GAP region average. Projections indicate a continued decline in annual precipitation, accelerating desertification, salinization of soils, and loss of agricultural land (16.6% reduction over the last decade).

In the CRAS project, **we will apply three specific workflows** within the CLIMAAX framework to address these critical climate hazards, ensuring that risk assessments are accurate, localized, and actionable. The **Heatwave** workflow will analyze expected heat wave occurrence, frequency and duration in future, vulnerable populations, and adaptation measures, while the **Relative Drought** and **Agricultural Drought** workflows will focus on expected future yield losses of several crops in case of artificial irrigation deficit. The results of workflows will provide quantitative data to develop sustainable water management for food security and resilient urban planning for public health. By implementing this approach, the CRAS project will enhance local climate resilience and provide a model for other municipalities in the Southeastern Anatolia Region, contributing to broader regional and national climate adaptation goals (Figure 6).

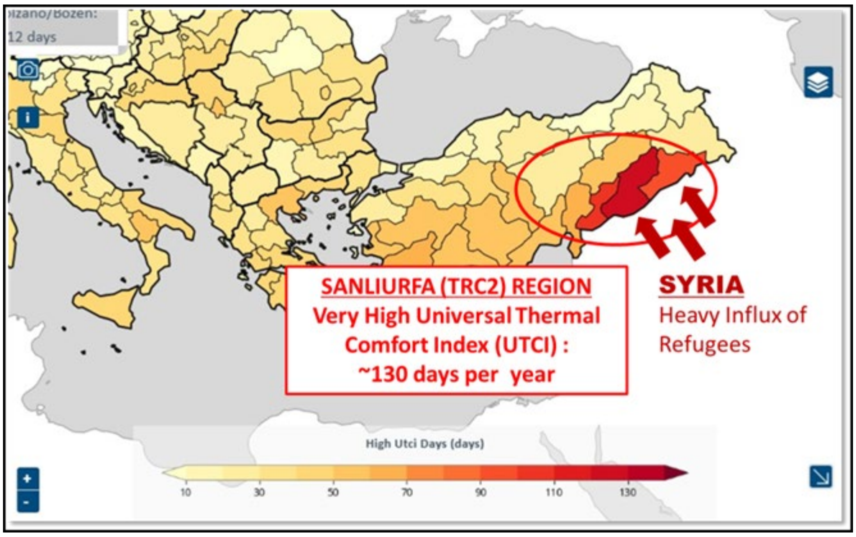

Figure 6: Geographic Location of Şanlıurfa

3.1.1 Main objectives of the project

The CRAS project delivers a high-resolution climate risk assessment for Şanlıurfa, focusing on heatwaves and drought, to inform local adaptation planning in line with the CLIMAAX methodology. To achieve this, the project applies the CLIMAAX methodology through three targeted workflows:

1. **Heatwaves** – Assessing temperature trends, vulnerable populations, and potential adaptation measures.
2. **Relative Drought** – Evaluating current and projected drought risk under different climate scenarios.
3. **Agricultural Drought** – Estimating yield losses for key crops (wheat, maize, cotton, pistachio) under irrigation deficit conditions.

The project also aims to:

- Identify vulnerable sectors and social groups, including low-income households, farmers, refugees, and the elderly.
- Disseminate findings through training sessions and stakeholder engagement activities.
- Provide reliable data to support the development of local adaptation strategies and integration into municipal policies.

The application of the CLIMAAX Handbook brings several key benefits to Şanlıurfa. It enables a standardized and high-resolution climate risk assessment, ensuring adaptation strategies are based on consistent and comparable data. By connecting with the wider CLIMAAX community, the project gains access to best practices and methodological support, strengthening the quality of local assessments. It also promotes sustainable data management and public engagement, encouraging long-term capacity building. Ultimately, this approach positions Şanlıurfa as a pioneer municipality in Türkiye's climate adaptation landscape, offering a replicable model for other regions.

3.1.2 Project team

The CRAS project team is composed of a multi-disciplinary group of professionals, combining local expertise, technical skills, and project management capabilities. The team structure ensures a holistic approach to climate risk assessment and adaptation, supported by CLIMAAX mentors for methodological alignment.

Key Team Members and Roles:

1. **Şanlıurfa Metropolitan Municipality (SMM)** leads the project through its Climate Change and Zero Waste Department, involving environmental experts, IT and GIS specialists responsible for data collection, risk assessment, and integration of CLIMAAX tools.
2. **Atalay Climate Consulting** provides project management and technical support, including workflow implementation, stakeholder coordination, and reporting, led by a PMP-certified project manager.

Local institutions such as **Harran University**, the **Karacadağ Development Agency**, and various **municipal departments** have been **informed and invited to contribute** to the project through knowledge-sharing and feedback opportunities. While formal partnerships are not established, their potential support is considered valuable for aligning the project with regional priorities. More than **150 stakeholders**—including local authorities, NGOs, and representatives of vulnerable communities—have been **engaged through information-sharing events and workshops** to encourage participation and future collaboration.

3.1.3 Outline of the document's structure

This deliverable follows the structure defined in the CLIMAAX Handbook and template, presenting the Phase 1 climate risk assessment results for Şanlıurfa.

- **Introduction** provides background information on Şanlıurfa, outlines the project's objectives, describes the project team, and introduces the document structure.
- **Climate Risk Assessment – Phase 1** details the implementation of selected workflows (Urban Heatwave, Relative Drought, Agricultural Drought). It covers scoping, risk exploration, risk analysis, and preliminary findings, including severity, urgency, and adaptive capacity.
- **Conclusions** summarize the main outcomes of Phase 1 and the implications for Şanlıurfa's climate resilience efforts.
- **Progress Evaluation and Contribution to Future Phases** reviews the progress against Key Performance Indicators (KPIs) and outlines next steps for Phase 2 and Phase 3.
- **Supporting Documentation** lists relevant background studies, visual materials, and datasets that support the findings and ensure transparency.

3.2 Climate risk assessment – phase 1

3.2.1 Scoping

The scoping process in Şanlıurfa is focused on:

- Addressing the most significant climate hazards, specifically heatwaves and drought.
- Defining the governance and policy context that will influence risk management strategies.

- Engaging local authorities, community representatives, NGOs, and vulnerable groups to foster a collaborative approach to climate adaptation.

3.2.1.1 Objectives

Şanlıurfa Metropolitan Municipality (SMM) has set an overall target to become “climate neutral” and “climate resilient” city by 2050. To achieve this target, SMM has started to implement, review and update the Sustainable Energy and Climate Action Planning (SECAP) process, which has three main pillars “mitigation, “ adaptation “ and “energy poverty”.

The first climate hazard assessments after 2022 lacked sufficient spatial and temporal resolution. The CRAS project uses the CLIMAAX method to locally and quantitatively analyze the risks of heatwaves and droughts in Şanlıurfa.

Objective, Purpose, and Expected Outcome

- Objective: To apply the CLIMAAX common methodology for multi-risk assessment at the NUTS3 level, supporting Şanlıurfa’s long-term adaptation and resilience goals.
- Purpose: To generate high-resolution, evidence-based insights into climate risks, enabling informed decision-making and funding applications at national and international levels.
- Expected Outcomes: i) Enhanced understanding of climate risks, particularly regarding heatwaves and drought. ii) Identification of vulnerable groups, including elderly >65 years old, children < 5 years, low-income communities, farmers, and refugees. iii) Informed policy development, enabling the integration of risk assessment data into local adaptation strategies and risk management plans. iv) Improved stakeholder engagement through training sessions and dissemination activities.

Contribution to Policy and Decision Making

The CRAS project's findings will directly support policy and decision-making processes by:

- Providing local authorities with spatial and temporal risk assessment data to shape urban planning, water management, and public health strategies.
- Enabling the integration of CLIMAAX tools into existing policies, ensuring sustainability and continuous improvement.
- Supporting the Şanlıurfa Metropolitan Municipality’s (SMM) Climate Change and Zero Waste Department in aligning with national and EU climate objectives, including the Global Covenant of Mayors for Climate and Energy, which Şanlıurfa joined in 2022.

Limitations and Boundaries of the Climate Risk Assessment

While the CRAS project aims to provide a thorough risk assessment, there are several limitations and boundaries to consider:

1. Data Availability:

- Challenges: Şanliufa (TRC2) region is out of the Euro-Cordex domain. The current “crop-table” doesn’t include two other main crops of our Region: cotton and pistachio
- Countermeasure 1: This challenge was solved by modifying the repositories and applying the “Mediterranean” domain’s Global and Regional Climate Models for Heatwave-Xclime and Agricultural Drought workflows. However, applying the Heatwave-Euroheat workflow was impossible as it requires only the Euro-Cordex domains' data set.
- Countermeasure 2: The Regional Crop_Table was prepared based on local crop coefficients. SMM has also reported an essential bug to CLIMAAX in Agricultural Drought to prevent incorrect results. The workflow was revised, and all users were informed.

2. Stakeholder Involvement:

- Challenges: Ensuring the engagement of all relevant stakeholders, including vulnerable communities and private sector representatives.
- Countermeasures: Conducting three targeted training sessions involving 150 stakeholders and ensuring transparent communication throughout the project phases.

3. Resource Constraints:
   - Challenges: Limited technical and financial resources within the Şanlıurfa Metropolitan Municipality, impacting data collection and analysis capacity.
   - Adaptation Strategy: Collaboration with Atalay Climate Consulting and leveraging CLIMAAX mentorship for methodological support.
4. External Influences:
   - Challenges: Regional geopolitical factors, including proximity to Syria, may influence data collection and stakeholder engagement.
   - Countermeasures: Establishing flexible project management practices and maintaining strong communication channels with international organizations operating in the region.

3.2.1.2 Context

Assessment and Management of Climate Hazards in Şanlıurfa
Şanlıurfa has long faced climate hazards—particularly heatwaves and drought—due to its hot, dry climate and water-stressed agricultural economy. In 2022, the Şanlıurfa Metropolitan Municipality (SMM) published a Climate Change Risk and Vulnerability Assessment Report, which included qualitative surveys and historical climate event analysis. However, these efforts lacked sufficient spatial and temporal resolution and did not fully integrate stakeholder input or quantitative risk analysis. The CRAS project builds upon this foundation using the CLIMAAX methodology to provide a proactive, standardized, and localized climate risk assessment, enabling better-informed adaptation strategies.

Problem Statement and Broader Development Context
Şanlıurfa's increasing climate vulnerability stems from the interplay of environmental and socioeconomic factors: rapid population growth, the highest birth rate in Türkiye, limited infrastructure, hosting approximately 350,000 refugees, and a low GDP per capita (€2,700). These dynamics amplify the region's sensitivity to extreme heat and chronic water scarcity.
The province is also part of the Southeastern Anatolia Project (GAP), which has enhanced agricultural productivity and significantly increased water demand, intensifying drought risks. At the national level, Türkiye's evolving climate policies—including alignment with the EU Green Deal and Horizon Europe frameworks—emphasize integrated risk assessment and local adaptation, positioning Şanlıurfa's efforts as highly relevant to broader regional and national resilience goals.

Governance Context
SMM established a Climate Change and Zero Waste Department in 2022, supported by 10 technical staff and guided by a Climate High Council and interdepartmental working group. Şanlıurfa is also a signatory of the Global Covenant of Mayors for Climate and Energy (GCoM) and actively implements its SECAP.

At the national level, climate adaptation in Türkiye is guided by:

- The National Climate Change Adaptation Strategy and Action Plan (2024–2030) encourages integrated risk assessments and the development of local adaptation strategies.
- The Climate Law of Türkiye provides the legal foundation for municipalities to implement climate action.

- The Integrated Disaster Risk Reduction Plan (IRAP) developed by the Disaster and Emergency Management Authority (AFAD) aims to enhance preparedness and response to natural hazards, including those induced by climate change.
- EU Integration: The CRAS project aligns with the CLIMAAX methodology, contributing to EU climate resilience initiatives, such as the Pathways2Resilience (P2R) project.

Relevant Sectors and Potential Impacts of Climate Change

The most climate-relevant sectors in Şanlıurfa include **agriculture**, **water supply**, **health**, **infrastructure**, and **energy**. A sectoral vulnerability analysis conducted via surveys revealed that agriculture and water supply are highly sensitive to heatwaves and droughts, particularly due to the region's dependence on irrigation. Public health is also at risk, especially among vulnerable groups during extreme heat events. Infrastructure and energy services face challenges from increased cooling demand, water scarcity, and potential damage from extreme weather.

External Influences on Climate Risks

Several external influences may impact Şanlıurfa's climate resilience efforts, including:

- The Southeastern Anatolia Project (GAP): While GAP promotes economic growth, it also increases water demand, potentially exacerbating drought risks.
- Regional Conflicts: The proximity to Syria introduces geopolitical challenges, influencing resource allocation, population dynamics, and stakeholder engagement.
- EU and International Projects: Collaboration with EU-funded projects like Pathways2Resilience (P2R) and Horizon Europe initiatives provides opportunities for capacity building, data sharing, and methodological alignment.

Potential Adaptation Interventions

The CRAS project supports and complements adaptation priorities outlined in Şanlıurfa's Climate Change Action Plan by promoting actions aligned with the CLIMAAX Handbook.

These include:

1. Water Management Strategies
    - Adoption of efficient irrigation techniques and structural transition to modern irrigation systems.
    - Reduction of water losses and promotion of demand management solutions.
    - Development of rainwater harvesting, reuse systems, and preventive measures to protect water resources.
2. Urban Heat Mitigation and Resilient Urban Planning
    - Expansion of urban green areas to meet international standards.
    - Climate-resilient settlement planning and enforcement of infrastructure to support population pressures.
    - Establishment of shaded public spaces and cooling infrastructure to address extreme heat.
3. Capacity Building and Community Resilience
    - Emergency preparedness and proactive systems to manage surface floods and extreme events.
    - Training and awareness-raising activities for communities and municipal staff.
    - Programs to protect vulnerable groups from climate impacts.
4. Sustainable Agriculture and Food Systems
    - Research and rehabilitation to prevent soil salinization and desertification.
    - Promotion of sustainable, organic agriculture and localized food systems.

5. Mainstreaming CLIMAAX Tools

- Integration of CLIMAAX workflows into municipal planning and decision-making processes to support long-term resilience and scalable adaptation planning.

3.2.1.3 Participation and risk ownership

The CRAS project prioritizes a comprehensive stakeholder engagement strategy, ensuring diverse groups are actively involved in the climate risk assessment process.

First Steps in Stakeholder Involvement
Initial stakeholder mapping identified actors from local government, academia, NGOs, the private sector, and community groups. The engagement strategy included:

- An internal workshop in October 2024 with municipal departments and technical staff to review preliminary findings.
- A large-scale regional stakeholder meeting in February 2025 with over 150 participants from public institutions, NGOs, universities, and international organizations.
- Ongoing communication channels, including training sessions, social media updates, and newsletters.

Relevant Stakeholders for the CRAS Project
The CRAS project engages a broad spectrum of stakeholders, categorized as follows Table 9:

Table 9: Relevant Stakeholders for the CRAS Project

Stakeholder Group	Role and Contribution
Government Institutions	Şanlıurfa Metropolitan Municipality, Provincial Directorates of Environment, Agriculture, Health, Education, Social Services, State Hydraulic Works (DSI). Institution of South Anatolian Project Agricultural Research and Training Center (GAPTAEM), Disaster and Emergency Management Authority (AFAD), General Directorate of Meteorology (MGM), Karacadağ Regional Development Agency, Şanlıurfa Water and Wastewater Works (ŞUSKİ)
Non-Governmental Organizations	Local and regional NGOs, including the Chamber of Environmental Engineers, Chamber of Agricultural Engineers, Chamber of Urban Planners, Regional Irrigation Unions, Foundation of Combating Erosion (TEMA), other environmental groups and community associations.
Academia	Harran University, contributing research expertise, student involvement, and data analysis support.
Private Sector	Local businesses, particularly in agriculture, water management, and urban development: Chamber of Şanlıurfa Industry and Commerce,
Community Representatives	Engagement with vulnerable groups, including low-income families, farmers, and refugee communities.
International Organizations	Collaboration with EU-funded projects, such as Pathways2Resilience (P2R), to share best practices and enhance capacity building.

Priority Groups and Vulnerable Areas
The CRAS project focuses on priority groups and vulnerable areas, including:

- Low-Income Communities: Particularly those affected by heatwaves, living in urban areas with limited green spaces.
- Farmers and Agricultural Workers: Exposed to heatwaves and drought risks due to high dependence on irrigation and variable rainfall patterns.

- Refugee Populations: Approximately 350,000-400,000 Syrian refugees who may have limited access to resources and infrastructure resilience.
- Elderly>65, Children>5 and Health-Vulnerable Individuals: At higher risk during heatwaves, requiring targeted public health measures.

Risk Ownership Regulation

Risk ownership within the CRAS project is clearly defined to ensure accountability and efficient management, following the CLIMAAX Handbook's guidelines:

- Şanlıurfa Metropolitan Municipality (SMM): Leads the overall project management, policy integration, and risk communication. Şanlıurfa Metropolitan Municipality (SMM) has established "The Climate Change and Zero Waste Department" to effectively manage climate change related issues by decision number 683 dated 15/12/2022.
- Provincial Directorates: Take ownership of sector-specific risks, such as environment and climate change, health, agriculture, education, tourism and water management.
- Local NGOs and Community Leaders: Act as intermediaries, helping to communicate risks to vulnerable populations and gather feedback.
- Private Sector: Engages in adaptation strategies, particularly in agriculture and urban development.

This structured risk ownership model aligns with local governance frameworks, enhancing the implementation of adaptation measures and ensuring sustainability (Figure 7).

Figure 7: Şanlıurfa Stakeholder Engagement Meetings realized in CRAS Project

Acceptable Risk Levels for the Community

During initial stakeholder consultations, a preliminary risk tolerance assessment was conducted, revealing:

- Heatwaves: The community accepts the risk of short-term heatwaves but prioritizes reducing impacts on vulnerable groups, such as elderly and refugees.
- Drought: High concern among farmers and water management authorities, indicating a low tolerance for prolonged drought periods and a strong demand for proactive measures.

Communication Strategy for Results Dissemination

Results are communicated through:

- Training workshops and stakeholder events.
- Visual reports and media coverage.
- Digital platforms, including the Şanlıurfa Metropolitan Municipality's official website, LinkedIn, and X (formerly Twitter)—which is widely used in Türkiye, especially by local stakeholders who may not be active on LinkedIn. This multi-channel approach promotes shared understanding and lays the groundwork for future co-designed adaptation actions.

3.2.2 Risk Exploration

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

3.2.2.1 Screen risks (selection of main hazards)

For risk exploration, a qualitative hazard identification, 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.** GCoM is the world's largest city and local government alliance, supporting voluntary actions for a low-emission, climate-resilient future. Şanlıurfa Metropolitan Municipality Sustainable Energy and Climate Action (SECAP) Working Group has conducted three Qualitative Analysis Surveys to assess potential climate hazards, current and future climate risks, and sectoral impacts. Surveys were shared with internal and external stakeholders via Google Forms. Results were first reviewed internally and then presented during the public Şanlıurfa Stakeholder Engagement Meeting in February 2025.

The survey studies have aimed at the following objectives:

- **Survey 1:** Identify current and future climate hazards for Şanlıurfa
- **Survey 2:** Assess negative impacts of climate hazards on urban service sectors and vulnerable community groups.
- **Survey 3:** Evaluate climate hazards' effects on service sectors, current adaptive capacity, and sectoral vulnerabilities.

Key Climate Hazards Evaluated:
Excluding events like sea level rise, monsoon rains, Avalanches, and typhoons, which are irrelevant for Şanlıurfa, the following hazards were assessed: Heavy Rainfall – Floods, Hailstorms, Storms – Tornadoes, Fog, Severe Winter Conditions – Cold Waves, Heatwaves – Urban Heat Islands, Drought, Wild Fires, Soil Salinization – Degradation, Landslides, Waterborne and Airborne Diseases, Vector-Borne Diseases and Pest Invasions.

Sectors and Services Evaluated:
Energy and Water Supply, Transportation and Communication, Food – Agriculture – Forestry, Waste and Wastewater Management, Industry – Commerce – Tourism, Housing – Residential Areas, Education, Health Systems – Public Health and Emergency Response Management

Vulnerable Population Groups Evaluated:
Elderly (>65 years), Chronically Patients, Disabled Individuals, Youth/Students, Children <5 years, Women, Refugees, Rural/Small Producers, Outdoor/Agricultural Workers, Low-Income Households

Current Situation: Hazard Occurrence and Impact
Based on surveys, past events, and stakeholder engagement meetings, drought, heat waves, soil degradation/salinization, and floods have been identified as the most significant climate hazards with high potential magnitude and likelihood (Figure 8).

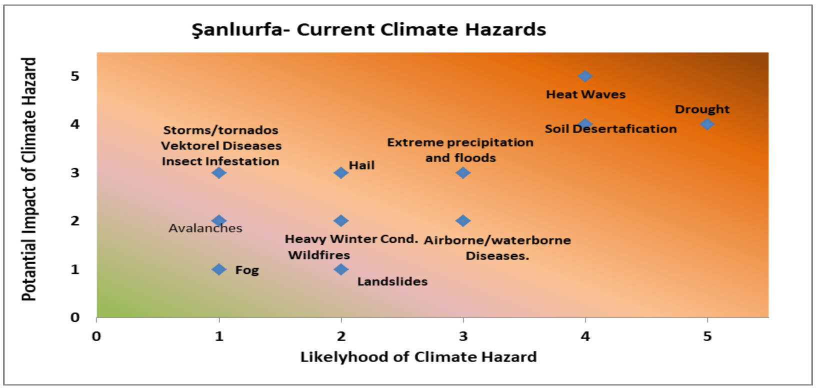

Figure 8: Project Climate Risk Exploration Analysis

The results of the surveys and the risk and vulnerability analysis were reported to GCoM using Carbon Disclosure Project (CDP-cities)/ ICLEI-Track 2024 Response. See details of assessment in Şanlıurfa MM Climate Change Risk and Vulnerability Assessment Report-English:
Climate Change Risk and Vulnerability Analysis can also be seen in Şanlıurfa MM Climate Change Action Plan-Turkish [2] in pages 67-78 (Chapter 3).

Climate-, Hazards and Potential Risks in Şanlıurfa
Risk and vulnerability screening surveys indicate that the major climate hazards of the region are Drought, Heatwaves, Soil Degradation and Floods (Table 10).

Table 10: Main Climate-Related Hazards and Potential Risks in Şanlıurfa

Climate Hazards	Impact Description	Most Exposed Sectors	Vulnerable Population Groups Most Exposed
Extreme Heatwave / Heat Stress	Vital danger for chronic patients, elderly, and outdoor workers due to extreme heat. İncrease in Forest fire risk. Decrease in agricultural and livestock production	Food-Agriculture-Forestry, Public Health, Energy and Water Supply, Industry-Trade-Tourism	Elderly>65 /children < 5 years old, Small-scale producers, Outdoor workers/farmers, Low-income households, Refugees
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

Hazards Covered in This Risk Assessment

- Heatwaves: Focusing on heatwave index, frequency and duration, vulnerable areas
- Drought: Relative and Agricultural drought. Drought risk, yield loss due to irrigation deficit

Existing Data, Knowledge, and Gaps

Table 11: Existing Data, Knowledge and Gaps

Hazard	Available Data	Data Gaps and Needs
Heatwaves	Daily Temperatures, Population Density, Land Surface Temperatures, Regional Climate Projections	Spatial distribution of vulnerable populations
Drought	Daily Precipitation, Temperature in 2 mt, Relative Humidity, Elevation, Solar Radiation, Wind Speed, Soil Available Capacity, Regional Crop Coefficients, irrigation patterns, Crop Productions, MED-Cordex Domain's data-sets, RCP4.5 and RCP 8.5 Projections.	Euro-Cordex domain's data-sets, Current regional irrigation patterns, current regional crop production data.

3.2.2.2 Workflow selection

The CRAS project applies the CLIMAAX framework using three targeted workflows to assess the most pressing climate hazards in Şanlıurfa: heatwaves and drought (relative and agricultural). Each workflow includes specific methodologies, datasets, and target groups.

Workflow #1: Heatwaves

Objective: To assess the impacts of heatwaves on public health, urban infrastructure, and community well-being, with a focus on vulnerable populations.
Methodology: To assess the heatwave hazard, EURO-CORDEX climate model data was analyzed using the xclim package to calculate heatwave frequency and total duration. Regional thresholds were defined using the 90th percentile of daily maximum and minimum temperatures (Tmax = 33°C, Tmin = 18°C), with a minimum event duration of two consecutive days. The analysis was conducted at a 12×12 km resolution. Exposure was mapped using high-resolution (30 m) Land Surface Temperature data from Landsat 8, highlighting urban heat island effects. Vulnerability was assessed using WorldPop datasets focusing on children under 5 and elderly populations over 65. These components were integrated using a 10×10 exposure-vulnerability matrix to produce spatial heatwave risk maps.
Vulnerable Groups: Elderly populations >65 years old, who are more susceptible to heat-related illnesses; children <5 years old, Refugees particularly those living in crowded urban settings with limited access to cooling infrastructure; low-income households, often residing in high-density areas with reduced green spaces, outdoor workers particularly seasonal agricultural workers.
Exposed Areas:

- Urban areas with high Land Surface Temperature, limited vegetation, and significant heat island effects, primarily in central Şanlıurfa.

Key **Actions in the Workflow:**

1. Data Collection: Definitions of temperature thresholds based on 90 percentile of regional daily temperatures
2. Hazard Assessment: Calculation and graphical representation of heatwave days, heatwave frequency (per year) and total length of heatwave projections according to RCP 4.5-RCP 8.5
3. Risk Assessment: Spatial distribution mapping of land surface temperatures, population density and heatwave risk map of vulnerable populations.

Workflow #2: Relative Drought

Objective: This workflow aims to visualize and explore the relative drought risk in the TRC52 Region. It includes maps of relative drought risk at the NUTS3 level in Türkiye.
Methodology: The workflow contains precalculated results, which can be explored in the visualization workflow. Relative drought hazard for the TRC2 Region was estimated as the probability of exceedance of the median of regional (EU level) severe precipitation deficits for a historical reference period (1981-2015) and for a future projection period (SSP1-2.6, SSP3-7.0, SSP5-8.5 for 2050 and 2080). Regional drought risk scores are on a scale of 0 to 5, with 0 representing the lowest risk and 5 the highest. The workflows take each risk determinant (i.e. hazard, exposure and vulnerability) and normalize it taking into account its maximum and minimum values across all sub-national administrative regions.
Vulnerable Groups: Farmers and agricultural workers dependent on irrigation systems and natural water cycles; Rural communities, whose livelihoods are closely tied to agricultural productivity; Low-income groups, who may struggle with food security during extended drought periods.
Exposed Areas: Agricultural zones of TRC2 are reliant on irrigation, particularly in the Harran Plain, where water availability is crucial for crop yields.
Key Actions in the Workflow:

1. Data Collection: Analyzed monthly precipitation patterns
2. Hazard Assessment: Drought hazard for a given region is estimated as the probability of exceeding the median of EU-level regional severe precipitation deficits for a historical reference period and for a future projection period
3. Risk Assessment: The relative drought risk was quantified as the product of drought hazard, exposure and vulnerability. The result of this workflow is a risk map showing the relative drought risk of Turkish NUTS3 regions so that we can compare our TRC52 region with other administrative areas in historic and future projections.

Workflow #3: Agricultural Drought

Objective: The aim is to estimate the potential loss in yield for a given crop without an artificial irrigation system compensating for precipitation scarcity.
Methodology: This workflow evaluates potential income losses due to reduced crop yields from precipitation scarcity in the absence of irrigation. Hazard is quantified as the shortfall in evapotranspiration, while exposure is measured through total crop production and revenue. Vulnerability is represented by the spatial distribution of existing irrigation systems. The analysis uses high-resolution (~10 km) climate data from the EU Copernicus Data Store, including variables such as precipitation, temperature, humidity, solar radiation, and soil water capacity. The assessment focused on four regionally significant crops: cotton, maize, wheat, and pistachio. Results include risk maps displaying potential yield losses and associated revenue impacts, offering practical resource allocation and climate-resilient planning guidance.
Vulnerable Groups: Farmers and agricultural workers, dependent on irrigation systems and natural water cycles; Rural communities, whose livelihoods are closely tied to agricultural productivity; Low-income groups, who may struggle with food security during extended drought periods.
Exposed Areas: Agricultural zones of TRC2 are reliant on irrigation, where water availability is crucial for crop yields.
Key Actions in the Workflow:

1. Data Collection: The evaluation is based on climate projections and global agricultural datasets that allow for predicting potential losses at approximately 10 km resolution. The data sets are downloaded from the EU Copernicus Data Store: Daily average precipitation flow;

Maximum and minimum temperature,2-meter relative humidity; Surface solar radiation; 10-meter wind speed; Soil available water capacity; Elevation; Thermal climate zone.

2. Hazard Assessment: The hazard assessment was performed for the 4 main crops of TRC2 region (Cotton, Maize, Wheat and Pistachio) parameterized in the regional crop coefficients. The assessment is performed using climate data averaged inter-annually to show the impact of precipitation scarcity on yield for an average growing season in the selected period.
3. Risk Assessment: In this workflow, we have visualized the revenue losses deriving from the reduction in crop yield due to precipitation scarcity and the absence of irrigation. Data on total crop production [ton] and revenue [EUR] is combined with the yield loss reduction calculated in the hazard workflow to derive a map of the revenue loss from the absence of irrigation. Revenue loss is expressed here as the 'lost opportunity cost' of not using irrigation. The maps also show the distribution of existing irrigation systems, which are used as a proxy of vulnerability to precipitation scarcity.

3.2.2.3 Choose Scenario

Şanlıurfa Metropolitan Municipality (SMM) has set an overall target to become a "climate neutral" and "climate resilient" city by 2050. The CRAS project applies hybrid-medium and pessimistic scenarios to model potential climate impacts under different conditions. The selected scenarios and temporal period include:

- Medium-Term (20-30 Years): Analyze socio-economic impacts of heatwave and prolonged drought and population growth by 2050
- Medium Scenario: SSI2 - RCP4.5
- Pessimistic Scenario: SSI5 - RCP8.5

3.3 Risk Analysis

This section presents how the selected CLIMAAX risk workflows were applied in Şanlıurfa. For each workflow, we summarize the methodology and datasets used for hazard, exposure, and vulnerability assessment, leading to spatial risk outputs.

3.3.1 Workflow #1: Heatwaves

Table 12: Data overview in workflow #1 Heatwaves

Hazard data	Vulnerabilit y data	Exposure data	Risk output
Daily Temperatures, Tmax, Tmin thresholds, Regional Climate Projections, Heatwave Index, Heatwave Frequency, Heatwave Duration	Population Density	Land Surface Temperatures	Heatwave Index, Heatwave Frequency, Heatwave Duration, Heatwave Risk Map to Vulnerable Population

Hazard assessment

Heatwave hazards were assessed using the Xclim package, which calculates heatwave index, frequency and duration. Regional thresholds were defined using the 90th percentile of daily maximum (33°C) and minimum (18°C) temperatures. Results were generated at 12×12 km resolution for both RCP4.5 and RCP8.5 scenarios (Figure 9).

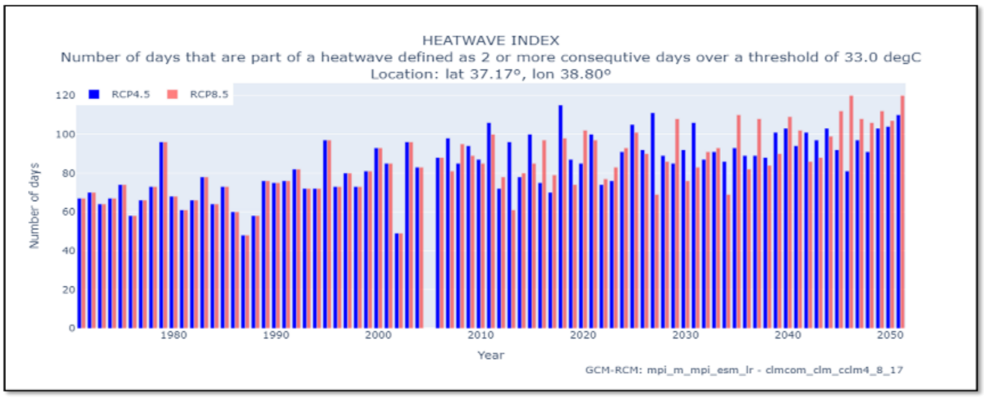

Figure 9: Heatwave Index Projections (RCP4.5-RCP8.5)

Risk assessment

Overheated city center of Şanlıurfa map below (about 20 km x 20 km) represents high to very high land surface temperature (around 50-55 C). Also, population density in the same geographic location is shown in Figure 10 below (Figure 10).

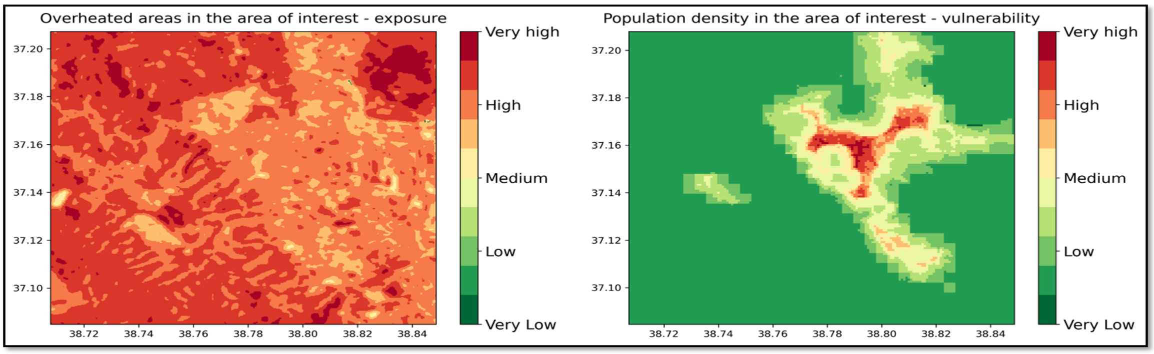

Figure 10: Overheated Surface Area and Population Density Maps in Şanlıurfa

The product of exposure and vulnerability data is the Heatwave risk map of Şanlıurfa City Center, as shown in Figure 11 below. The geographic location of neighborhoods which will be exposed to Major Heatwave Risk and high priority for adaptation actions are determined as follows table 13.

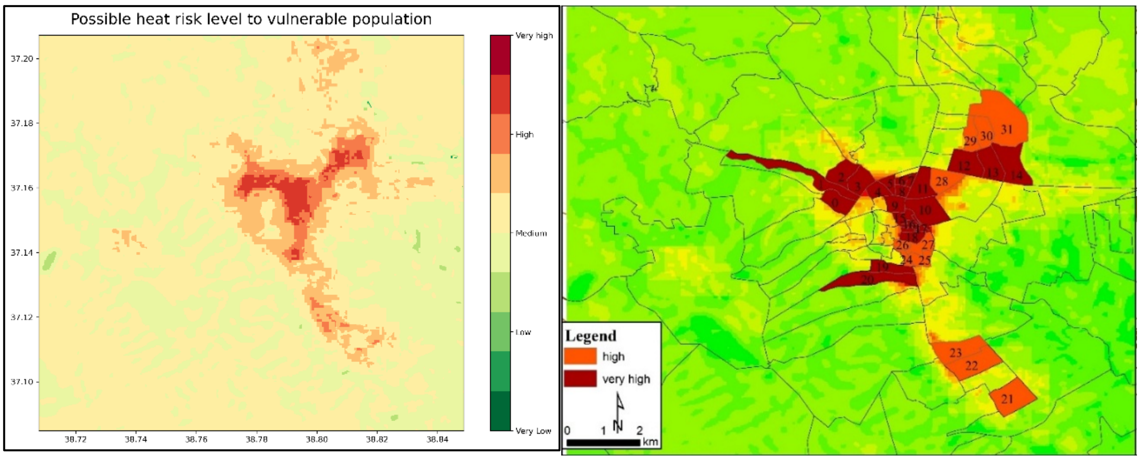

Figure 11: Possible Heatwave Risk Level to Vulnerable Population in Şanlıurfa City Center

Table 13: Possible Heatwave High Risk to Vulnerable Population in Neighborhood

Neighborhood Name	Risk Level	No	Neighborhood Name	Risk Level	No
AKABE	very high	0	EYÜPKENT	high	21
SÜLEYMANİYE	very high	1	HAYATİ HARRANİ	high	22
YAVUZ SELİM	very high	2	SÜLEYMANŞAH	high	23
BAĞLARBAŞI	very high	3	GÜMÜŞKUŞAK	high	24
ŞEHİTLİK	very high	4	KENDİRCİ	high	25
CENGİZ TOPEL	very high	5	PINARBAŞI	high	26
BAHÇELİEVLER	very high	6	TÜRKMEYDANI	high	27
ŞAİR ŞEVKET	very high	7	ŞAİR NABİ	high	28
MİMAR SİNAN	very high	8	OSMAN GAZİ	high	29
ATATÜRK	very high	9	ULUBATLI	high	30
KAMBERİYE	very high	10	ERTUĞRUL GAZİ	high	31
BAMYASUYU	very high	11			
YENİŞEHİR	very high	12			
YEŞİLDİREK	very high	13			
VEYSEL KARANİ	very high	14			
YUSUFPAŞA	very high	15			
HAKİMDEDE	very high	16			
BEYKAPUSU	very high	17			
KURTULUŞ	very high	18			
EYYÜBİYE	very high	19			
ŞIH MAKSUT	very high	20			

3.3.2 Workflow #2: Relative Drought

The hazard component for relative drought was analyzed using the Weighted Anomaly Standardized Precipitation (WASP) index, which captures precipitation deficits while accounting for seasonal variation. Figure 13 illustrates the WASP index values for Şanlıurfa and Diyarbakır across the historical baseline and three future scenarios: SSP1-2.6, SSP3-7.0, and SSP5-8.5, for near-future (nf) and far-future (ff) periods. The results show a projected increase in precipitation anomalies under SSP5-8.5, indicating heightened drought risk by 2050 and 2080. Median values, as well as the 25th and 75th percentiles, are displayed to reflect the spread and uncertainty across model outputs (Table 14).

Table 14: Data overview in workflow #2 Drought

Hazard data	Vulnerability data	Exposure data	Risk output
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

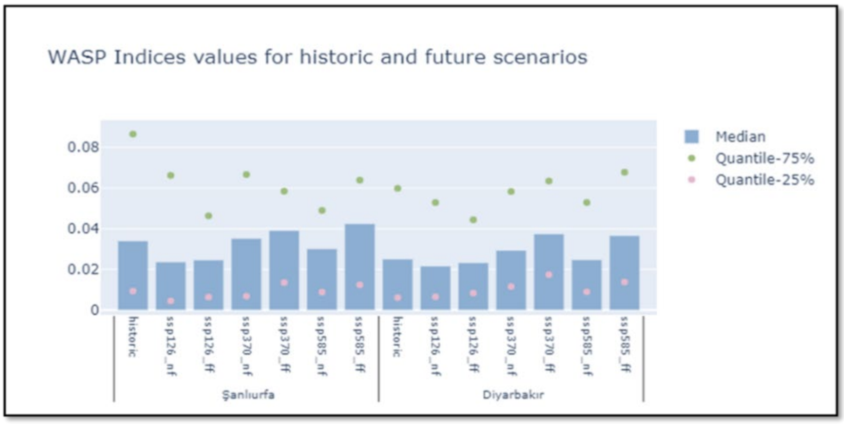

Figure 12: The weighted anomaly of standardized precipitation (WASP) index in TRC2 Region

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 Şanlıurfa (TRC2 region), the risk was calculated using the WASP index (hazard), exposure indicators (cropland, population, water stress), and vulnerability data (rural population share, GDP per capita). Current and future relative drought risks are demonstrated in the figures below. The relative drought risk score in the Şanlıurfa Region remains at 4 (high) out of 5 under both the SSP1 (sustainability – RCP2.6) and SSP5 (fossil-fueled development – RCP8.5) scenarios by 2050 (Figure 13).

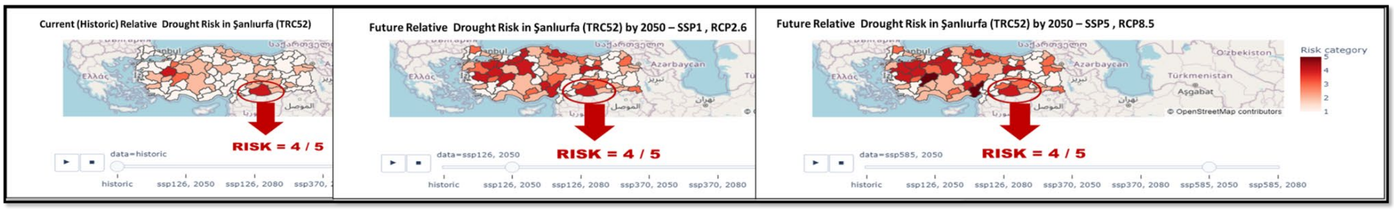

Figure 13: Current and Future Relative Drought Risk Level in Şanlıurfa

3.3.3 Workflow #3: Agricultural Drought

Table 15: Data overview in workflow #3 Agricultural Drought

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 cotton, maize, wheat, and pistachio	Irrigation availability (GAEZ)	Crop production (MapSPAM 2010); Crop values (FAO GAEZ)	Maps showing crop yield loss and revenue loss due to irrigation deficit; vulnerability based on irrigation system coverage

The hazard assessment was performed for the four main crops of TRC2 region (Cotton, Maize, Wheat and Pistachio) parameterized in the regional crop coefficients as shown in Table 16 below:

Table 16: 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
111	wheat	Regional	0.66	1.14	0.26	0.137	0.522	0.183	0.137	286	139	0.2	1.25	0.55	1	1
112	maize	Regional	0.29	1.25	0.37	0.177	0.25	0.339	0.234	141	281	0.2	1	0.55	1	1.25
9211	Cotton	Regional	0.32	1.25	0.62	0.166	0.274	0.31	0.25	120	301	0.2	1.35	0.65	1	0.85
365	Pistachio	Regional	0.4	1.1	0.45	0.089	0.292	0.354	0.266	71	297	1.25	1.25	0.4	0	0.85

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 Şanlıurfa and Diyarbakır regions (Figure 14).

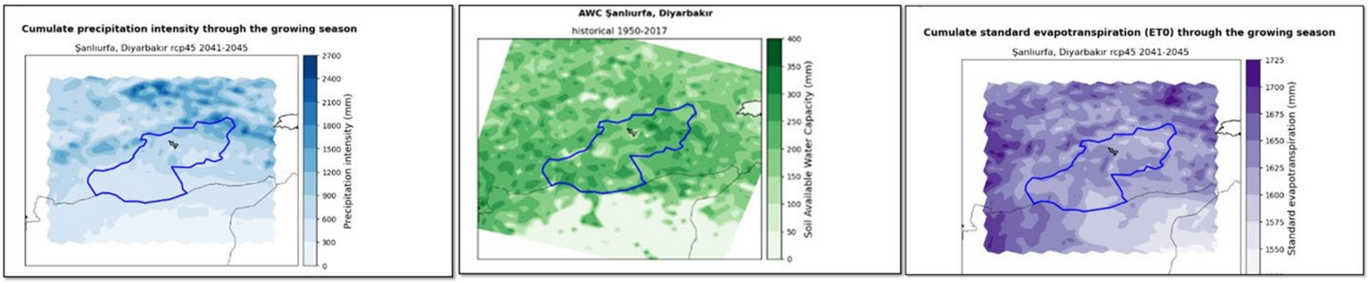

Figure 14: Maps of Precipitation, Water Available Capacity and Standard Evapotranspiration

The potential yield losses due to precipitation deficits (in the absence of irrigation) were calculated using crop-specific parameters for cotton, maize, wheat, and pistachio (Figure 15;16).

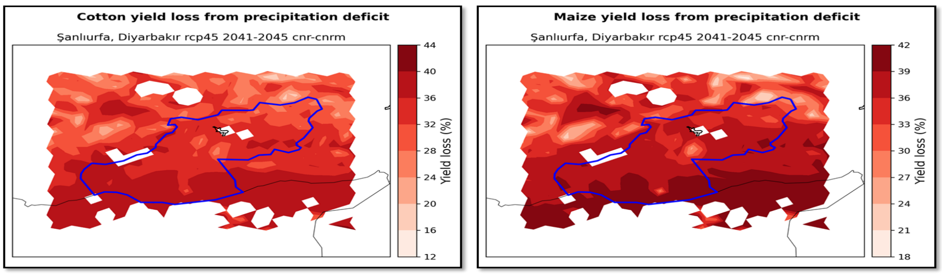

Figure 15: Maps of Yield Loss in Main Crops (Cotton and Maize) because of İrrigation Deficit.

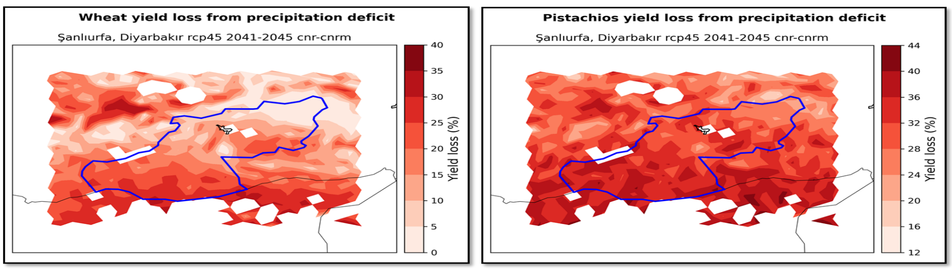

Figure 16: Maps of Yield Loss in Main Crops (Wheat and Pistachio) because of Irrigation Deficit.

Risk assessment

Revenue losses were calculated by combining modeled yield loss percentages with crop-specific production and economic value data. While the outputs provide valuable insights, it is important to note that the dataset used in this workflow does **not fully reflect the current irrigation patterns or productivity levels in Şanlıurfa**. Therefore, some results may differ from observed site-specific data (Figure 17).

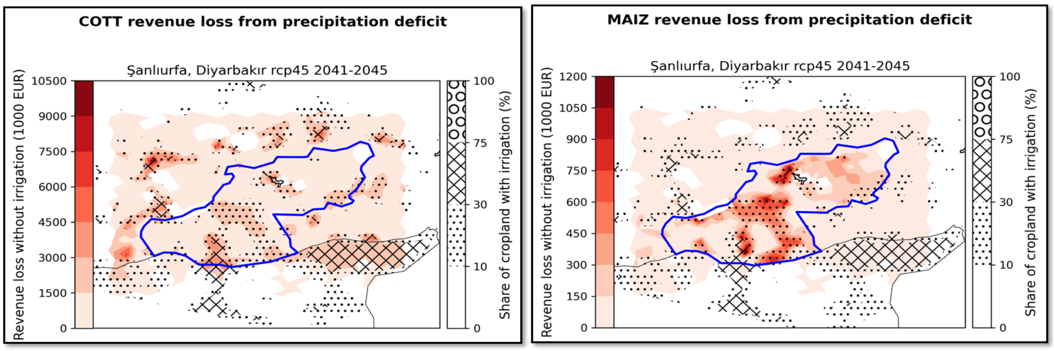

Figure 17: Maps of Revenue Loss in Main Crops because of İrrigation Deficit.

Table 17: Comparison of Revenue Losses between regional data and workflow outputs.

Crop	Average Yield		Average Revenue		Yield Loss (Workflow)	Revenue loss - Region	Revenue loss - Workflow
	kg/1000m2	kg/grid	EUR/1000 m2	EUR/grid	%	EUR/grid	EUR/grid
Cotton (fiber)	194	27,879,070	290	41,818,605	40	**16,727,442**	**3,000,000**
Maize	900	129,600,000	180	25,920,000	40	**10,368,000**	**750,000**
Wheat	260	37,440,000	91	13,104,000	20	**2,620,800**	**150,000**
Pistaccio	67	9,648,000	315	45,345,600	30	**13,603,680**	**No data**

3.4 Preliminary Key Risk Assessment Findings

The preliminary key risk assessment findings provide an in-depth evaluation of the severity, urgency, and capacity aspects of the identified climate risks for Şanlıurfa, focusing on heatwaves and drought. These findings are critical for shaping adaptation strategies and prioritizing risk management actions.

3.4.1 Severity

Key Results from the Heatwave Risk Analysis

- Şanlıurfa experiences ~130 UTCI days per year—among the highest in Europe.
- The Heatwave Index (≥2 consecutive days >33°C) is currently ~80 days, projected to reach 100 days by 2050.
- Heatwave frequency (≥2 days with Tmax >33°C and Tmin >18°C) is currently 8–10 events annually and will likely remain stable.
- Total annual heatwave days may increase from ~80 to 100 by 2050.

- Urban areas with high land surface temperatures and dense populations face serious public health risks.
- High-risk neighborhoods—such as Kamberiye, Bahçelievler, and Eyyubiye—have been identified and prioritized for adaptation.

Key Results from the Relative and Agricultural Drought Risk Analysis

- Şanlıurfa has a relative drought risk score of 4/5, the highest in Türkiye, consistent across SSP1–2.6 and SSP5–8.5 scenarios.
- WASP index confirms significant long-term precipitation deficits.
- The region receives ~350 mm of seasonal rainfall but faces evapotranspiration rates of ~1650 mm, indicating heavy reliance on irrigation.
- Modeled yield losses without irrigation: Cotton (32–40%), Maize (33–42%), Wheat (10–25%), Pistachio (24–36%).
- Revenue loss estimates diverge from current local productivity data, highlighting the need for refinement using actual irrigation patterns and crop yields in the next project phase.

Severity of the Identified Risks

Heatwaves: With a very high Universal Thermal Climate Index (UTCI), frequent and prolonged heatwaves, and extreme Land Surface Temperatures (LST), heatwaves pose a severe risk—especially in densely populated urban areas. High-risk neighborhoods have been identified and prioritized for adaptation actions.

Drought: Şanlıurfa has one of the highest relative drought risk scores in Türkiye. This is expected to persist under both optimistic and pessimistic climate scenarios. Extremely low annual precipitation combined with high evapotranspiration will continue to drive significant crop yield losses—up to 42% without sufficient irrigation.

3.4.2 Urgency

Timing and Impact of Risks

Heatwaves: Represent an immediate threat, especially during summer months when temperatures surpass 40°C. Urgent adaptation is needed—particularly increasing green space in high-risk urban areas.

Drought: A gradual but persistent hazard with significant projected impacts by 2050. Proactive action on water conservation and irrigation efficiency is essential to prevent major yield and revenue losses.

Onset of Hazards and Urgency Evaluation

Heatwaves: Sudden-onset hazard requiring rapid-response systems and emergency preparedness. **Drought**: Despite being gradual in appearance, it can escalate quickly necessitating early planning and sustained mitigation efforts.

3.4.3 Capacity

Current Climate Risk Management Measures

The CRAS project assessed Şanlıurfa's capacity across financial, social, human, physical, and natural dimensions:

- **Institutional Commitment**: Şanlıurfa has committed to the Global Covenant of Mayors (GCoM) and implemented its SECAP in 2022, aiming for climate neutrality and resilience by 2050.
- **Financial**: While municipal resources are limited, Şanlıurfa has strong potential to leverage EU funding via Pathways2Resilience (P2R) and Horizon Europe.

- **Social**: Active civil society and local NGOs contribute to awareness-raising and community engagement.
- **Human**: The Climate Change and Zero Waste Department includes 9 environmental experts, supported by Atalay Climate Consulting for technical capacity.
- **Physical**: Infrastructure gaps remain, particularly in water management and urban cooling systems.
- **Natural**: Agricultural lands and water resources are under stress but present opportunities for improved sustainable management.

Opportunities from Addressing Risks

- **Financial**: Unlocking access to national and EU climate funds.
- **Social**: Building community resilience through inclusive education and participation.
- **Economic**: Enhancing local food security via climate-smart agriculture and efficient water use.
- **Environmental**: Potential for ecosystem restoration, especially in soil health and water conservation.

3.5 Preliminary Monitoring and Evaluation

Lessons Learned from Phase 1

The first phase of CRAS highlighted both the strengths and limitations of current climate risk assessment practices. One of the main challenges was data integration. Since Şanlıurfa lies outside the Euro-CORDEX domain, regional datasets had to be adapted for use in CLIMAAX workflows. For agricultural drought analysis, regional crop coefficients were successfully applied and the crop table was expanded to include key crops like cotton and pistachio. However, the outdated MapSPAM dataset led to discrepancies between workflow outputs and actual field conditions. Future assessments will include updated yield/revenue data and current irrigation maps for more accurate results.

Stakeholder engagement proved effective overall, with high participation during workshops and training events. However, the involvement of private sector actors remained limited and will need to be strengthened in the next phase. Methodologically, while the CLIMAAX approach was useful, it requires further adaptation to better address local complexities, particularly around drought risk.

Stakeholder Feedback

Feedback from local authorities and community groups was generally positive. Stakeholders appreciated the data-driven risk maps and the transparency of the project. Still, several emphasized the need for more frequent updates and broader outreach, including additional training sessions.

New Data and Further Needs

New high-resolution regional climate projections from the Turkish State Meteorological Service, updated crop yield and revenue data, and detailed irrigated land maps are now available and will be integrated into future work. Additional research is also needed on urban heat vulnerability and improved agricultural impact data, along with continued capacity-building to support long-term climate risk monitoring.

3.6 Conclusions Phase 1- Climate risk assessment

The CRAS project's Phase 1 has successfully laid a data-driven foundation for climate risk management in Şanlıurfa, with a focus on two critical hazards: **heatwaves** and **drought**. Applying the CLIMAAX methodology, the project generated localized insights into hazard severity, exposure, and vulnerability—enabling more targeted adaptation planning.

Key Findings

- Heatwaves and drought are the most pressing risks.
- Urban areas show very high heat stress due to elevated Land Surface Temperatures (LST) and population density.
- The Heatwave Index based on 33°C (determined as 90-percentile of regional data-set) is currently 80 days and is projected to increase to 100 days by 2050. Heatwave frequency based on the thresholds of day: 33 C and night: 18 C with 2 consecutive days is currently 8-10 and will remain the same by 2050. Total number of heatwave days is currently 80 days and has a tendency to increase up to 100 days by 2050.
- The geographic location of neighbourhoods which will be exposed to "very high" and "high" Heatwave Risk and will have high priority for adaptation actions are determined and visualised by a heatwave vulnerability map.
- Şanlıurfa also has one of the highest relative drought risk scores (4/5) in Türkiye. WASP index analysis confirms ongoing severe precipitation deficits, compounded by very low growing season rainfall (~350 mm) and high evapotranspiration (~1650 mm).
- Agricultural drought analysis shows significant yield losses in case of irrigation deficit: Cotton (32–40%), Maize (33–42%), Wheat (10–25%), and Pistachio (24–36%).
- Vulnerable groups face disproportionate risks. Urban heat islands affect the elderly, children, low-income communities, and refugees. In rural areas, small-scale farmers dependent on irrigation are at high risk of drought-induced income loss.
- Risk mapping enabled evidence-based adaptation planning. By combining regional climate models (RegCM4.3.4), stakeholder input, and geospatial datasets, the project produced detailed risk maps to guide future municipal action.

Challenges Addressed

- Integration of multiple data sources, including climate models and stakeholder insights.
- High levels of stakeholder engagement through training sessions and workshops.
- Successful adaptation of CLIMAAX workflows to fit Şanlıurfa's regional context.

Challenges Remaining

- **Limited high-resolution local data** (e.g., irrigation maps, crop yield records) constrained model accuracy in some areas.
- **Insufficient private sector engagement**, especially in agriculture and urban development.
- **Need for continued capacity building** among municipal staff and technical stakeholders.

Next Steps – Phases 2 and 3

- **Phase 2: Refinement of Risk Analysis**
- Integration of updated datasets (e.g., local irrigation maps and yield records), improved model calibration, and comparative trend analysis.
- **Phase 3: Development of Adaptation Strategies**
- Use of risk results to shape city-level adaptation plans. Launch of pilot actions (urban greening, water conservation), and development of policy recommendations aligned with national/EU goals.

3.7 Progress evaluation and contribution to future phases

The Phase 1 deliverable of the CRAS project forms a strong analytical foundation for Şanlıurfa's climate resilience planning. This phase focused on assessing the climate risks posed by heatwaves and drought, applying the CLIMAAX methodology through three tailored workflows. The results of this phase will inform deeper local-scale analysis in Phase 2 and the co-design of adaptation strategies in Phase 3 (Table 18;19).

Connection to Future Phases

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

- Building on Phase 1 outputs, Phase 2 will integrate high-resolution local datasets (e.g. updated crop yield data, local irrigation patterns, high-resolution population maps).
- The CLIMAAX Toolbox will be further customized to better reflect local conditions and data availability.
- A comparative analysis will validate Phase 1 findings and enhance their spatial and sectoral precision.

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

- Informed by risk analysis, this phase will co-develop local adaptation measures with stakeholders.
- Expanded engagement with decision-makers and communities will support uptake and implementation.
- Outputs will include a local climate adaptation roadmap, aligned with national and EU-level strategies.

Table 18: Overview of key performance indicators

Key performance indicators	**Progress**
Risk assessment of 2 climate hazards (**heatwaves** and drought) at NUTS3 level.	3 Workflow (Urban Heatwave, Relative Drought and Agricultural Drought) were Successfully completed using CLIMAAX methodology.
Identification of 4 vulnerable sectors/populations.	Vulnerable groups identified: elderly>65 / Children<5 years old , low-income households, refugees, and outdoor workers/farmers.
Engagement of stakeholders through dissemination/training.	Two stakeholder engagement meetings were completed. Two more planned for later phases.
Provision of risk assessment data to 6 decision-making institutions.	Reports shared with Harran University, Provincial Directorate of Environment, and others.
Execution of 8 communication actions to inform stakeholders.	Three actions completed: stakeholder meeting, media article, and workshop.
Engagement of 5 municipalities in dissemination efforts.	Initial outreach completed- Neighbourhood municipalities- Mardin, Diyarbakır and Adıyaman were participated to 2nd Stakeholder Engagement Meeting. Full engagement planned in Phase 3.

Table 19: 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; will be expanded in 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 successfully achieved its objectives—producing a robust, stakeholder-informed climate risk baseline for Şanlıurfa. The findings directly feed into Phases 2 and 3, where more granular data will be incorporated, and locally tailored adaptation strategies will be co-developed. This ensures that Şanlıurfa's climate action remains both scientifically grounded and locally owned.

4 Adaptation Strategies and Objectives

As Şanlıurfa Metropolitan Municipality, we have taken a significant step toward combating climate change and building resilient cities by securing grant support through the Climaax and Pathways2Resilience projects.

Within the scope of these European Union-supported initiatives, we aim to enhance Şanlıurfa's resilience to the impacts of climate change. The journey began with our official Project Launch Ceremony and Stakeholder Engagement Meeting realised on February 21, 2025.

ADAPTATION STATEGIES WORKSHOP GROUPS AND THEIR OUTPUTS

We have conducted a participatory workshop with our valuable stakeholders. In this session, key sectors such as agriculture and livestock, tourism and cultural heritage, water pollution, public health and air quality, green spaces, and urban planning were addressed. Sector-specific recommendations were collected through focused discussions (Figure 18).

Figure 18: Project Launch Ceremony and Stakeholder Engagement Meeting, February 21, 2025.

AGRICULTURE AND LIVESTOCK GROUP

- Transitioning irrigation systems to pressurized irrigation technologies
- Protection of underground water reserves
- Utilizing rainwater harvesting technologies in agriculture
- Preventing stubble burning to reduce desertificatioSupporting drought-resistant crop patterns
- Promoting good agricultural practices through state support — particularly in the region's cotton production, encouraging organic and naturally colored cotton
- Supporting silk farming as an alternative agricultural product
- Providing state incentives to support small family farms
- Promoting the cultivation of regionally appropriate aromatic plants and sericulture (silkworm farming)
- Improving housing, education, and healthcare conditions for seasonal agricultural workers
- Expanding green areas and creating social rehabilitation spaces

TOURISM AND CULTURAL HERITAGE GROUP

- Increasing and enhancing green spaces along tourism routes through afforestation
- Promoting the use of renewable energy-powered transport vehicles

- Converting at least one transportation vehicle along the Göbeklitepe tourism route to an electric bus
- Introducing heat pump-based cooling systems in touristic areas such as Balıklıgöl and traditional marketplace zones
- Organizing evening museum hours and cultural nights to promote Şanlıurfa's heritage and to provide public relief from extreme summer heat conditions.
- Diversifying tourism activities at Göbeklitepe by introducing an alternative lighting system powered by renewable energy sources to enable evening visits.
- Transitioning historic bazaars to green electricity, ensuring that the energy demand of traditional markets is met through renewable sources.
- Implementing an Ephesus-model approach to increase tourist numbers while reducing operational costs through the use of green energy.
- Introducing an incentive scheme using environmental recognition flags — businesses that adopt clean energy practices may be awarded a Green Flag, while those that implement zero waste and anti-waste measures could receive a Blue Flag. These recognitions may be accompanied by benefits such as discounts on water utility bills as a form of reward and encouragement.

WATER POLLUTION WORKING GROUP

- Implement water-saving practices in agricultural activities.
- Provide training and support for farmers on efficient water use.
- Promote the harvesting and storage of rainwater in suitable urban areas.
- Ensure the treatment and reuse of wastewater and expand its application in appropriate sectors.
- Emphasize that limited access to clean water may result in increased food insecurity
- Conduct awareness campaigns and educational programs on water conservation
- Transition open-channel irrigation systems to closed-pipe systems in agriculture.
- Upgrade existing infrastructure to prevent water losses caused by pipe leakages in buildings.
- Increase urban green areas and support reforestation efforts.
- Promote rain gardens and permeable surfaces in public parks and urban roads.
- Establish Water Management Protocols, Joint Watershed Governance, and Early Warning Systems for major water bodies such as the Euphrates and Tigris Rivers.
- Develop an integrated and sustainable water management strategy.
- Encourage the use of rainwater harvesting systems in existing buildings.
- Mandate the integration of water efficiency systems into national building regulations and codes.

URBAN GREEN SPACES WORKING GROUP

- Urban green areas should be increased, considering the irrigation requirements of these areas.
- Develop long-term afforestation strategies, and detail plans in short-, medium-, and long-term phases.
- Introduce a mandatory green space allocation in building permit regulations.
- Prioritize the use of native and drought-tolerant plant species in landscaping practices.
- Promote the integration of sponge city concepts, mulching, composting, and blue-green infrastructure into public parks.
- Establish community gardens and urban allotments within parks and green areas to create income opportunities for disadvantaged groups.
- Plant productive tree species, such as pistachio and olive trees, in public parks.
- Design parks to be accessible for people with disabilities and elderly residents.
- Expand municipal tree sapling production facilities.
- These planning principles should be implemented with the aim of enhancing urban quality of life, ensuring the protection of ecological balance, and building a sustainable urban future.

URBAN PLANNING WORKING GROUP

- Transportation and Accessibility
- Urban transportation planning should ensure safe, inclusive systems for vulnerable groups, incorporating public transportation, bicycle lanes, and pedestrian pathways.
- In historic city centers, lighting systems should be improved to increase safety, and spaces should be revitalized to ensure urban continuity and functionality. (Solar-powered lighting can be considered.)
- The Divan Yolu should be closed to motorized traffic to promote pedestrian movement.
- The quality of public transportation should be enhanced, and a light rail system should be developed.
- Sidewalks should be widened and bicycle infrastructure expanded.
- Charging stations should be increased to promote the use of electric public and private vehicles.
- Urban Transformation and Planning
- Zoning expansion should be directed toward the Karaköprü and airport axis, while new development should be discouraged toward Harran and Akçakale directions.
- Informal settlements should be included in urban transformation programs and converted into green public spaces
- Construction should be restricted in stream beds and flood-prone areas to mitigate disaster risk.

PUBLIC HEALTH AND AIR POLLUTION WORKING GROUP

- Preventive measures and strategic planning should address air pollution sources such as traffic, fossil fuel combustion, desert dust, stubble burning, low-quality coal, emissions from ovens and furnaces, and poorly located industrial facilities.
- Coal usage should be reduced, while promoting solar panels, geothermal energy, and other renewable energy sources.
- Rail systems should be adopted in urban transport to reduce traffic-related pollutants. Public transport must be expanded and made more accessible.
- Industrial air emissions must be subject to stricter monitoring and regulation.
- Vulnerable groups, particularly the elderly and those in fragile health, are more severely affected by air pollution and climate change impacts.
- Promotion of zero-emission vehicles should be prioritized in urban mobility strategies.
- Given that healthcare is costly and often inaccessible in many areas of Türkiye, it is recommended to establish a cancer research and treatment center, alongside public awareness campaigns about air pollution-related diseases.
- As air pollution is a primary driver of greenhouse gas emissions, tackling air quality issues is directly aligned with climate change mitigation.
- Mobile air quality monitoring stations should be installed to ensure continuous and localized greenhouse gas and pollutant measurement.

According to outcomes of stakeholder engagement meetings, Sanlıurfa's adaptation strategy deployement has been concluded as follows:

ŞANLIURFA ADAPTATION STRATEGIES	
Strategy 1 – Climate-Resilient Settlements and Healthy Urban Life	
Strategy 2 – Combating Drought and Sustainable Agriculture	
Strategy 1 – Climate-Resilient Settlements and Healthy Urban Life	
Objective 1.1 - Disaster Risk Reduction and Protection Programs	
Objective 1.2 - Climate-Resilient Urban Development and Planning	
Objective 1.3 - Protection of Vulnerable Community Segments and Healthy Urban Life	
Objective 1.1 – Disaster Risk Reduction and Protection Programs	
GOALS	
2035	**2050**
Capacity increase and renovation investments in all rainwater collection channels across the city to match the 100-year rainfall intensity	Making city infrastructure and existing structures resilient against climate extremes through zoning regulations and urban transformation efforts
Action 1.1.1 - Emergency Preparedness and Response Program for Climate Disasters	
Action 1.1.2 - Capacity Development Program for Surface Flood Prevention Structures and Systems	
Action 1.1.3 - Development of Proactive Systems Against Surface Floods	
Objective 1.2 – Climate-Resilient Urban Development and Urban Planning	
GOALS	
2035	**2050**
Increasing urban green space per capita by 100%, from 4.6 m^2 to 9 m^2	Establishing accessible green areas and parks in every neighbourhood with a minimum area of 0.5 hectares to achieve a homogeneous distribution across the city, and increasing green space per capita to 15 m^2
Action 1.2.1 - Increasing the Urban Green Lands up to International Standards	
Action 1.2.2 - Urban Planning for Climate-Resilient Cities	
Objective 1.3 – Protection of Vulnerable Population Segments and Healthy Urban Life	
GOALS	
2035	**2050**
Implementation of physical and social protection mechanisms against the devastating effects of heatwaves on the vulnerable population living in Şanlıurfa	-
Action 1.3.1 – Protection of Vulnerable Population Segments against Climate Hazards	
Action 1.3.2 - Preservation of Air Quality	
Action 1.3.3 - Preventive Activities against Climate-Related Diseases	

Action 1.3.4 - Strengthening of urban infrastructure and facilities against mass migration	
Strategy 2 – Drought Prevention and Sustainable Agriculture	
Objective 2.1 – Protection and Develop of Water Resources and Effective Demand Manag.	
Objective 2.2 – Drought and Soil Salinity Prevention Program	
Objective 2.3 – Sustainable Agriculture from Farm to Fork and Food Security	
Objective 2.1 – Protection and Develop of Water Resources and Effective Demand Manag.	
GOALS	
2035	**2050**
- Increase the population served by wastewater treatment services from 48% to 95%. - Reduce network water leakage by 50%.	Reuse of treated water, rainwater harvesting, and greywater systems to be widely adopted throughout the city.
Action 2.1.1 - Develop solutions for reducing water leaks and effective demand management.	
Action 2.1.2 - Develop systems for water recovery and reuse.	
Action 2.1.3 - Oversight of preventive activities for the conservation of water resources.	
Objective 2.2 - Drought and Soil Salinity Prevention Program	
GOALS	
2035	**2050**
• Implementation of educational activities and administrative regulations containing sanctions aimed at eliminating wild irrigation within city limits • Completion of rehabilitation investments with drainage channels in agricultural areas experiencing rising groundwater and desertification	• Completion of necessary investments for the transformation of open system fields into closed pressurized systems in currently open systems within city limits • Widespread adoption of technological applications such as subsurface and surface drip irrigation, soil moisture measurement, automation, remote control, and monitoring throughout the province
Action 2.2.1: Prepare and implement a structural transformation program to increase irrigation efficiency.	
Action 2.2.2: Prepare and implement a research and rehabilitation program to prevent desertification in agricultural lands.	
Action 2.2.3: Conduct education, awareness, and consciousness-raising activities on the adverse effects of drought and over-irrigation.	
Objective 2.3- Sustainable Agriculture from Farm to Fork and Food Security	
GOALS	
2035	**2050**
• Increasing the number of organic producers and their level of knowledge and awareness • Facilitating organic producers' access to consumer markets • Establishing and promoting the "GO" standardization of the GAP Organic brand	-
Action 2.3.1- Supporting and Developing Sustainable Organic Aggriculture	
Action 2.3.2- Establishment and Dissemination of Organic Marketplaces	

Online Resources for Further Reading and Reference

- Climate Adapt High UTCI Days – https://climate-adapt.eea.europa.eu/en/metadata/indicators/high-utci-days
- GCoM using Carbon Disclosure Project (CDP-cities)- https://myportal.cdp.net/guidance/questionnaire?tags=&outputType=REPORTING&type=CSTAR&locale=en
- Global Covenant of Mayors for Climate & Energy - https://www.globalcovenantofmayors.org/
- Pathways2Resilience – https://www.pathways2resilience.eu/get-involved#
- Plant Water Consumptıon of Irrıgated Plants in Turkey - https://www.tarimorman.gov.tr/TAGEM/Belgeler/yayin/Tu%CC%88rkiyede%20Sulanan%20Bitkilerin%20Bitki%20Su%20Tu%CC%88ketimleri.pdf
- Şanlıurfa Metropolıtan Munıcıpalıty Clımate Change Mıtıgatıon And Adaptatıon Actıon Plan- https://www.sanliurfa.bel.tr/files/1/iklim_degisikligi.pdf
- Şanlıurfa MM Climate Change Risk and Vulnerability Assessment Report- *https://www.Şanlıurfa.bel.tr/uploads/2024/20240925064813-36184-90200.pdf*
- TÜİK- Turkish Statistical Institute- https://www.tuik.gov.tr/Home/Index
- Turkish State Meteorological Service – https://www.mgm.gov.tr
- Turkish State Meteorological Service / Heating and Cooling Day Degrees - https://www.mgm.gov.tr/veridegerlendirme/gun-derece.aspx?g=yillik&m=06-00&y=2024&a=02#sfB
- Turkish State Meteorological Service - Climate Indices - https://www.mgm.gov.tr/iklim/indis.aspx
- Updated Köppen-Geiger climate map of the World https://people.eng.unimelb.edu.au/mpeel/koppen.html
- What is the GCoM Common Reporting Framework (CRF)? - https://www.globalcovenantofmayors.org/faq/hat-is-the-gcom-common-reporting-framework-crf/
- CLIMAAX M6 Deliverable: CRAS – Şanlıurfa Risk Assessment - http://doi.org/10.5281/zenodo.15106529

ŞANLIURFA BÜYÜKŞEHİR BELEDİYESİ

Sanliurfa Metropolitan Municipality

Department of Climate Change and Zero Waste

April 2025, ŞANLIURFA

Consultancy and Technical Support:

ATALAY İKLİM-PLAN

www.atalayconsulting.com
Tel: 0545-5855520