MERSİN SUSTAINABLE ENERGY AND CLIMATE ACTION PLAN

2023

MERSİN BÜYÜKŞEHİR BELEDİYESİ 1873

TÜBİTAK MAM

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MAYOR’S PRESENTATION

Due to the progress of industry and the consumption of fossil fuel, greenhouse gas emissions resulting from human activity are increasing at rates faster than ocean and forest areas can hold. Our country is in a geographical area that will be most affected by climate change, as there will certainly be disasters related to climate change and the efforts to fight it. This issue is one of the most important for us to solve.

Day by day, local governments are developing and implementing strategies for confronting climate change. Mersin is one of the most developed provinces of Türkiye. With its fertile soil and growth of agricultural products, it stands out against the rest of the country. Mersin is also advanced in technology, as it has rich natural and underground resources, as well as port activities and an oil refinery. Due to its international port and adjacent free zone, Mersin provides global trade connections to many provinces, especially in eastern and central Anatolia.

Our increasingly growing city is also one of the most affected by climate change, which will have a negative impact on our agriculture and industry. As people’s welfare increases, so do new lifestyles and new technologies, which can affect not only the environment of our province, but also our country and the rest of the world. Actions conducted by local governments to reduce greenhouse gas emissions and climate change adaptation efforts are vital.

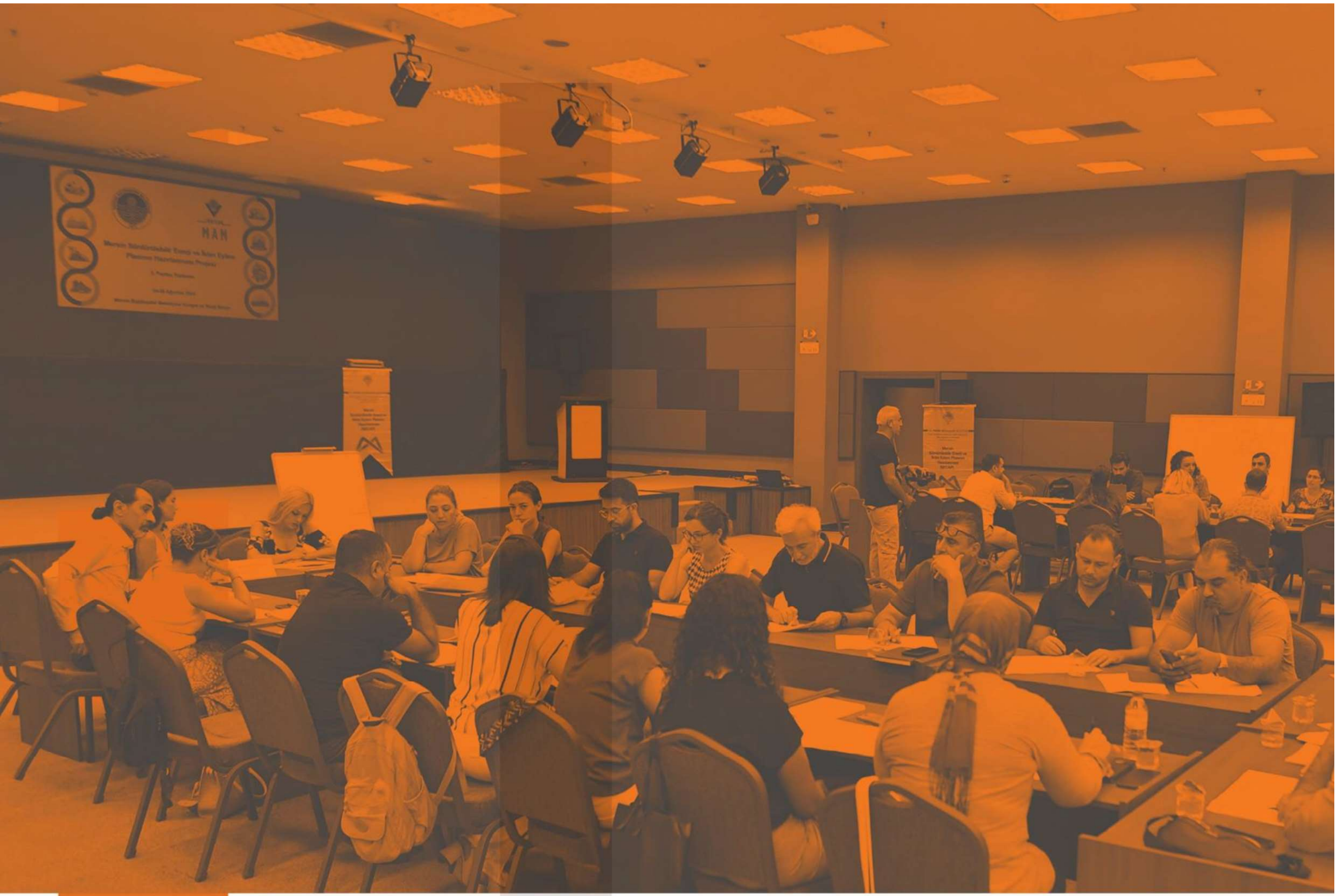
Cities with high population, production, and consumption also have elevated levels of pollutants which trigger and worsen climate change. The greenhouse gas emission inventory includes all significant greenhouse gas emissions occurring within the geopolitical and operational boundaries of local governments. Therefore, the role of local governments in the fight against climate change increases day by day. The Mersin Metropolitan Municipality has shown our determination in this fight by becoming members of international organizations such as ICLEI (Local Governments for Sustainability) and GCoM (Global Covenant of Mayors for Climate and Energy).

In order to quantify the greenhouse gas emissions occurring within the borders of Mersin, the Mersin Metropolitan Municipality Department of Climate Change and Zero Waste worked with TUBITAK Marmara Research Center, Vice Presidency of Climate Change and Sustainability and prepared a "Greenhouse Gas Inventory Report" in accordance with international standards and protocols. Our city has taken a key step in adapting to climate change by conducting joint work with the "Sustainable Energy and Climate Action Plan", which includes reducing greenhouse gas emission and climate change adaptation activities.

For an environmentally friendly world and a better future, we must reduce carbon emissions in the fields of transportation, energy, services, and construction. We must also focus our efforts on activities that are in accordance with environmental standards and actions that reduce the impact of climate change. I hope and wish that this study will contribute to national, regional, and urban climate change policies and aid in meeting our goals for a sustainable future.

Vahap SEÇER

Mayor of Mersin Metropolitan Municipality



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Mercan Yüzüncü Yıl Centre for Environmental and Climate Science is an educational centre that aims to raise awareness of people on environmental and climate aspects.

Our goal is to provide visitors with information and raise awareness on important issues such as climate change, environmental pollution, protection of natural resources and sustainability. At the same time, through our centre, we aim to educate young generations on scientific methods and contribute to their journeys for becoming conscious environmentalist leaders of the future.

Our science centre has interactive experiment setups, a 120-seat planetarium and an observatory.

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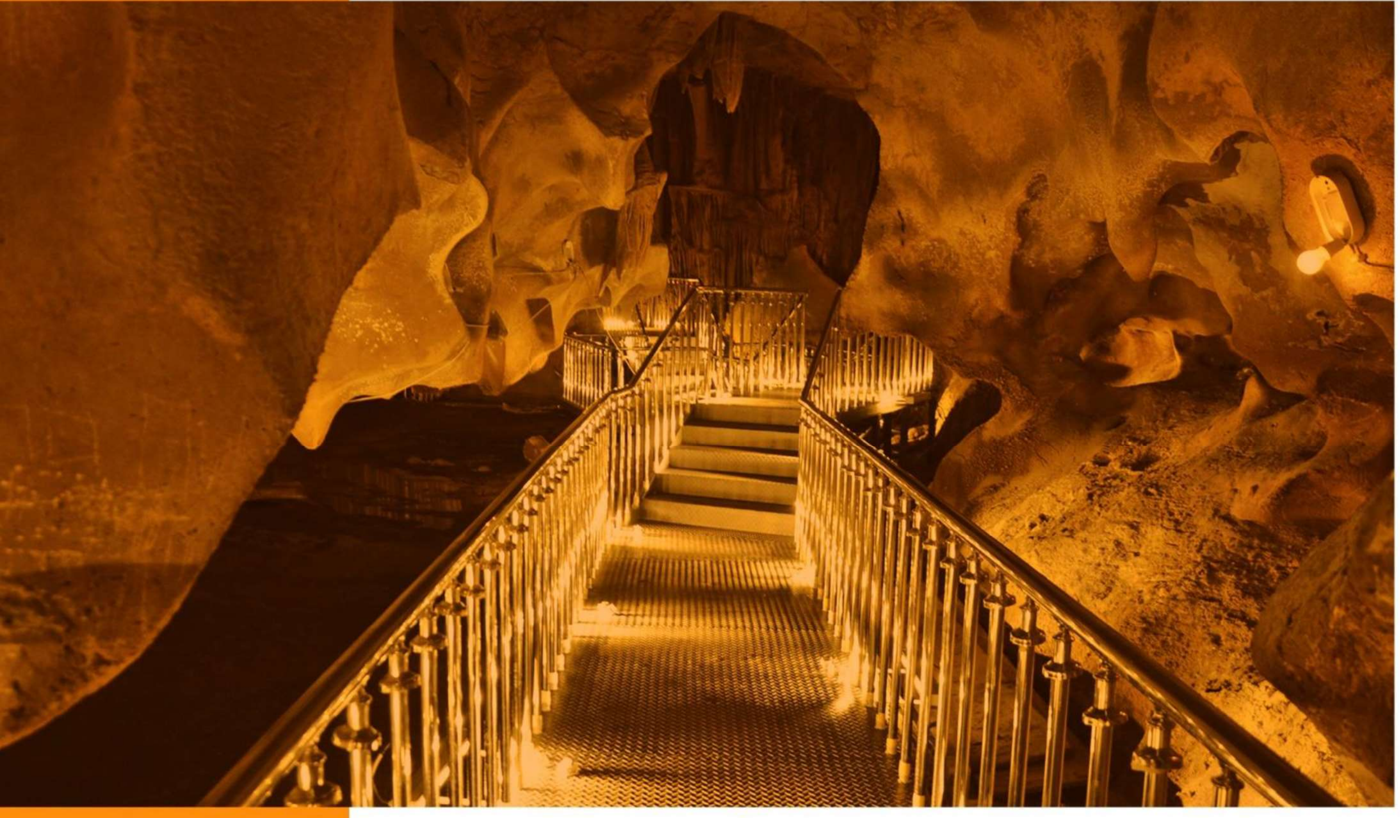

TAŞKUYU CAVE

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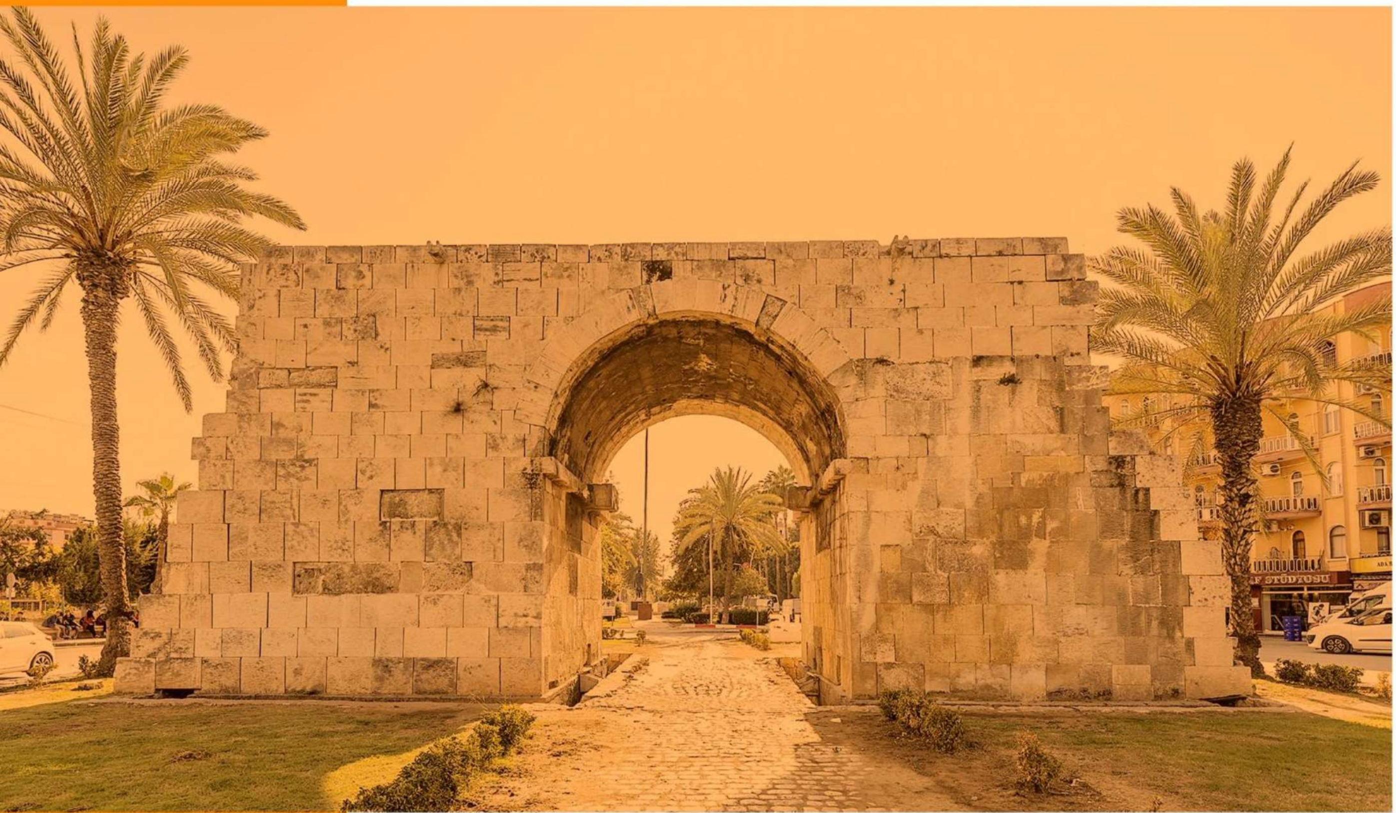
LIST OF ABBREVIATIONS

AFOLU	Agriculture, Forestry and Other Land Use
AFAD	Disaster and Emergency Management Presidency
C40	C40 Cities Climate Leadership Group
COP	Conference of the Parties
CORINE	Coordination of Information on the Environment
EMRA	Energy Market Regulatory Authority
GCoM	Global Covenant of Mayors for Climate and Energy
GDP	Gross Domestic Product
GHG	Greenhouse Gas Emissions
GPC	Global Protocol for Community-Scale Greenhouse Gas Emission Inventories
ICLEI	Local Governments for Sustainability
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
KGM	General Directorate of Highways
MGM	General Directorate of Meteorology
MMM	Mersin Metropolitan Municipality
MoAF	Ministry of Agriculture and Forestry
MoCT	Ministry of Culture and Tourism
MoEUCC	Ministry of Environment, Urbanisation and Climate Change
MoIT	Ministry of Industry and Technology
MoTI	Ministry of Transport and Infrastructure
NDC	Nationally Determined Contribution
OECD	Organisation for Economic Co-operation and Development
OGM	General Directorate of Forestry
TUBITAK MAM	The Scientific and Technological Research Council of Türkiye - Marmara Research Center
TurkStat	Turkish Statistical Institute
UNFCCC	United Nations Framework Convention on Climate Change
WRI	World Resources Institute
WWTP	Wastewater Treatment Plant



CLEOPATRA’S GATE

1. INTRODUCTION

Climate change, which is considered one of the most important problems facing our planet in the 21st century, is triggered by the accumulation of greenhouse gases in the atmosphere caused in part by various human activities such as the use of fossil fuels and land use changes. As a result of the researches carried out by the scientific community, it is foreseen that if the global warming process continues at the current rate, many severe disasters such as extreme weather events, floods, widespread and severe drought events and forest fires will arise in the climate zone including our country.

Furthermore, it is known that approximately 60% of greenhouse gas emissions worldwide are generated within cities mainly due to energy consumption. Therefore, it is predicted that efforts conducted at the city level will contribute significantly to combating global climate change, leading to an intensified focus on such endeavors. Cities, due to the activities taking place within their boundaries, make substantial contributions to the process of climate change. Conversely, the events expected to occur as a result of climate change threaten the existence of the systems that make up cities. At the urban scale, especially in areas such as infrastructure, public health, and water resource management, higher vulnerabilities to the impacts of climate change are expected. For these reasons, it is acknowledged that local climate change action plans should contain objectives aimed at both rapidly and fairly reducing the city's contributions (i.e. greenhouse gas emissions) to climate change and enhancing the city's capacity to adapt to climate change.

Many municipalities in our country are currently preparing climate change action plans and in this context, they are also members of various international voluntary initiatives. Mersin Metropolitan Municipality became a member of the Global Covenant of Mayors for Climate and Energy (GCoM) in 2021, one of the most important of these initiatives. GCoM has been signed by 50 municipalities from our country, 15 of which are metropolitan municipalities. This initiative, which was first launched in 2008 within the European Commission, aims to support local governments in achieving climate and energy targets and to bring together many cities and regions that want to implement the targets set within the framework of the Covenant. Municipalities that are parties to the GCoM are obliged to prepare action plans containing the measures they plan to implement in terms of greenhouse gas emission reduction and adaptation to climate change. Therefore, the role of local governments in combating climate change is increasing day by day.

1.1. Purpose

Within the scope of the project, it was aimed to prepare emission inventories of the main sources of greenhouse gas emissions within the provincial borders of the Mersin Metropolitan Municipality, to establish the baseline scenario for the greenhouse gas emissions, to calculate the greenhouse gas emission reduction levels for the set-targets, to conduct a general assessment in three areas that will be most affected by climate change impacts, to identify adaptation measures, and to prepare the climate change action plan based on thorough evaluations. The project also includes reporting all the conducted studies and presenting them as the "Mersin Sustainable Energy and Climate Action Plan".

1.2. Scope

Within the scope of the study:

- Information on factors affecting greenhouse gas emissions and climate change in Mersin was collected.
- Stakeholders who will contribute to the preparation of the Action Plan were determined, and evaluation meetings were organized.
- An emission inventory has been created for the Mersin province using emission factors accepted in national/international standards, and a "Greenhouse Gas Emission Inventory Report" has been prepared.
- In addition to the baseline scenario, GHG emission mitigation scenarios were designed in line with the opinions and suggestions of relevant stakeholders, taking into account the existing plans and policies of Mersin province, and GHG emission mitigation amounts were calculated on the basis of 2 (two) scenarios.
- A general assessment was made within the scope of adaptation to climate change and adaptation measures were identified in priority sectors for Mersin.
- Incorporating all the obtained outputs, the "Mersin Sustainable Energy and Climate Action Plan" was prepared.

Greenhouse gas emissions include carbon dioxide (CO_2); methane (CH_4) and nitrous oxide (N_2O) emissions. Hydrofluorocarbons (HFCs); F-gases such as perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), etc. could not be included in the system due to lack of data. The institutions and organizations included in the preparation of the action plan are given in Table 1.1. It is envisaged that the stakeholders will contribute towards both in providing data specific to Mersin and determining the actions regarding with reduction of GHG emissions and improving adaptive capacity to climate change. Approximately 40 people representing the project stakeholders participated in the opening meeting held on September 6, 2022, and the project team presented the scope of the project including detailed information about the data needs and sources, the expectations from the stakeholders and the steps to be followed.

Table 1.1: Institutions and organizations involved in the project

Public institutions and organizations	Representatives of the private sector, Universities, NGOs
Mersin Metropolitan Municipality - Directorate of Climate Change and Zero Waste - Directorate of Environmental Protection and Control - Directorate of Studies and Projects - Directorate of Technical Works - Directorate of Housing and Urbanisation - Directorate of Parks and Gardens - Directorate of Transportation - Directorate of Agricultural Services Mersin Water and Sewerage Administration (MESKİ) Akdeniz Municipality Anamur Municipality Bozyazi Municipality Mersin Yenişehir Municipality Mezitli Municipality Mut Municipality Silifke Municipality Tarsus Municipality Toroslar Municipality Erdemli Municipality Aydıncık Municipality Çamlıyayla Municipality Gülnar Municipality Mersin Governorship Mersin Provincial Directorate of Industry and Technology Mersin Provincial Directorate of Environment, Urbanisation and Climate Change Mersin Provincial Directorate of Agriculture and Forestry Mersin Regional Directorate of Forestry Mersin Provincial Directorate of National Education SSI Mersin Provincial Directorate Mersin Provincial Directorate of Culture and Tourism Mersin Provincial Directorate of Disaster and Emergency Meteorology 6. Regional Office Anamur, Mersin and Silifke Meteorological Directorates Directorate of Highways Mersin 5. Regional Office 6. Regional Directorate of Turkish State Railways TURKSTAT Adana Regional Office 6. Regional Directorate of State Hydraulic Works	Mersin Chamber of Commerce and Industry (MTSO) Mersin-Tarsus Agricultural Product Processing Specialization Organized Industrial Zone (TÜİOSB) Mersin Tarsus Organized Industrial Zone Mersin Chamber of Agricultural Engineers Mediterranean Chamber of Agriculture Mut Chamber of Agriculture Chamber of Environmental Engineers Chamber of Civil Engineers Chamber of Urban Planners Chamber of Forest Engineers Chamber of Electrical Engineers Mersin Chamber of Maritime Commerce Chamber of Landscape Architects Aksa Natural Gas Çukurova General Directorate Kalde Energy Electricity Generation Co. Inc. ŞİŞECAM - Soda, Glass Packaging and Flat Glass Production Facilities Eren Holding - Medcem Cement ÇİMSA - Mersin Factory İZOCAM - Glass Wool and Foamboard Production Facilities Tarsus University Mersin University Toros University Çağ University Agriculture and Rural Development Support Agency (TKDK) Mersin Tourism Operators Association (MERTİD) Entrepreneurial Business Women's Association (GIŞKAD) Çukurova Development Agency Mersin Investor Business People Association (MERYAD) Toroslar Electricity Distribution Company Mersin International Port Management (MIP) Akdeniz Clean Air Center TEMA Foundation MENKOBIRLİK Yenişehir Clean Environment Inc.

In order to obtain the necessary data for the GHG emission inventory and develop actions for mitigation and adaptation, TUBITAK MAM and Mersin Metropolitan Municipality project teams organized series of one-on-one meetings on 26-27 October 2022 with the officials of Mersin Metropolitan Municipality, Directorate of Environmental Protection and Control, Directorate of Climate Change and Zero Waste, Directorate of Reconstruction and Urbanisation and Directorate of Transportation and officials of Mersin Regional Directorate of Forestry, Mersin Agriculture and

Forestry Directorate, Mersin Environment, Urbanisation and Climate Change Directorate, Mersin Industry and Technology Directorate and Mersin Chamber of Commerce and Industry (MTSO).

Finally, 8 sectoral meetings were held between 2-5 May 2023 in order to determine the actions applicable to reduction of GHG emissions and increase the capacity to adapt to climate change. Within 8 online meetings organized for different areas (e.g. buildings and infrastructure, transportation, industry and energy, waste and wastewater management, agriculture and livestock, forestry and water resources, tourism and cultural heritage and coastal areas and fishery), general information about the Mersin GHG emissions inventory and the details of the calculations made for the relevant sectors were shared, and the opinions and suggestions of the participants were obtained. In addition, mitigation and adaptation measures for the relevant areas were discussed and potential strategies were presented to evaluation of participants through online surveys.

Finally, stakeholders came together to clarify the actions that can be implemented in Mersin to reduce greenhouse gas emissions and increase the capacity to adapt to climate change. 8 sector-based roundtable meetings were held physically at the Mersin Metropolitan Municipality meeting hall. Approximately 90 people representing the relevant departments of Mersin Metropolitan Municipality, district municipalities and all other stakeholders participated in the meetings. During the meetings, the current situation assessment, sub-actions, responsible and related institutions/units, implementation period, performance indicators and performance targets of the actions determined for each sector were discussed. Prior to the 4 parallel sessions, short informative speeches were made on behalf of Mersin Metropolitan Municipality and TUBITAK MAM teams, and the action tables created on the basis of the relevant sector were explained to the participants with TUBITAK MAM representatives as table moderators, and their opinions and suggestions were received. The action tables were updated by taking into account the issues communicated within the framework of the meeting. Afterwards, the tables were finalized by taking the written opinions and suggestions of the stakeholders on the actions.

2. COMBATING CLIMATE CHANGE AND ITS IMPACTS

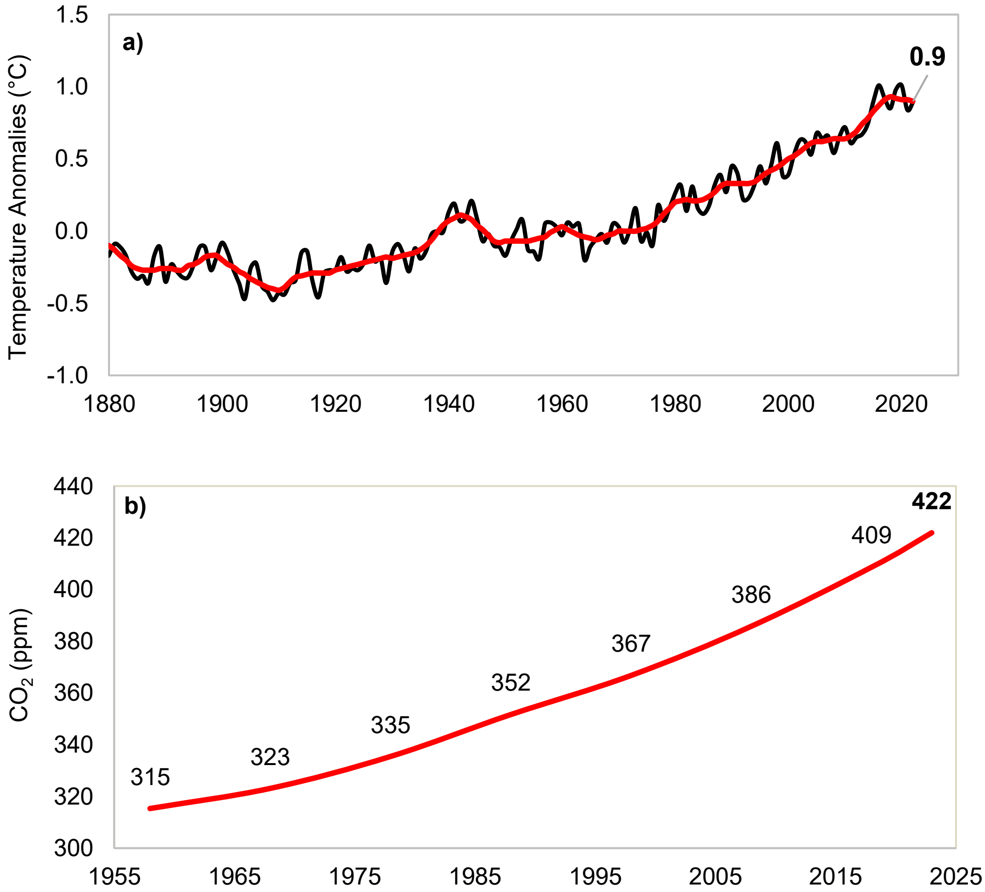
2.1. Climate Change

Climate change is defined as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (UNFCCC, 1992). The increase in extreme weather events and changes in vegetation cover in recent years are among the significant consequences of climate change. The rise in average temperatures, noticeable changes in precipitation regimes and amounts, heatwaves, droughts, excessive rainfall, and increased occurrences of floods, hailstorms, storms, and tornadoes have a substantial impact on various sectors and daily life, particularly in agriculture, health, and energy sectors. Severe weather events categorized as *"Heat Waves", "Extreme Rainfall", "Flood", "Meteorological and Hydrological Drought", "Ecological and Agricultural Drought", "Tropical Cyclones/Winter Storms and Storms", "Hurricane", "Hail", "Lightning", "Extreme Winds"* and *"Fire Weather"* have shown visible changes associated with climate change. These changes are ***identified*** in the high and medium confidence range to be ***linked*** to human activities, as stated in the latest assessment report prepared by the Intergovernmental Panel on Climate Change (IPCC) (IPCC, 2021).

According to the IPCC 6th Assessment Report published in 2022, the Mediterranean Basin, which includes our country, is projected to be among the most affected regions by climate change. It is estimated that the agriculture, forestry and water resources, as well as the energy, health, transportation, and tourism sectors, will experience significant impacts due to climate change in our country with its semi-arid climate. Given our country's semi-arid climate, the increase in temperatures will lead to increased evaporation rates, decreased rainfall and soil moisture in a large part of our country, and a rise in severe weather events and associated disasters. This will have a severe impact on the agricultural sector, while the competition for water resources between the agriculture, tourism, textile manufacturing, and drinking/utility water sectors, already under water stress, will further intensify (IPCC, 2021).

The increase in global temperature and atmospheric carbon dioxide concentration, as observed since the pre-industrial era, is primarily attributed to the changes and variability in the absorption, transmission, and reflection-scattering of solar radiation by the atmosphere (including clouds, aerosols, and air molecules) and the Earth's surface (such as water bodies like oceans, seas, and lakes, snow surfaces, ice caps, vegetation, etc.). This increase in temperature is influenced by natural factors such as the Earth's precession and the El Niño phenomenon, as well as anthropogenic (human-induced) factors including rapid population growth, increased consumption patterns, industrialization, energy production, and the use of fossil fuels.

Human activities, particularly the combustion of fossil fuels, have significantly contributed to the rise in global surface temperature (Figure 2.1a) and atmospheric carbon dioxide concentration (Figure 2.1b), and these trends continue to persist.



Source: (NASA, 2023)

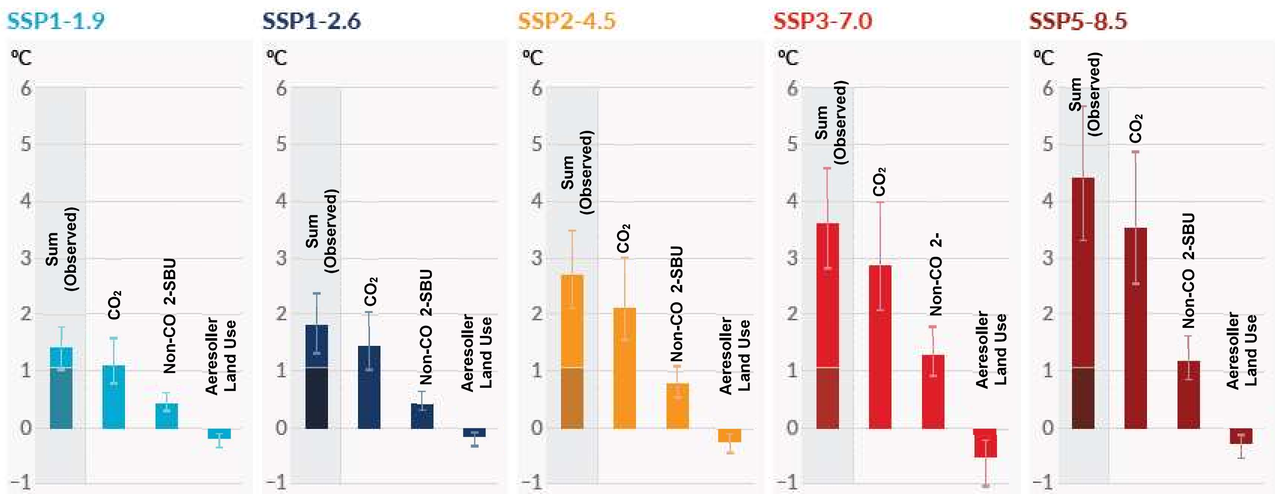
Figure 2.1: a) Change of global surface temperature, b) Change of atmospheric carbon dioxide concentration

Since the pre-industrial era, the global average surface temperature has increased by approximately 1°C. This number is increasing by 0.2 every 10 years, and the current warming trend is advancing at an unprecedented pace.

Today's atmospheric concentration of CO_2 has risen to 50% above the pre-industrial levels. The concentration, measured as 280 ppm in 1850, reached to 422 ppm by mid-2023, and the 350 ppm safety limit has already been exceeded. For this reason, negotiations are being carried out at the international level and various steps are being taken to limit the countries' GHG emissions.

The IPCC 6th Assessment Report emphasizes the need for these efforts to be faster and more effective. It states that the evidence attributing changes observed in extreme events such as heatwaves, heavy rainfall, droughts, and tropical cyclones to human influence has strengthened since the 5th Assessment Report. The link between increased greenhouse gas concentrations resulting from human activities and climate change has been consistently expressed with increasing confidence starting from the 2nd Assessment Report to the latest, the 6th Assessment Report. The IPCC 1st Assessment Report (1990) stated that human activities significantly increased greenhouse gas concentrations in the atmosphere. The 2nd Assessment Report noted the distinction between signals of human-induced climate change and natural variability, highlighting the visible impacts of human activities on the global climate. The 3rd Assessment Report pointed to new and strong evidence indicating that a significant portion of the warming over the past 50 years is due to human activities. The 4th and 5th Assessment Reports strongly emphasized that climate change is most likely caused by human activities.

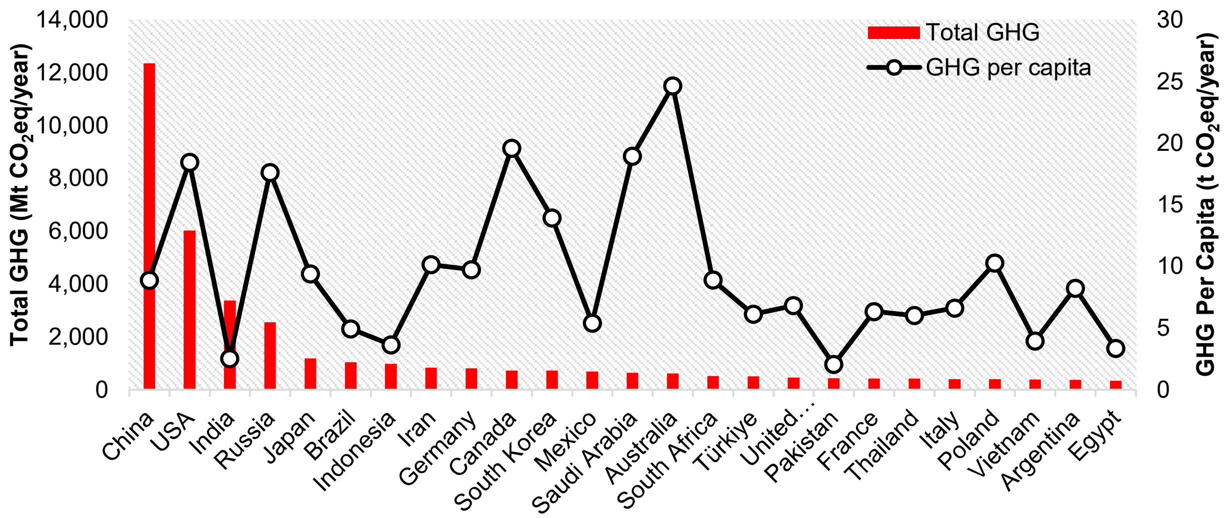
In the 6th Assessment Report, five new emission scenarios covering the future developments of anthropogenic factors related to climate change are considered for the near-term (2021-2040), mid-term (2041-2060), and long-term (2081-2100) periods, relative to the period of 1850-1900. According to the scenario results (Figure 2.2), global surface temperature will continue to increase at least until the middle of the century under all emission scenarios. If there is no reduction in CO_2 and other greenhouse gas emissions in coming years, the targets of 1.5°C and 2°C will be exceeded in the 21st century (IPCC, 2021). Therefore, in order to achieve the targets, countries need to make significant improvements in addition to their current plans and policies.



Source: (IPCC, 2021)

Figure 2.2: Change in global surface temperature in 2081–2100 (ºC)

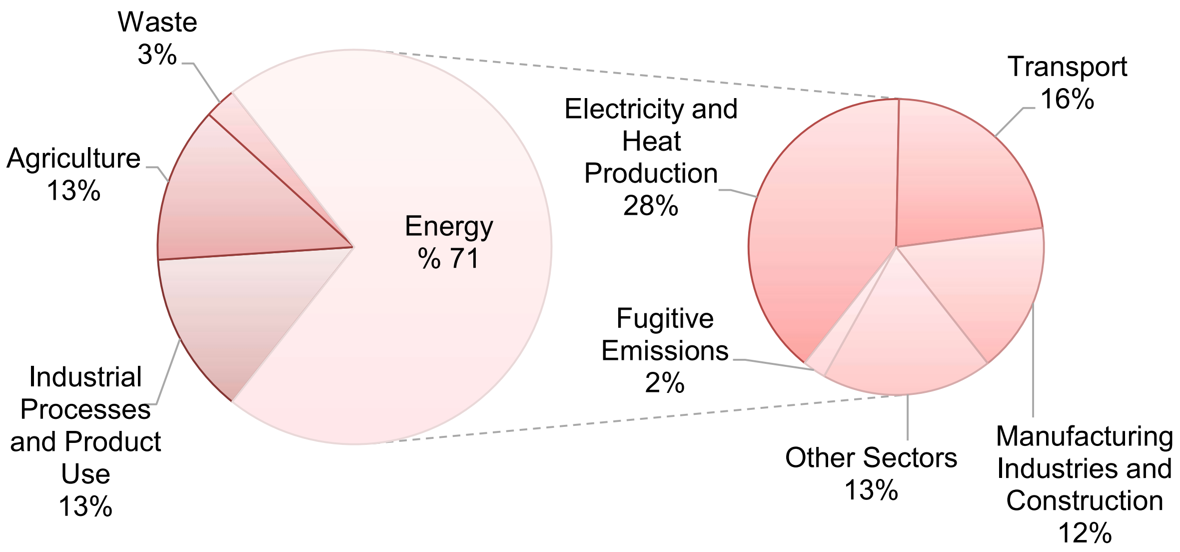
Türkiye ranks 16th among the 25 countries with the highest greenhouse gas emissions in 2019 (Figure 2.3). China is the world's top greenhouse gas emitter with a rate of 26.4%. China is followed by the United States with 12.5% and India with 7.1%. The U.S. reduced its per capita greenhouse gas emissions from 23.4 t/year in 1990 to 18.2 t/year by 2019, while China increased its greenhouse gas emissions from 2.8 t/year to 9 t/year, and China increased its GHG from 1.4 t/year to 2.5 t/year. Türkiye, as a developing country, currently causes 1% of global greenhouse gas emissions and ranks 16th. Its' 3.8 t/year per capita greenhouse gas emissions in 1990 reached 5.9 t/year by 2019.



Kaynak: (CW, 2019; WB, 2019)

Figure 2.3: Greenhouse gas emissions by country

Türkiye's total greenhouse gas emissions in 2021 is 564 Mton CO_2e. With 402 Mton CO_2e, the energy sector accounts for 71% of total emissions. The agricultural sector has a rate of 12.7% with 72 Mton CO_2e, industrial processes and product use have a rate of 13.3% with 66.7 Mton CO_2e and the waste sector has a rate of 3% with 15 Mton CO_2e (Figure 2.4).



Source: (TurkStat, 2023)

Figure 2.4: Distribution of GHG by sector

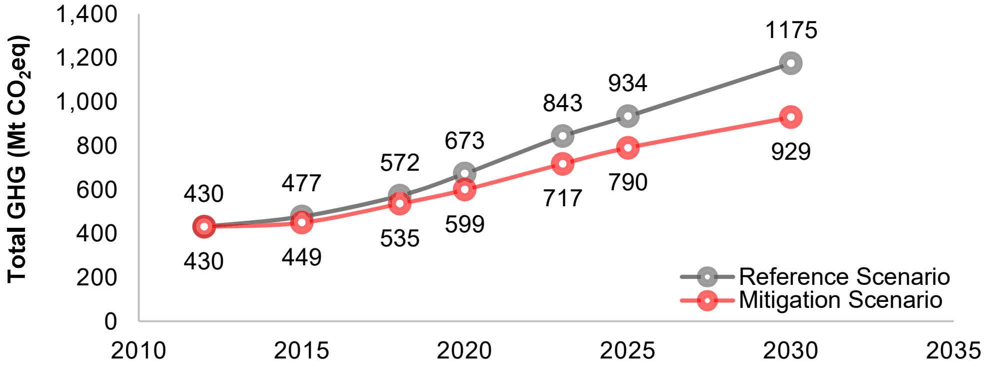
2.2. International Negotiation Processes and Türkiye's Position

The first and most significant step taken at the international level to address the impacts of global warming caused by human activities was the United Nations Framework Convention on Climate Change (UNFCCC), which was opened for signature at the United Nations Conference on Environment and Development (the Rio Earth Summit) in 1992. At the time of the Convention's opening for signature, Türkiye was included in Annex I (industrialized countries and countries in transition to a market economy) and Annex II (industrialized countries) lists, and it continued to remain in Annex I by being granted special conditions at the 7th Conference of the Parties held in 2001. Türkiye became a Party to the Convention on 24 May 2004, which entered into force on 21 March 1994, becoming the 189th Party.

On the other hand, the Kyoto Protocol, which was signed at the 3rd Conference of the Parties in 1997 and entered into force on 16 February 2005, sets quantified emission limits or reduction commitments for the Annex I Parties of the Convention listed under Annex B. However, Türkiye, which became a Party to the Protocol on 26 August 2009, was not included in Annex B as it had not become a Party to the Convention when the Protocol was adopted, and therefore, it did not have any quantified emission limitation or reduction obligations (MoEUCC, 2021).

Countries that are Parties to the UNFCCC are represented at the Conference of the Parties (COP), which is the highest decision-making body of the Convention, and all Parties come together annually to continue negotiations on climate change. The 21st Conference of the Parties (COP21), held in Paris in November 2015, was a significant turning point as the legally binding international Paris Agreement was adopted to strengthen the global response to the threat of climate change.

The Paris Agreement aims to limit global warming to well below 2 °C, preferably to 1.5 °C, compared to pre-industrial levels. It also emphasizes the need for Parties to make their "nationally determined contributions" (NDCs), demonstrating their best efforts and enhancing these efforts in coming years, accelerating the provision of financial resources, technology transfer, and capacity-building support from developed country Parties to developing countries, particularly Small Island Developing States, and undertaking absolute emission reduction targets (UNFCCC, 2015). The Agreement entered into force on 4 November 2016, requiring the approval of 55 countries representing at least 55% of global emissions. Türkiye, which signed the Agreement on 22 April 2016, ratified it in the Turkish Grand National Assembly as of 6 October 2021. The "Law on the Approval of the Paris Agreement" was published and entered into force in the Official Gazette numbered 31621 on 7 October 2021. Prior to the adoption of the Paris Agreement at COP21, countries submitted their intended nationally determined contributions (INDCs) regarding greenhouse gas emission reductions to the UNFCCC Secretariat. Türkiye, in its national contribution submitted to the Secretariat on 30 September 2015, declared its aim to achieve a 21% reduction in greenhouse gas emissions by 2030 compared to projected levels (Figure 2.5).



Source: (MoEU, 2015)

Figure 2.5: Nationally Determined Contribution of Türkiye

In order to achieve the set reduction target, various plans and policies have been determined, including increasing electricity generation capacity from solar and wind energy, commissioning one nuclear power plant, reducing the rate of energy losses, reducing fuel consumption from road transportation, phasing out old vehicles, improving the energy efficiency of new and existing buildings, supporting good agricultural practices, promoting waste recycling and energy recovery from waste, increasing carbon sinks, conducting forest rehabilitation and pasture improvement projects (MoEU, 2015). Prior to the COP21, national commitments on mitigation and adaptation were prepared as intended nationally determined contributions (INDCs), which were later formalized as Nationally Determined Contributions (NDCs) and submitted to the Secretariat after the approval of the Paris Agreement. In Türkiye, efforts to update the NDC were carried out in 2022, and it was announced that the reduction target for 2030 was raised to 41% and emissions are expected to peak in 2038, as reported during COP27.

2.3. Local Climate Change Policies

Local governments play a significant role in both reducing greenhouse gas emissions and adapting to climate change. Urban activities account for approximately 60% of global greenhouse gas emissions and 78% of energy use (UN, 2021). In the global ranking of cities' carbon footprints, Istanbul ranks 26th, while Ankara ranks 80th, with Seoul, Guangzhou, and New York City being in the top three (GGMCF, 2021). Cities also harbor vulnerable structures in the face of climate change impacts such as anticipated temperature increases, sea-level rise, and altered precipitation patterns. Therefore, efforts by local governments to reduce greenhouse gas emissions and enhance climate change adaptation are of great importance, and such initiatives have gained momentum in our country.

Climate change action plans to be prepared by local governments should include targets to reduce the city's contributions to climate change (i.e. greenhouse gas emissions) quickly and fairly and to increase the city's capacity to adapt to climate change impacts. In this context, it was aimed to prepare local climate change action plans in 30 Metropolitan Municipalities in our country by 2024.

In line with this goal, efforts are underway to support local governments to prepare their climate change action plans. Currently, studies are being carried out within the provincial and district municipalities for the preparation of Local Climate Change Action Plans (LCCAP). In this context, there are various voluntary initiatives in the international arena, and one of the most important of these is the Global Covenant of Mayors for Climate and Energy (GCoM), which has been signed in our country by 50 municipalities, 15 of which are metropolitan cities. This initiative, which was first launched in 2008 within the European Commission, aims to support local governments in achieving climate and energy targets and to bring together many cities and regions that want to implement the targets set within the framework of the convention. Municipalities that are parties to the Convention are obliged to prepare action plans containing the measures they plan to implement in terms of greenhouse gas emission reduction and adaptation to climate change (GCoM, 2022). Another initiative established by local governments to combat climate change at the international level is the Local Governments for Sustainability (ICLEI). This association, whose main purpose is to increase capacity building and cooperation of local governments under the theme of sustainability, has over 2,500 members, 8 of which are from our country (ICLEI, 2021).

There are many studies already completed or ongoing by local governments, especially metropolitan municipalities, for the preparation of greenhouse gas emission inventories and climate change action plans. Mitigation and adaptation actions that can be generally implemented by local authorities are given in Table 2.1.

Table 2.1: Mitigation and adaptation actions that can be implemented by local authorities

Sector	Mtitigation	Adaptation
Energy	• Reducing fossil fuel use • Renewable energy use • Efficient street lighting	• Strengthening the electricity transmission and distribution infrastructure • Increasing the resilience of grids to climate change
Industry	• Improvement of processes, identification of the best available techniques • Reduction of fuel and electricity consumption	• Determination of climate resistance, preparation of action plans
Buildings/Housing	• Increasing energy efficiency • Thermal insulation • Energy-efficient design during the construction phase and completion of energy identity documents • Green roof applications • Awareness-raising activities	• Disaster management • Awareness-raising activities • Strengthening infrastructure in buildings
Transportation	• Low-carbon emission network • Increasing the use of electric and hybrid vehicles	• Improvement of traffic signaling systems

Sector	Mtitigation	Adaptation
	• Saving energy and fuel with efficient technologies • Dissemination of intelligent transportation systems • Enabling public transport • Encouraging pedestrian access • Expansion of bicycle paths	
Waste and Wastewater	• Obtaining energy from landfill gas • Reduction of emissions from storage • Ensuring solid waste and wastewater recovery • Reducing water losses in drinking water supply and distribution systems in order to protect existing water resources	• Reducing industrial waste and ensuring recycling • Creation of waste collection points • Positioning of containers in such a way that they are not affected by weather conditions • Ensuring that the treated water is reused • Taking measures to save water in car washes
Agriculture	• Reduction of the use of chemical fertilizers • Installation of solar energy for use in agricultural activities • Realization of animal and plant production suitable for the region • Modification and alteration of tillage practices • Carrying out afforestation works on the edges of agricultural areas	• Expansion of systems to reduce water consumption • Determination of drought resistant plant pattern • Improving food safety • Encouraging urban agriculture
Other (Water resources, food security, public health, heat island, land use, AFOLU etc.)	• Obtaining agricultural fertilizer from animal waste • Land consolidation • Use of organic fertilizers • Reduction of heating, cooling and electricity consumption in health institutions	• Establishment of early warning systems in response to flash floods and floods • Rainwater collection • Agricultural drought management • Combating water and foodborne diseases • Being prepared for epidemic diseases • Switching to natural soil floor in parks and gardens • Increasing carbon sink sources

3. MERSIN IN GENERAL

3.1. The Importance of Mersin

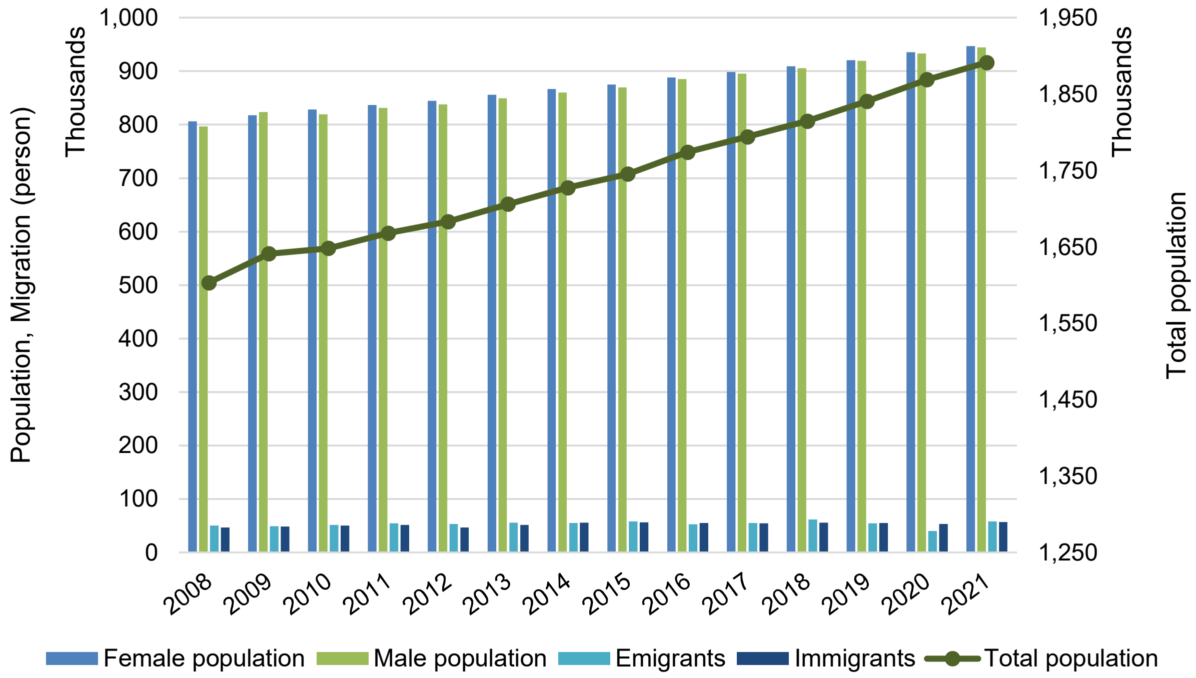
Mersin, which was known as Cilicia in classical times, is located in a region that has hosted different civilizations, ranging from the Hittites to the Persians, from the Macedonians to the Byzantines. As the 9th largest province in terms of areal coverage in Türkiye, Mersin encompasses significant tourist attractions such as the Cennet-Cehennem Cave, Aya Thekla Church, and the Temple of Zeus. With its 321 km long coastline, Mersin is also one of the important residential areas for summer tourism in our country. In addition to the central districts of Akdeniz, Mezitli, Yenişehir, and Toroslar, it has a total of 13 districts including Anamur, Aydıncık, Bozyazı, Silifke, Tarsus, Çamlıyayla, Erdemli, Gülnar, and Mut. The international port and adjacent free zone in Mersin provide a connection for global trade, particularly for many provinces located in Eastern Anatolia and Central Anatolia regions (GM, 2022).

Source: (GM, 2022; AA, 2014; MMM, 2023)

Figure 3.1: Photos of Mersin

3.2. Population

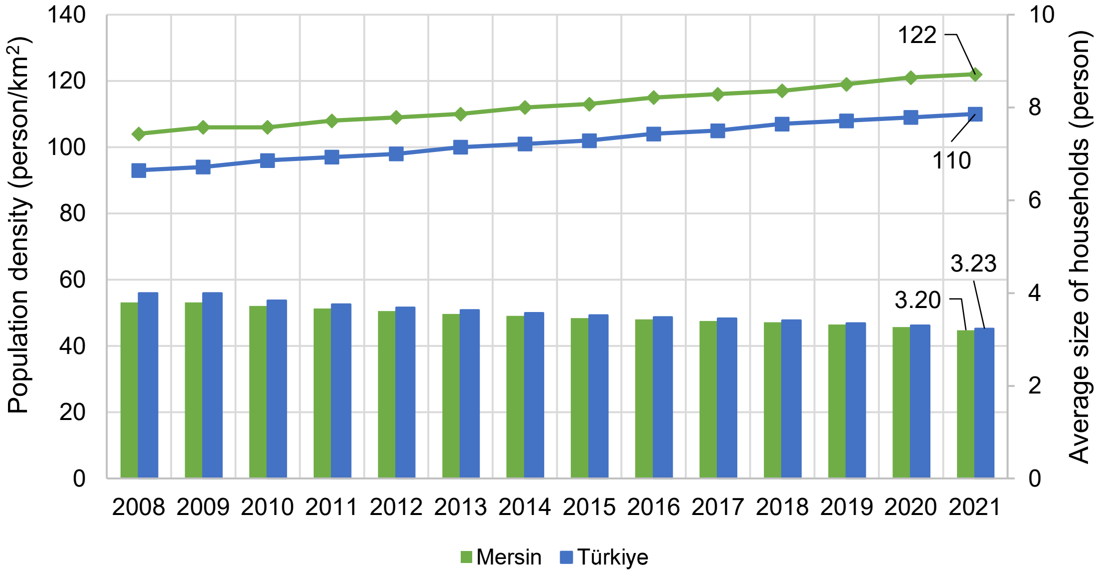
The population of 1,488,755 of the Mersin province in 2000 has increased by approximately 27% in the last 21 years and reached 1,891,145 in 2021. Mersin is the 11th largest province in Türkiye. As shown in Figure 3.2, the female and male populations are very close to each other. The majority of population lives in urban areas, and between 1990 and 2000, the urban population increased by 23.67% and the rural population by 30.92%. Mersin province received 57,213 immigrants in 2021 and 57,930 migrated. Between 2016 and 2019, Mersin province received migration from outside of Türkiye, approximately 81% of which were foreign nationals, while 17,401 people, 59% of whom were foreign nationals, migrated from Mersin in the same time period. On the other hand, there has not been a steady increase or decrease in migration inwards or outwards over the years. The difference between the migration received and the migration given in 2021 is 717 people. While 10% of the immigration received was from Adana, 12% of the migration given was to Istanbul (TurkStat, 2023).



Source: (TurkStat, 2023)

Figure 3.2: Population and migration change in Mersin province (2008-2021)

The average household size of 3.7 in 2010 showed a decreasing trend and decreased to 3.2 people in 2021. This number is 3.23 for the average of Türkiye. The number of illiterates decreased from 36,077 in 2017 to 28,917 in 2021. As can be seen in Figure 3.3, as of 2021, the area of the province is 15,853 km^2 and the population density is approximately 122 people/km^2 (TurkStat, 2023).



Source: (TurkStat, 2023)

Figure 3.3: Change in population density and household size in Mersin (2008-2021)

3.3. Geography

In terms of surface area of Mersin province, 53% is covered with forest and nursery, 21% is covered with agricultural land, 22% is comprising non-agricultural land, and around 4% is covered by meadows and pastures. Geographically, the province is located between the latitudes of 36-37° North and the longitudes of 33-35° East. With an area of 15,853 km^2, Mersin has a coastline of 321 km and a land border of 608 km. It is bordered by the provinces of Konya, Karaman, and Niğde to the north, Antalya to the west, Adana to the east, and the Mediterranean Sea to the south. Mersin is divided into 13 districts.

Figure 3.4: Map of Mersin Province

Mersin province is predominantly composed of high, rugged, rocky Western and Central Taurus Mountains. The plains and gently sloping areas are developed in the central parts of the province, as well as in areas such as the provincial capital, Tarsus and Silifke, where these mountains extend towards the sea. In the northern part of the province, between the mountains or in the higher regions, there are flat or gently sloping areas. Mersin province is not rich in rivers. The most important rivers in the province are the Göksu and Berdan rivers.

3.4. Climate Conditions

Mersin province's coastal areas have a typical Mediterranean climate, with hot and dry summers and mild and rainy winters. As you move inland from the coast, a continental climate is observed. In the higher regions of the province, summers are cool and dry, while winters are cold and snowy. According to the climate statistics for Mersin province from 1940 to 2021 provided by the Turkish State Meteorological Service (MGM), the lowest average temperatures are around - 6.5°C in January and February, and the average temperatures during the hottest months, from June to September, are around 39.9°C. The annual average temperature is 19.2°C. The average daily sunshine duration is 7.5 hours, and the annual average number of cloudy days is 40.7 days. The average number of rainy days is approximately 57 days. The average sea water temperature in this region is measured to be 20.8°C.

Based on the data from 1940 to 2021, the annual average precipitation in Mersin province is 613.9 mm. The highest rainfall occurs in November (average 76.9 mm), December (average 138.5 mm), January (average 119.9 mm), February (average 85.2 mm), and March (average 56.4 mm). Precipitation measurements at the MGM's stations indicate that rainfall is higher in mountainous areas. In the coastal regions, the prevailing wind directions are southwest to west. The annual average wind speed in the city is about 2.1 m/s. The relative humidity is on average 64.1% over the past 30 years. Throughout the year, these values range between 60.0% and 66.6% (MGM, 2022).

3.5. Economics

Mersin is one of the most developed provinces of Turkey in many areas. The most important reasons for this development are its fertile soil, advanced industrial status, rich in natural and underground resources, port activities in Mersin and the presence of Mersin oil refinery. While 40% of the income is derived from industry and 30% from agriculture, 10% is obtained from the trade sector. Approximately 32% of Mersin's 517,000 working population is employed in the agricultural sector. With an area of 1,585,300 hectares, Mersin constitutes approximately 2% of the total area of Turkey and agricultural production is carried out on 21% of the province's surface area (PDEUCC, 2022). Mersin ranks 28th in terms of the value of animal products in 2020 with 816.3 million TL, 24th in terms of the value of livestock in 2021 with approximately 3.5 billion TL and 2nd after Konya and Antalya with 17 billion TL in terms of the value of crop production in 2021.

Mersin, 2020 yılı hayvansal ürünler değeri bakımından 816,3 milyon TL ile 28. sırada, 2021 yılı canlı hayvan değeri bakımından yaklaşık 3,5 milyar TL ile 24 sırada ve 2021 yılı bitkisel üretim değeri bakımından 17 milyar TL ile Konya ve Antalya'dan sonra 2. sırada yer almaktadır (TurkStat, 2023).

According to the 2021 Report of Mersin Chamber of Commerce and Industry (MTSO), a total of 177,000 hectares of agricultural land is cultivated in the province. Mersin ranks 2nd in Türkiye in terms of vegetable production with a share of 7.5% and 1st in fruit production with a share of 16%. Mersin is the 3rd largest province in Türkiye in terms of the value of crop production, and the annual production value has expanded by 31%. The area planted with ornamental plants has increased by 32% compared to the previous year, reaching 1,054,606 m^2, while the production quantity has increased by 17% to reach 31,991,610 units. Mersin accounts for 2% of Türkiye's ornamental plant production and ranks 10th among the provinces that produce ornamental plants. Mersin is also the top exporter of fresh fruits and vegetables in Türkiye, covering 21% of the country's total exports in that category. In terms of greenhouse cultivation, the areas have expanded by approximately 19% to reach 223,893 decares, constituting 37% of Türkiye's total and placing Mersin in the 1st position (MTSO, 2022). According to the Mediterranean Exporters' Associations (AKİB) export of fresh fruits and vegetables from Mersin has increased from a total of $ 639,988,782 in 2020 to $ 655,911,594 in 2021.

The livestock sector is carried out in mountainous regions and highlands. The total proportion of non-agricultural land, meadows and pastures in the province is about 26%. The beekeeping sector has developed in the province. Although the province has extensive coasts in the Mediterranean region, fish production is about 28,800 tons (TurkStat, 2023). There are 20 sea bream-sea bass production facilities with a total capacity of 49.8 thousand tons per year, one trout production facility with a capacity of 287 tons per year, three blackfish production facilities with a capacity of 170 tons per year, and four sea bass production facilities with a capacity of 70 tons per year. Apart from sea bream-sea bass production, the other fish farming facilities are land-based. The rivers of Tarsus, Berdan, and Tragon are abundant with freshwater fish. Mersin, which is rich in forest areas, has the third-largest forest cover in Türkiye, occupying 53% of its land area. The coastline from Anamur to Tarsus is covered with maquis vegetation. Among the maquis vegetation, there are wild olive and stone pine trees called "Delice". While dense forests are found up to an altitude of 2,200 meters from the maquis zone, dwarf and sparse forests are present in higher regions. Oak, mastic, sandalwood, myrtle, and juniper trees are found in forested areas up to an altitude of 600 meters. Various types of pine trees, fir trees, and cedar trees are found in higher elevations. The forested and maquis areas cover 785,000 and 100,000 hectares, respectively. Every year, 3,500 tons of resin and 250,000 m^3 of industrial timber are obtained from these forests.

According to industrial registration records, the manufacturing industry accounts for 89% of the enterprises operating in the industrial sector in Mersin province. Among the sub-sectors of the manufacturing industry, food product manufacturing constitutes 32%, followed by machinery and equipment manufacturing, rubber and plastic product manufacturing, fabricated metal product manufacturing, mineral product manufacturing, clothing manufacturing, chemical and chemical product manufacturing, and wood, wood product, and mushroom product manufacturing with percentages of 11%, 8%, 8%, 7%, 7%, 5%, and 5%, respectively. Developments in foreign trade volume in 2021 were parallel to the national trends. Mersin experienced a 31% increase in export volume and a 39% increase in import volume compared to 2020. The manufacturing industry played a determining role in this, while the agricultural sector also made a contribution. Mersin companies conducted exports worth $4.2 billion and imports worth $3.9 billion in 2021 (MoIT, 2021).

Mersin province is among the rich provinces in terms of minerals. The General Directorate of Mineral Research and Exploration has carried out studies in Mersin and its surrounding areas, resulting in the identification of metallic minerals such as chromium, as well as iron, copper-lead-zinc deposits, and industrial raw material sources including primarily dolomite and barite, as well as cement raw materials, phosphate, limestone, and magnesite beds and formations. Chrome, copper, iron, quartzite, aluminum, barite, and dolomite are extracted in this province, and some of these minerals are exported to foreign countries through the Port of Mersin.

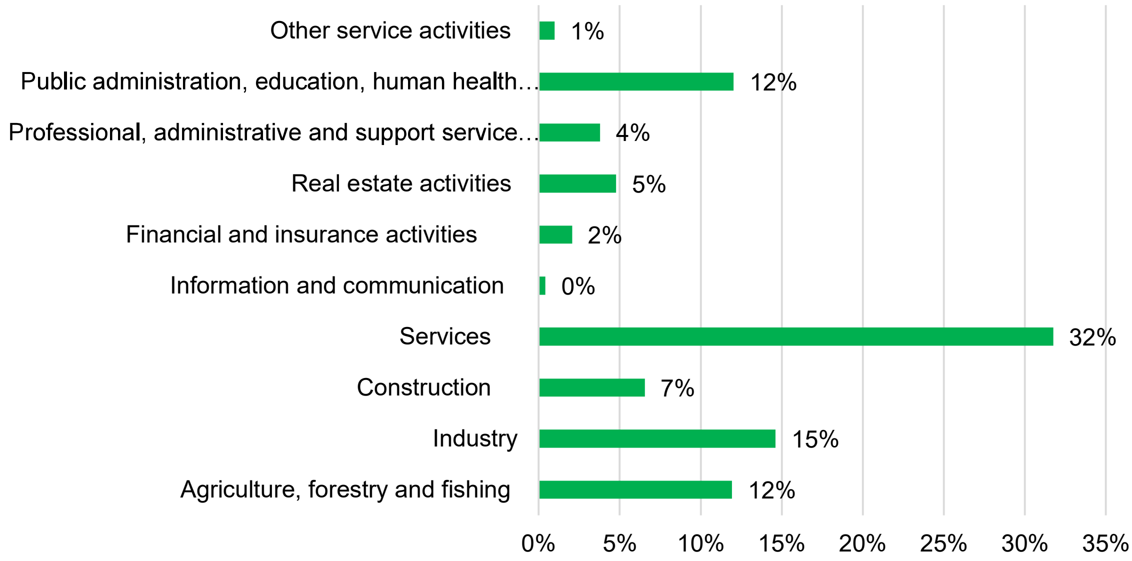
Mersin Free Zone with an area of 860,076 m² opened in 1987 and is the first free zone of our country. In 2020, $2,520,963,199 trade occurred. There are a total of 406 companies in the region with 293 domestic, 79 foreign and 34 domestic-foreign partnerships. Mersin Port is among the top 92 in the world with its container volume, and ranks 1st in Türkiye with its 2.6 million TEU container business volume. Freight traffic handled increased by 10% annually to 36.4 million tons. Mersin ranks 4th in Türkiye in terms of the number of ships calling at ports for operations. Mersin Technology Development Zone (Mersin TEKNOPARK) was established in 2006 and 86 companies operate within.

Mersin, due to its geographical location; covers a significant part of the Eastern Mediterranean Basin to the west of the Çukurova part of the Mediterranean Region. With 321 km long coastline, it has one of the longest coastlines in Türkiye. From Tarsus to Anamur, Mersin has a great potential in terms of tourism with its ancient cities, historical and natural values.

The region consisting of natural beaches and 108 km of sandy coastline, is also very rich in terms of historical and cultural values. Mersin, which has been a settlement since the Neolithic period, has many archaeological and historical artifacts from the Chalcolithic, Hittite, Roman, Byzantine and Ottoman civilizations. There are two centers that are the most important in terms of faith tourism in the province. First, the House and Well of St. Paul, one of Jesus' Apostles, in Tarsus were declared a place of pilgrimage by the Vatican. The other is St. Aya Tekla (Meryemlik), in Silifke/Başucu which is important for the Muslim and Christian world and is accepted as a place of pilgrimage in the early Christian period, are the most important religious visiting centers. In addition, the Ashabı Kehf Cave of Tarsus is also located within the borders of the province.

In order to shift the yacht tourism to the Eastern Mediterranean, marina projects in accordance with international standards are being developed and Mersin Main Marina with a capacity of 500 yachts has been built. Yacht Basen with a capacity of 300-350 yachts operates in Mersin Çamlıbel region in which blue cruise, daily tour and moonlight tours are also made. There are also healing water springs in the region, highlanding, suportive activities, paragliding, sailing sports, underwater diving, rafting, water skiing activities can be done. A significant number of people in the region migrate to the cooler Taurus plateaus in the summer months and revive the highland tourism.

The per capita gross domestic product (GDP) value of Mersin province increased from 15,207 TL in 2011 to 74,343 TL in 2021. Mersin is the 10th largest province with a share of 1.9% in Türkiye's GDP (TurkStat, 2023). According to the 2019 data, TURKSTAT ranked Mersin 4th among the provinces that contributed the most to the 0.9% increase of the annual GDP compared to the previous year with the chained volume index (Figure 3.5).



Source: (TurkStat, 2023)

Figure 3.5: Distribution of Mersin gross domestic product according to economic activity (2020)

TARSUS WATERFALL

4. MERSİN GREENHOUSE GAS EMISSION INVENTORY

4.1. Methodology

The greenhouse gas emission inventory for the province of Mersin has been prepared in accordance with the criteria set forth by the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC), which was published in 2014. The GPC, developed through a collaborative effort by the C40 Cities Climate Leadership Group, the International Council for Local Environmental Initiatives (ICLEI), and the World Resources Institute (WRI), is based on the IPCC National Greenhouse Gas Inventory Guidelines. It provides the necessary standards and tools for identifying total emissions and major emission sources, setting emission reduction targets, planning effective reduction strategies, and monitoring progress.

Within the scope of the GPC, an inventory boundary needs to be defined, which encompasses the geographical area, time interval, gases, and emission sources covered by the GHG inventory. Depending on the purpose of the inventory, the boundary would be aligned with the administrative boundary of a local government, a neighborhood or district within a city, a combination of administrative divisions, a metropolitan area, or any other geographically defined entity.

Greenhouse gas emissions resulting from city activities are assessed under the main sectors of:

- Stationary energy
- Transportation
- Waste
- Industrial processes and product use (IPPU)
- Agriculture, forestry, and other land use (AFOLU)

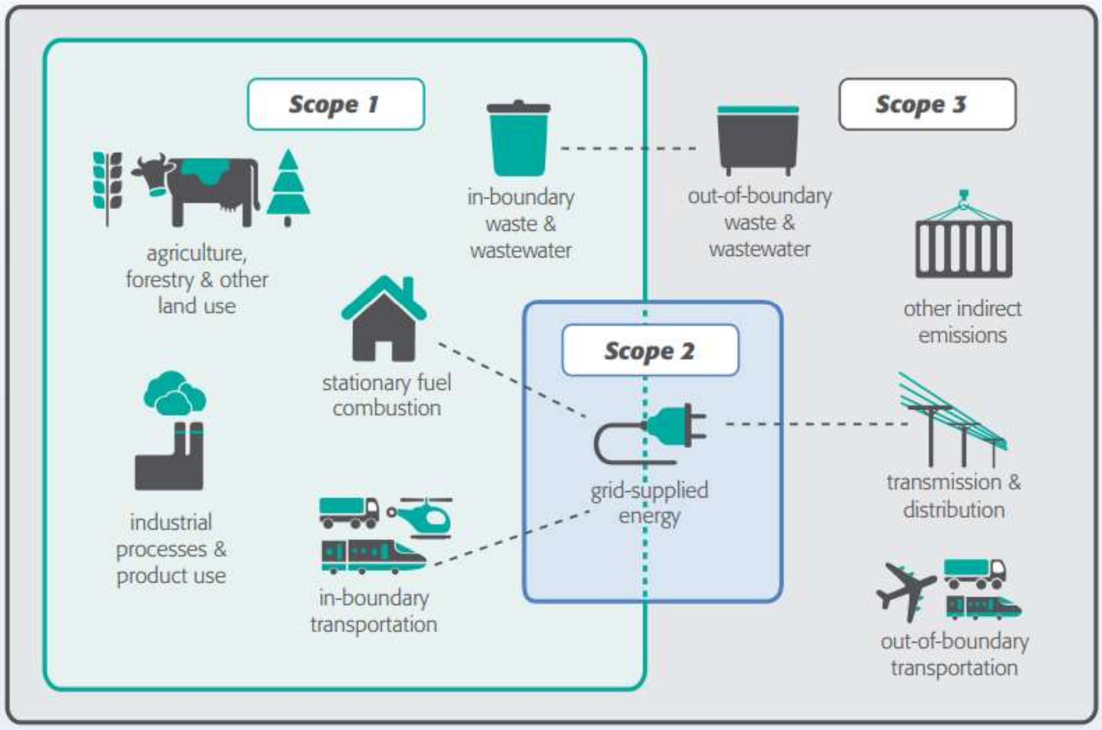
These sectors are further divided into sub-sectors and subsequently into sub-categories. The sub-sectors represent components of a sector, such as waste treatment methods or modes of transportation like road transport. The sub-categories offer opportunities for using disaggregated data, improving inventory details, and facilitating the identification of mitigation actions and policies. They are used to specify an additional level of categorization, such as vehicle types within each transportation mode or building types within the energy sector. Table 4.2 provides details on the sectors covered in this study.

The main greenhouse gases considered in GPC-based inventories and defined in the Kyoto Protocol are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6) and nitrogen trifluoride (NF_3).

On the other hand, emissions are classified into three categories according to whether they occur within or outside the city boundaries:

- Scope 1: GHG emissions from sources located within the city boundaries.

- Scope 2: GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the city boundaries.
- Scope 3: All other greenhouse gas emissions that occur outside the city boundaries as a result of activities taking place within the city boundaries.



Source: (GPC, 2014)

Figure 4.1: Sources and boundaries of greenhouse gas emissions

In the protocol, the calculation and reporting of greenhouse gas emissions are based on the principles of relevance, completeness, consistency, transparency and accuracy to represent a real and impartial emission account, and these principles have been taken into account in the calculation and reporting processes of the greenhouse gas emission inventory prepared within the scope of this study.

To ensure transparency, it is necessary to provide references to all data sources and assumptions used in the creation of the greenhouse gas emission inventory. The "tier" approach used by the IPCC emphasizes increasing accuracy, which requires more detailed and high-quality data. In the GPC, references to the relevant IPCC methodologies, tiers, and methods are provided in each section of emission source categories. The quality of activity data and emission factors used in the calculation of emissions are assessed as high, medium, or low (Table 4.1) (GPC, 2014).

Table 4.1: Data quality assessment criteria

Data Quality	Activity Data	Emission Factor
High (H)	Detailed activity data	Specific emission factors (Local)
Medium (M)	Modeled activity data using robust assumptions	More general emission factors (National)
Low (L)	Highly-modeled or uncertain activity data	Default emission factors (International)

Within the scope of this study, all data and emission factors have been obtained from official statistics and the 2022 National Inventory Report to the maximum extent possible. The aim was to ensure high quality and consistency with national reports. An assessment of data quality is provided in Section **Hata! Başvuru kaynağı bulunamadı.**.

4.2. Greenhouse Gas Emission Calculation

Inventory Boundaries and Greenhouse Gases

The inventory boundaries covers all emission sources within the administrative boundaries of Mersin province, under the authority and responsibility of Mersin Metropolitan Municipality. The inventory focuses on three greenhouse gases: CO_2, CH_4, and N_2O. For the calculation of CH_4 and N_2O emissions in terms of carbon dioxide equivalent, global warming potentials provided in the IPCC Fourth Assessment Report (AR4) are used to ensure compatibility with the National Greenhouse Gas Inventory. Accordingly, the global warming potentials for CH_4 and N_2O are 25 and 298, respectively. However, due to data limitations, emissions from F-gases (HFCs, PFCs, SF_6, etc.) could not be calculated and thus, were not included in the inventory.

Greenhouse Gas Emissions

The inventory calculations were based on the BASIC level approach, which covers emission sources commonly found in almost all cities (Stationary Energy, In-City Transportation, and In-City Waste) and utilizes readily available calculation methodologies and data. Additionally, the BASIC+ level approach, which includes more comprehensive emission sources and involves more challenging data collection and calculation procedures, was partially considered. The inclusion status, indicators, and reasons for the inclusion or exclusion of Scope 1, Scope 2, and Scope 3 emissions in the inventory are shown in Table 4.2.

Table 4.2: Greenhouse gas emissions included in the inventory

GPC Ref No	Scope	GHG Supply	Application	Indicator/Justification
I		**STATIONARY ENERGY**		
I.1		Residential Buildings		
I.1.1	1	Direct Emissions	Included	
I.1.2	2	Indirect Emissions	Included	
I.2		Commercial/Institutional Buildings		
I.2.1	1	Direct Emissions	Included	
I.2.2	2	Indirect Emissions	Included	
I.3		Manufacturing Industries and Construction		
I.3.1	1	Direct Emissions	Included	
I.3.2	2	Indirect Emissions	Included	
I.4		Energy Industries		
I.4.1	1	Direct Emissions	Not calculated	NE : Due to data inadequacy
I.4.2	2	Indirect Emissions	Not calculated	NE : Due to data inadequacy
I.5		Agriculture, Forestry and Fishing Activities		
I.5.1	1	Direct Emissions	Included	
I.5.2	2	Indirect Emissions	Included	
I.6		Non-specified Sources		
I.6.1	1	Direct Emissions		
I.6.2	2	Indirect Emissions		
I.7		Fugitive emissions from mining, processing, storage, and transportation of coal		
I.7.1	1	Direct Emissions	Not calculated	NE : Due to data inadequacy
I.8		Fugitive emissions from oil and natural gas systems		
I.8.1	1	Direct Emissions	Not calculated	NE : Due to data inadequacy
II		**TRANSPORTATION**		
II.1		Road Transportation		
II.1.1	1	Direct Emissions	Included	
II.1.2	2	Indirect Emissions	Included	IE: Considered under I.2.
II.2		Railways		
II.2.1	1	Direct Emissions	Not calculated	NE : Due to data inadequacy
II.2.2	2	Indirect Emissions	Not calculated	NE : Due to data inadequacy
II.3		Waterborne Navigation		
II.3.1	1	Direct Emissions	Included	
II.3.2	2	Indirect Emissions	Included	IE: Considered under I.2.
II.4		Aviation		
II.4.1	1	Direct Emissions	Not calculated	NO: No activity
II.4.2	2	Indirect Emissions	Not calculated	NO: No activity
II.5		Off-road Transportation		
II.5.1	1	Direct Emissions	Included	IE: Considered under II.1.
II.5.2	2	Indirect Emissions	Included	IE: Considered under I.5.
III		**WASTE**		
III.1		Solid Waste Disposal		
III.1.1	1	Direct Emissions	Included	
III.2		Biological Treatment of Wastes		
III.2.1	1	Direct Emissions	Included	IE: Considered under III.1.
III.3		Incineration and Open Burning		

GPC Ref No	Scope	GHG Supply	Application	Indicator/Justification
III.3.1	1	Direct Emissions	Not calculated	NO: No activity
III.4		Wastewater Treatment and Discharge		
III.4.1	1	Direct Emissions	Included	
IV		**INDUSTRIAL PROCESSES AND PRODUCT USE**		
IV.1	1	Direct emissions from industrial processes	Included	
IV.2	1	Direct emissions from product use	Not calculated	NE: Due to data inadequacy
V		**AGRICULTURE, FORESTRY AND OTHER LAND USE**		
V.1	1	Direct emissions from livestock	Included	
V.2	1	Direct emissions and sinks from land use and land use change	Included	
V.3	1	Non-CO_2 emissions from agricultural land	Included	
IE - Included Elsewhere NE - Not Estimated NO - Not Occurring C - Confidential				

Data Sources and Key Stakeholders

In order to create the greenhouse gas emissions inventory, an initial open data search was conducted, resulting in access to various data at the provincial and district levels. Key data sources include the Central Distribution System of the TSI, Provincial Environmental Status Reports, Provincial Industrial Status Reports, Agricultural Briefing Reports, Traffic and Transportation Statistics, Maritime and Air Transportation Statistics from Ministry of Transport and Infrastructure, Energy Market Regulatory Authority (EMRA) Sector Reports, and EMRA Electricity Generation License Statistics. In addition, data was obtained through various stakeholders identified at the provincial level Table 4.3 provides information on the key stakeholders who supported data acquisition for the inventory and the information obtained through these stakeholders.

Table 4.3: Data provided through key stakeholders

Key Stakeholder	Data acquired within the scope of the inventory study
Mersin Metropolitan Municipality and relevant sub-units	Wastewater and solid waste statistics, industrial facilities process information, transportation statistics (bicycle path, pedestrian path, public transportation, transportation master plan current status data), master plan, environmental plan
Provincial Directorate of Environment, Urbanization and Climate Change	Number of buildings with energy identity certificate, industrial wastewater treatment plant statistics, waste characterization
Provincial Directorate of Industry and Technology	Sectoral energy consumption statistics, soda, glass and cement production statistics
Provincial Directorate of Agriculture and Forestry	Fertilizer consumption statistics, disaster statistics, district-based animal numbers, fruit, vegetable, ornamental plant and field products production statistics
Regional Directorate of Forestry	Fire statistics, forest areas and production statistics
General Directorate of Meteorology and 1.Regional Office	Historical meteorological data
TurkStat Adana Regional Office	Building permit statistics, motor vehicle statistics

In the process of obtaining the data, on 26-27 October 2022, a series of one-on-one meetings on 26-27 October 2022 with the officials of Mersin Metropolitan Municipality, Directorate of Environmental Protection and Control, Directorate of Climate Change and Zero Waste, Directorate of Reconstruction and Urbanisation and Directorate of Transportation and officials of Mersin Regional Directorate of Forestry, Mersin Agriculture and Forestry Directorate, Mersin Environment, Urbanisation and Climate Change Directorate, Mersin Industry and Technology Directorate and Mersin Chamber of Commerce and Industry.

Base Year

Ensuring data quality and maximum accessibility to data is of great importance in order to maximize the accuracy and minimize the uncertainty of the greenhouse gas emissions inventory. Both greenhouse gas emissions inventory and other statistics such as consumption data lag behind the period in which the study is conducted. Furthermore, the Covid-19 pandemic in 2020 and 2021 led to significant changes in sectoral consumption patterns. Therefore, in order to exclude the effects of the pandemic from the inventory and to conduct the study with the maximum available data, the base year for the greenhouse gas emissions inventory has been set as 2019. However, emission quantities for the years 2020 and 2021 have also been calculated wherever data is available.

4.2.1 Stationary Energy

Stationary energy emissions generally include the residential and commercial buildings, manufacturing and construction industries, energy production, and agriculture, forestry, and fishing sectors associated with fuel consumption and/or production. All emission factors used to determine stationary source emissions have been obtained from the 2022 National Greenhouse Gas Emission Inventory Report.

I.1 Residential Buildings

Greenhouse gas emissions from the consumption of fuels in residential buildings within the boundaries of Mersin are obtained by multiplying the fuel consumption within the province by the emission factor corresponding to the fuel type. The total fuel consumption of Mersin in 2019, 2020, and 2021 is provided in Table 4.4. Additionally, as of 2021, the number of residential subscribers using natural gas in Mersin is 131,116 (EMRA_a, 2022).

According to the GPC, fuel consumptions that occur within the city boundaries should be considered under Scope 1. For this reason, greenhouse gas emissions calculated for natural gas, kerosene, LPG and coal consumption in residential buildings are evaluated under Scope 1 *(I.1.1).* Greenhouse gas emissions from electricity consumption in residential buildings are considered under Scope 2 *(I.1.2)*.

Table 4.4: Amount of fuel consumed in residential buildings of Mersin

Fuel Type	Amount of Consumption 2019	Amount of Consumption 2020	Amount of Consumption 2021	Unit
Natural gas	67.6	75.9	77.0	Million Sm^3
Kerosene	66	81	78	Tone
LPG	10,356	10,759	10,733	Tone
Domestic coal	37,000	35,340	37,062	Tone
Imported coal	55,500	53,010	55,594	Tone
Wood/biomass	-	-	-	-
Electricity	844,290	846,566	815,061	MWh

Source: (TurkStat, 2023; PDEUCC, 2022; EMRA_a, 2022)

Assumptions and Presumptions

- It was assumed that the fuel sale amounts obtained on a provincial basis from the annual sector reports of EMRA were utilized within the territorial boundaries of Mersin. The assumption is made that around 35% of the consumption attributed to the "LPG (Cylinder)" category in the EMRA reports occurs in the residential sector.
- Greenhouse gas emissions arising from transmission and distribution losses due to grid supplied energy consumption, which are evaluated under Scope 3 (I.1.3), have not been included in the inventory due to the lack of available data.
- In the process of making projections, various factors have been taken into account: For natural gas and coal consumption, factors considered include the number of residential subscribers using natural gas, the total number of residential units, and the mid-year total population. As for electricity consumption, the mid-year total population and per capita GDP have been taken into consideration. Furthermore, for LPG and kerosene consumption, the trend observed between 2015 and 2021, as well as electricity consumption, have been utilized.

I.2 Commercial/Institutional Buildings

The greenhouse gas emissions resulting from fuel consumption in commercial and institutional buildings within the boundaries of Mersin are obtained by multiplying the fuel consumption within the province by the corresponding emission factor for each fuel type. The total fuel consumption for the years 2019, 2020, and 2021 within the boundaries of Mersin is provided in Table 4.5.

Table 4.5: Amount of fuel consumed in commercial/institutional buildings of Mersin

Fuel Type	Amount of Consumption 2019	Amount of Consumption 2020	Amount of Consumption 2021	Unit
Natural gas	15.2	17.5	17.0	Million Sm^3
Fuel oil	3,438	2,996	3,979	Tone
LPG	19,433	20,558	20,508	Tone
Electricity	1,220,176	1,249,113	1,297,755	MWh

Source: (TurkStat, 2023; EMRA_a, 2022)

According to the GPC, fuel consumptions that occur within the city boundaries should be considered under Scope 1. Therefore, greenhouse gas emissions calculated for natural gas, fuel oil, and LPG consumption in commercial/institutional buildings are evaluated under Scope 1 (I.2.1). Greenhouse gas emissions resulting from electricity consumption in commercial/institutional buildings are addressed under Scope 2 (I.2.2).

Assumptions and Presumptions

- It was assumed that the fuel sale amounts obtained on a provincial basis from the annual sector reports of EMRA were utilized within the territorial boundaries of Mersin. In the EMRA reports, it is assumed that 6.5% of the consumption specified under the "Cylinder" item for LPG consumption is realized in the service sector.
- Since there is no data on the amount of fuel oil consumed in the service sector in the city, the total fuel oil consumption specified in the dealer delivery category in the reports of EMRA is considered under *I.2 Commercial/Institutional Buildings* sector. In the national energy balance tables, it is noticed that most of the total fuel oil consumption is occurred in the service sectors.
- The sum of electricity consumption from governmental buildings, commercial buildings and street lighting has been accepted as the total electricity consumption of the service sector.
- Greenhouse gas emissions arising from transmission and distribution losses due to grid supplied energy consumption, which are evaluated under Scope 3 (I.1.3), have not been included in the inventory due to the lack of available data.
- When making projections, for natural gas and electricity consumption; gross domestic product and the total population in the middle of the year, LPG and fuel oil consumption trend between 2015-2021 and natural gas consumption were taken into account.

I.3 Manufacturing Industry and Construction

The greenhouse gas emissions resulting from fuel consumption in manufacturing and construction activities within the boundaries of Mersin are calculated by multiplying the fuel type-specific emission factor with the total fuel consumption within the province. The total fuel consumption in Mersin for the years 2019, 2020, and 2021 is provided in Table 4.6.

According to the GPC, fuel consumptions that occur within the city boundaries should be considered under Scope 1. Therefore, the greenhouse gas emissions resulting from natural gas, coal, and fuel oil, diesel, and LPG consumption in the manufacturing and construction sectors are evaluated under Scope 1 (I.3.1). The emissions resulting from electricity consumption in these sectors are addressed under Scope 2 (I.3.2).

Table 4.6: Amount of fuel consumption manufacturing and construction industries of Mersin

Fuel Type	Amount of Consumption 2019	Amount of Consumption 2020	Amount of Consumption 2021	Unit
Natural gas	567.7	581.5	723.2	Million Sm^3
Imported coal	591,073	755,108	671,731	Tone
Anthracite	143,181	380,911	147,539	Tone
Petroleum coke	260,839	441,617	247,941	Tone
LPG	1,180	934	1,168	Tone
Fuel oil	163	134	115	Tone
Diesel	14,629	11,042	10,671	Tone
Electricity	2,154,954	2,427,722	2,600,343	MWh

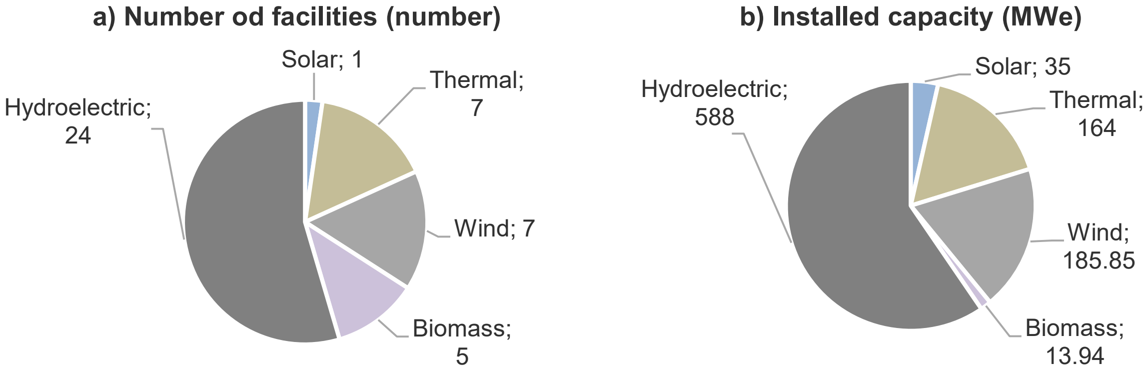
Source: (TurkStat, 2023; PDEUCC, 2022; EMRA_a, 2022)

Assumptions and Presumptions

- It was assumed that the fuel sale amounts obtained on a provincial basis from the annual sector reports of EMRA were utilized within the territorial boundaries of Mersin. For LPG consumption, it is assumed that the entire amount specified under the "Bulk" category in the EMRA reports is attributed to the industrial sector.
- Due to the lack of data on fuel oil consumption in the service sector, the total fuel oil consumption specified in the EMRA reports under the "Free User Delivery" category is considered under Scope 1 of the manufacturing and construction industries (I.3). National energy balance tables also indicate that the majority of total consumption occurs in the service sectors.
- Due to the lack of data on diesel consumption in the industrial sector, 1% to 3% of the total diesel consumption specified in the EMRA reports is considered under Scope 1 of the manufacturing and construction industries (I.3). National energy balance tables also indicate that only a limited portion of total consumption occurs in the industrial sectors.
- The electricity consumption for industrial purposes is considered as the total electricity consumption of the manufacturing and construction industries (I.3).
- Greenhouse gas emissions arising from transmission and distribution losses due to grid supplied energy consumption, which are evaluated under Scope 3 (I.1.3), have not been included in the inventory due to the lack of available data.
- Projections are made taking into account gross domestic product (GDP) for natural gas and diesel consumption, GDP and mid-year total population for electricity consumption, and trends from 2015 to 2021 for solid fuels, LPG, fuel oil consumption, and electricity consumption.

I.4 Energy Generation

As of the end of 2022, there are 44 licensed power generation facilities within the boundaries of Mersin, operating for the purpose of electricity production (EMRA_b, 2022). Figure 4.2 provides the number of facilities and their total capacities categorized by facility types.



Source: (EMRA_b, 2022)

Figure 4.2: Number and capacity information of electricity generation plant

Under the category of fossil fuel-based energy generation facilities, there are 4 natural gas-fired thermal power plants with a total capacity of 142.8 MW and 1 naphtha-fired thermal power plant with a capacity of 12.1 MW in Mersin. Additionally, there is a thermal power plant with a capacity of approximately 9.6 MW operating at the ÇİMSA facilities, which generates electricity using process waste heat.

According to the GPC, greenhouse gas emissions from electricity generation activities within the city boundaries are considered out of scope (I.4.4). Similar to other sectors, emissions from the energy generation are calculated by multiplying the fuel consumption of thermal power plants by the emission factor by fuel type. Accordingly, in 2019, 2020, and 2021, the total amount of natural gas consumed in the conversion and cycle sector in Mersin was 140.5 million m^3, 37.3 million m^3, and 50.7 million m^3, respectively. The corresponding CO_2e emissions for the natural gas consumptions were 271.4 kton, 72.1 kton, and 98.0 kton CO_2e, per year, respectively.

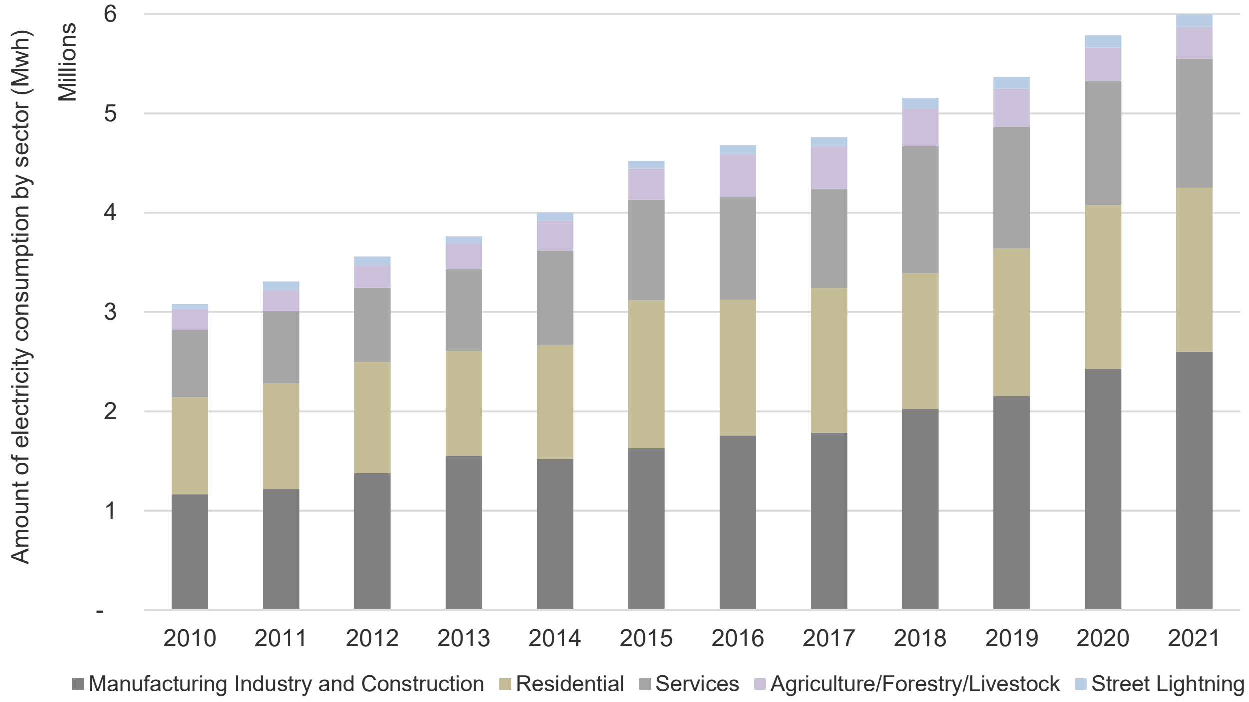
The Provincial Environmental Status Report, prepared annually by the Mersin Provincial Directorate of Environment, Urbanisation, and Climate Change, states that the amount of coal consumed in the thermal power plants was 265,543 tons in 2020 and 224,707 tons in 2021. Due to the lack of consumption data for previous years and the absence of a coal-fired thermal power plant operating in the province, the coal consumption data was not included in the inventory calculations.

According to the GPC, fuel consumptions that occur within the city boundaries should be considered under Scope 1. However, when considering fuel consumption information for low-capacity power generation plants, especially those operating within the industrial sectors, it is addressed under the manufacturing and construction industries (Scope 3 - I.3). Therefore, emissions under Scope 1 (I.4.1) are not calculated under this category.

Assumptions and Presumptions

- As for the installed power distribution, capacity and facility information in operation by the end of 2022 and capacity and facility information commissioned between 2014-2021 were evaluated based on Electricity Market License Statistics.
- Greenhouse gas emissions arising from transmission and distribution losses due to grid supplied energy consumption, which are evaluated under Scope 3 (I.1.3), have not been included in the inventory due to the lack of available data.

Finally, the total amount of electricity consumed between 2010 and 2021 on the basis of sectors is given in Figure 4.3.



Source: (EMRA_a, 2022)

Figure 4.3: Total electricity consumption by sectors (Mwh)

I.5 Agriculture, Forestry and Fishing Activities

Greenhouse gas emissions from fuel consumption in the agriculture, forestry, and fishing activities within the boundaries of Mersin were calculated by multiplying the amount of fuel consumed within the province by the emission factor specific to each fuel type. The total fuel consumption within the boundaries of Mersin in 2019, 2020, and 2021 is presented in Table 4.7.

It is also known that coal consumption is being used for heating purposes in greenhouses during agricultural production, and no information has been obtained on the amount of its consumption in Mersin. However, the amount of greenhouse gas emissions related to the total coal consumed in the city is included under the residential sector *(I.1)*.

Table 4.7: Amount of fuel consumed in the agricultural activities in Mersin

Fuel Type	Amount of Consumption 2019	Amount of Consumption 2020	Amount of Consumption 2021	Unit
Natural gas	1.40	1.78	2.93	Million Sm^3
Electricity	386,192	336,668	319,800	MWh

Source: (TurkStat, 2023; EMRA_a, 2022)

According to the GPC, fuel consumptions that occur within the city boundaries should be considered under Scope 1. For this reason, greenhouse gas emissions calculated for natural gas consumption in the agriculture, forestry and fishery activities are evaluated under Scope 1 *(*I.5.1*).* Greenhouse gas emissions from electricity consumption in these sectors are considered in Scope 2 *(I.5.2)*.

Assumptions and Presumptions

- Since there is no data on the amount of diesel consumed by the vehicles used in the agricultural sector (off-road vehicles) in the city, the relevant consumption is considered under *the Transport sector II.*
- The amount of electricity consumed in agricultural irrigation and other activities is included under Agriculture, Forestry and Fishing Activities.
- Greenhouse gas emissions arising from transmission and distribution losses due to grid supplied energy consumption, which are evaluated under Scope 3 (I.1.3), have not been included in the inventory due to the lack of available data.
- When making projections for natural gas and electricity consumption, gross domestic product and the trend between 2010-2021 were taken into account.

4.2.2 Transportation

The greenhouse gas emissions due to the transportation sector are considered under five sub-sectors: road, railway, waterborne navigation, aviation, and off-road. All emission factors used to determine emissions from the transportation sector are obtained from the 2022 National Greenhouse Gas Emission Inventory Report.

II.1 Road Transportation

In the GPC, due to differences in data availability, a specific method is not recommended for calculating road emissions. The methodologies used to determine emissions are generally categorized as top-down and bottom-up approaches. The top-down approach computes the emission amount by multiplying the total fuel sold with the greenhouse gas emission factor, while the bottom-up approach requires detailed activity data.

Greenhouse gas emissions from road transportation in Mersin are derived by multiplying the amount of fuel sold within the city's boundaries by the emission factor specific to the fuel type. The fuel consumption data for Mersin in the years 2019, 2020, and 2021 are provided in Table 4.8.

Table 4.8: The amount of fuel consumed within the scope of road transportation in Mersin

Fuel Type	Amount of Consumption 2019	Amount of Consumption 2020	Amount of Consumption 2021	Unit
Gasoline	50,487	52,025	67,029	Tone
Diesel	797,361	785,246	775,395	Tone
LPG	87,016	83,349	82,793	Tone
CNG	681	5	1,564	Bin Sm^3

Source: (EMRA_a, 2022)

The amount of diesel fuel sold within the province of Mersin has been evaluated in terms of consumption under the sub-category of road transport, excluding the consumption in manufacturing industry, railway, and waterborne navigation. This ratio corresponds to an average of 97%, including vehicles such as tractors that fall under the off-road category. In order to distribute the total fuel sales according to the sub-category of road vehicles, it is necessary to allocate them based on vehicle classes. The number of vehicles determined by fuel types within the boundaries of Mersin province for the year 2019 is presented in Table 4.9. The total number of vehicles for the year 2019 is 619,418.

Table 4.9: Number of motor vehicles by fuel type in 2019

Fuel Type	Truck	Truck	Minibus	Motorcycle	Bus	Car	Special Purpose	Tractor
Gasoline	116	2,157	157	148,448	22	54,304	45	715
Diesel	32,732	101,877	8,975	184	5,316	98,203	1,282	34,860
LPG	2	2,916	5	10	1	125,838	1	1
CNG	-	-	-	2	-	-	-	-
Diesel-Electric	-	-	-	-	-	22	-	-
Gasoline-Electric	-	-	-	-	-	149	-	-
Electricity	-	-	-	1.069	-	8	-	-
TOTAL	**32,850**	**106,950**	**9,137**	**149,714**	**5,339**	**278,524**	**1,328**	**35,576**

Source: (TurkStat, 2023)

According to the GPC, even if fuel purchases are made for cross-border travels, all domestic fuel sales should be considered under Scope 1. Therefore, the greenhouse gas emissions calculated for vehicles powered by gasoline, diesel, and LPG fuels are evaluated under Scope 1 (II.1.1). The calculations related to transit travels included in Scope 1 emissions are based on highway transit data found in the 2019, 2020, and 2021 Traffic and Transportation Information Reports prepared by the General Directorate of Highways.

Assumptions and Presumptions

- It was assumed that the fuel sale amounts obtained on a provincial basis from the annual sector reports of EMRA were utilized within the territorial boundaries of Mersin.
- It was assumed that all of the gasoline consumed within the province is used in the road subcategory of the transport sector.

- The consumption rates of diesel for the manufacturing industry, railway and maritime transportation were determined by using the Energy Balance Tables.
- Scope 2 *(II.1.2)* emissions from the consumption of electrically powered vehicles are included in the inventory under stationary energy.
- Emissions from cross-border travel outside the city, which are considered under Scope 3, and transmission and distribution losses due to grid-supplied energy for electric vehicle use, are not included in the inventory due to the lack of fuel consumption data.
- When projections were computed to estimate the number of vehicles per 1,000 people, a regression analysis was used using the data of workable population aged between 15 and 64 year and GDP per capita in the last 15 years.
- Calculations for transit for the road are also included in the inventory.

II.2 Railway

There is no urban rail transportation system used for intra-city transportation within the boundaries of Mersin province. The length of the Mersin-Yenice railway line, which is used for intercity transportation, and train-kilometer data were obtained from the TCDD (Turkish State Railways) 2017-2021 Statistical Yearbook. The greenhouse gas emissions resulting from railway transportation in Mersin are calculated by multiplying the amount of fuel sold within the provincial boundaries by the emission factor corresponding to the fuel type. The amount of diesel fuel consumed for railways in Mersin is calculated as 2,163 tons, 1,039 tons, and 1,854 tons for the years 2019, 2020, and 2021, respectively (EMRA_a, 2022). Scope 1 emissions include the emissions resulting from the direct combustion of fossil fuels during the railway transit time within the city boundaries of stationary railway lines. The greenhouse gas emissions calculated for diesel consumption are evaluated under Scope 1 (II.2.1).

Assumptions and Presumptions

- The entire railway line operating within the boundaries of Mersin province is assumed to be diesel-powered.
- It is assumed that the fuel sales quantities obtained from the annual sector reports of EMRA are used within the boundaries of Mersin.
- The consumption rates of diesel for railway transportation are determined based on the National Inventory Report CRF tables and train-kilometer statistics, assuming that it will account for approximately 0.3% of the total consumption.
- Since there is no electricity provided from the grid to power rail transportation systems, Scope 2 (II.2.2) emissions are not included in the inventory.
- Emissions related to trips outside the city boundaries, which are evaluated under Scope 3, are not included in the inventory due to unavailable data.

II.3 Waterborne Navigation

Waterborne navigation encompasses ships, ferries, and other vessels operating within the city boundaries, as well as sea vehicles whose journeys commence or conclude at ports within the city boundaries but have destinations outside the city.

The greenhouse gas emissions attributed to waterborne navigation in Mersin have been obtained by multiplying the quantity of fuel sold within the provincial boundaries by the emission factor corresponding to the fuel type. The fuel consumption amount within the Mersin province in 2019 is provided in Table 4.10.

Table 4.10: The amount of fuel consumed within the scope of waterborne navigation in Mersin

Fuel Type	Amount of Consumption 2019	Amount of Consumption 2020	Amount of Consumption 2021	Unit
Fuel-Oil Marine Fuel	649	0	0	Tone
Diesel	12,889	13,741	10,724	Tone

Source: (EMRA_a, 2022)

Greenhouse gas emissions from waterborne navigation in Mersin have been calculated based on the fuel consumption data obtained from the EMRA Sector Reports, considering fuel-oil as the maritime fuel. Furthermore, diesel fuel consumption has been included in waterborne navigation to a certain extent. Scope 1 emissions encompass the emissions resulting from the direct combustion of fossil fuels for all journeys that begin and end within the city boundaries. The greenhouse gas emissions calculated for diesel fuel and fuel oil consumption are evaluated under Scope 1 (II.3.1).

Assumptions and Presumptions

- The assumption is made that the fuel sales quantities obtained from annual sector reports of EMRA are used within the boundaries of Mersin.
- The consumption rates of diesel fuel for sea transportation are determined based on Energy Balance Tables, assuming that it accounts for approximately 1.6% of the total consumption.
- Scope 2 emissions, which originate from any grid-supplied energy consumed by marine vessels typically at piers or ports, are included in the inventory under Scope 2 (II.3.2) emissions in the stationary sources category.
- Emissions associated with journeys outside the city, evaluated under Scope 3, are not included in the inventory due to the unavailability of fuel consumption data.

II.4 Aviation

There is no airport within the borders of Mersin province.

II.5 Off-road

Greenhouse gas emissions of this category, which typically includes off-road vehicles, landscaping and construction equipment, tractors, bulldozers, snowmobiles and other off-road vehicles, are assessed under *II.1 Road Transportation* and Scope 1 (*II.1.1)*.

4.2.3 Waste and Wastewater

The waste sector is covered under four subcategories in the GPC: solid waste disposal, biological treatment of waste, waste incineration (including open burning), and wastewater treatment and discharge. All emission factors, as well as other factors and coefficients used to determine emissions from the waste sector, are obtained from the 2022 National Greenhouse Gas Emission Inventory Report.

III.1 Solid Waste Disposal

Within the scope of solid waste disposal, CH_4 emissions arising from the storage of domestic (municipal) and industrial wastes are handled. In the calculation of CH_4 emissions, the sanitary landfills were classified as managed waste disposal sites, while applications such as municipal dumps and burial practices are classified as unmanaged waste disposal sites. The calculations rely on municipal waste indicators published on a provincial basis by TURKSTAT, data provided by the Mersin Metropolitan Municipality, and the Provincial Environmental Status Report (TurkStat, 2023; PDEUCC, 2022).

Methane emissions released from landfill areas continue for several decades (and sometimes even centuries) after waste disposal. Waste disposed of in a specific year contributes to greenhouse gas emissions in that year and subsequent years. The same applies to unmanaged landfill areas other than sanitary landfills. Therefore, the first-order decay (FOD) method, which is one of the widely accepted approaches to estimate methane emissions from solid waste disposal, has been preferred.

$$CH_4 = \{\sum_x \left[MSW_x \; x \; L_0(x) \; x \; \left(\left(1-e^{-k}\right) x \;\; e^{-k(t-x)}\right)\right] - R(t)\} \; x \; (1-OX)$$

Given in equality;

CH_4 : *Total CH_4 emissions intonnes*

x: *Landfill opening year or earliest year of historical data available*

t: *Inventory year*

MSW_x: *Total municipal solid waste disposed at SWDS* in year x *in tonnes*

R: *Methane recovered in inventory year, tons*

L_o: *Methane generation potential ($L_0 = MCF \; x \; DOC \; x \; DOC_F \; x \; F \; x \; 16/12$)*

k: *Methane generation rate constant*

OX: *Oxidation factor*

MCF: *Methane correction factor based on type of landfill site for the year of deposition*

DOC: *Degradable organic carbon in year of deposition, fraction (tonnes C/tonnes waste)*

DOC_F: *Fraction of DOC that is ultimately degraded*

F: *Fraction of methane in landfill gas*

Within the scope of solid waste disposal, the data on the amount of municipal waste produced and sent to landfill in Mersin for the years 2019, 2020 and 2021 are given in Table 4.11. Apart from the amount of waste send off for disposal, 116, 167 and 171 kt of waste were sent to recovery for 2019, 2020 and 2021, respectively.

Table 4.11: Quantities of municipal waste produced in Mersin and send off for disposal sites

Type of Waste	Amount of Waste 2019	Amount of Waste 2020	Amount of Waste 2021*	Unit
Municipal Solid Waste	763	819	839	kt/year
Waste Per Capita	1.15	1.2	1.1	ton/year. person
Amount of waste sent to managed disposal sites	577	597	613	kt/year
Amount of waste sent to unmanaged disposal sites	70	54	56	kt/year

***Data for 2021 was obtained by calculation.**

Since the disposal of solid wastes is carried out within the boundaries of Mersin province, the calculated emissions are evaluated under Scope 1 *(III.1.1)*.

Assumptions and Presumptions

- Waste composition data was provided by Mersin Metropolitan Municipality, and missing historical data ws completed based on the Turkish national average.
- The amount of methane gas recovered from the Merkez, Silifke, and Tarsus solid waste disposal sites (sanitary landfills) has been taken into account in the in the calculations.
- Sludge sent to the disposal facilities was also included in the calculations.
- Medical wastes generated within the provincial boundaries are sterilized at the Medical Waste Sterilization Facility in Mersin and then disposed off at the sanitary landfill under the administration of Mersin Metropolitan Municipality. It is assumed that all medical wastes are disposed of in the sanitary landfills.
- It is assumed that approximately 2% of currently generated industrial wastes are sent to disposal sites, and all of them are disposed of in unmanaged disposalsites. This percentage is derived from calculations in the National Inventory Report of Türkiye.

- Emissions from solid waste generated within the city boundary but disposed in landfills or open dumps outside the city boundary are not included in the inventory due to lack of data.

III.2 Biological Treatment of Wastes

Biological treatment of wastes includes the composting and anaerobic digestion of food waste, garden and park waste, sludge, and other organic wastes. The biological treatment of solid wastes reduces the total waste volume and the toxicity of the waste for final disposal (landfilling or incineration). In cases where wastes are biologically treated (e.g., composting), the associated emissions of CH_4, N_2O, and non-biogenic CO_2 resulting from the biological processing of the waste are calculated (GPC, 2014). The amount of methane recovered at the Karaduvar and Mezitli Anaerobic Digestion Plants is reported under the III.4 *Wastewater Treatment and Discharge* section.

III.3 Incineration of Waste

Incineration is a controlled and industrial process that allows for energy recovery and where inputs and emissions can be measured, making it a reliable method. In contrast, open burning is an uncontrolled and usually illegal process. When calculating emissions, different data should be used for incineration and open burning. Emissions from incineration include CH_4, N_2O, and non-biogenic CO_2 (GPC, 2014). However, since open burning is not practiced in Mersin, it is not included in the inventory calculations.

III.4 Wastewater Treatment and Discharge

Wastewater can be categorized as domestic and industrial wastewater, and as a result of the treatment of wastewater, CH_4 and N_2O emissions are released. In the calculation of CH_4 emissions from domestic and industrial wastewater, data such as the amount of rural and urban population, organic content of wastewater are needed. In this context, municipal wastewater statistics published by TURKSTAT and the Provincial Environmental Status Report published by TURKSTAT were used for the data needed in the calculations (PDEUCC, 2022; TurkStat, 2021).

$$CH_4 = \sum_i [(TOW_i \; x \; S_i)EF_i - R_i] \; x \; 10^{-3}$$

Given in equality;

***CH_4* :** *Total CH_4 emissions in metric tonnes*

***TOW_i*:** *Organic content in the wastewater (kg BOD/year for domestic wastewater, kg COD/year for industrial wastewater)* $TOW_i = P \; x \; BOİ \; x \; I \; x \; 365$

***EF_i*:** *Emission factor (*kg CH_4/ kgBOD for domestic wastewater, kg *CH_4/ kgCOD for industrial wastewater)*

$$EF_j = B_o \; x \; MCF_j \; x \; U_i \; x \; T_{i,j}$$

S_i: *Organic component removed as sludge in inventory year (kg BOD/year for domestic wastewater, kg COD/year for industrial wastewater)*

R_i: *Amount of CH_4 recovered in inventory year, kg CH_4/year*

i: *Income group*

P: *City population in inventory year*

BOD: *City-specific per capita BOD in inventory year, g BOI /person/day*

I: *Correction factor for additional industrial BOD discharged into sewers*

B_o: Maximum *CH_4*, kg CH_4/kg *BOD or kg CH_4/kg COD*

MCF_j: *Methane correction factor (fraction)*

U_i: *Fraction of population in income group i in inventory year*

$T_{i,j}$: *Degree of utilization (ratio) of treatment/discharge pathway or system, j,for each income group fraction i in inventory year*

N_2O emissions can arise as direct emissions from treatment processes in wastewater treatment plants or as indirect emissions due to the discharge of wastewater into receiving bodies. Although direct emissions from nitrification and denitrification processes in wastewater treatment plants are considered to be a minor source, they have been considered in the calculations.

$$N_2O = \left[\left(P\ x\ Protein\ x\ F_{NPR} x\ F_{NON-COM}\ x\ F_{IND-COM}\right) - N_{SLUDGE}\right]\ EF_{EFFLUENT}\ x\ \frac{44}{28} x\ 10^{-3}$$

The terms given in equation

N_2O: *Total* N_2O emissions in tonnes

P: *The total population served by the treatment plant*

Protein: *Annual per capita protein consumption,, kg/person/year*

$F_{NON-COM}$: Factor to adjust for non-consumed protein

F_{NPR}: *Nitrogen fraction in protein*

$F_{IND-COM}$: *Factor for industrial and commercial co-discharged protein into the sewer system*

N_{SLUDGE}: *Nitrogen removed with sludge, kg N/year*

$EF_{EFFLUENT}$: Emission factor for N_2O emissions from discharged to wastewater kg *N_2O-N/kg N_2*O

The industrial wastewater amount in Mersin for 2019, 2020 and 2021 is 15,405, 15,180 and 17,196 thousand m^3/year, respectively (PDEUCC, 2022; TurkStat, 2021). Since wastewater treatment and discharge are carried out within the boundaries of Mersin province, the calculated emissions are evaluated under Scope 1 *(III.4.1).*

Assumptions and Presumptions

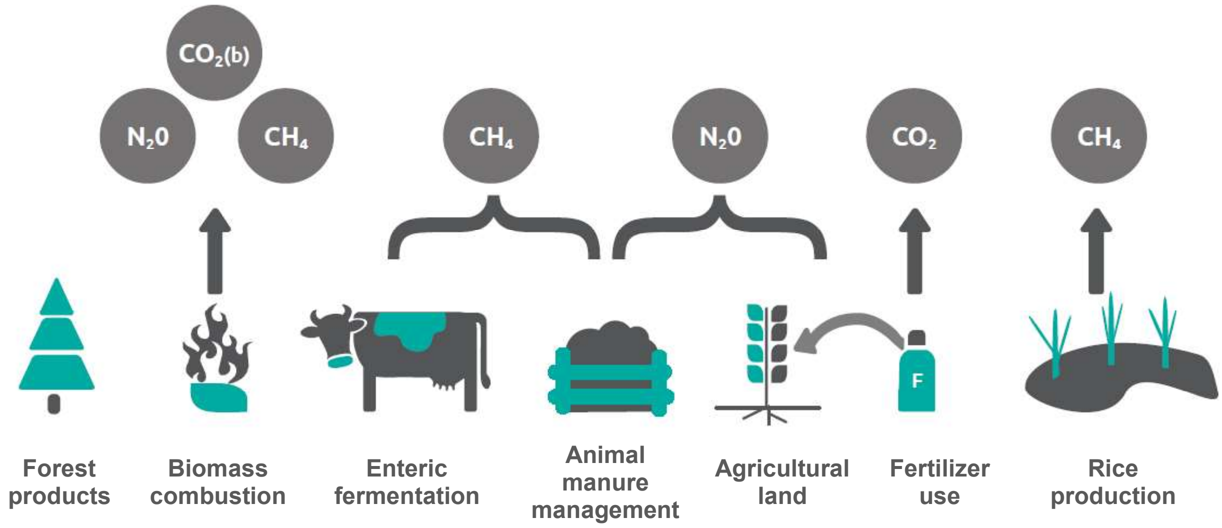
- The emission factors and other factors used in the calculations (e.g., FNON-COM, I, Bo vb.) were obtained from the National Greenhouse Gas Inventory, and it is assumed that they are the same for Mersin.
- Data on wastewater generated within the city boundary but treated outside of the city boundary is not available; therefore, Scope 3 emissions were not included in the inventory.
- Methane emissions from sludge recovery at Karaduvar and Mezitli Wastewater Treatment Plants were included in the calculations.

4.2.4 Industrial Processes and Product Use

All greenhouse gas emissions arising from industrial processes, product use and non-energy uses of fossil fuels are evaluated under this scope. Emissions from two cement plants, three glass plants, and one soda production facility operating in Mersin province have been calculated using activity data and greenhouse gas emission reports obtained from these facilities. Due to insufficient data, emissions related to product use are currently not included in the inventory.

4.2.5 Agriculture, Forestry and Other Land Use

Emissions/sinks from agriculture, forestry, and other land use are classified into three subcategories in the GPC: Livestock emissions, emissions and sinks from land use and land-use change, and emissions from agricultural lands (Figure 4.4). All emission factors used in determining emissions/sinks from agriculture, forestry, and other land use are derived from the 2022 National Greenhouse Gas Emission Inventory Report.



Source: (GPC, 2014)

Figure 4.4: Distribution of emissions/sinks from agriculture, forestry and other land use

V.1 Emissions from livestock

Under this section, CH_4 emissions from enteric fermentation and CH_4 and N_2O emissions from animal manure processing are investigated. In the calculations, livestock statistics published by TURKSTAT on a province-specific basis were used (TurkStat, 2021).

The amount of CH_4 emissions generated as a result of enteric fermentation is obtained by multiplying the number of animals by the emission factors specific to the animal type. Data on the number of animals used in the calculations were retrieved from TURKSTAT statistics. As for the emission factor, the values specified in the IPCC 2006 guidelines for Western Europe and Asia are used.

$$CH_4 = N_T \ x \ EF_{enteric,T} \ x \ 10^6$$

The terms given in the above equation are explained as

CH_4 4: Total *CH_4* emissions *per year (kt)*

T: *Animal species*

N_T: *Total number of animals per year (head)*

$EF_{enteric,\ T}$ *fermentation emission factor* for animal species *(kg CH_4/head/year)*

The amount of CH_4 emissions generated as a result of the use of animal manure is obtained by multiplying the number of animals by the emission factors specific to the animal type. The amount of N_2O emission resulting from the use of animal manure is obtained by multiplying the number of animals by the emission factors specific to the animal type and the rate related to the manure management system. Data on the number of animals used in the calculations were retrieved from TURKSTAT statistics. Emission factors including the effect of animal type and manure management system together are taken from the National Greenhouse Gas Emission Inventory Report for 2022 years.

$$CH_4 \ / \ N_2O = N_T \ x \ EF_{manure,T} \ x \ 10^{-6}$$

The terms given in the above equation are explained as:

CH_4 / N_2O: *Total annual CH_4 / N_2O emissions (kt)*

T: *Animal species*

N_T: *Total number of animals per year (head)*

$EF_{manure,T}$: *Fertilizer management emission factor for T* animal species *(kg CH_4/head/year – kg N_2O/head/year)*

V.2 Emissions/sinks from land use and land-use change

In this section, land uses are classified under 6 categories in accordance with the IPCC: forest land, cropland, grassland, wetland, settlement and other land. GPC recommends a simplified approach that consists of multiplying the net annual carbon stock change by surface area for different categories of land use (and land use change). The total change in carbon stock is calculated by the equation given below.

$$\Delta C_{AFOLU} = \Delta C_{FL} + \Delta C_{CL} + \Delta C_{GL} + \Delta C_{WL} + \Delta C_{SL} + \Delta C_{OL}$$

The terms in the above equation are explained as:

Δ: *Carbon stock change*

AFOLU: *Agriculture, Forestry and Other Land Use*

FL: *Forest land*, **CL** *Cropland*, **GL**: *Grassland*, ***WL***: *Wetland,* ***SL***: *Settlements* and ***OL:*** *Other land*

Land use data for Mersin were obtained from CORINE (Coordination of Information on the Environment Inventory) and classified according to the categories described above (CORINE, 2018). The land use distribution of the province in 2018 is given in Figure 4.5.

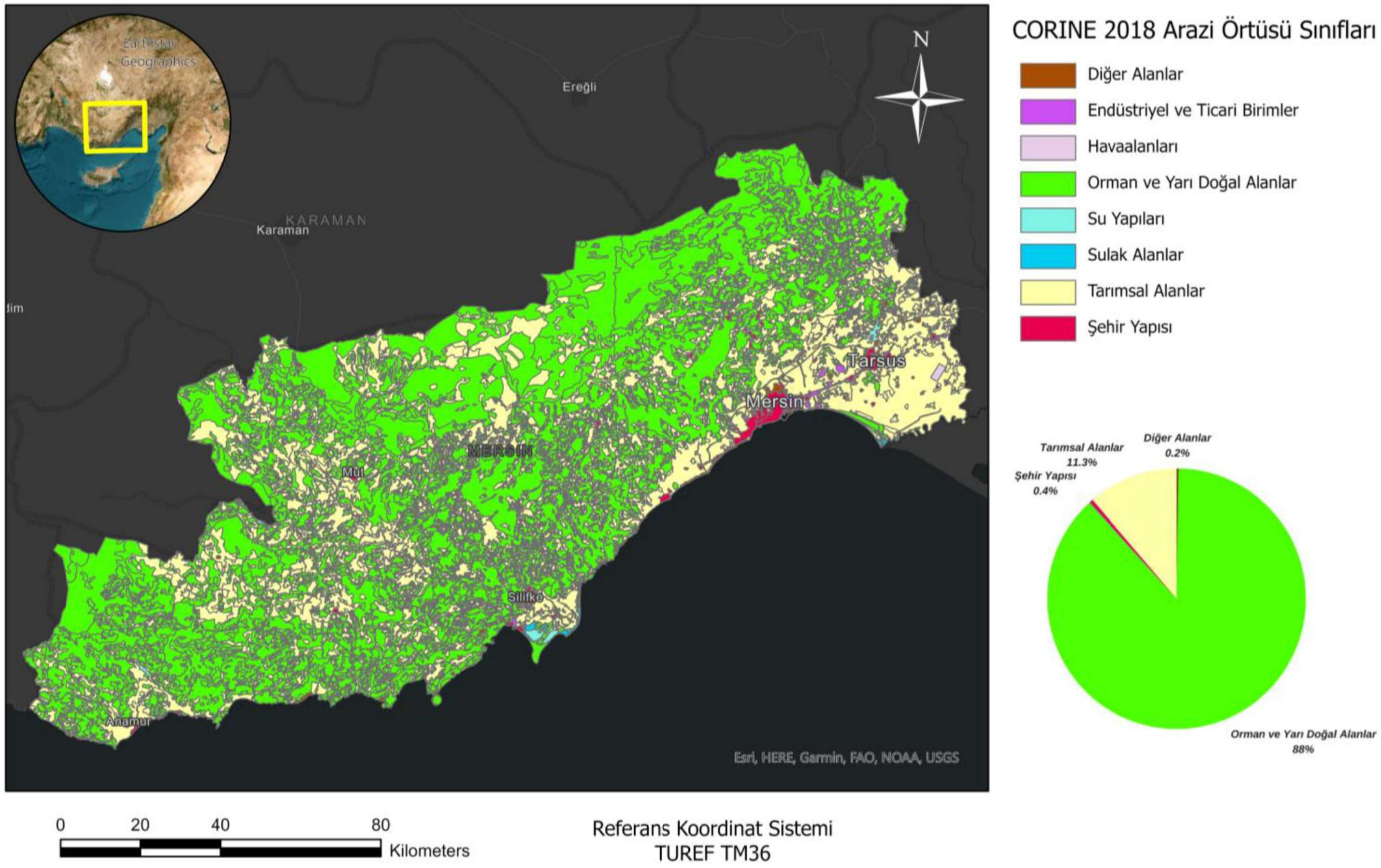


Figure 4.5: Land use distribution of Mersin in 2018

Land use changes were evaluated using the CORINE database and emissions due to land use changes were included in the inventory. In this context, the amount of areal changes between 1990 and 2018 is given in Table 4.12. The amount of emissions and sinks caused by this change is indicated in Table 4.13.

Table 4.12: The amount of land exchange in Mersin (1990-2018) (ha)

Intended use of land		2018					
		Forest land	**Cropland**	**Grassland**	**Wetlands**	**Settlements**	**Other land**
1990	**Forest land**		13.791	84.943	167	938	327
	Cropland	8.382		31.711	1.381	15.613	657
	Grassland	98.589	141.880		360	3.068	39.147
	Wetlands	35	950	708		103	368
	Settlements	-	-	-	-		-
	Other land	2.313	485	10.116	76	39	

Source: (CORINE, 2018)

Table 4.13: Emissions and sinks from Mersin due to land use changes

Intended use of land	Area changed between 1990-2018 (ha)	Total net emissions ($t_{CO2, e}$)	Net emissions on an annual basis ($t_{CO2}e$)
Forest land	100,165	1,377,335	49,191
Cropland	57,744	101,838	3,637
Grassland	283,044	-252,995	-9,036
Wetlands	2,163	850	30
Settlements	3,606	95	3
Other land	13,029	-64,808	-2,315

V.3 Emissions from agricultural land

The following emission sources are considered under this category:

1. CO_2 emissions from the application of urea fertilizers.
2. N_2O emissions from the application of synthetic fertilizers.
3. N_2O emissions from the application of animal manure to the soil.
4. N_2O emissions from urine and dung deposited by grazing animals.
5. CH_4 emissions from rice production.

In addition to these, CH_4 and N_2O emissions from the burning of agricultural residues and N_2O emissions from composting are not included in the inventory due to a lack of information on the occurrence of these activities in the region and the fact that these categories are not considered key categories in the 2022 National Greenhouse Gas Emission Inventory Report. N_2O emissions from agricultural residues, organic matter loss/gain in soil, atmospheric deposition, and leaching/surface runoff have also not been included in the inventory.

1. The amount of CO_2 emissions resulting from the use of urea fertilizers is calculated by multiplying the amount of fertilizer used by the corresponding emission factor. The physical consumption of fertilizers used in the calculations is obtained from the Mersin Provincial Directorate of Agriculture and Forestry.

$$CO_2 = M \, x \, EF \, x \, \frac{44}{12} \, x \, 10^{-3}$$

The terms given in the above equation are expressed as:

***CO_2:** Total annual CO_2 emissions (kt)*

***M:** Total annual urea fertilizer consumption (t)*

***EF:** Emission factor (0.2 t CO_2-C / t urea fertilizer)*

2. The amount of N_2O emissions resulting from the use of synthetic fertilizers is calculated by multiplying the nitrogen content in the fertilizer by the corresponding emission factor. The equivalent amount of fertilizer used in the calculations is determined using the physical consumption values of nitrogen-based fertilizers provided by the Mersin Provincial Directorate of Agriculture and Forestry.

$$N_2O = M \, x \, 0{,}21 \, x \, EF \, x \, \frac{44}{28} \, x \, 10^{-3}$$

The terms given in the above equation are expressed as:

***N_2O:** Total annual N_2Oemission (kt)*

***M:** Total annual consumption of nitrogen fertilizer (t)*

***EF:** Emission factor (0.1 kg N_2O-N / kg N)*

3. The amount of N_2O emissions resulting from the application of animal manure to the soil is calculated by multiplying the livestock population values by the nitrogen conversion rates specific to each animal type, the rates related to the manure management system, and the corresponding emission factor. The livestock population data used in the calculations is obtained from the TURKSTAT statistics. The emission factors that incorporate both the animal type and the manure management system are obtained from the 2022 National Greenhouse Gas Emission Inventory Report.

$$N_2O = N_T \, x \, EF_{soilmanure, \; T} \, x \, (1 - \; Frac_{other}) \, x \, EF \, x \, \frac{44}{28} \, x \, 10^{-6}$$

The terms given in the above equation are expressed as:

***N_2O:** Total annual N_2O emission (kt)*

***T:** Animal species*

***N_T:** Total number of animals per year (head)*

***EF**_{soil fertilizer, T}*

***$EF_{soil\ fertilizer,\ T}$:** Emission* factor for T animal species *(kg N/head/year)*

***$Frac_{other}$:** Proportion of use of animal manure in other applications (%)*

***EF:** Emission factor (0.1* kg N_2O*-N / kg N)*

4. The amount of N_2O emissions generated from the excrement of grazing animals is calculated by multiplying the livestock population values by the nitrogen conversion rates specific to each animal type, the rates related to the manure management system, and the corresponding emission factor. In this context, factors related to pasture lands have been chosen for the selection of manure management system factors. The livestock population data used in the calculations is obtained from the TURKSTAT statistics. The emission factors that incorporate both the animal type and the manure management system, taking into account their combined effect, are obtained from the 2022 National Greenhouse Gas Emission Inventory Report.

$$N_2O = N_T\ x\ EF_{pasturemanure,\ T}\ x\ EF\ x\ \frac{44}{28}\ x\ 10^{-6}$$

The terms given in the above equation are expressed as:

***N_2O:** Total annual N_2O emissions (kt)*

***T:** Animal species*

***N_T:** Total number of animals per year (head)*

***$EF_{pasturemanure,\ T}$:** Emission* factor for T animal species *(kg N/head/year)*

***EF:** Emission factor (0.1 kg N_2O-N / kg N)*

5. The amount of CH_4 emissions generated from rice production is obtained by multiplying the area of rice cultivation by the corresponding emission factor. The data on rice cultivation area used in the calculations is obtained from the TURKSTAT statistics. The emission factors are obtained from the relevant 2022 National Greenhouse Gas Emission Inventory Report. The determination of emission factors takes into account the irrigation regime (continuously flooded, intermittently flooded-single aeration, and intermittently flooded-multiple aeration), and it is assumed that the practice in Mersin is compatible with the national practices.

$$CH_4 = M\ x\ EF_{irrigation,\ T}\ x\ \ 10^{-6}$$

The terms given in the above equation are expressed as:

***CH_4 :** Total annual CH_4 emission (kt)*

***M:** Area planted with rice (decares/year)*

***$EF_{irrigation}$**:* Emission factor for T irrigation type *(g CH_4 / m^2)*

4.3. Total Greenhouse Gas Emissions

The amounts of greenhouse gas emissions for 2019 as the inventory base year, and 2020 and 2021 realized on the basis of sectors within the borders of Mersin province are given in Table 4.14 and Table 4.15 with the units of CO_2e. The distribution of emissions among the main sectors is shown in Figure 4.6, Figure 4.7 and Figure 4.8. Accordingly, the largest share is taken by stationary energy with an average of 44%, followed by the transportation sector with 24%. The total net emissions calculated for the whole province of Mersin for 2019, 2020 and 2021 are 15,593 Mtons, 18,097 Mtons and 17,310 Mtons of CO_2e, respectively. With these values, the total greenhouse gas emissions in Mersin constitute approximately 3.1% of the total greenhouse gas emissions of Türkiye.

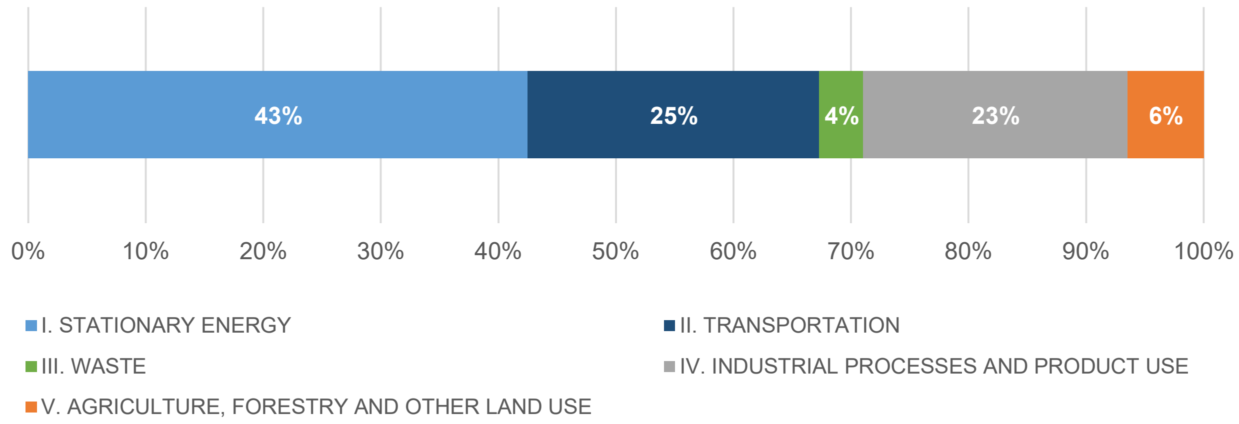


Figure 4.6: Sectoral distribution of total greenhouse gas emissions in 2019 (%)

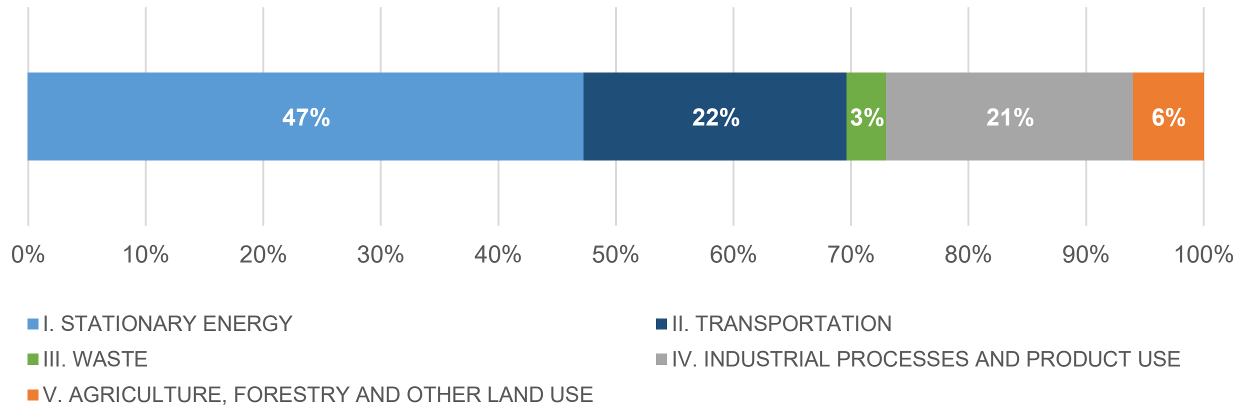


Figure 4.7: Sectoral distribution of total greenhouse gas emissions in 2020 (%)

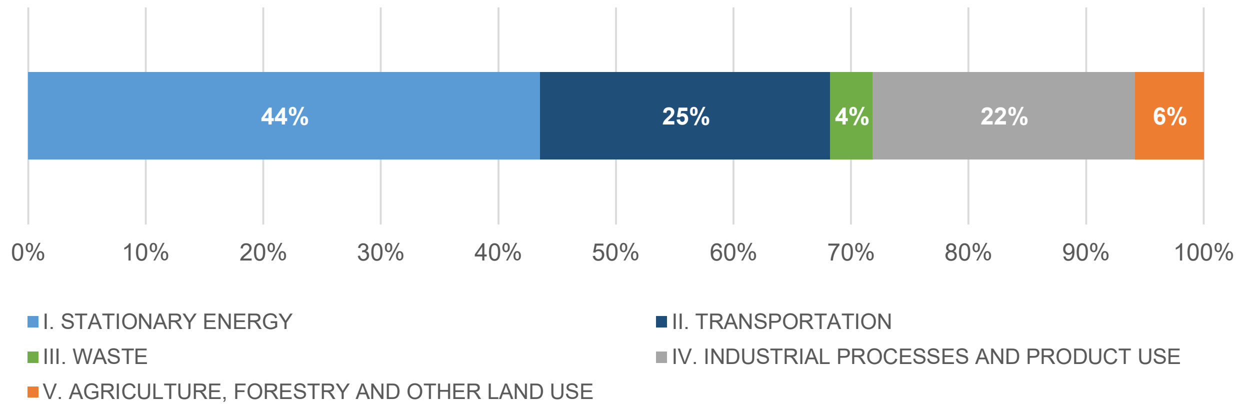


Figure 4.8: Sectoral distribution of total greenhouse gas emissions in 2021 (%)

When an evaluation is made in terms of emissions per capita, it is seen that the three-year average for Mersin province is 9.1 kg CO_2e/person (Figure 4.9). This value is 30% higher compared to the Turkish average level of 6.35 kg CO_2 e/person.

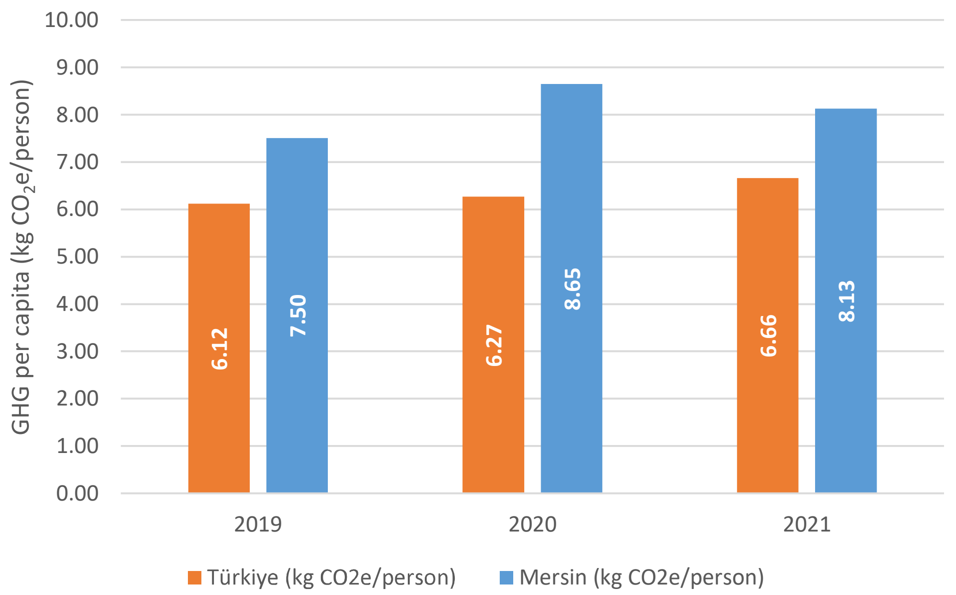


Figure 4.9: Amount of greenhouse gas emissions per capita (kg CO_2e/person)

Table 4.14: Total emissions by greenhouse gas type (kt CO_2e)

Sector	GHG (kt CO_2e)								
	2019			2020			2021		
	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
I. STATIONARY ENERGY	**6.597,5**	**21,5**	**11,6**	**8.515,1**	**24,0**	**17,2**	**7.514,0**	**22,7**	**12,6**
I.1 Residential buildings	1.005,3	13,3	0,9	1.130,9	12,7	0,8	1.142,1	13,3	0,9
I.2 Commercial/Institutional buildings and facilities	711,2	0,2	0,1	767,1	0,2	0,1	796,2	0,2	0,1
I.3 Manufacturing Industries and construction	4.701,3	8,0	10,7	6.450,6	11,0	16,3	5.415,4	9,1	11,7
I.4 Energy industries	269,5	0,5	1,4	71,6	0,1	0,4	97,3	0,2	0,5
I.5 Agriculture, forestry and fishing activities	179,7	-	-	166,4	-	-	160,3	-	-
I.6 Non-specified sources	-	-	-	-	-	-	-	-	-
I.7 Fugitive emissions from mining, processing, storage, and transportation of coal	-	-	-	-	-	-	-	-	-
I.8 Fugitive emissions from oil and natural gas systems	-	-	-	-	-	-	-	-	-
II. TRANSPORTATION	**3.791,9**	**15,1**	**60,3**	**3.974,5**	**15,8**	**62,6**	**4.179,1**	**18,4**	**66,4**
II.1 Road transportation	3.741,4	15,0	59,0	3.928,2	15,7	61,9	4.139,7	18,3	65,4
II.2 Railways	8,2	-	1,0	3,3	-	0,4	5,8	-	0,7
II.3 Waterborne navigation	42,4	0,1	0,3	43,0	0,1	0,4	33,6	0,1	0,3
II.4 Aviation	-	-	-	-	-	-	-	-	-
II.5 Off-road transportation	-	-	-	-	-	-	-	-	-
III. WASTE	**16,4**	**405,9**	**157,7**	**14,9**	**431,2**	**159,8**	**14,6**	**452,1**	**161,8**
III.1 Solid waste disposal	16,4	319,2	-	14,9	344,5	-	14,6	362,4	-
III.2 Biological treatment of wastes	-	-	-	-	-	-	-	-	-
III.3 Incineration and open burning	-	-	-	-	-	-	-	-	-
III.4 Wastewater treatment and discharge	-	86,7	157,7	0,0	86,7	159,8	-	89,7	161,8
IV. INDUSTRIAL PROCESSES AND PRODUCT USES	**3.508,80**			**3.797,70**			**3.863,50**		
V. AGRICULTURE, FORESTRY AND OTHER LAND USE	**56,3**	**502,3**	**447,4**	**62,8**	**529,2**	**491,8**	**58,3**	**482,7**	**463,8**
V.1 Livestock	-	499,4	62,0	-	526,3	66,2	0,0	479,7	62,1
V.2 Land use and land use change	41,5	-	-	41,5	0,0	-	41,5	-	-
V.3 Agricultural land	14,8	2,8	385,4	21,3	2,9	425,6	16,8	3,1	401,7

Table 4.15: Total greenhouse gas emissions for 2019, 2020 and 2021 (kt CO_2e)

Scope/Sector		GHG (kt CO_2e) 2019	2020	2021
I. STATIONARY ENERGY		**6.630,6**	**8.556,3**	**7.549,4**
	I.1 Residential buildings	1.019,4	1.144,5	1.156,4
Scope 1	I.1.1 Emissions from fuel combustion within the city boundary	336,7	345,5	355,8
Scope 2	I.1.2 Emissions from grid-supplied energy consumed within the city boundary	682,7	799,0	800,6
Scope 3	I.1.3 Emissions from transmission and distribution losses from grid supplied energy consumption	-	-	-
	I.2 Commercial/Institutional buildings and facilities	711,5	767,4	796,5
Scope 1	I.2.1 Emissions from fuel combustion within the city boundary	98,1	103,3	105,2
Scope 2	I.2.2 Emissions from grid-supplied energy consumed within the city boundary	613,4	664,1	691,3
Scope 3	I.2.3 Emissions from transmission and distribution losses from grid supplied energy consumption	-	-	-
	I.3 Manufacturing Industries and construction	4.720,0	6.478,0	5.436,2
Scope 1	I.3.1 Emissions from fuel combustion within the city boundary	3.731,6	5.301,9	4.176,5
Scope 2	I.3.2 Emissions from grid-supplied energy consumed within the city boundary	988,4	1.176,1	1.259,7
Scope 3	I.3.3 Emissions from transmission and distribution losses from grid supplied energy consumption	-	-	-
	I.4 Energy industries	-	-	-
Scope 1	I.4.1 Emissions from energy used in power plant auxiliary operations within the city boundary	-	-	-
Scope 2	I.4.2 Emissions from grid-supplied energy consumed in power plant auxiliary operations within the city boundary	-	-	-
Scope 3	I.4.3 Emissions from transmission and distribution losses from grid supplied energy consumption in power plant auxiliary operations	-	-	-
Out of scope	I.4.4 Emissions from energy generation supplied to the grid	271,4	72,1	98
	I.5 Agriculture, forestry and fishing activities	179,7	166,4	160,4
Scope 1	I.5.1 Emissions from fuel combustion within the city boundary	2,6	3,3	5,4
Scope 2	I.5.2 Emissions from grid-supplied energy consumed within the city boundary	177,1	163,1	154,9
Scope 3	I.5.3 Emissions from transmission and distribution losses from grid supplied energy consumption	-	-	-
	I.6 Non-specified sources	-	-	-
Scope 1	I.6.1 Emissions from fuel combustion within the city boundary	-	-	-
Scope 2	I.6.2 Emissions from grid-supplied energy consumed within the city boundary	-	-	-
Scope 3	I.6.3 Emissions from transmission and distribution losses from grid supplied energy consumption	-	-	-
	I.7 Fugitive emissions from mining, processing, storage, and transportation of coal	-	-	-
Scope 1	I.7.1 Emissions from fugitive emissions within the city boundary	-	-	-
	I.8 Fugitive emissions from oil and natural gas systems	-	-	-
Scope 1	I.8.1 Emissions from fugitive emissions within the city boundary	-	-	-
II. TRANSPORTATION		**3.867,4**	**4.052,9**	**4.263,9**
	II.1 Road transportation	3.815,4	4.005,8	4.223,5
Scope 1	II.1.1 Emissions from fuel combustion for on-road transportation occurring within the city boundary	3.815,4	4.005,8	4.223,5
Scope 2	II.1.2 Emissions from grid-supplied energy consumed within the city boundary for on-road transportation	-	-	-
Scope 3	II.1.3 Emissions from portion of transboundary journeys occurring outside the city boundary, and transmission and distribution losses from grid-supplied energy consumption	-	-	-
	II.2 Railways	9,2	3,6	6,5
Scope 1	II.2.1 Emissions from fuel combustion for railway transportation occurring within the city boundary	9,2	3,6	6,5
Scope 2	II.2.2 Emissions from grid-supplied energy consumed within the city boundary for railways	-	-	-

Scope/Sector		GHG (kt CO_2e) 2019	2020	2021
Scope 3	II.2.3 Emissions from portion of transboundary journeys occurring outside the city boundary, and transmission and distribution losses from grid-supplied energy consumption	-	-	-
	II.3 Waterborne navigation	42,8	43,5	33,9
Scope 1	II.3.1 Emissions from fuel combustion for waterborne navigation occurring within the city boundary	42,8	43,5	33,9
Scope 2	II.3.2 Emissions from grid-supplied energy consumed within the city boundary for waterborne navigation	-	-	-
Scope 3	II.3.3 Emissions from portion of transboundary journeys occurring outside the city boundary, and transmission and distribution losses from grid-supplied energy consumption	-	-	-
	II.4 Aviation	-	-	-
Scope 1	II.4.1 Emissions from fuel combustion for aviation occurring within the city boundary	-	-	-
Scope 2	II.4.2 Emissions from grid-supplied energy consumed within the city boundary for aviation	-	-	-
Scope 3	II.4.3 Emissions from portion of transboundary journeys occurring outside the city boundary, and transmission and distribution losses from grid-supplied energy consumption	-	-	-
	II.5 Off-road transportation	-	-	-
Scope 1	II.5.1 Emissions from fuel combustion for off-road transportation occurring within the city boundary	-	-	-
Scope 2	II.5.2 Emissions from grid-supplied energy consumed within the city boundary for off-road transportation	-	-	-
III. WASTE		**580,0**	**605,9**	**628,5**
	III.1 Solid waste disposal	335,6	359,4	377,0
Scope 1	III.1.1 Emissions from solid waste generated within the city boundary and disposed in landfills or open dumps within the city boundary	335,6	359,4	377,0
Scope 3	III.1.2 Emissions from waste generated outside the city boundary and disposed in landfills or open dumps within the city boundary	-	-	-
	III.2 Biological treatment of wastes	-	-	-
Scope 1	III.2.1 Emissions from solid waste generated within the city boundary that is treated biologically within the city boundary	-	-	-
Scope 3	III.2.2 Emissions from waste generated outside the city boundary but treated biologically within the city boundary	-	-	-
	III.3 Incineration and open burning	-	-	-
Scope 1	III.3.1 Emissions from solid waste generated and treated within the city boundary	-	-	-
Scope 3	III.3.2 Emissions from waste generated outside the city boundary but treated within the city boundary			
	III.4 Wastewater treatment and discharge	244,5	246,6	251,4
Scope 1	III.4.1 Emissions from wastewater generated and treated within the city boundary	244,5	246,6	251,4
Scope 3	III.4.2 Emissions from wastewater generated outside the city boundary but treated within the city boundary	-	-	-
IV. INDUSTRIAL PROCESSES AND PRODUCT USES		**3.508,8**	**3.797,7**	**3.863,5**
Scope 1	IV.1 Emissions from industrial processes occurring within the city boundary	3.508,8	3.797,7	3.863,5
Scope 1	IV.1 Emissions from product use occurring within the city boundary			
V. AGRICULTURE, FORESTRY AND OTHER LAND USE		**1.006,0**	**1.083,9**	**1.004,8**
	V.1 Livestock	561,4	592,6	541,8
Scope 1	V.1.1 CH_4 emissions from enteric fermentation	439,4	462,8	421,6
Scope 1	V.1.2 CH_4 and N_2O emissions from animal manure processing	122,1	129,8	120,2
	V.2 Land use and land use change	41,5	41,5	41,5
	V.3 Agricultural land	403,1	449,8	421,5
Scope 1	V.3.1 CO_2 emissions from the application of urea fertilizers	14,8	21,3	16,8
Scope 1	V.3.2 N_2Oemissions from the application of synthetic fertilizers	105,6	124,0	113,2
Scope 1	V.3.3 N_2O emissions from the application of animal manure to the soil	109,4	118,1	113,6
Scope 1	V.3.3 N_2O emissions from urine and dung deposited by grazing animals	170,4	183,5	174,9
Scope 1	V.3.3 CH_4 emissions from rice production	2,8	2,9	3,1

4.4. Monitoring and Evaluation

The greenhouse gas emission inventories are created for various reasons such as identifying hotspots of emissions in terms of sectors/activities, determining policies for emission reductions, comparison between cities/regions, and raising public awareness. A reliable inventory should be prepared in accordance with the principles of relevance, completeness, consistency, transparency and accuracy. Particularly, in line with the transparency principle, all the accepted assumptions related to the data used during the calculations are provided under the relevant chapters. The quality of the collected data has been evaluated based on the criteria listed in Table 4.1, and the results have been shared in Table 4.16.

Table 4.16: Evaluation of data quality

GPC Ref No	GHG Source / Data Coverage	Data source	Activity data	Emission factor
I	**STATIONARY ENERGY**			
I.1	Residential Buildings			
	Natural gas consumption	(EMRA_a, 2022)	High	Low
	Kerosene oil consumption	(EMRA_a, 2022)	High	Low
	LPG consumption	(EMRA_a, 2022)	High	Low
	Domestic coal consumption	(PDEUCC, 2022)	Low	Middle
	Imported coal consumption	(PDEUCC, 2022)	Low	Middle
	Electricity consumption	(TurkStat, 2023)	High	High
I.2	Commercial/Institutional Buildings			
	Natural gas consumption	(EMRA_a, 2022)	High	Low
	Fuel oil consumption	(EMRA_a, 2022; EIGM, 2022)	Middle	Low
	LPG consumption	(EMRA_a, 2022)	Middle	Low
	Electricity consumption	(TurkStat, 2023)	High	High
I.3	Manufacturing and Construction Industries			
	Natural gas consumption	(EMRA_a, 2022)	High	Low
	Imported coal consumption	(PDEUCC, 2022)	High	Middle
	Anthracite consumption	(PDEUCC, 2022)	High	Middle
	Petroleum coke consumption	(PDEUCC, 2022)	High	Middle
	LPG consumption	(EMRA_a, 2022)	Middle	Low
	Fuel oil consumption	(EMRA_a, 2022; EIGM, 2022)	Middle	Low
	Diesel consumption	(EMRA_a, 2022; EIGM, 2022)	Middle	Low
	Electricity consumption	(TurkStat, 2023)	High	High
I.4	Energy Industries			
	Natural gas consumption	(EMRA_a, 2022)	High	Low
I.5	Agriculture, Forestry and Fishing Activities			
	Natural gas consumption	(EMRA_a, 2022)	High	Low
	Electricity consumption	(TurkStat, 2023)	High	High
I.6	Non-specified Sources		Not calculated	
I.7	Fugitive Emissions from Mining, Processing, Storage, and Transportation of Coal		Not calculated	

GPC Ref No	GHG Source / Data Coverage	Data source	Activity data	Emission factor
I.8	Fugitive Emissions from Oil and Natural Gas Systems		Not calculated	
II	**TRANSPORTATION**			
II.1	Road Transportation			
	Gasoline consumption	(EMRA_a, 2022)	High	Low
	Diesel consumption	(EMRA_a, 2022; EIGM, 2022)	Middle	Low
	LPG consumption	(EMRA_a, 2022)	High	Low
II.2	Railways			
	Diesel consumption	(EMRA_a, 2022; EIGM, 2022)	Middle	Low
	Train line length and km statistics	(TurkStat, 2023; TCDD, 2021)	Middle	
II.3	Waterborne Navigation			
	Fuel oil consumption	(EMRA_a, 2022)	High	Low
	Diesel consumption	(EMRA_a, 2022; EIGM, 2022)	Middle	Low
II.4	Aviation		Not calculated	
II.5	Off-road Transportation		Included under II.1 and I.5	
III	**WASTE**			
III.1	Solid Waste Disposal			
	Amount of household waste produced	(TurkStat, 2023)	High	Low
	Composition of household waste	Mersin Metropolitan Municipality	High	Low
	Amount of industrial waste produced	(MBB; TurkStat,2022)	Middle	Low
	Amount of medical waste	Mersin Metropolitan Municipality	High	Low
	Methane recovery quantity	Mersin Metropolitan Municipality	Middle	Low
III.2	Biological Treatment of Wastes		Included under III.4	
III.3	Incineration and Open Burning		Not available	
III.4	Wastewater Treatment and Discharge			
	Mid-year population	(TurkStat, 2023)	High	
	Gross domestic product	(TurkStat, 2023)	High	
	Amount of industrial wastewater	Provincial Directorate of Environment, Urbanisation and Climate Change	High	Low
	Methane recovery quantity	MESKI	High	
IV	**INDUSTRIAL PROCESSES AND PRODUCT USE**			
	Direct emissions from industrial processes			
	Process emissions for cement production	Industrial plants	Middle	Middle
	Process emissions for glass production	Industrial plants	High	Middle
	Process emissions for soda production	Industrial plants	High	Middle
	Direct emissions from product use		Not calculated	
V	**AGRICULTURE, FORESTRY AND OTHER LAND USE**			
V.1	Direct emissions from livestock			
	Number of animals	(TurkStat, 2021)	High	Middle
V.2	Direct emissions and sinks from land use and land use change			
	Land use changes	(CORINE, 2018)	Middle	Middle

GPC Ref No	GHG Source / Data Coverage	Data source	Activity data	Emission factor
V.3	Non-CO_2 emissions from agricultural land			
	Number of animals	(TurkStat, 2021)	High	Middle
	Amount of chemical fertilizer consumption	(MİTOM, 2023)	Middle	Middle
	Rice planted area	(TurkStat, 2021)	High	Middle

In order to successfully carry out the inventory preparation process, it is recommended to establish a coordination team to manage the data flow between municipal units and other stakeholders operating within the province and to collect the necessary data for annual updates of the inventory. It is beneficial for the coordination team to be led by the Directorate of Climate Change and Zero Waste of Mersin Metropolitan Municipality, with the participation of the following institutions:

- Mersin Metropolitan Municipality Directorate of Environmental Protection and Control
- Mersin Metropolitan Municipality Directorate of Transportation
- Mersin Metropolitan Municipality Directorate of Agricultural Services
- Mersin Water and Sewerage Administration (MESKİ)
- Mersin Provincial Directorate of Industry and Technology
- Mersin Provincial Directorate of Environment, Urbanisation and Climate Change
- Mersin Provincial Directorate of Agriculture and Forestry
- TURKSTAT Adana Regional Office
- Mersin Chamber of Commerce and Industry (MTSO)
- ŞİŞECAM - Soda, Glass Packaging and Flat Glass Production Facilities
- Eren Holding - Medcem Cement
- ÇİMSA - Mersin Factory
- İZOCAM - Glass Wool and Foamboard Production Facilities
- Aksa Natural Gas Çukurova General Directorate
- Kalde Energy Electricity Generation Co. Inc.

Finally, there is no obligation to verify inventory reports prepared on the basis of cities. However, it is considered useful for a team consisting of officials who are not involved in inventory preparation within the Directorate of Climate Change and Zero Waste of Mersin Metropolitan Municipality to review the inventory prepared as a 3rd party.

5. MERSİN METROPOLITAN MUNICIPALITY GREENHOUSE GAS EMISSION INVENTORY

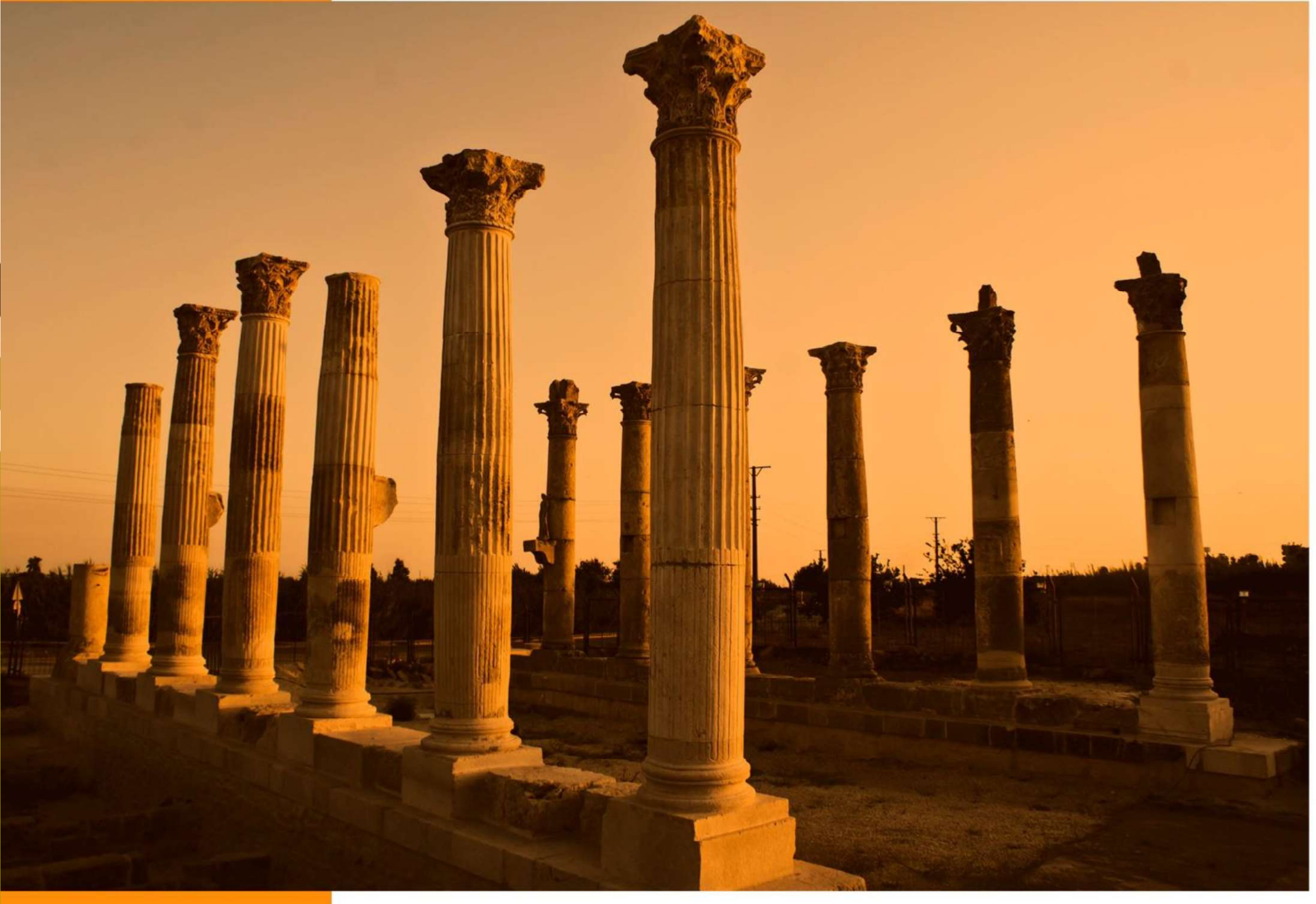
In addition to the greenhouse gas emission inventory created for the entire Mersin province within the scope of the project, a separate greenhouse gas emission inventory has been established for areas directly related to the activities of Mersin Metropolitan Municipality. In this context, data regarding the total fuel consumption (natural gas) in municipal buildings, electricity consumption in buildings and street lighting, fuel consumption in transportation vehicles (diesel, gasoline, and CNG), solid waste and wastewater generation, and refrigerant gas consumption for the years 2019, 2020, and 2021 have been provided by Mersin Metropolitan Municipality officials. The emissions calculations follow the same methodology, emission factors, and assumptions as those used for the overall calculations in Mersin. The ratio of emissions calculated for areas under the responsibility of Mersin Metropolitan Municipality to the total greenhouse gas emissions calculated for the Mersin province is 1.28%, 1.27%, and 1.23% for the years 2019, 2020, and 2021, respectively (Table 5.1).

Table 5.1: Total greenhouse gas emissions of Mersin Metropolitan Municipality (t CO_2e)

Scope / Sector		GHG (t CO_2e)		
		2019	**2020**	**2021**
I. STATIONARY ENERGY				
	I.2 Commercial/Institutional Buildings	**19.406**	**21.268**	**21.864**
Scope 1	I.2.1 Emissions from fuel combustion within the city boundary	4.021	4.307	6.302
Scope 2	I.2.2 Emissions from grid-supplied energy consumed within the city boundary[1]	15.385	16.962	15.562
II. TRANSPORTATION				
	II.1 Road Transportation	**45.714**	**47.167**	**47.566**
Scope 1	II.1.1 Emissions from fuel combustion for on-road transportation occurring within the city boundary	45.714	47.167	47.566
Scope 2	II.1.2 Emissions from grid-supplied energy consumed within the city boundary for on-road transportation	-	-	-
III. WASTE				
	III.1 Solid Waste Disposal	**64**	**77**	**53**
Scope 1	III.1.1 Emissions from solid waste generated within the city boundary and disposed in landfills or open dumps within the city boundary	64	77	53
	III.4 Wastewater Treatment and Discharge	**324**	**328**	**332**
Scope 1	III.4.1 Emissions from wastewater generated and treated within the city boundary	324	328	332
IV. INDUSTRIAL PROCESSES AND PRODUCT USE				
Scope 1	IV.1 Emissions from industrial processes occurring within the city boundary[2]	1,20	1,20	1,37
	SUM	**65.509**	**68.841**	**69.816**

[1] The amount of electricity consumption in 2019 has been obtained by proportioning the consumption amount of commercial/institutional buildings in Mersin province in 2020 and 2021 to the consumption amount of Mersin Metropolitan Municipality.

[2] The amount of refrigerant gas consumption for 2019 and 2020 has been obtained by averaging the data for 2021 and 2022.



SOLİ POMPEİOPOLİS

6. CURRENT SITUATION ASSESEMENT ON SECTORAL BASIS

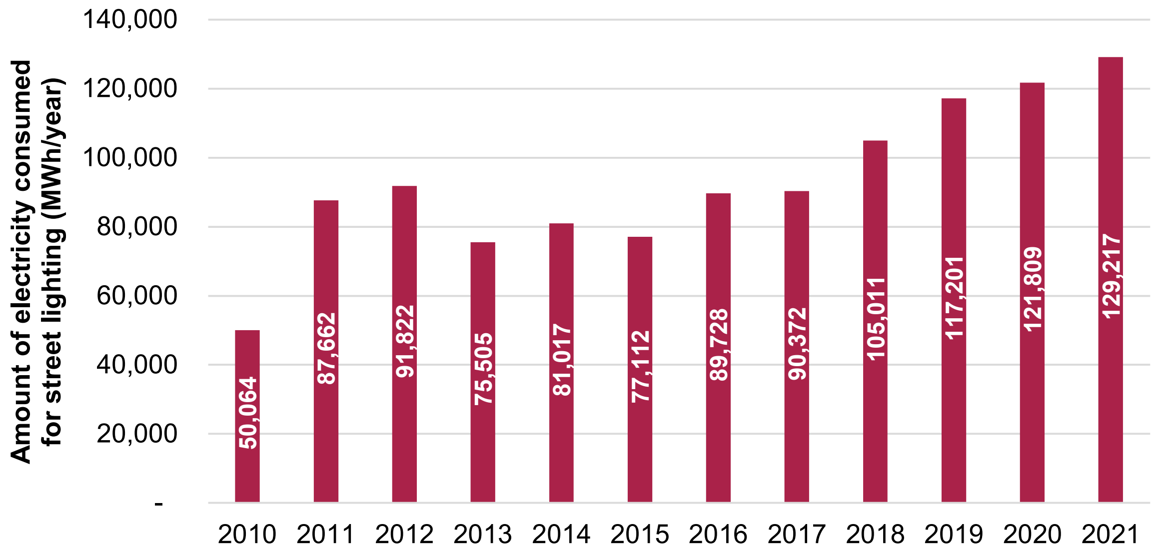
6.1. Buildings and Infrastructure

There are several different dimensions in which buildings and related infrastructure are associated with climate change. First of all, since most of the energy used in buildings for heating, cooling, lighting and other needs is met from fossil fuels, a significant portion of greenhouse gas emissions on a city basis is also realized in buildings. According to the GHG emission inventory prepared for Mersin, 7% and 5% of total emissions are associated with residential and service buildings, respectively. When industrial sector emissions are excluded, these rates increase to 15% and 10%. In Mersin, the number of residential buildings that have received occupancy permits since 2011 is 24,853 and the number of dwellings is 183,267. According to TurkStat data, there are 964,785 residences and 212,719 residential buildings in Mersin as of 2021. (TurkStat, 2023).

Natural gas consumption in residential buildings in the city is ~77 million Sm3/year and coal consumption is ~92.6 tons/year. As of 2021, service buildings consume ~17 million Sm^3/year of natural gas, ~4,000 tons/year of fuel oil and 20.5 thousand tons/year of LPG. The use of SPP systems is widespread in the city, especially for water heating. In rural areas, there are pellet boiler and SPP applications for heating and hot water use. However, there are problems in public access to companies, especially in the installation of SPPs. As of 2020, the number of residential subscribers using natural gas is 313,334. According to MoEUCC data, as of 2022, 15,163 residential buildings (7.1%) and 898 other buildings have EPC certificates in class C and above.

In terms of electricity consumption, 52% of the total consumption is realized in residential and service buildings and electricity consumption has increased by 5% per year on average over the last 10 years (Figure 4.3). On the other hand, the amount of electricity consumed for street lighting is 130,000 MWh/year (Figure 6.1**:** Total amount of electricity consumed for street lighting (MWh) (2010-2021)

) Total consumption has increased 2.5 times in 2021 compared to its level in 2010, and it will be possible to reduce energy consumption through structural changes such as switching to LED-based systems and a compatible infrastructure, or using lighting systems integrated with solar energy, or measures such as optimizing the lighting system in terms of layout and hours of use.



Source: (TurkStat, 2023)

Figure 6.1: Total amount of electricity consumed for street lighting (MWh) (2010-2021)

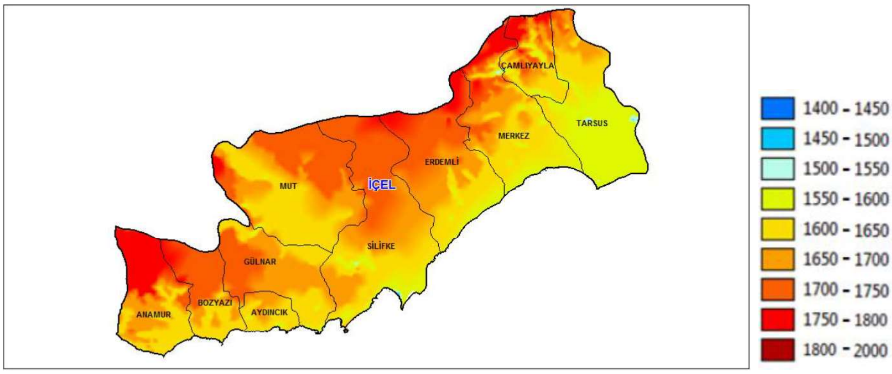
In order to reduce greenhouse gas emissions, it is important that existing buildings are improved in a way to include practices such as thermal insulation, completely renovated during the urban transformation process, and new buildings are constructed in a way to keep energy efficiency at the highest level. In addition to energy consumption in buildings, water consumption, consumption of other natural resources and waste generation activities are also carried out, which indirectly affect waste and wastewater emissions. Therefore, actions on water saving, use of sustainable materials and waste management in buildings can indirectly contribute to emission reduction. As of 2020, the amount of water distributed from the watersystem in Mersin has increased by 2.3 times compared to 2004 (TurkStat, 2023).

In addition to their contribution to greenhouse gas emissions, buildings and infrastructure are highly vulnerable to extreme weather events and natural disasters, which are expected to increase in frequency and severity as a result of climate change. Therefore, in order to increase climate resilience in the construction of buildings, it is necessary to evaluate and implement various actions such as the realization of designs that make maximum use of daylight, the selection of durable materials, the preference of appropriate structures in areas where climate hazards such as floods and cyclones are expected, and the implementation of plans that increase green areas and support air corridors in areas where climate hazards such as urban heat islands are expected.

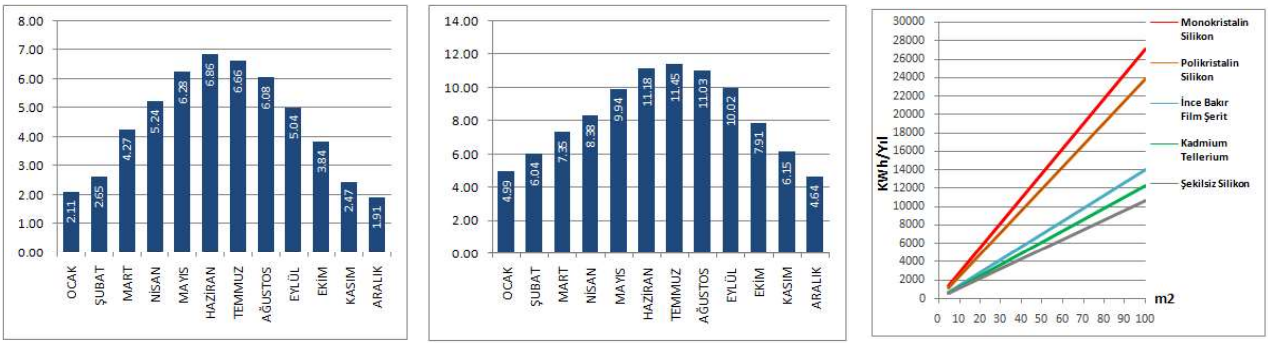
6.2. Industry and Energy

Energy production and manufacturing industries are among the sectors that contribute the most to greenhouse gas emissions, and it is important to increase their capacity to adapt to climate change for the sustainability of these sectors. Energy and industry sectors are directly or indirectly sensitive to factors such as temperature increases and drought, extreme weather events and sea level rise, which are among the impacts of climate change. In this context, the electricity generation sector, in particular, is exposed to significant risks such as reduced efficiency due to the increase in the need for cooling in thermal power plants and interruptions in transmission-distribution lines due to extreme weather events. In terms of industrial sectors, especially in sectors such as textile and food production, where water consumption is high and production is dependent on agricultural resources, risks may arise due to limited resources, and extreme weather events may cause interruptions in both businesses and logistics and transportation activities (MoSIT, 2015; CA, 2021).

The methods preferred in combating energy poverty, especially in cities, can also contribute to efforts to combat climate change. For this purpose, increasing the use of renewable energy resources and improving energy efficiency are among the leading actions. The installed capacity of unlicensed solar energy-based electricity generation plants in Mersin is 143 MW. As shown in Figure 6.2, according to the Solar Energy Potential Atlas prepared by the General Directorate of Renewable Energy on a provincial basis, the average daily sunshine duration in Mersin is 8.2 hours/day and the total daily solar radiation is 4.4 kWh/m^2 –day (GEPA, 2022).



Total solar irradiation (KWh/m^2-year)

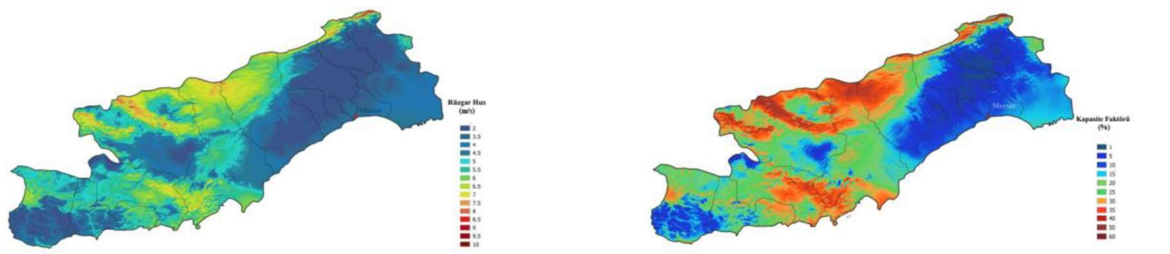


Global solar irradiation (KWh/m^2-gün) | Sunshine duration (hours) | PV type-area-energy that can be produced (KWh-Year)

Source: (GEPA, 2022)

Figure 6.2: Solar energy potential of Mersin province

On the other hand, according to the Wind Energy Potential Atlas prepared by the General Directorate of Renewable Energy on a provincial basis, especially Mut, Silifke and Erdemli districts of Mersin have the physical geography that meets the minimum wind speed and capacity factor values required for economic wind power plant investments (Figure 6.3) (REPA, 2022).



Annual average wind speed distribution (m/s) - 100 meters

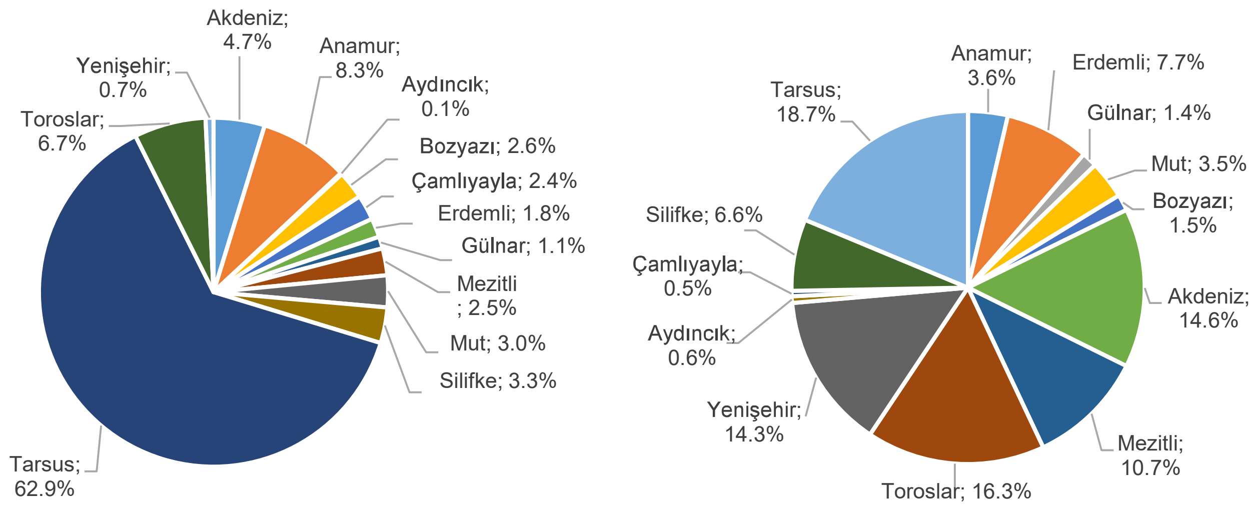
Capacity factor distribution (%) - 100 meters

It has been prepared by taking into account the technical values of a wind turbine with a power of 3 MW.

Source: (REPA, 2022)

Figure 6.3: Wind energy potential of Mersin province

According to the Biomass Energy Potential Atlas prepared by the General Directorate of Renewable Energy on a provincial basis, the economically achievable energy potential that can be obtained by evaluating the wastes generated in animal and plant production in Mersin through biomethanization and incineration facilities is on the order of 82 thousand TOE/year. In terms of municipal waste, there is a potential of approximately 1,922 TOE/year and the breakdown of this potential by districts is given Figure 6.4 (BEPA, 2022).



Energy equivalent of animal and vegetable wastes (TOE/year)

Energy equivalent of municipal waste (TOE/year)

Source: (BEPA, 2022)

Figure 6.4: Distribution of biomass energy potential for animal, vegetable and urban wastes in Mersin districts (%)

Currently, the installed capacity of wastewater treatment plants is approximately 5 MW. In 2023, 1.5 MW at Karaduvar WWTP, 4.5 MW at Tarsus WWTP and 1.5 MW at D1 Drinking Water Reservoir are planned to be installed. In this way, it is aimed to increase the amount of electricity generated to 150 million kWh. There are 32 public buildings, 48 residential buildings and 583 industrial buildings with more than 2000 m2 of roof area.

Table 6.1 presents the current situation for Türkiye and Mersin for the main indicators monitored within the scope of ensuring access to safe, sustainable and affordable energy for all, which is one of the themes emphasized within the scope of sustainable development goals.

Table 6.1: Energy poverty indicators for Türkiye and Mersin

Indicator	Türkiye	Mersin
Proportion of the population with access to electricity (%) - 2023	100	100
Average duration of uninterrupted electricity supply (days/year)	364	362
Total residential electricity consumption per capita (kWh/person) - 2020	726	882
Natural gas per capita in residential buildings (Sm^3/person) - 2020	186,7	41
Installed capacity of solar power plants (MWm) - 2023	4.595,4	52,5
Installed capacity of wind power plants (MWm) - 2023	15.098,9	258,6
Biomass power plant installed capacity (MWm) - 2023	2.787,3	25,8
Installed capacity of hydroelectric power plants (MWm) - 2023	34.318,5	605,1
Share of renewable energy sources in electricity generation capacity (%) - 2023	40	9
Distribution of thermal energy consumed by source (heating and cooling) (%)	NE	NE
Proportion of households with access to clean energy sources (%)	NE	NE
Electricity distribution company loss rate (%) - 2022	1,86	10,62
Average outage duration per customer of electricity distribution company (min) - 2022	1.990	4.458

Source: (EMRA_a, 2022; EIGM, 2022; EMRA_b, 2022)

6.3. Transportation

Mersin province has a total road length of 1,492 km, including 155 km of highways, 488 km of state roads, and 849 km of provincial roads (MoTI_a, 2023). There are three important highway transportation axes connecting the province to other regions. These are the roads that connect the province to Central Anatolia and Marmara regions via Aksaray, to İzmir via Antalya-Muğla-Aydın along the Mediterranean, to Çanakkale along the Aegean, to the Central Aegean via Silifke-Karaman-Konya-Afyon and to Central Anatolia via Silifke-Karaman-Konya.

As for railway transportation, the existing conventional railway network of Mersin is 136 km long. In 2022, a total of 2,602,372 passengers were transported within Mersin province (MoTI_a, 2023).

Mersin province is connected to the country's railway network through a 43.4 km line starting from Yenice. The railway extends eastward through Adana to Southeastern Anatolia and Syria, while it terminates at Mersin Port in the west. Mersin Gar Directorate, under the administration of Adana 6th Regional Directorate, provides passenger and freight transportation services with a double-track length of 55.21 km within the boundaries of Mersin. There are railway connections of 250 meters to Mersin Port. Daily reciprocal train services operate between Mersin and Adana, as well as train services between Mersin and İskenderun. Additionally, reciprocal services are available between Mersin and İslahiye. Connections from Yenice to Ankara, Eskişehir, Afyon, and Haydarpaşa are also available, and transportation to all cities with connections through Adana is possible. There are daily reciprocal train services between Mersin and Ankara (Papatya & Mehmet Nedim, 2019).

Mersin has the largest cargo port in Türkiye, making it one of the important gateways for import and export to the world. Mersin International Port offers regular voyages and commercial connections to numerous ports in continents such as America, Europe, Africa, Asia, and Australia, including destinations like Tunisia, Sydney, Abidjan, Liverpool, Panama, and Odessa. While Mersin International Port is primarily used for cargo transportation, it also serves passenger ships, especially during the summer months. In addition to Mersin International Port, there are other facilities in Mersin Province, such as Taşucu Port, which provides passenger bus and ferry services between Girne and Mersin, as well as Anamur Pier, Bozyazı, Yeşilovacık, and Karaduvar Fishing Harbors. Taşucu SEKA Port, which is privatized, is currently used for bulk cargo transportation. The construction of Mersin Yacht Port with a capacity of 1,000 yachts and Erdemli-Kumkuyu Yacht Port with a capacity of 450 yachts has been completed (MoTI_a, 2023).

There is no airport within the boundaries of Mersin province. The nearest airport to Mersin is Adana Şakirpaşa Airport and it is open to domestic and international flights. There are daily flights from Ankara, Istanbul and Izmir to Adana and the annual passenger capacity of Adana Şakirpaşa Airport is 5,000,000 passengers/year. In Tarsus district, the construction of Çukurova Regional Airport is continuing in order to serve Mersin and Adana provinces and Çukurova Region.

Urban transportation in Mersin is currently by road and rail system projects are ongoing. The majority of motor vehicles in Mersin are fossil fuel vehicles with high emissions. In 2019, there were 1,248 electric and hybrid vehicles, of which 1,069 were motorcycles. Currently, 51% of the buses used in public transportation are diesel (213 units) and the rest are CNG (208) fueled vehicles.

The number of passengers carried by public transportation is approximately 40.5 million in 2022. In the Mersin Transportation Master Plan study area, 21.5% of the nearly 2.5 million annual trips are made by public transportation. 50.3% of the trips are made by municipality/public bus and 49.7% by minibus/dolmus. The number of lines used in public transportation is 540 and 118 public transportation vehicles currently have bicycle carrying apparatus.

It is aimed to increase the use of bicycles throughout the city. The construction of 128 km of round-trip bicycle paths has already been completed; these roads include recreational areas on the coastal band and bicycle paths on the main roads in the traffic flow. Kentbis Smart Bicycle Rental System provides service with 100 bicycles at 6 stations along the Adnan Menderes Boulevard Kültür Park beach. The system has 84 thousand members and is used 10 thousand times a month. The system has 24-30 parking lots at 6 stations. In addition, there are 38 parking lots for a total of 144 vehicles belonging to Mersin Metropolitan Municipality. 61% of bicycle users use bicycles for sports and exercise and 39% for transportation. Among Kentbis users, 18% prefer cycling for transportation purposes. For bicycle users and pedestrians, issues such as frequent intersections with vehicles, narrow sidewalks, occupation of sidewalks and bicycle lanes, and insufficient shading are prioritized as open for improvement.

In addition to the studies on cycling, other studies are being carried out in the province to contribute to the reduction of GHG emissions from the transportation sector or to increase the resilience of the sector to climate change. In this context; Mersin Transportation Master Plan (MUAP) studies are ongoing. Within the scope of sustainable transportation policies, MUAP studies aim to plan the necessary infrastructure, especially charging stations, to encourage the use of electric vehicles (private, public transportation, etc.) throughout Mersin and to carry out pilot studies. Moreover, within the scope of MUAP, planning studies for the creation of a Sustainable Urban Mobility Plan inventory and the preparation of a Sustainable Logistics Action Plan, as well as the organization of Low Emission Zones (LEZs) and traffic calming practices in Mersin city center are also ongoing.

Periodic optimization studies are carried out for public transport routes in the province. On the other hand, the rail system project planned for the east-west axis, where passenger mobility is high, is under construction. The 1st phase of the project, which has a project length of 13.4 km, will connect Mezitli, Yenişehir, Toroslar and Akdeniz districts to each other with an uninterrupted railroad when completed. Mezitli-Machinery Supply Line includes 11 stations and 1 warehouse/workshop area planned as Old Bus Station Warehouse Area.

Within the provincial borders, there are practices such as free travel for passengers aged 65 and over, discounted public transportation for students and interlining tickets between public transportation vehicles.

6.4. Solid Waste and Wastewater Management

The daily waste generation per capita in Mersin in 2020 is 1.21 kg and 73% of the household solid waste is transferred to 3 sanitary landfills in the province. In 2020, out of 818.5 kt of waste collected, 167 kt was recycled (TurkStat, 2023). Electricity generation from landfill gas started in October 2015 at Mersin Merkez Sarıibrahimli Solid Waste Landfill and Disposal Facility, in April 2016 at Silifke Göksu Solid Waste Landfill and Disposal Facility and in July 2016 at Tarsus Gürlü Solid Waste Disposal Facility, and the average landfill gas amount in 2020 is 2.5 million m^3/hour.

In Mersin, the ratio of the municipal population served by the sewerage system to the total municipal population is 76%. Approximately 76% of the total municipal population receives wastewater treatment. There are 14 wastewater treatment plants in the province and they are commonly operated with classical activated sludge and extended aeration processes. The amount of wastewater per capita is 210 liters per day and the total amount of wastewater treated in 2020 is approximately 109 million m^3. The amount of methane recovered in the biomethanization plants established within Karaduvar and Mezitli Wastewater Treatment Plants is 183 m^3/hour. There are 86 industrial wastewater sources within the provincial borders.

Different studies on solid waste and wastewater management are carried out throughout the province. In this context, waste sorting units have been installed in municipal buildings and campuses and a zero waste system has been introduced. In addition, efforts are underway to start the operation of 1 composting facility, which is currently not in use. Scientific studies on obtaining useful products from waste are ongoing in the relevant departments of universities. Some of these studies carried out at Mersin University Department of Environmental Engineering are as follows:

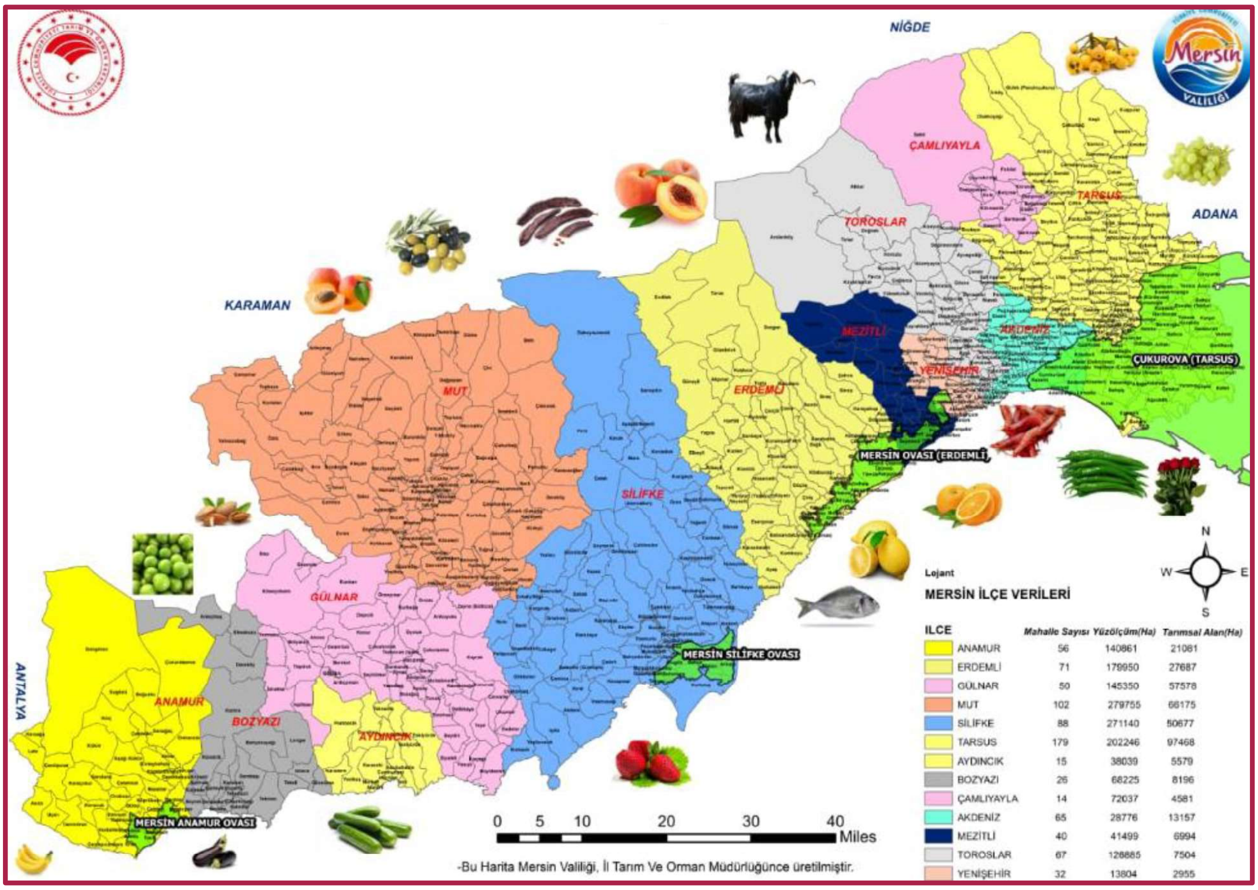
- Dark Fermentation of Industrial Organic Wastes and Sewage Sludge: Investigation of the Effect of Various Pretreatments on Biohydrogen Production Project: It is aimed to realize biohydrogen production with the dark (anaerobic) fermentation process applied on the basis of biomass energy, which is one of the renewable energy sources, and it is aimed to use industrial organic wastes (solid wastes and wastewater) and sewage sludge generated in domestic wastewater treatment plants as raw materials in biomass cofermentation.
- Investigation of Biogas Production Potential of Feed Manufacturing Industry Wastes and Sewage Sludge: It is aimed to investigate the biogas production potential of organic wastes and sewage sludge from feed manufacturing industry and the effects of various pretreatments on biogas potential.

Regarding wastewater management, there is an ongoing project to divert the effluent of the Karaduvar Wastewater Treatment Plant to the soda production facility in the region. Efforts are underway to utilize approximately 5,000 m^3/day of effluent from the Mersin Tarsus OIZ treatment plant in industrial facilities.

6.5. Agriculture and Livestock

Mersin, which makes a major contribution to Türkiye's agricultural production, can be cultivated in summer and winter, and early fruit and vegetable varieties are grown. Agricultural production is carried out in 21% of the province's surface area. Of the 331 thousand hectares of total agricultural land, 146 thousand hectares are in cropland, 154 thousand hectares in fruit and 31 thousand hectares in vegetables. Mersin province accounts for 13% of Türkiye's fruit production, 7.5% of vegetable production, 16.6% of greenhouse vegetable production, 60% of fruit production and 1% of field crops production (PDEUCC, 2022). Mersin ranks 28th in terms of the value of animal products in 2020 with 816.3 million TL, 24th in terms of the value of livestock in 2021 with approximately 3.5 billion TL and 2nd after Konya and Antalya with 17 billion TL in terms of the value of crop production in 2021. (TurkStat, 2023).

A wide variety of agricultural products are grown in Mersin. Mersin province agricultural data map is given in Figure 6.5. According to 2022 production data, some of the main cereal crops are wheat, corn, soybeans, barley, rye, rice, chickpeas, broad beans and lentils. Peanuts and sesame also play a major role in Mersin's agricultural sector. Almost all kinds of vegetables are cultivated in the province. Tomatoes, peppers, eggplants, beans, zucchini, green beans, peas, okra, cucumbers, broccoli, spinach, cabbage, lettuce, leeks, onions and cauliflower are among the main vegetables grown. Mersin is also very advanced in the greenhouse sector and has the largest greenhouse area after Antalya. Cucurbits are grown in abundance. Bananas, grapes, strawberries, strawberries, apricots, peaches, carob, olives, pomegranates, apples, figs, plums, almonds and cherries are other fruits grown (TurkStat, 2023). Mersin is one of Türkiye's grain, fruit and vegetable warehouses. Early fruit and vegetables are sent to all parts of Türkiye from Mersin. Mersin is defined not only as a cotton warehouse but also as a early fruit and vegetable warehouse.



Source: (MİTOM, 2023; GM, 2022)

Figure 6.5: Agricultural data map of Mersin

Within the scope of the Basin-Based Support Model by the former Ministry of Food, Agriculture and Livestock, support practices in agricultural basins have been carried out since 2017. Product lists are prepared annually to determine the products to be supported in agricultural basins. In addition, the products that cannot benefit from Diesel-Fertilizer Support for the parcel they produce, Difference Payments Support for the product they sell and Certified Seed Use Support for the seed they use have also been determined. The products identified in this context should be evaluated within the scope of determining climate change adaptation activities in terms of agricultural basins. In the 2021 production season, the list of products supported on the basis of agricultural basins in Mersin districts is given in Table 6.2.

Table 6.2: Products supported in Mediterranean agricultural basins

Districts	Products Supported within the Scope of TürkiyeAgricultural Basins Production and Support Model
Akdeniz	Barley, Wheat, Corn (Grain), Soybean, Fodder Crops, Olive and Olive Oil
Anamur	Barley, Wheat, Chickpea, Fodder Crops, Olive and Olive Oil
Aydıncık	Barley, Wheat, Chickpea, Fodder Crops, Olive and Olive Oil
Bozyazı	Barley, Wheat, Chickpea, Fodder Crops, Olive and Olive Oil
Çamlıyayla	Barley, Wheat, Chickpea, Sunflower (Oil), Forage Crops, Olive-Olive Oil
Erdemli	Barley, Wheat, Chickpea, Fodder Crops, Olive and Olive Oil
Gülnar	Barley, Wheat, Dry Beans, Chickpeas, Fodder Crops, Olive and Olive Oil
Mezitli	Wheat, Fodder Crops, Olive and Olive Oil
Mut	Barley, Wheat, Chickpea, Fodder Crops, Olive and Olive Oil, Potato
Silifke	Barley, Wheat, Paddy, Corn (Grain), Chickpea, Fodder Crops, Olive and Olive Oil
Tarsus	Barley, Wheat, Paddy, Maize (Grain), Cotton (Blended), Soybean, Sunflower (Oil), Fodder Crops, Olive-Olive Oil, Potato, Onion (Dry)
Toroslar	Barley, Wheat, Corn (Grain), Chickpea, Fodder Crops, Olive-Olive Oil
Yenişehir	Barley, Wheat, Corn (Grain), Fodder Crops, Olive and Olive Oil

In terms of livestock, the changes in the number of bovine, ovine and poultry in the province are presented in Figure 6.6, Figure 6.7 and Figure 6.8 respectively (TurkStat, 2023). In 2021, the number of bovine animals in the province is approximately 114 thousand, the number of ovine animals is 1 million 763 thousand and the number of poultry is 24 million.

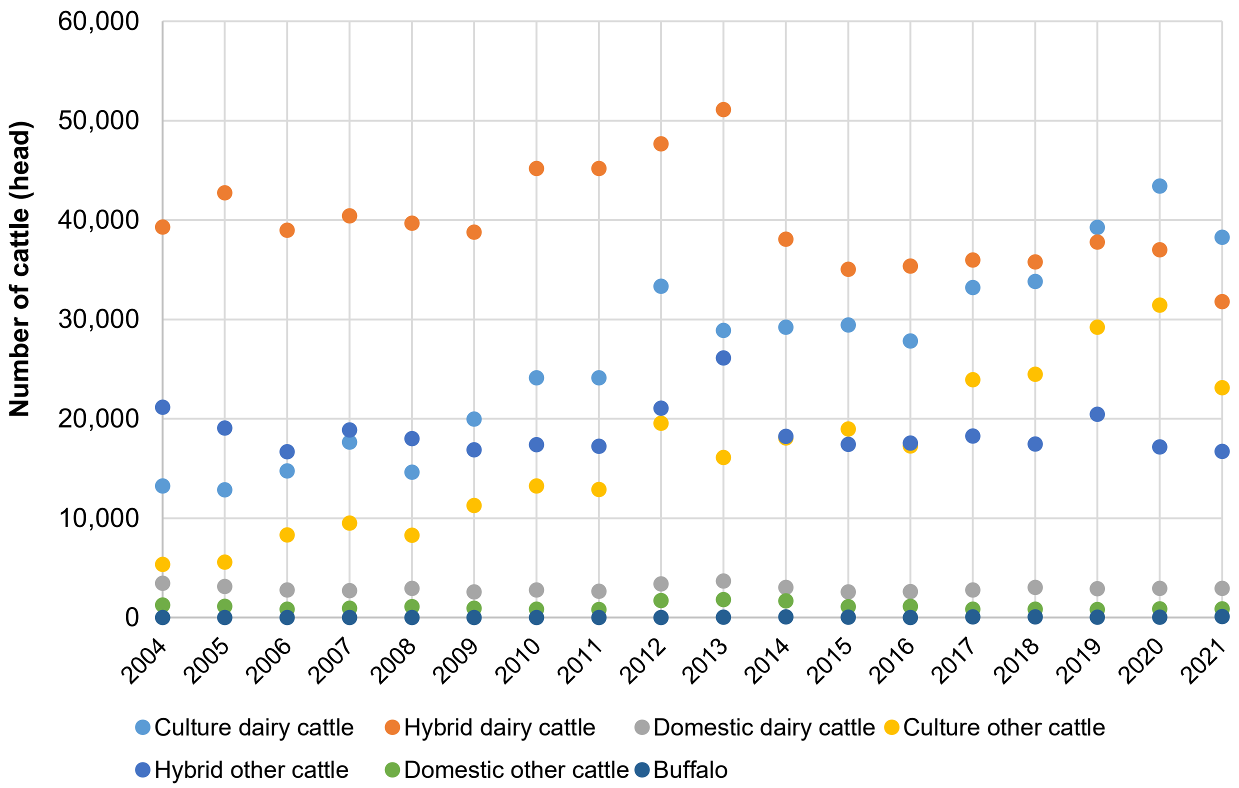


Figure 6.6: Change in number of bovines (head)

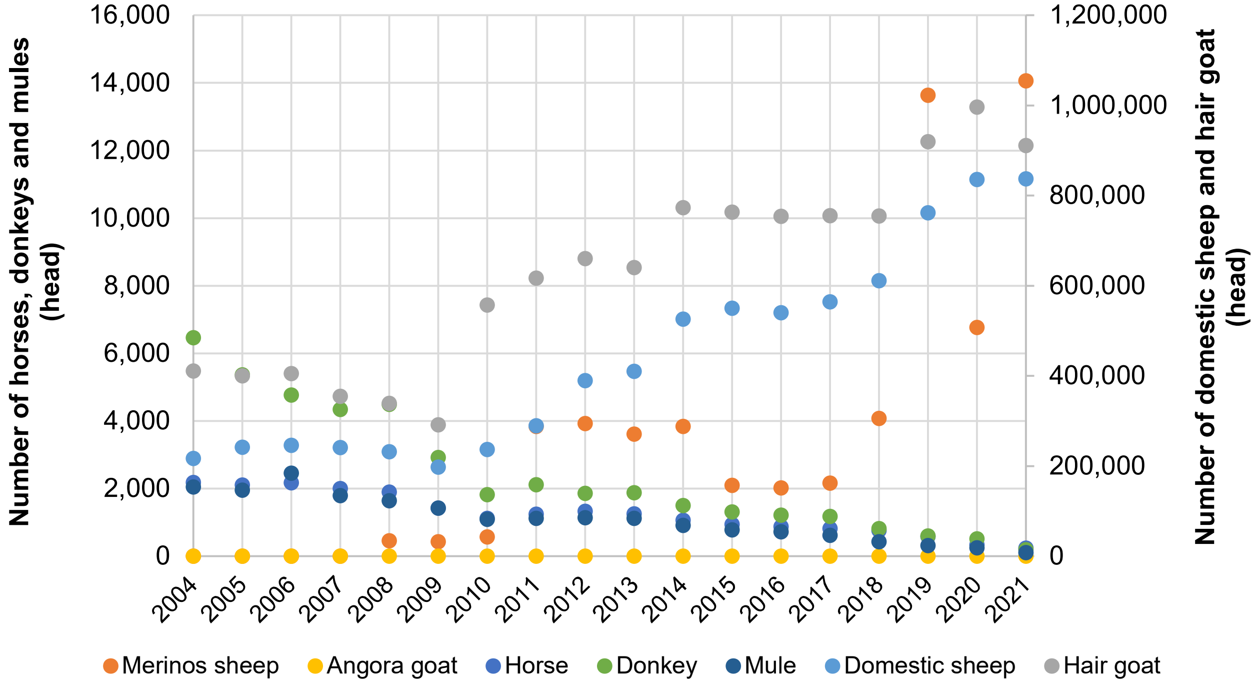


Figure 6.7: Change in number of ovines and other livestocks (head)

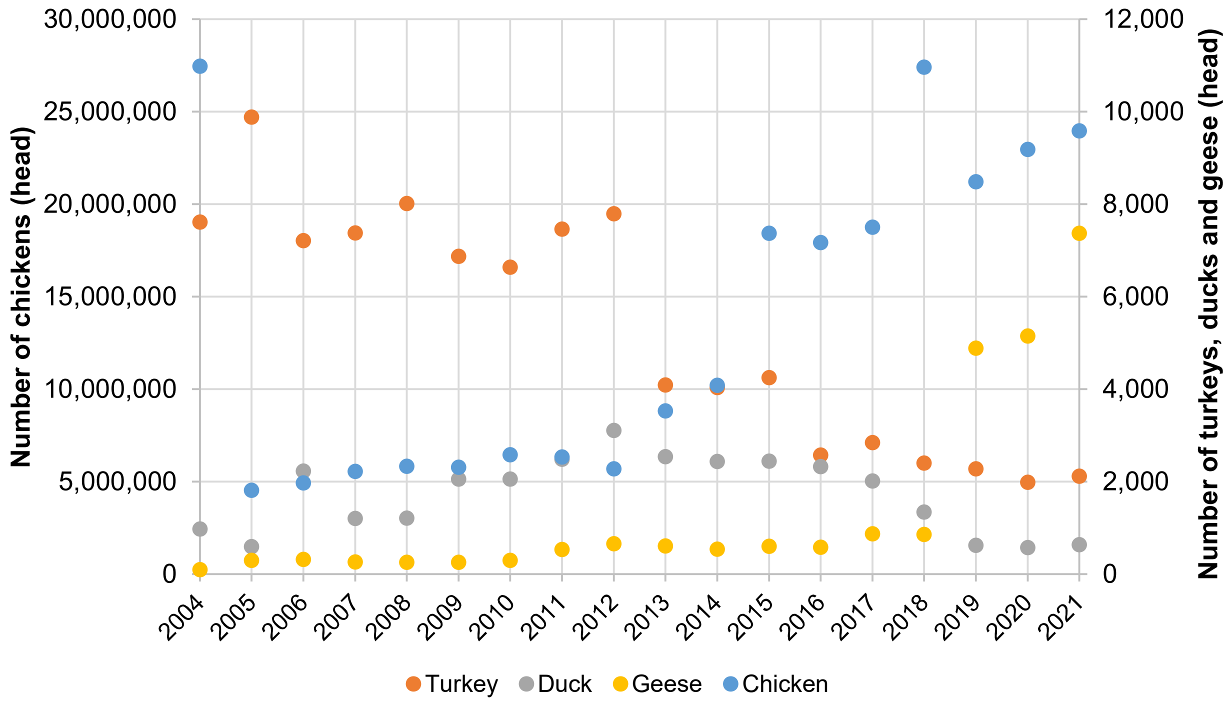


Figure 6.8: Change in number of poultries (head)

Various activities related to the agriculture and livestock sector are carried out in the province. Within the scope of compost production from organic wastes, a facility has been established within Toroslar Municipality where banana, tree, etc. wastes will be used. Toroslar Municipality plans to collect packaging waste (used for pesticides, fertilizers, etc. and left by farmers in open land, forest areas or irrigation canals) and dispose of the waste at the cement factory in Silifke. In 2023, 100 km of irrigation pipes were distributed by MBB. In addition to the lavender seedlings and distillation supports provided by Mersin Metropolitan Municipality, bee and breeding sheep and goat breeders are supported within the scope of Solar Panel Supports. Supports are also provided under the Sustainable Finance Mechanism for Forest Villagers Project (ORKÖY PV)..

6.6. Forestry and Water Resources

According to the information obtained from Mersin Regional Directorate of Forestry, the amount of forested area in Mersin province is 835,534 ha; 468,129 ha of this area is classified as normal closed wooded forest. The remaining area is classified as forested areas with hollow closed trees. 195.521 ha are classified as treeless forest areas. At the same time, the amount of area that does not qualify as forest but is defined as forest area is 532.013 ha and the amount of forest area in Mersin is 1.563.068 ha in 2022. Important forest areas in the province are Soli Plateau Forests (Tarsus), Kızkalesi Forests, Alahan Monastery Forests: (Silifke), Çamlıyayla Forests, Mut Göksu Delta Forests and Taurus Mountains National Park.

The dominant tree species in the province is red pine with 56%. Juniper (25%) and cedar (7%) are the other dominant tree species in the region. In addition to these tree species, larch, oak, maquis, fir, laurel, olive, pistachio pine are also found throughout Mersin. Taurus cedar, Ottoman cedar, Taurus fir, Mediterranean olive tree and Mersin pine are tree species that grow in the region.

It is very important to protect the fauna of forest areas against climate change impacts. Adequate security measures need to be taken to ensure that they can continue their mission in the existing ecosystem. In the region, Anatolian parsis and wild goat are species belonging to the forest fauna that are at risk of extinction.

Mersin province is a critical region in terms of forest fires and it is observed that almost all of its districts have faced this risk at least once a year in the last decade. In the last decade, a total of 14,700 ha of forest area has been burned in the region; the distribution by district and year is given in Table 6.3. Gülnar district has lost the most forest area due to fire in the province. In the last ten years, 54% of the forest areas burned in the province belong to Gülnar district. Gülnar district is followed by Silifke with 30%. Anamur ranks third with 11%. Gülnar, Silifke and Anamur districts are settlements with high risk of forest fires.

Table 6.3. Forest fires in Mersin in the last ten years

Districts		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	TOPLAM
ANAMUR	**Quantity**	19	8	7	15	9	16	17	16	13	23	**143**
	Burned Area(Ha)	14.12	4.75	71.34	26.38	896.2	10.7	190.5	318.43	36.98	16.52	**1586.01**
BOZYAZI	**Quantity**	13	8	4	9	1	6	22	7	12	5	**87**
	Burned Area(Ha)	7.52	0.56	0.04	5.55	0.02	5.74	57.47	30.62	176.66	2.03	**286.213**
ÇAMLIYAYLA	**Quantity**										4	**4**

Districts		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	TOPLAM
	Burned Area(Ha)										0.08	**0.08**
ERDEMLİ	Quantity	13	11	4	11	15	10	4	10	5	12	**95**
	Burned Area(Ha)	68.10	1.80	1.16	54.12	3.96	2.82	10.22	5.16	0.65	2.42	**150.41**
GÜLNAR	Quantity	23	7	17	6	1	11	12	14	8	10	**109**
	Burned Area(Ha)	315.18	28.0	172.7	4.02	0.40	29.1	22.07	51.00	6400.1	910.18	**7932.88**
MERSİN	Quantity	9	9	8	19	6	8	10	8	21	9	**107**
	Burned Area(Ha)	4.90	1.17	2.63	3.20	2.71	3.22	3.13	11.29	7.06	24.53	**63.84**
MUT	Quantity	28	13	13	20	2	4	8	10	13	12	**123**
	Burned Area(Ha)	14.73	10.14	11.96	14.66	0.19	13.83	52.25	3.23	3.04	2.51	**126.54**
SİLİFKE	Quantity	27	24	17	17	13	12	10	12	11	8	**151**
	Burned Area(Ha)	67.04	22.08	13.89	58.39	8.38	2.81	20.20	19.70	3020.42	1146.14	**4379.05**
TARSUS	Quantity	23	11	10	10	7	4	7	10	5	4	**91**
	Burned Area(Ha)	17.58	8.52	8.02	32.01	15.00	1.70	4.93	69.72	16.05	1.34	**174.87**
TOPLAM	Quantity	155	91	80	107	54	71	90	87	88	87	**910**
	Burned Area(Ha)	509.17	77.08	281.75	198.33	926.92	69.98	360.79	509.15	9660.97	2105.67	**14699.81**

The amount of active green areas in the province is 281.4 ha, while passive areas are 1032.4 ha. The distribution of the amount of green areas in the districts is given in Figure 6.9. Parks, children's gardens, squares, urban tree-lined roads, educational institution gardens, national gardens, picnic areas, natural and national parks and urban forests are classified as active green areas, whereas convention gardens, cemeteries, refuges, other institution gardens and animal gardens are classified as passive green areas. Tarsus has the most green areas among other districts. In 2019, the amount of green area per capita in the province was 2.71 m^2.

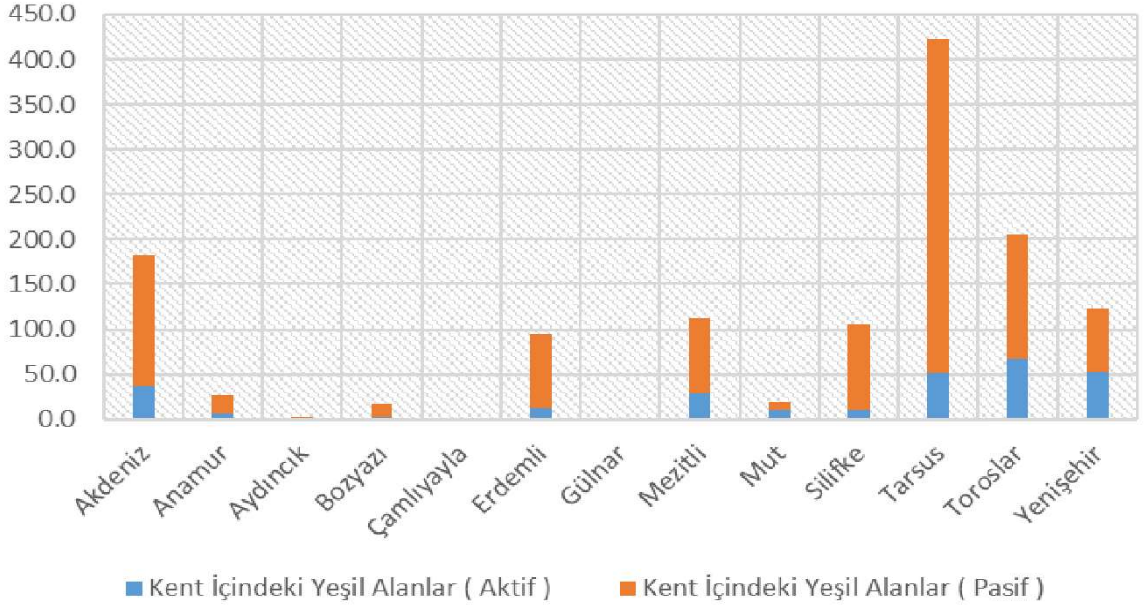


Figure 6.9. Amount of green areas in the province

The total amount of water abstracted for Mersin's municipal water supply network is 2.5% of Turkey's total. The annual change in the amount of municipal water is given in Figure 6.10. Water abstractions per capita for Mersin are generally above the average for Turkey.

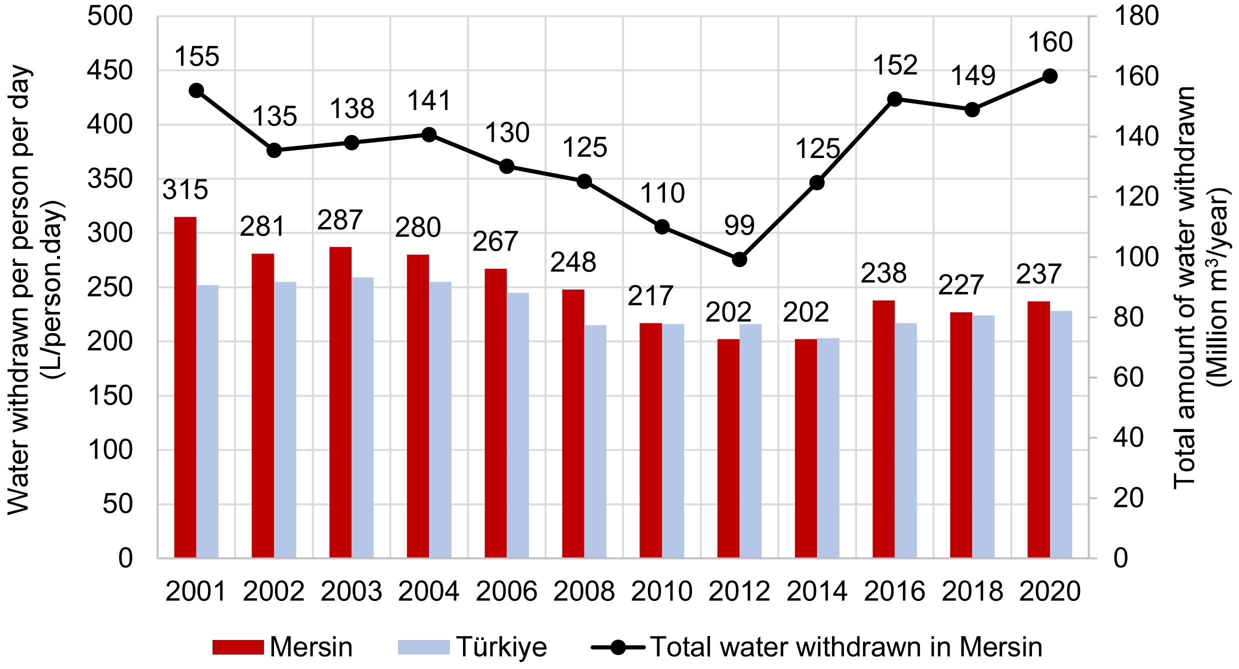


Figure 6.10. Changes in the amount of municipal water by years

The main surface water resources in Mersin are Berdan Dam, Pamukluk Dam, Arslanköy Pond, Sorgun Dam, Aksıfat Dam, Gezende Dam, Bardat Pond and Alaköprü Dam. The river potential in the province is given in Figure 6.11. In addition to surface water resources, Mersin has a groundwater potential of 212.67 hm^3/year (PDEUCC, 2022).

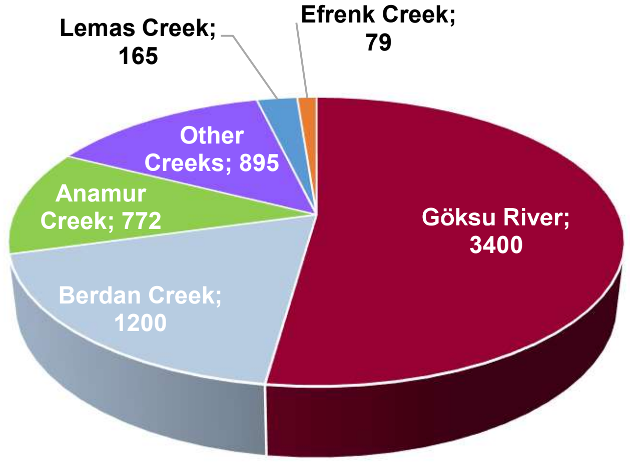


Figure 6.11. Surface water (river) potential of Mersin, hm^3/year

6.7. Coastal Areas and Fisheries

According to the "Integrated Marine Pollution Program 2020-2022: 2022 Mediterranean Final Report" prepared by TUBITAK MAM in 2022, it is observed that the water quality has lost its natural characteristics and periodic eutrophic conditions have started to develop only in the narrow coastal area between Mersin Port and Seyhan delta due to the influence of Seyhan and Göksu Rivers and the presence of discharge areas caused by the dense human population in Mersin Bay. In the shallow gulf waters in this region, the coastal-offshore interaction weakens in certain periods, and terrestrial pressures become more evident more easily. Especially the coastal waters in the inner gulf, which have poor water circulation, have high concentrations of nutrient salts compared to other regions, indicating that the system has mesotrophic characteristics in the inner gulf waters. Although there are periodic increases in other coastal areas, they generally have oligotrophic characteristics. There is a need to collect and treat wastewater from urban and tourism areas, which are spread over a wide coastal area and increase significantly in the summer period, in a common sewage system (MoEUCC, TUBITAK MAM, 2022).

With a 321 km coastline, Mersin is an important port city of Turkey. In 2021, 8% of the number of ships calling at our country's ports belonged to Mersin Port. Mersin Port is the only container port in the Mediterranean Region of Turkey. It is also the 2nd largest container handling port in Turkey. (MoTI_b, 2023). Mersin has the largest cargo port in Turkey. For this reason, it is one of Turkey's most important gateways to the world in terms of import-export. From Mersin Port, there are regular voyages and commercial connections to Tunisia, Sydney, Abidjan, Liverpool, Panama, Odessa and numerous other ports in the Americas, Europe, Africa, Asia and Australia. Mersin Port, one of the most important commercial ports of the country, is mainly used for freight transportation, but also serves passenger ships, especially in the summer months. In addition to Mersin Port, Mersin Province has Taşucu Port, which provides passenger bus and ferry services between Kyrenia and Mersin, Anamur pier and Bozyazı, Yeşilovacık and Karaduvar Fishing Ports. Taşucu SEKA Port is under privatization and is currently used for bulk cargo transportation. Construction of 500 yacht capacity Mersin Marina and 250 yacht capacity Erdemli-Kumkuyu Marina have been completed. The Yacht Basin operating in Çamlıbel, Mersin has a capacity of 300-350 yachts. Blue tour, day tour and moonlight tours are organized from Mersin Yacht Basin. Mersin has 11 blue flag beaches (BF, 2023).

Fish production in the province is approximately 28,800 tons per year (TurkStat, 2023). In Mersin province, there are 20 sea bream and sea bass production facilities with a total capacity of 49.8 tons/year, 287 tons/year trout production facility, 3 black sea bass production facilities with a capacity of 170 tons/year and 4 sea bass production facilities with a capacity of 70 tons/year. Except for sea bream and sea bass production, other fish farms are in the form of land facilities. Tarsus, Berdan and Tragon streams are full of freshwater fish. The spatial distribution of fish farms is given in Figure 6.12.

Figure 6.12. Spatial distribution of fish farms

The coastal areas and living creatures defined as protected areas throughout the province are as follows:

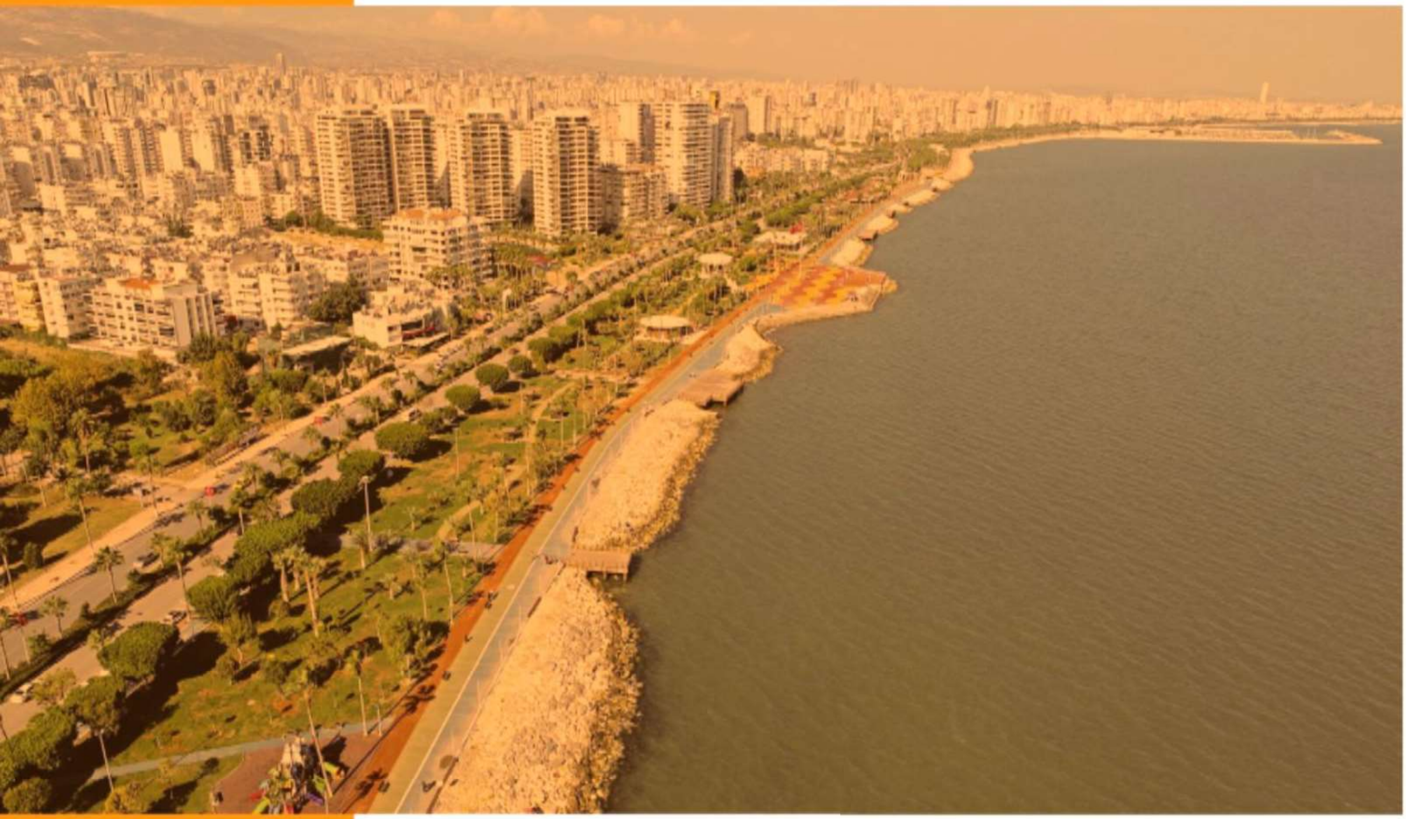
- - Mersin Bozyazı Red Harbor Cape and its surroundings: Mediterranean Monk Seal, Crested Cormorant, Grouper, Lagoon, steep cliffs and sea caves.
- - Mersin Gazipaşa- Anamur coasts: Grey shearwater, crested cormorant, Cilician colony, Mediterranean monk seal, sea turtle breeding area, Nile turtle, grouper.
- - Mersin Kazanlı Beach, Mersin Göksu Delta, Mersin Alata Coast: Sea turtle breeding area.
- - Mersin/Tarsus Seyhan Delta: Approximately 6145 ha The most important breeding area in the region, especially Rhinobatas rihinobatas and Carcharhinus plumbeus, protected by organizations and international agreements such as IUCN, CBO, CITES.
- - Kazanlı Beach: The length of the beach is approximately 4.4 km and it is a Grade 1 Natural Site - Sea Turtle Breeding Beach.

6.8. Tourism and Cultural Heritage

Mersin offers opportunities for all types of tourism, with faith, culture, sea, plateau and nature tourism being prominent. With a 321 km long coastline, 108 km of which are sandy and natural beaches, the region is also rich in historical and cultural values. There are currently 11 blue flag beaches in Mersin province (BF, 2023). On the other hand, Mersin has 4 cultural assets on the UNESCO World Heritage Tentative List, namely Alahan Monastery and St. Paul's Church, St. Paul's Well and its Surroundings, Mamure Castle and Korykos Ancient City (Kızkalesi) (MİKTB, 2023). Some of the other main historical and cultural values of Mersin are; Makam-ı Danyal Prophet Tomb and Mosque, Eshab-ı Kehf, Aya Thekla Church, Cennet, Cehennem and Asthma Cave, Gilindire (Aynalıgöl) Cave, Anamurium Ruins, Zeus Temple and Church, Soli Pompeipolis, Caretta Caretta Turtle and Mediterranean Seals, Göksu Delta Bird Sanctuary, which holds the record in Turkey with 334 bird species. Gastronomy tourism is also of great importance in Mersin and the number of products with geographical indications is 21 (TurkPatent, 2023).

Currently, Mersin has 57 facilities with operating certificates with 4,487 rooms and 9,399 beds, 31 facilities with investment certificates with 5,283 rooms and 12,598 beds, and 505 facilities with simple accommodation operating certificates with 9,734 rooms and 19,518 beds. As of the end of 2022, Mersin province was visited by approximately 1.5 million tourists, 87% of whom were locals, and the occupancy rate of the facilities was 76% (MoCT, 2023).

The standards set within the scope of the Turkey Sustainable Tourism Program are in three stages, and it has been made compulsory to obtain the Stage I Certificate until 31.12.2023 for all Accommodation Facilities with Tourism Management Certificate and Facilities with Simple Accommodation Tourism Management Certificate.



MERSİN COAST

7. CURRENT PLANNING EFFORTS IN MERSIN

Strategy documents and plans prepared in the region have been reviewed in order to identify activities that can be associated with climate change in Mersin. The actions and activities planned within this framework are listed under the following sections.

7.1. Mersin Province Clean Air Action Plan

Within the scope of the Circular on Air Quality Assessment and Management dated September 9, 2013 and numbered 2013/37, "Mersin Province Clean Air Action Plan (MTHEP)" covering the years 2020-2024 was prepared by Mersin General Directorate of Environmental Management in January 2020. In the report, the air quality situation in the province is presented, monitoring data are evaluated, parameters and sources to be evaluated for emission inventory are selected, emission inventories are created and finally measures to be taken and solution proposals are put forward (MTHEP, 2020). According to emission inventory data:

- PM_{10} emissions are predominantly caused by industry, traffic and heating are close to each other and studies should be carried out to reduce emissions,
- SO_2 emissions are caused by heating,
- NO_2 emissions are originated from traffic and industry,
- In general, emissions from industry and traffic are higher than emissions from heating in the province,
- Emissions from domestic heating can be kept under control depending on several factors such as climatic characteristics of the province, fuel quality and appropriate combustion techniques,

are envisaged.

The objectives that are evaluated within the scope of the plan and can be evaluated in the climate action plan are as follows;

- Natural gas utilization rate to be at least 50% for residential buildings and 90% for industry by 2024,
- Under energy for heating, development of filter systems in the chimney for buildings consisting of at least 8-10 flats using coal in the central heating system,
- Afforestation of at least 1,000 hectares annually,
- Every year, most of the vehicles registered in traffic are measured for exhaust emissions within the legal period,
- Inspection of private companies authorized for exhaust emission measurement once a year,
- Increasing the number of air quality monitoring stations to 7 by 2021,
- There will be no facility within Mersin province that does not have an "Environmental Permit" until 2024,

- Inspection of facilities that carry risks in terms of emission values at least once a year, such as petro-chemical, cement, asphalt construction sites, quarries and crushing and screening plants, lentil production, bulgur production, vegetable oil and olive oil production,
- To give "Environmental Permit" to at least 40 facilities that fall within the scope of the "Regulation on Permits and Licenses Required by the Environmental Law" every year and to control industrial emissions from these facilities,
- Relocation of industrial facilities and workshops, that produce goods other than daily necessities, from the urban settlements to outside of the residential areas,
- Banning the use of radiators and stoves on days when the day and night temperatures are above 15°C,
- Adjusting heating systems so that the indoor temperature of the building is not above 18°C for workplaces and 20°C for residences,
- Implementing measures and incentives to reduce the proportion of coal in heating and to expand the use of natural gas.

7.2. Mersin - Adana Planning Region 1/100.000 Scale Environmental Plan Revision

According to the plan, the population of Mersin Province in 2025 and 2035 is calculated as 2,550,000 and 3,220,000, respectively. The population in the capacity of the current plan is 4,720,000. The objectives and strategies specified in the plan within the scope of climate change are briefly as follows (MPGM, 2017):

- To strengthen Mersin's economic, social, historical, cultural, diplomatic, communication and transportation links and to ensure that it serves as an international logistics regional center,
- To ensure urban functional integration by designing the spatial development of Mersin within the scope of ecological, economic and social sustainability,
- To produce strategies that improve the quality of life in all urban and rural settlements throughout the province,
- Within the framework of sustainability principles, evaluating the sectoral potentials in Mersin, taking into account the balance between protection and utilization, and taking principle decisions guiding the development strategies and targets,
- Protecting natural, historical and socio-cultural values and developing them through sustainable means,
- In line with the growth and development potentials of the region, establishing and developing a rational-balanced relationship in settlement and transportation grading,
- Within the framework of environmental problems, to develop principles and decisions that prevent pollution in receiving environments (water, soil and air),
- To produce strategies and spatial decisions against disaster risks, to construct development strategies within the scope of urban resilience.

Agriculture-Livestock and Forestry: Forest areas are protected by the plan decisions, and the processing of forest products is also taken into consideration in areas designated as Organized Agriculture and Livestock Areas (OTHA). In some of these areas, the livestock sector within the agricultural sector, especially in settlements where the topography exceeds 500 meters and the plateau identity stands out, it is also aimed to carry out ovine and/or bovine breeding in a more modern and organized manner. Within the livestock sector, especially in regions where the geographical structure is suitable, beekeeping is a sector that has been developing in recent years and has an important potential. Some of the Organized Livestock Areas in line with the demands of the settlements where the geography is suitable can be used for the beekeeping activities. For these reasons, "Organized Agriculture and Livestock Areas", which are explained under the sub-heading of "industrial sector", have been planned in order to make better use of the agriculture and livestock potential in the whole province and to create employment within the province.

Within the scope of the Mersin-Adana Planning Region 1/100.000 Scale Environmental Plan Revision, Organized Agriculture and Livestock Areas have been envisaged in order to support the agricultural sector and increase its added value, especially for the production of agricultural and animal products, including all stages of the production chain from the production level to the consumer, and to ensure that integrated or non-integrated small-scale facilities can be located collectively.

Table 7.1: Distribution of Organized Agriculture and Livestock Areas by Districts

District	OTHA (number)	Area (ha)	%
Toslar	3	283	5,30
Tarsus	8	1.663	31,17
Mezitli	2	176	3,30
Akdeniz	1	144	2,70
Erdemli	5	571	10,70
Silifke	3	465	8,72
Mut	6	976	18,29
Anamur	2	127	2,38
Bozyazı	1	32	0,60
Aydıncık	1	185	3,47
Gülnar	5	713	13,36
Total	**37**	**5.335**	**100,00**

In this context, there are 37 Organized Agriculture and Livestock Areas in Mersin Province, totaling 5,335 ha (Table 7.1). Organized Agriculture and Livestock Areas were created by evaluating the environmental relations of these areas, the economic structures of settlements, and the weight of agriculture and livestock sectors. Approximately 40% of the Organized Agriculture and Livestock Areas are located in the Central Mersin Planning Subregion, which includes the districts of Mut, Silifke and Erdemli. Especially in the region where agricultural areas such as Mut and Silifke are predominant, areas with a higher diversity of agricultural products and special products compared to other districts are considered as Organized Agricultural Areas. The suitability of the designated areas should be re-evaluated according to the expected change in climatic conditions and should be reviewed within the scope of climate change adaptation strategies. In addition, the increasing capacity expected due to planned agricultural and animal husbandry areas and its impact on total greenhouse gas emissions needs to be reflected on emission inventory section of this report and national greenhouse gas mitigation commitments should be reviewed.

Energy Sector: Article 412 of the 9th Development Plan prepared by the former State Planning Organisation states that nuclear energy will be included among the sources of electricity generation in order to create a healthy diversification in energy supply, Article 72 of the 10th Development Plan prepared by the former Ministry of Development states that the use of nuclear energy in electricity generation is important, and Article 784 states that an agreement has been signed with the Russian Federation for the construction of the 4,800 MW Akkuyu Nuclear Power Plant (NPP).

Services Sector: In addition to the agricultural and industrial sectors, Mersin has always been a "port city" and therefore the services sector has always been among the most important sectors in the province. Mersin, with its Port and Free Zone, is not only an important service region for the province, but also plays an important role in the services sector for the Eastern Mediterranean Region and especially for the Southeastern Anatolia and Central Anatolia Regions of Turkey. While the trade, tourism and transport sectors stand out within the scope of the services sector in Mersin, one of the sub-sectors that attracts attention is the logistics sector. By increasing the size of the existing Logistics Areas that support the agricultural and industrial identity, the role of the aforementioned sector within the city identity has been increased. It is foreseen that the logistics sector will play an important role for Mersin from a sectoral point of view, considering the Free Zone, Port and Railway relations of the city.

Another services sub-sector that stands out within the scope of the Plan decisions is tourism. Until today, Mersin has only been characterised by coastal tourism. Within the scope of the Plan, areas for alternative tourism types such as underwater diving, golf, day tourism areas, caves, paragliding, bird watching, as well as tourism areas for underwater diving, golf, day-trips within the scope of Nature Tourism are proposed for the coastal route of the city. In addition to these, areas for transhumance-tableland tourism, eco and agro tourism, which have an important place in the identity of the Mediterranean Region, are foreseen. In addition to these tourism areas, areas for mountain trekking and rafting as part of nature tourism have been identified. In the plan revision study, agro tourism, nature tourism, faith tourism and cultural tourism were evaluated within eco-tourism.

In particular, harbours are expected to be affected by sea level rise, which can exacerbate coastal flooding during extreme storm events expected as a result of climate change. Floods are also expected to affect nature tourism. In addition, flood-prone road and railway infrastructure is likely to face more frequent inland flooding and deeper flood waters due to climate change (CA, 2021; UNCTAD, 2019). In addition, accidents or longer travelling times due to bending of the rails on railway lines as a result of extreme temperatures can be listed among other impacts of climate change on the transport sector and transport infrastructure. Measures to be taken in this context should also be included in the planning of service sector, and the vulnerability of the sector should be reduced by creating action plans and strategies for extreme situations expected to occur due to climate change.

Transport: Within the scope of the environmental plan, the general transport structure has been shaped by strengthening and upgrading road connections, ensuring integration between railway and maritime transport, strengthening both passenger and freight transport with new airport proposals, expanding the port and proposing a Logistics Zone behind the port area. Railway and Light Rail transport systems are important in terms of both freight and passenger transport in Mersin. With the rail system investments and arrangements, the development and competitiveness of all sectors in the region will increase, and the rail system will also support the tourism sector in the province.

It is aimed to extend the existing railway line between Mersin and Adana along the Akdeniz-Silifke, Silifke-Karaman and Silifke-Antalya routes, and to extend the rail transport infrastructure throughout the province. The target here is to construct a railway system that will provide an uninterrupted and fast connection of the linear axis extending from Adana to Antalya in the east-west direction, and then to complete the axis reaching the north with the Karaman - Mut - Silifke line. It is envisaged that the railway line continuing through northern side from Silifke district will be connected to the existing Konya-Karaman conventional line of Turkish State Railways. The proposed railway line along the Akdeniz-Silifke line is proposed to head north from the borders of Karacailyas, exit west of the Logistics Zone and continue to Silifke district, parallel to the north of the motorway. This line will also support the activities in the Logistics Zone and will be an alternative for transport activities by reducing the freight transport pressure on highways. Therefore, it will also serve the greenhouse gas reduction targets.

7.3. Mersin Provincial Disaster Risk Reduction Plan

According to the plan, Mersin's priority disaster types are identified as Earthquake, Flood, Mass Movements, Fire, Technological and Industrial Accidents, Meteorological Disasters and Hazards caused by Climate Change. The objectives and strategies specified in the plan within the scope of climate change adaptation and mitigation related activities are briefly as follows (AFAD, 2021):

Drought: Drought is "the adverse effect on land and water resources as a result of precipitation falling significantly below normal levels". Meteorological measurements, primarily the amount of precipitation, in other words, the lack of precipitation is generally accepted as the first sign of drought. Since the 70s, in the Eastern Mediterranean Basin and in the provinces of Turkey with Mediterranean precipitation regime, although year-to-year precipitation variability is high, significant decreases have been observed especially in winter precipitation and consequently in total annual precipitation. In addition, studies indicate that if population growth continues at its current rate, water demand will double in the next 20 years and serious problems will be experienced in water supply. The fact that water resources are limited already makes it difficult to respond to the increasing demand.

Hail: Hail disaster is caused by severe storms which are not very frequent. Since hail is usually observed during the flowering and fruiting period of trees, it leads to an increase in agricultural damage and thus to great economic losses. Especially in these months, hail protection and hail disaster damage prevention activities such as hail forecasting, early warning and disaster insurance should be given importance.

The main feature that distinguishes meteorological disasters from other disasters is their predictability days before. This feature makes it possible to take precautions, to be prepared and therefore to prevent and minimise damages and losses. For this reason, it will be very useful to evaluate meteorological data in the applications and plans to be made. It becomes even more important to follow the Meteorological Warnings and Assessments prepared after the analyses made by the General Directorate of Meteorology and the relevant Meteorological Regional Directorates. For this reason, more active use, dissemination and follow-up of the colour-coded MeteoWarning system published through web, mobile applications, visual and written media constitute the first step in preventing damages caused by meteorological events.

Climate projections have been prepared by the General Directorate of Meteorology for the period up to 2100. Climate projections are based on 3 Global Climate Models (HadGEM2-ES, MPI-ESM-MR, GFDL-ESM2M) for Turkey and the neighbourhood with 20 km resolution on the basis of the most likely scenario (RCP4.5) and the most pessimistic scenario (RCP8.5) among the scenarios created by the Intergovernmental Panel on Climate Change (IPCC).

- According to RCP4.5 scenario projections;
    - Annual average temperatures are projected to increase by 1.4°C - 2.7°C on average by 2100.
    - By the end of the century, the maximum annual increase is expected to exceed 4°C.
    - Although annual total precipitation is expected to decrease in the range of 5 - 12% on average until 2100, the increasing trend in precipitation irregularities is remarkable.
    - Decreases of up to 50 - 65% and increases of 70 - 80% are expected from time to time.
    - Summer days (maximum temperature > 25ºC) are expected to increase up to 200 days on average.
    - Daily maximum precipitation (maximum total precipitation in 1 day during the year) is generally expected to be around 100 mm, but it is expected to increase to 170 mm.
- According to RCP8.5 scenario projections;
    - Annual average temperatures are projected to increase by 2.6°C - 3.7°C on average by 2100.
    - In the period until the end of the century, the maximum annual increase is expected to be up to 6.6 °C.

- Although annual total precipitation is expected to decrease in the range of 5 - 16% on average until 2100, the increasing trend in precipitation irregularities is remarkable.
- Decreases of up to 60 - 80% and increases of up to 140% are foreseen from time to time.
- Summer days are expected to be up to 240 days on average.
- Daily maximum rainfall is generally expected to be around 100 mm, but is expected to increase to 240 mm.

Some of the actions to reduce disaster risks from meteorological and climate change are as follows:

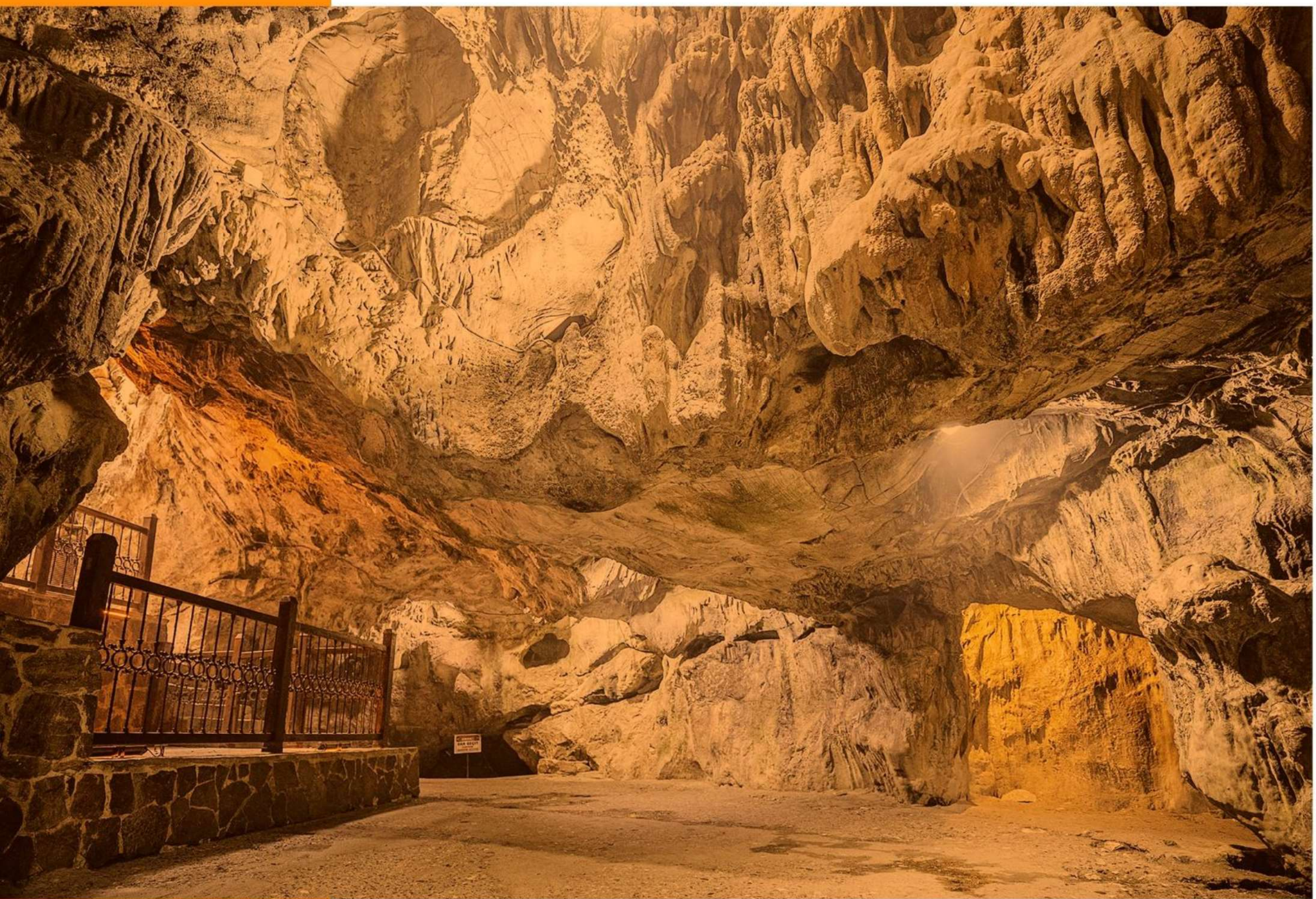
Within the scope of dissemination and measurement of disaster awareness culture to the whole society;

- Carrying out trainings and awareness-raising activities for the whole society under the following areas;
    - Extreme heat/drought,
    - Energy and water saving,
    - Meteorological and climate change induced disasters,
    - The importance and protection of forested areas (especially before seasons of increased forest fires).
- Increasing inter-institutional co-operation on reducing disaster risks;
    - Making the information in the databases related to meteorological disasters available to other institutions,
    - Increasing the co-operation of public institutions with the university by producing joint projects,
    - Developing a climate map of Mersin in co-operation with the University,
    - Sharing the projections made for Mersin regarding climate change with public institutions.
- Increasing scientific studies in the determination of disaster risks, publishing the results, announcing them to relevant institutions and the public;
    - Developing projects to predict the emergence dates of plant pests by using meteorological factors within the scope of combating plant pests,
    - Developing projects for the use of meteorological factors in yield estimation,
    - Potential water consumption and mapping of crops.
- Developing, establishing, operationalising and publicising early warning and forecasting systems;
    - Increasing the prevalence of meteorological warnings,
    - Establishing a database based on air pollution data,
    - Development of drought forecasting and warning systems,
    - Establishing sectoral climate indices.
- Ensuring that non-structural measures are taken to protect against the effects of disasters;
    - Protecting and increasing green spaces and forests in urban areas,

- Informing producers about the preference of drought-resistant agricultural products,
- Extending the cultivation and planting of drought-resistant species that require less water consumption,
- Preparation of agriculture action plan for combating climate change and drought,
- Increasing forest areas, with a focus on the protection of existing forest assets,
- Preparation of action and management plans to mitigate the negative impacts of climate change on agriculture and water resources,
- Ensuring the control of the application of chimney filters in industrial plants,
- Encouraging and generalising the thermal insulation of existing buildings,
- Encouraging rain harvesting in existing buildings,
- Ensuring efficient use of water in agricultural irrigation, encouraging systems that lead to this,
- Ensuring the cultivation of deep-rooted trees in Mut, Silifke and Gülnar districts where strong winds are frequently experienced,
- Developing measures to minimise the impact of hail in agricultural areas (nets, etc.),
- Encouraging projects on thermal insulation and localized energy production for buildings,
- Encouraging the use of green energy in order to reduce the use of fossil fuels,
- Increasing the use of renewable energy.

- Ensuring that structural measures are taken to protect against the impacts of disasters;
  - Undergrounding of electric wires and energy transmission lines in order to strengthen the infrastructure against meteorological disasters,
  - Encourage the construction of smart public buildings to support the reduction of emissions,
  - Establishment of rainwater storage areas and alternative storage facilities in residential buildings.
- Ensuring safe construction;
  - Carrying out the necessary engineering studies by taking into account rainfall and climate projections in infrastructure designs.
- Development of risk identification projects;
  - Production of hazard and risk maps on district basis by the working group established to determine the risks related to meteorological disaster types such as hail, storm, sea level rise,
  - Carrying out studies to reduce greenhouse gas emissions and improve air quality.
- Consideration of disaster risks in spatial planning;
  - Considering the maps prepared according to drought scenarios in the projects to be carried out,
  - Permitting the settlement areas by considering its water resources, taking these into account in the master plans,

- Considering disaster risks in new settlements and paying attention to them in master plans,
- In order to reduce the effect of temperature and humidity in urban planning; providing air corridors to receive land and sea breezes according to the prevailing wind direction,
- Selection of higher altitude areas for new settlements in response to sea level rise.



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8. ASSESSMENT OF GREENHOUSE GAS MITIGATION POTENTIAL

8.1. Projection of Greenhouse Gas Emissions

Population and gross domestic product (GDP) are the two parameters that are taken as basis in the realisation of greenhouse gas emission projections. Within the scope of the study, the projection was made until 2055. In order to realise the population projection for Mersin province for the year of 2055, the province-based population projection published by TURKSTAT and the population growth rates obtained from national population projections were used. On the other hand, the refugee population has also been added to the total. Therefore, the population data for 2019 appears to be higher than the data in the official statistics (1,840,425). In order to realise GDP projections for Mersin province for the year of 2055, GDP data published by TURKSTAT on province basis and projections made by OECD for Turkey were taken into consideration. The population and GDP projections based on these assumptions are given in Table 8.1.

Table 8.1: Population and GDP projections for Mersin

Year	Population (person)	Mid-Year Population (person)	GDP ($/person.year)	GDP (Million $/year)
2019	2,077,907	2,057,465	7,620	14,024
2023	2,161,214	2,157,930	10,774	20,737
2025	2,183,762	2,175,779	11,675	22,775
2030	2,273,739	2,265,217	13,398	27,457
2035	2,350,072	2,343,041	14,853	31,692
2040	2,411,469	2,405,917	16,293	35,894
2045	2,459,062	2,454,826	17,814	40,227
2050	2,493,595	2,490,666	19,390	44,597
2055	2,517,304	2,515,315	20,961	48,855
2060	2,531,297	2,530,299	22,589	53,119

In addition to population and GDP, other parameters taken into account in the projections on sectoral basis within the scope of the study are as follows: number of residential subscribers using natural gas, number of dwellings, number of buildings and flats with annual residence permits, number of service buildings, rural population, ration of rural/urban population, working age population, fuel type distribution of vehicles, maritime/railways fuel consumption, population served by municipal waste services, amount of waste per capita, waste composition. In addition to these, the trend of the past years was also analysed and taken into consideration in the projection phase. Starting from 2019, which is the base year of the inventory created specifically for Mersin province, projections were carried out in sub-sector breakdown until 2055, which is the projection period. The baseline scenario projections realised under these assumptions are given on sectoral basis between Figure 8.1 - Figure 8.4.

In terms of fixed sources, 71% of total emissions in 2019 were in the manufacturing and construction industry, followed by the housing and services sectors with 15% and 11%, respectively (Figure 8.1). By 2055, it is seen that emissions will increase 2 times.

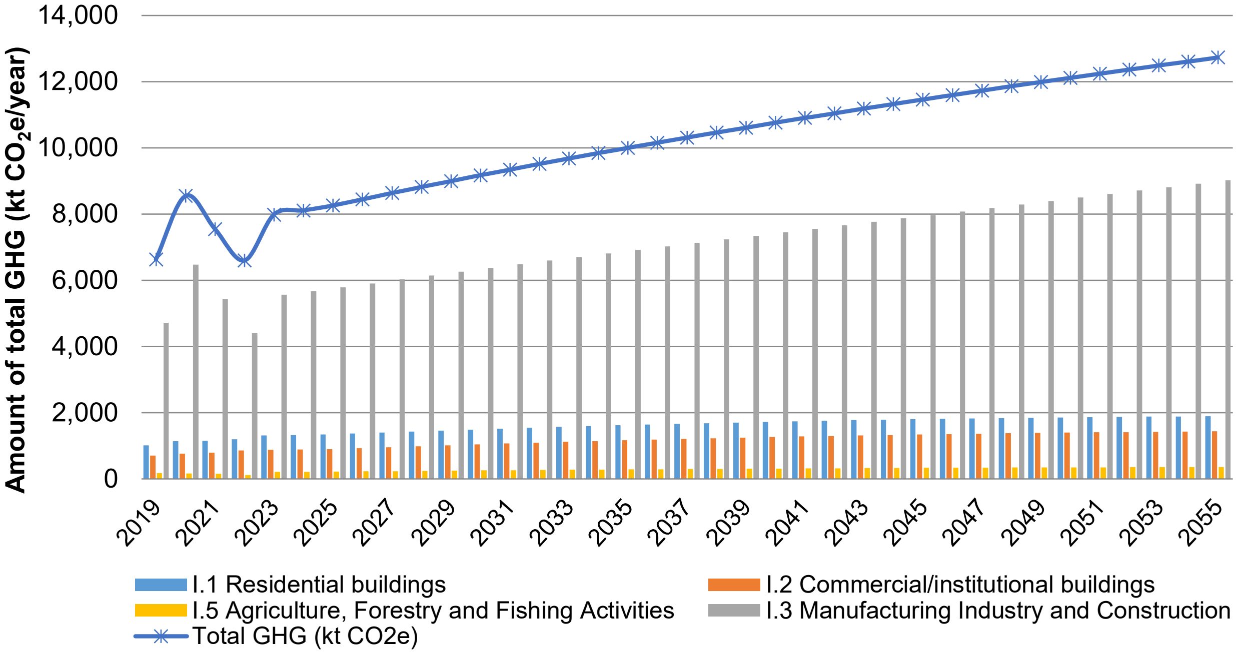


Figure 8.1: Greenhouse gas emission projections for stationary energy (kt CO_2e / year)

In the transport sector, 98.7% of the total emissions of approximately 3,867 kt CO_2e in 2019 are from the road sub-category, 1.1% from maritime transport and 0.2% from rail transport (Figure 8.2). By 2055, it is seen that there is an increase of approximately 2.7 times in emissions.

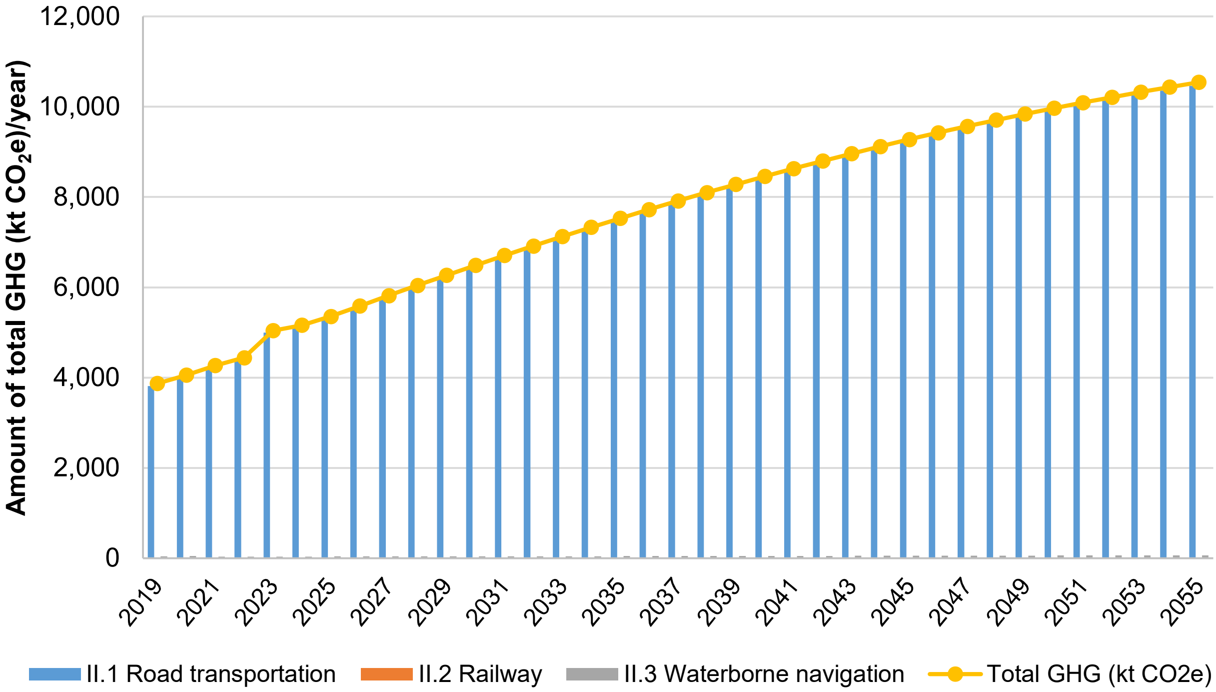


Figure 8.2: Greenhouse gas emission projections for transportation (kt CO_2e / year)

In the waste sector, total emissions in 2055 increased approximately 2.6 times from approximately 580 kt CO_2e in 2019 to 1526 kt CO_2e in 2055. The total emissions from the sector are caused by solid waste disposal with 58% and wastewater treatment and discharge with 42% for the base year (Figure 8.3).

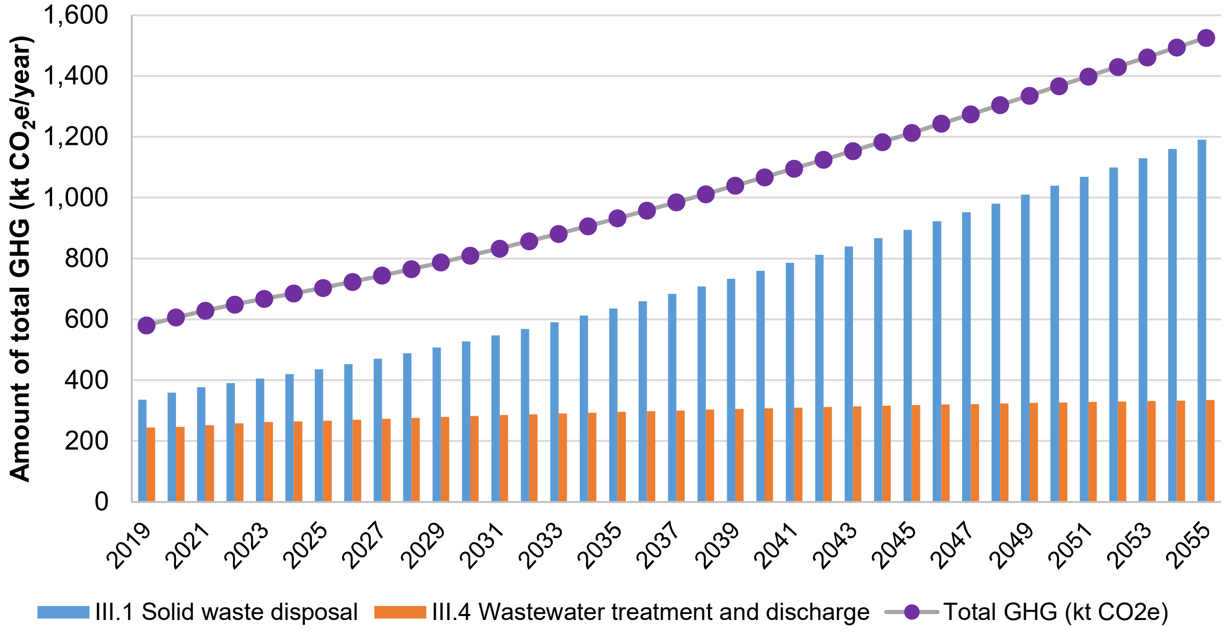


Figure 8.3: Greenhouse gas emission projections for waste (kt CO_2e / year)

In the agriculture and livestock sector, total emissions, which were approximately 964.5 kt CO_2e in 2019, increased approximately 1.7 times to 1634 kt CO_2e in 2055. The highest emission source in the sector is enteric fermentation with 46% (Figure 8.4).

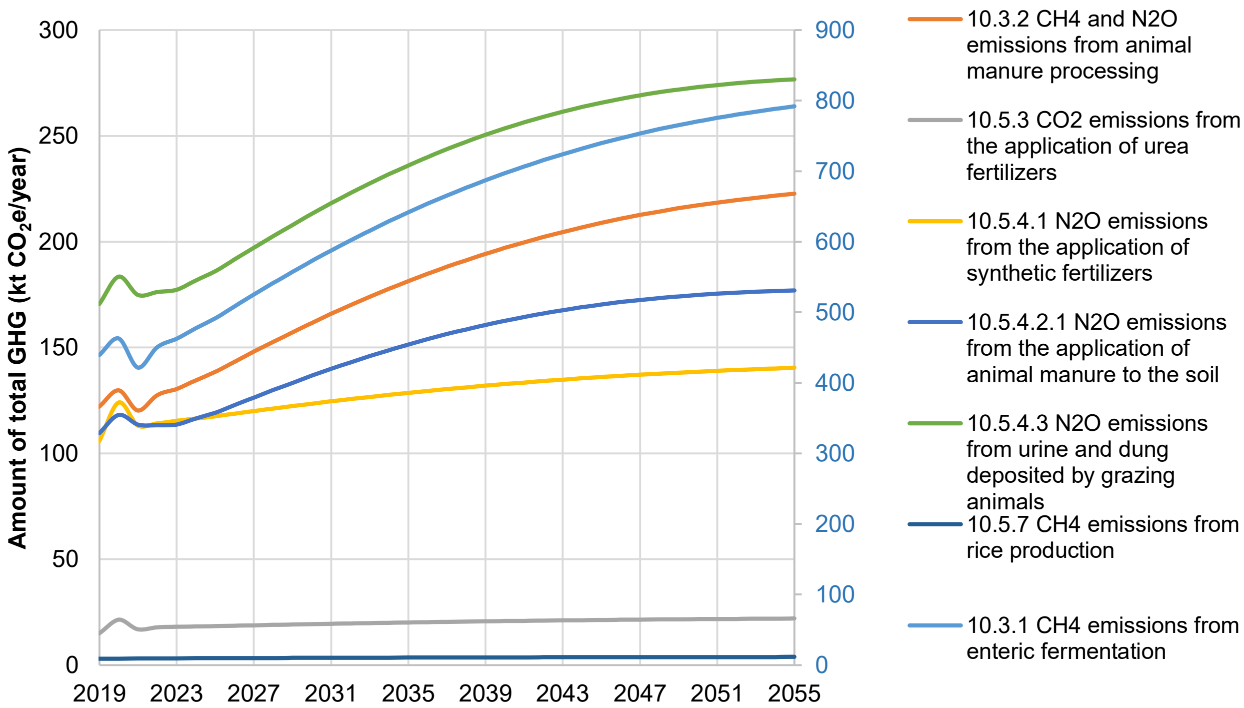


Figure 8.4: GHG emission projections for agriculture, forestry and other land use (kt CO_2e / year)

8.2. Assessment of Greenhouse Gas Mitigation Potential on a Sectoral Basis

GHG mitigation projections for Mersin province were analyzed on a sectoral basis. In this framework, GHG emission mitigation potential was evaluated in terms of stationary energy (residential and commercial buildings, agriculture, forestry and fishing activities), transportation and waste sectors, taking into account the areas where local governments may have direct control. Workshops were organized to diversify and prioritize mitigation actions and stakeholders' opinions and suggestions were collected. Sectoral mitigation measures that can be considered for Mersin province and quantified mitigation projections are described below under the relevant sections.

8.2.1 Stationary Energy

Emissions from stationary energy generally cover the residential and commercial buildings, manufacturing industry and construction, energy production and agriculture/livestock, forestry and fishing sectors, which are associated with the consumption and/or production of fuels. In this framework, mitigation scenarios that can be realized for the residential and service buildings and agriculture, forestry and livestock sectors are evaluated below.

The Energy Performance Certificate (EPC) has been implemented since 2011 within the scope of the Energy Performance in Buildings Regulation (BEP). The Regulation stipulates that buildings constructed after the Regulation should be designed with a minimum energy identity certificate class of C, and that new buildings with a lower level than this should not be granted occupancy licenses. As of 2021, 1,222,186 buildings in Turkey have EPCs, of which 319,534 are existing buildings and 902,652 are new buildings (Demirsoy, G., Sözen, A., 2021). In Mersin, the number of residential buildings that have received occupancy permits since 2011 is 27,982 and the number of dwellings is 218,924. According to TurkStat data, there are 967,691 dwellings and 212,719 residential buildings in Mersin as of 2021 (TurkStat, 2021). According to the information provided by Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, as of 2022, 15,163 residential buildings (7.1%) and 898 other buildings have EPC certificate in class C and above.

Within the scope of mitigation scenarios, the impacts of several activies on GHG mitigation were evaluated on the basis of two alternative scenarios, such as implementing thermal insulation practices in existing and new buildings, abandoning the use of coal in residential buildings and expanding energy efficiency practices in residential buildings (Figure 8.5). In the first alternative scenario, the abandonment of coal use in residential buildings by 2040, a decrease in the proportion of uninsulated houses from 81% to 46%, and an increase in specific consumption to 35% through energy efficiency practices were studied. In the second alternative scenario, the targets of eliminating the use of coal by 2032, ensuring that all residential buildings meet the C class requirements of BEP Regulation as a minimum by 2045 and improving energy efficiency by 60% by 2055 compared to the current situation were evaluated. When the scenario results are analyzed, it is projected that total emissions of residential buildings can be reduced by 17% in 2035 and 32% in

2055 in the first alternative scenario compared to the reference scenario. In the second alternative scenario, these rates reach 50% and 63%, respectively.

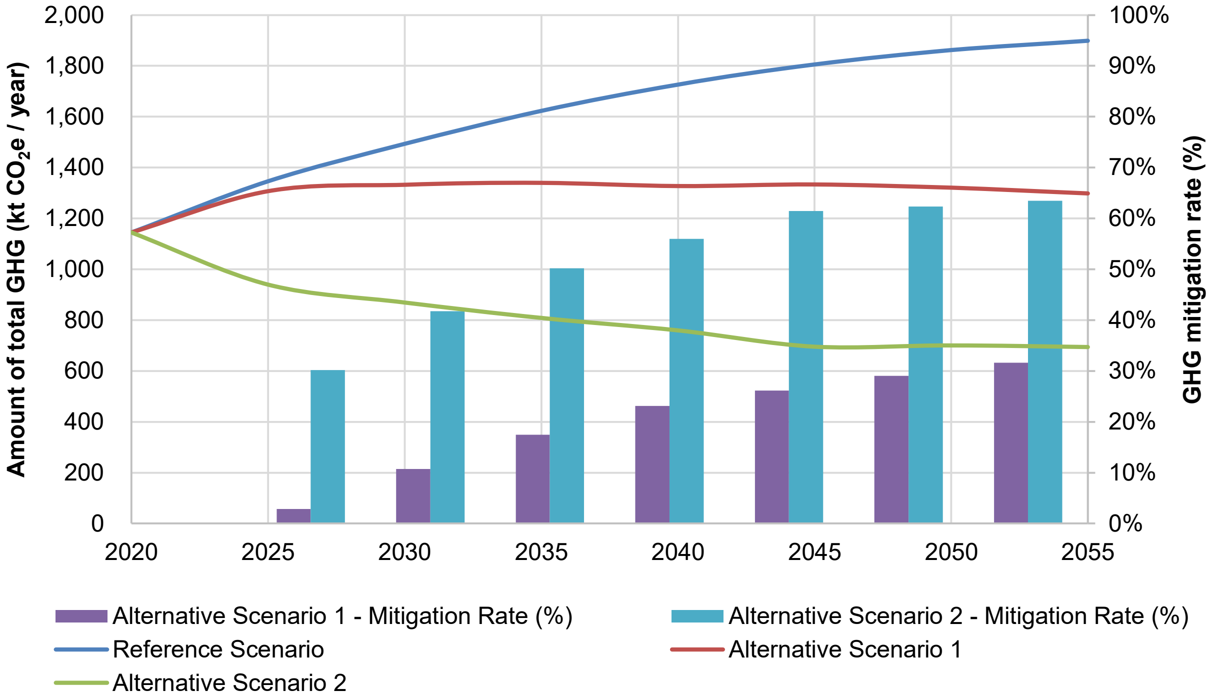


Figure 8.5: Comparison of reference scenario and mitigation scenarios for residential buildings

On the other hand, the potential for residential buildings, commercial buildings (public buildings, education and health buildings, sports facilities) and industrial buildings was determined by taking into account the amount of roof area suitable for the installation of solar energy panels. It has been calculated that there is a potential for rooftop solar energy installation in approximately 6,280 buildings for public, education, health buildings, sports facilities and hotels, equivalent to approximately 124 GWh per year. In this framework, the amount of GHG mitigation in terms of commercial buildings and agricultural production facilities was evaluated on the basis of 2 alternative scenarios where the use of renewable energy sources in electricity consumption develops at a limited level and develops rapidly (Figure 8.6 ve Figure 8.7). When the scenario results are analyzed, it is projected that GHG reduction in the commercial buildings, emission reductionss can be achieved by 49% in 2055 in the first alternative scenario and 77% in the second alternative scenario compared to the reference scenario. For the agriculture sector, two alternative scenarios were evaluated in which electricity consumption is gradually obtained entirely from renewable energy sources and natural gas consumption is gradually phased out, and it was revealed that a mitigation potential of 21% and 42% could be created in 2035, respectively.

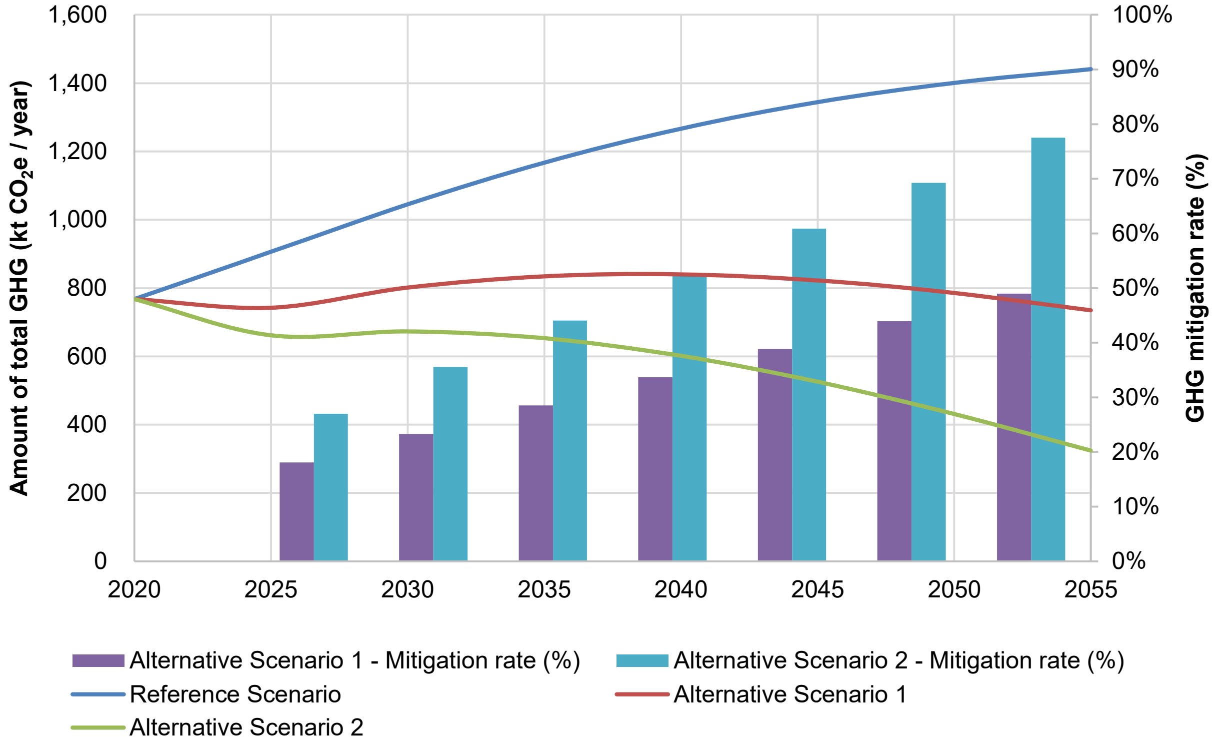


Figure 8.6: Comparison of reference scenario and mitigation scenarios for commercial buildings

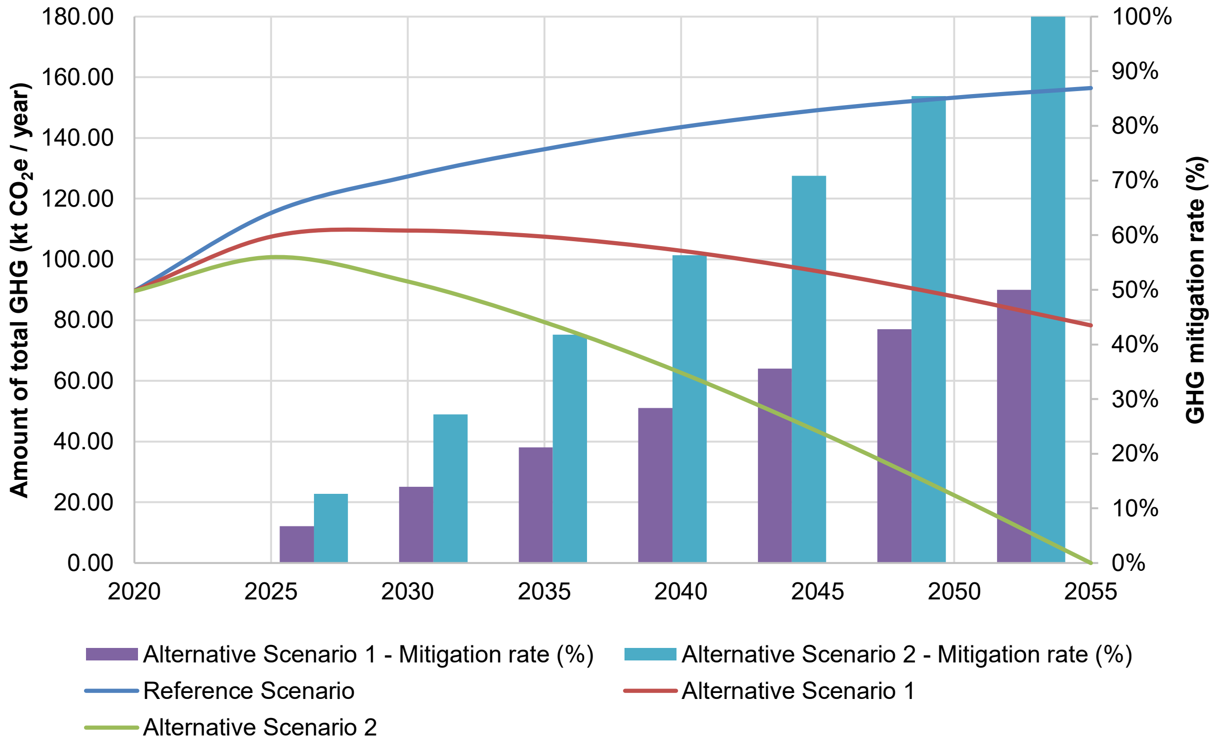


Figure 8.7: Comparison of reference scenario and mitigation scenarios for agricultural activities

8.2.2 Transportation

In Mersin, almost all motor vehicles are fossil fuel vehicles with high emissions. In 2020, the total number of electric and hybrid vehicles increased from 1,248 in 2019 to 1,729 in 2020, of which 1,694 were motorcycles. On the other hand, there is no province in Turkey without an electric car charging station and the infrastructure for electric vehicle charging stations is improving day by day. In addition to that, with the ongoing and planned public transportation projects in Mersin province in the coming years, a significant reduction in vehicle ownership is expected. Accordingly, mitigation measures from the transportation sector are discussed under 2 alternative scenarios. Alternative scenario 1 considers a 20% decrease in vehicle ownership for automobiles and a 5% decrease for other vehicle types by 2055 compared to the reference scenario. On the other hand, 30% and 80% of cars and motorcycles, respectively, and 10% of vans, buses and minibuses will be electric vehicles in 2055. Alternative scenario 2, which is more ambitious than alternative scenario 1, considers a 40% decrease in car ownership and a 10% decrease in other vehicle types by 2055 compared to the reference scenario. In addition, 60% and 100% of cars and motorcycles and 40% of vans, buses and minibuses will be electric vehicles in 2055, respectively. The GHG mitigation potentials obtained as a result of alternative mitigation scenarios are shown in Figure 8.8.

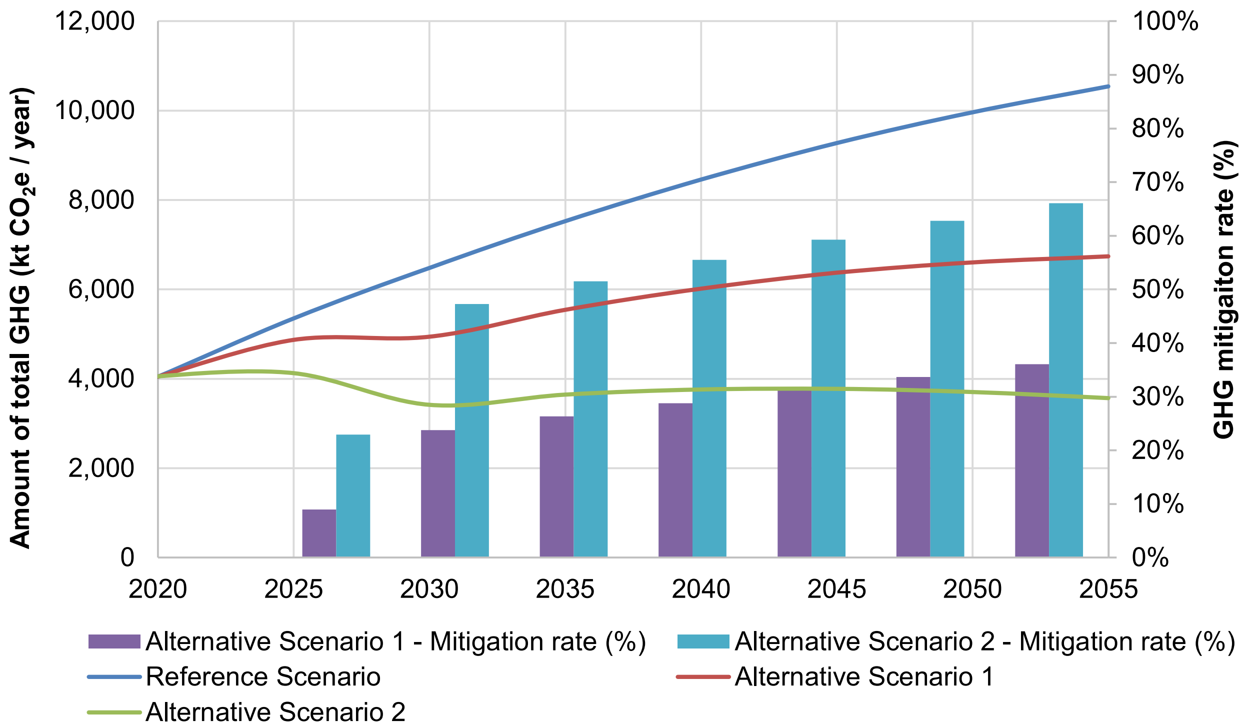


Figure 8.8: Comparison of reference scenario and mitigation scenarios for transportation

According to the results of Alternative Scenario 1, the GHG reduction rate is 26% in 2035 and 36% in 2055. The results obtained for the road transportation are 26.5% and 36.3% for 2035 and 2055, respectively.

When the results of Alternative Scenario 2 are analyzed, the GHG reduction rate from the transportation sector, which was 52% in 2035, reached 66% in 2055. When the results obtained on the basis of the road transportation are evaluated, the GHG reduction rates obtained for the years 2035 and 2055 are 52% and 66.6%, respectively.

8.2.3 Waste and Wastewater

In the reference scenario calculations for Mersin province, it was assumed that the amount of waste generated per capita per day will increase in a similar trend with the data of previous years. In addition, unmanaged waste, which constitutes 7% of total waste, will be zero by 2055. Currently, methane recovery from solid waste storage is included in the calculation as 4.03 kt, 3.67 kt and 3.60 kt for 2019, 2020 and 2021, respectively. Approximately 20% of total methane emissions are recovered at the moment. For the reference scenario, it was assumed that this rate will not change over the years, i.e. the amount of methane recovery calculated for the future. On the other hand, the current solid waste electric motor efficiency is included in the calculations as 42.5%. Methane recovery from wastewater treatment is currently realized in 2 wastewater treatment plants and accounts for 0.8% of total wastewater methane emissions.

In this context, 40% reduction in waste generation per capita per day by 2055, 50% increase in the amount of waste sent for recovery, 50% recovery of 50% of total methane emissions from waste storage and 10% increase in engine efficiency compared to the current situation (46.75%) are considered under alternative scenario 1. Alternative scenario 1 also envisages that 50% of the methane emissions from wastewater treatment will be recovered by 2055. By 2055, waste generation per capita per day and the amount of waste sent for recovery is reduced by 70%, methane recovery from waste storage reaches 70%, and solid waste engine efficiency increases by 25% compared to the current situation (53.13%) under alternative scenario 2. In alternative scenario 2, it is also envisaged that 70% of methane emissions from wastewater treatment will be recovered by 2055. The amount of GHG reduction is shown in Figure 8.9.

When the scenario results are analyzed considering the fact that Mersin province is already recovering methane, the GHG mitigation rate from the sector, which was 18.2% in 2035 in alternative scenario 1, reached approximately 51.6% in 2055. These mitigation values are 27% and 67.2% for alternative scenario 2, respectively.

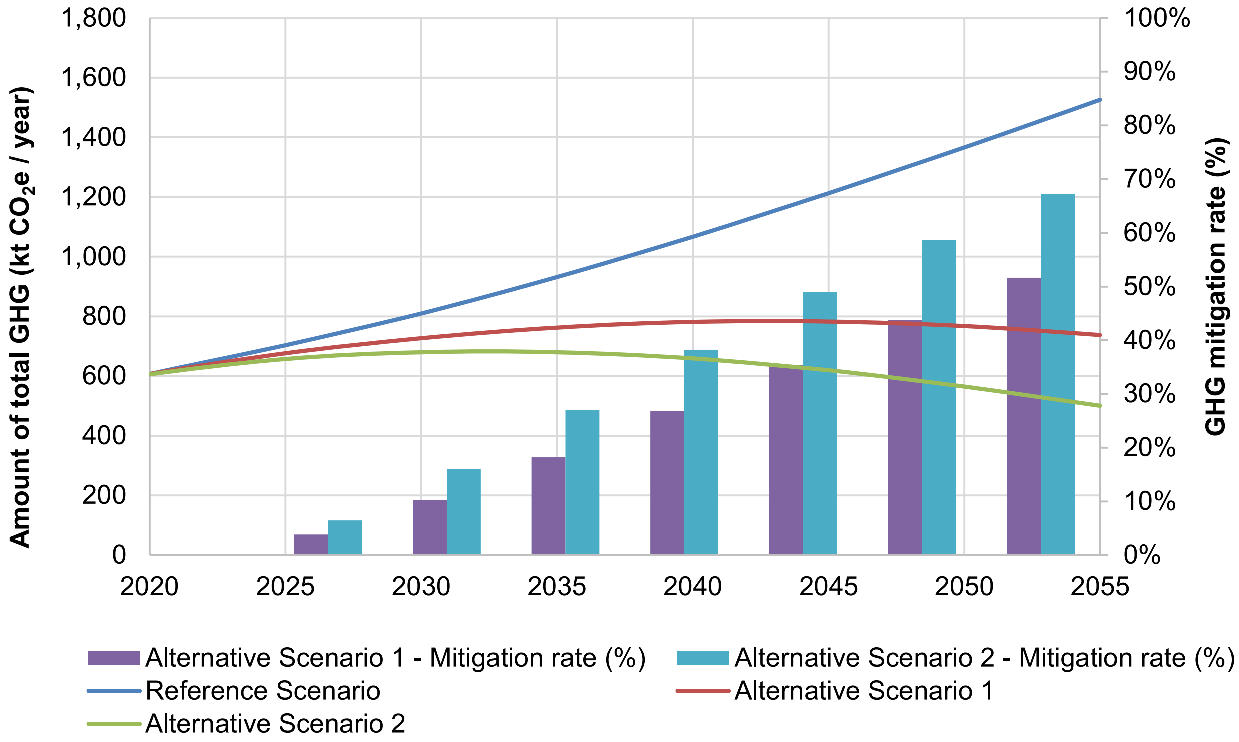


Figure 8.9: Comparison of reference scenario and mitigation scenarios for waste and wastewater

8.2.4 Overall Assessment

In the light of sectoral assessments, actions for mitigation of total GHG emissions in stationary energy, transportation and waste sectors were evaluated under 2 alternative scenarios. Emission reduction targets were determined by reducing emissions by a certain amount according to the projected reference scenario. In addition, the GHG mitigation curve for the 2053 net zero emission target, which was created by considering national targets, was also evaluated and the results of all scenarios are presented in Figure 8.10.

According to this assessment, it was evaluated that greenhouse gas emissions could be reduced by 25% in the first alternative scenario and 48% in the second alternative scenario in 2035 compared to the reference scenario. These mitigation rates are 20% and 42% for 2030, respectively, and the results obtained in the second alternative scenario are slightly above the 41% mitigation target set by Turkey in its NDC for 2030. On the other hand, these rates are expected to reach 35% and 63% by 2050. In order to reach the 2053 net zero emission target, additional greenhouse gas emission savings of 17% in 2035 and 32% in 2050 need to be achieved over the alternative scenario 2, and these rates indicate that additional reductions of approximately 1,900 kt CO_2e/year in 2035 and 4,800 kt CO_2e/year in 2050 are needed. While it is assessed that the first alternative scenario can be realized with the short-term targets set within the scope of the action plan, there is a need for financial and technical enrichment of the existing actions in order to achieve a mitigation path in line with national targets, especially in the long term.

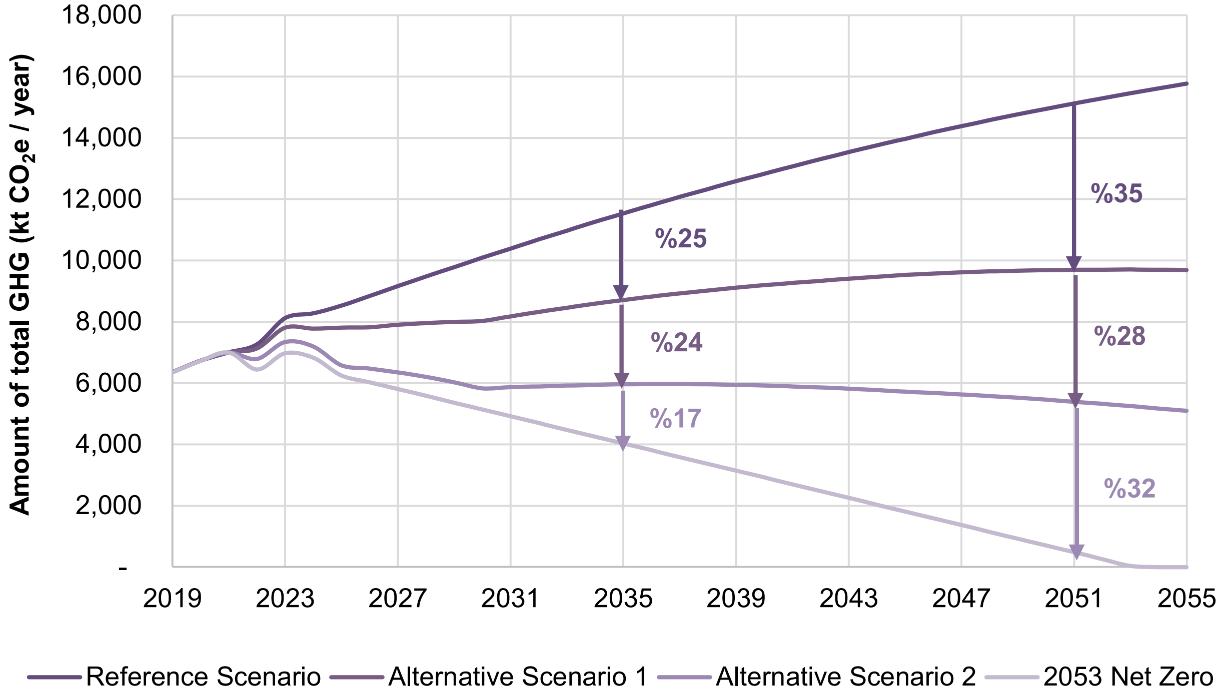


Figure 8.10: Comparison of reference scenario and mitigation scenarios

Sectoral changes are presented in Figure 8.11. Accordingly, it is calculated that GHG emissions in the category of stationary energy, which covers energy consumption in the residential and commercial buildings, industry and agriculture sectors, can be reduced by 16% in the alternative scenario 1 and 38% in the alternative scenario 2 in 2030 compared to the reference scenario. These rates are projected to be 36% and 67% for 2050. In order to reach the 2053 net zero emission target, additional greenhouse gas emission savings of 45% in 2030 and 96% in 2050 are required compared to the baseline scenario.

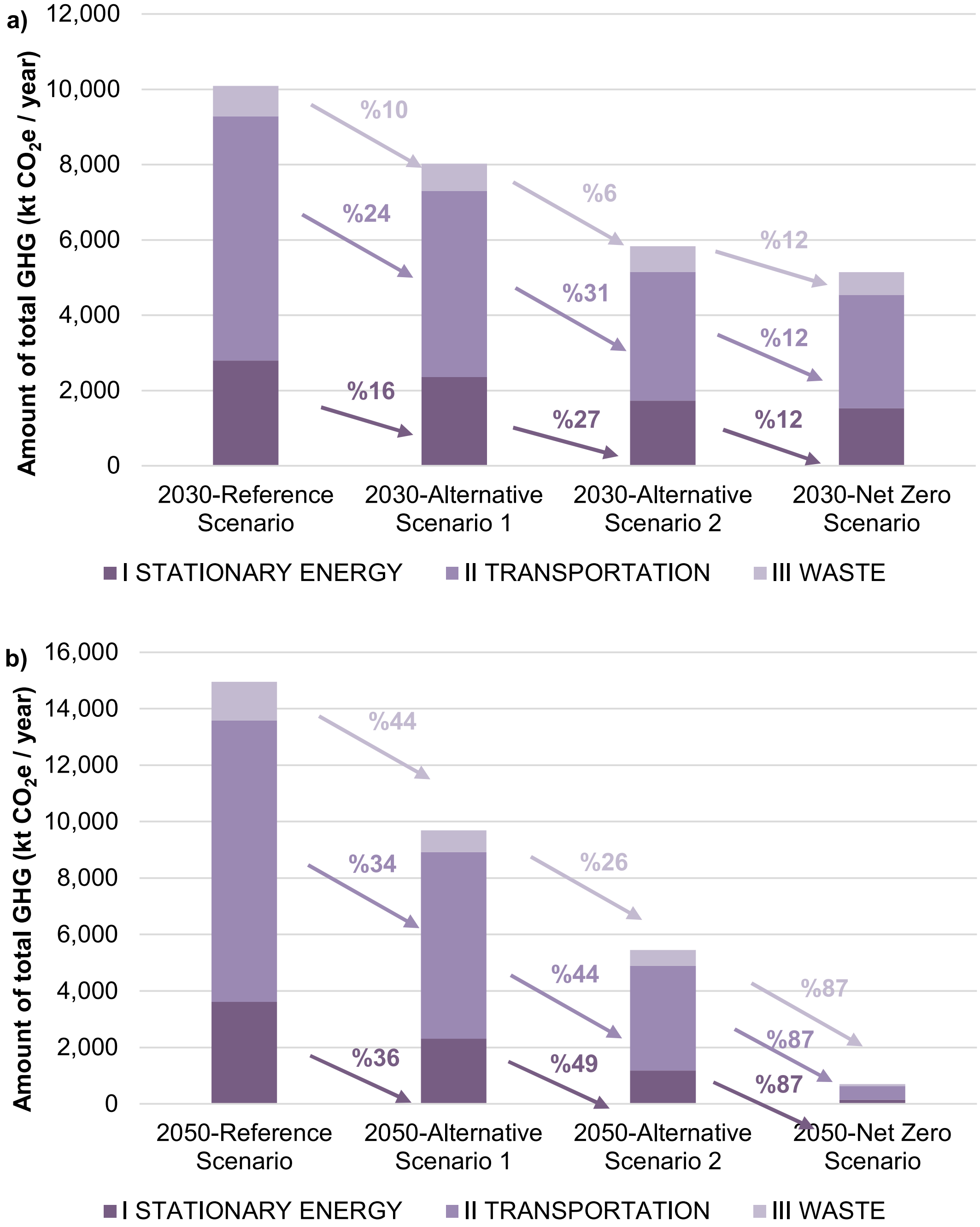


Figure 8.11: Comparison of reference scenario and mitigation scenarios on a sector basis approach a) for 2030, b) for 2050

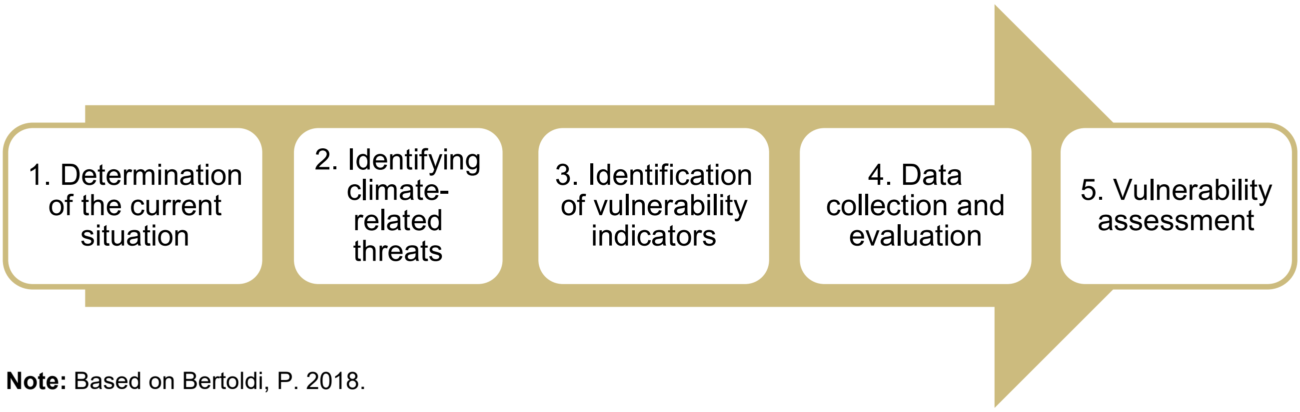
On the other hand, it is calculated that emissions from the transportation sector can be reduced by 24% in the alternative scenario 1 and 47% in the alternative scenario 2 in 2030 compared to the baseline scenario. These rates are estimated to be 34% and 64% for 2050. In order to reach the 2053 net zero emission target in the transportation sector, additional greenhouse gas emission savings of 54% in 2030 and 95% in 2050 are required compared to the reference scenario. In the waste sector, it is calculated that in 2030, approximately 10% in the alternative scenario 1 and 16% in the alternative scenario 2 can be reduced. These rates are projected to be approximately 44% and 59% for 2050, respectively. In order to reach the 2053 net zero emission target in the waste sector, additional GHG emission savings of 26% in 2030 and 95% in 2050 are required compared to the baseline scenario.

9. ASSESSMENT OF ADAPTIVE CAPACITY TO CLIMATE CHANGE

In the implementation of the climate change adaptation planning process, the methodology, which is outlined by the EU Climate Adaptation Platform (Climate-ADAPT) and prioritized for our country, basically consists of 6 steps and adopted in this study (Climate ADAPT, 2022; MoEUCC_b, 2020). Accordingly, the steps to be followed in the development of the adaptation action plan are

1. Organizing administrative processes / ensuring prerequisites
2. Climate change risk and vulnerability assessment
3. Identifying adaptation measures
4. Assessment/prioritization of adaptation measures
5. Implementation of adaptation actions
6. Monitoring and evaluation

There are two approaches that are basically followed in risk and vulnerability assessment within the scope of climate change adaptation, namely spatial impact modeling and indicator-based assessment, and the second approach has been taken into consideration within the scope of the Project studies (Bertoldi P., 2018).



Note: Based on Bertoldi, P. 2018.

Figure 9.1: Risk assessment approach for climate change adaptation

In the first stage, a survey was conducted to obtain stakeholders' views on the areas expected to be affected by climate change in Mersin province and the measures that can be implemented within the scope of adaptation to climate change. The survey was answered by 108 respondents in Mersin and the institutional distribution of the respondents is presented in Figure 9.2.

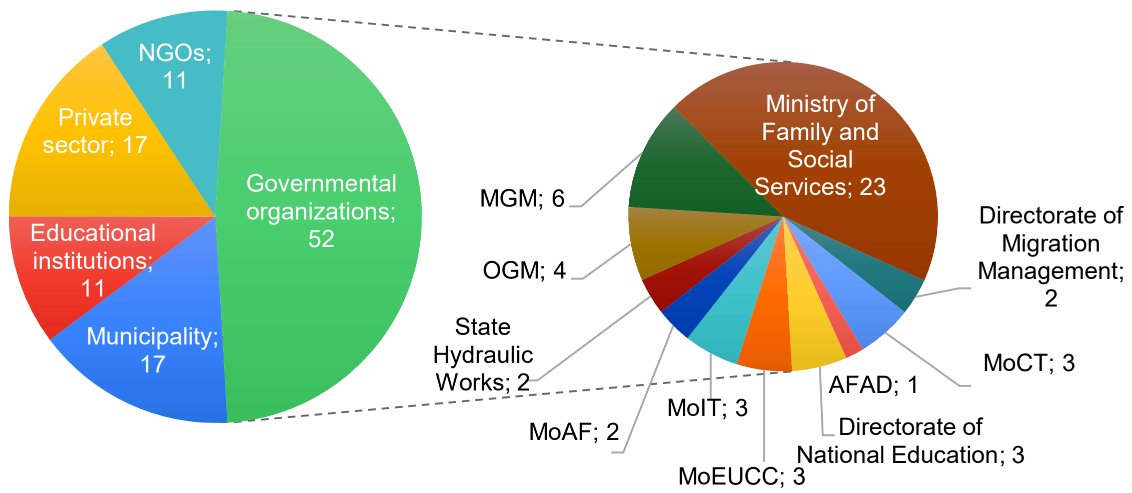


Figure 9.2: Institutional distribution of survey respondents

According to the general evaluation results of the questionnaire, the majority of the respondents indicated that the impacts of climate change expected to have an impact on Mersin will be primarily temperature increase, drought and forest fires (Figure 9.3), while on a sectoral basis, land use, forestry and biodiversity, agriculture and animal husbandry, and water resources are among the sectors expected to be most affected (Figure 9.4).

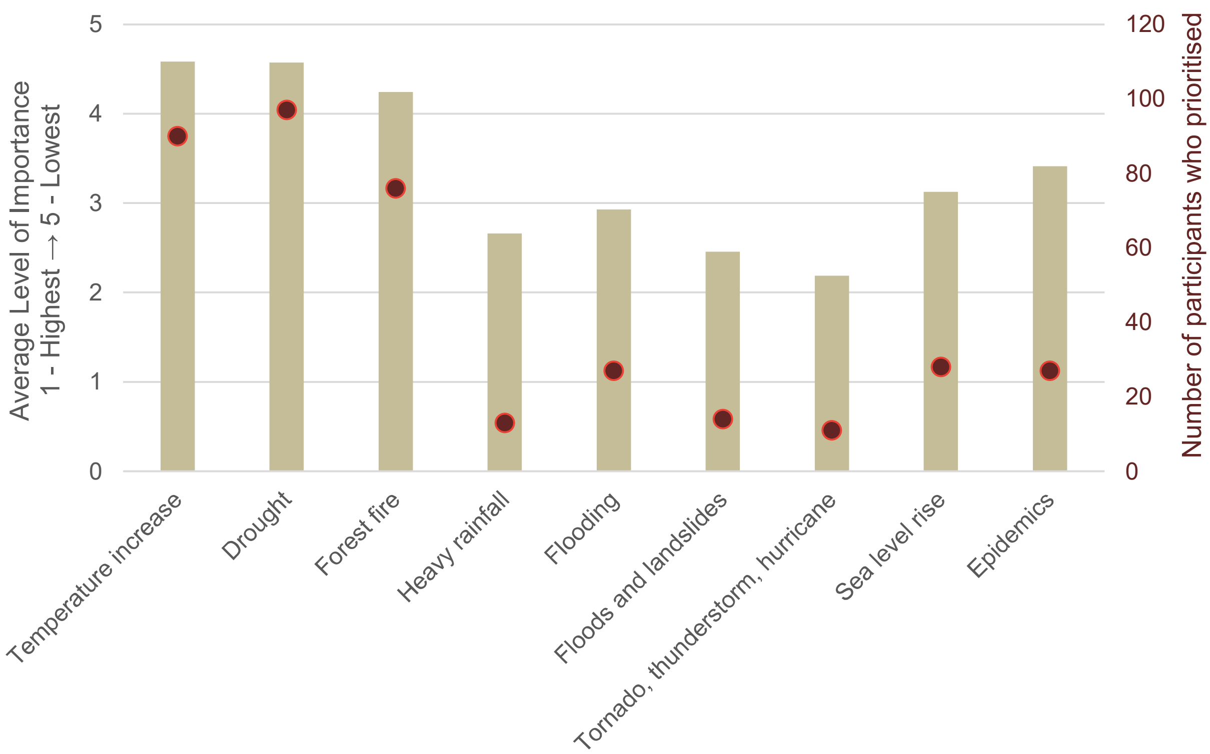


Figure 9.3: Prioritization of climate change impacts according to survey respondents

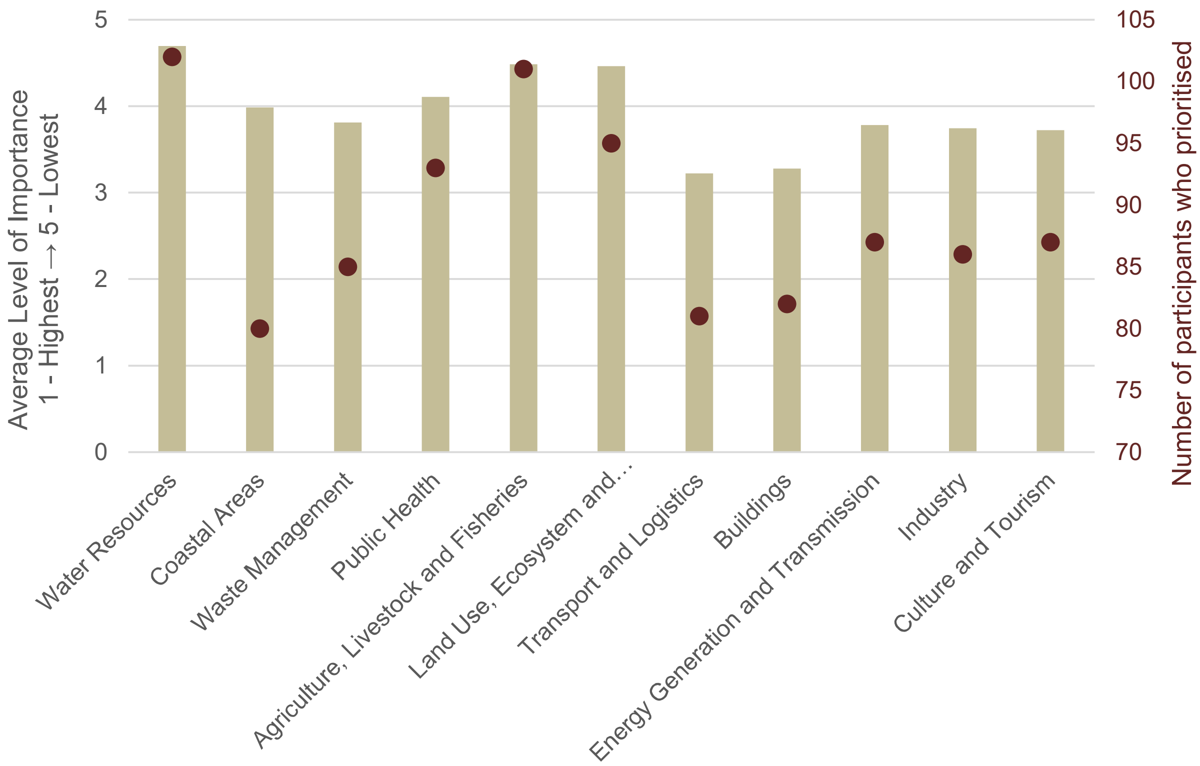


Figure 9.4: Prioritization of sectors according to survey respondents

9.1. Climatological Analysis

9.1.1 Temperature

In order to determine the climatic characteristics of Mersin province, long-term (1963-2021) data sets of the General Directorate of Meteorology (MGM) observation stations were analyzed.. Table 9.1 shows annual and seasonal average temperatures for some selected districts. Anamur, Silifke, Erdemli and Akdeniz stations, which are located along the shoreline and at elevations close to sea level, have long-term annual average temperatures of around 19.5°C, while the long-term annual average temperature of Mut, which is located at a higher altitude and where the sea effect is felt relatively less, is around 18°C. Long-term average temperatures in Fall, Winter and Spring are also relatively higher in the coastal districts. However, long-term summer average temperatures show that Mut is about 1-2° C warmer than the other stations. The main reason for this is that the thermal air circulation (thermal circulation) that occurs as a result of the temperature and density difference between land and sea and the resulting sea breezes (cooler winds blowing from the sea towards land) lose their effect inland.

Table 9.1: Annual and seasonal average temperatures in Mersin Province (°C)

Station name	Annual Average Temperature (1959-2021)	Fall Seasonal Average Temperature (1959-2021)	Winter Seasonal Average Temperature (1959-2021)	Spring Seasonal Average Temperature (1959-2021)	Summer Seasonal Average Temperature (1959-2021)
Anamur-17320	19.54	21.55	12.27	17.21	27.14
Silifke-17330	19.59	21.68	11.20	17.93	27.54
Mersin-17340	19.40	21.46	11.29	17.71	27.12
Erdemli-17958	18.67	20.64	10.73	16.74	26.57
Mut-17956	17.95	19.19	7.60	16.50	28.52

"Long Term Average Maximum Temperatures", "Long Term Annual Maximum Temperatures", "Seasonal Average Maximum Temperatures" and "Long Term Averages of Seasonal Maxima" are given in Table 9.2 for Anamur, Silifke, Erdemli, Akdeniz and Mut. "Long Term Average Maximum Temperatures", where the maxima of each month are taken into account, are around 28.7, 29.9, 28.5, 28.0 and 30.0° C for Anamur, Silifke, Erdemli, Akdeniz and Mut, respectively. However, the "Long Term Annual Maximum Temperature Averages", which take into account the maxima realized in each year, are 38.5, 38.9, 36.4, 35.3 and 41.8° C for these districts, respectively, and it is seen that Mut has much higher values in maximum temperatures than other districts. If we look at the "Seasonal Average Maximum Temperatures" and "Long Term Averages of Seasonal Maximum Temperatures"; it is seen that these values are 30.7 and 34.0, 20.2 and 22.0, 28.4 and 32.0, 32.8 and 34.2° C for the Autumn, Winter, Spring and Summer seasons, respectively for Akdeniz district.It can be said that the values are similar for other coastal districts. In Mut district, these values are higher in the order of 31.9 and 37.9, 18.2 and 20, 29.9 and 35.0, 40.3 and 41.7°C.

Table 9.2: Long-term temperature data for Mersin province (°C)

Station name	Long Term Average Maximum Temperature (1959-2021)	Long Term Average Annual Maximum Temperatures (1959-2021)	Fall Seasonal Average Maximum Temperature (1959-2021) / Seasonal Maxima Long Run Average (1959-2021)	Winter Seasonal Average Maximum Temperature (1959-2021) / Seasonal Maxima Long Run Average (1959-2021)	Spring Seasonal Average Maximum Temperature (1959-2021) / Seasonal Maxima Long Run Average (1959-2021)	Summer Seasonal Average Maximum Temperature (1959-2021) / Seasonal Maxima Long Run Average (1959-2021)
Anamur-17320	28,74	38,52	30,68 / 34,68	20,02 / 21,46	27,24 / 31,86	36,85 / 38,43
Silifke-17330	29,90	38,87	32,39 / 36,28	20,63 / 22,40	29,74 / 34,03	36,86 / 38,55
Mersin-17340	28,03	35,28	30,69 / 34,03	20,17 /22,00	28,42 / 31,96	32,83 / 34,23
Erdemli-17958	28,48	36,35	31,10 / 34,62	20,21 / 21,95	28,78 / 33,04	33,81 / 35,50
Mut-17956	30,06	41,78	31,87 / 37,94	18,23 / 19,97	29,86 / 35,01	40,27 / 41,70

The monthly "Average Maximum Temperature", "Monthly Long Term Observed Maximum Temperature", "Monthly Long Term Average Minimum Temperature" and "Monthly Long Term Average Temperature" changes for the Reference Period (RP) between 1963-2021 are shown in Figure 9.5. It can be said that there are no significant differences in the above four parameters for Anamur, Silifke and Mersin Center (Akdeniz). While Mersin's average temperature values are at a minimum of 10° C in January, they reach maximum values around 27° C in July-August. Long-term monthly minimum values occur in January with 1-2° C, and in July-August the minimum values reach 21° C and then decline. Mean Maximum Temperature values (red) calculated within the RP reached 19-20° C in winter and 33° C in July-August-September. Monthly Long Term Average Maximum Temperatures (yellow) reached 25° C during the winter months and reached the highest values of 41-42° C in September. Looking at Mut MGM station data, it is seen that the average minimum temperatures are lower compared to Anamur, Silifke, Erdemli and Mersin, hovering around 3° C below zero. In each of the parameters of Average Temperature, Average Maximum Temperature and Monthly Long Term Maximum Temperature, it is seen that it has higher values around 30° C, 40.5° C and 46° C, respectively, compared to the other 4 districts.

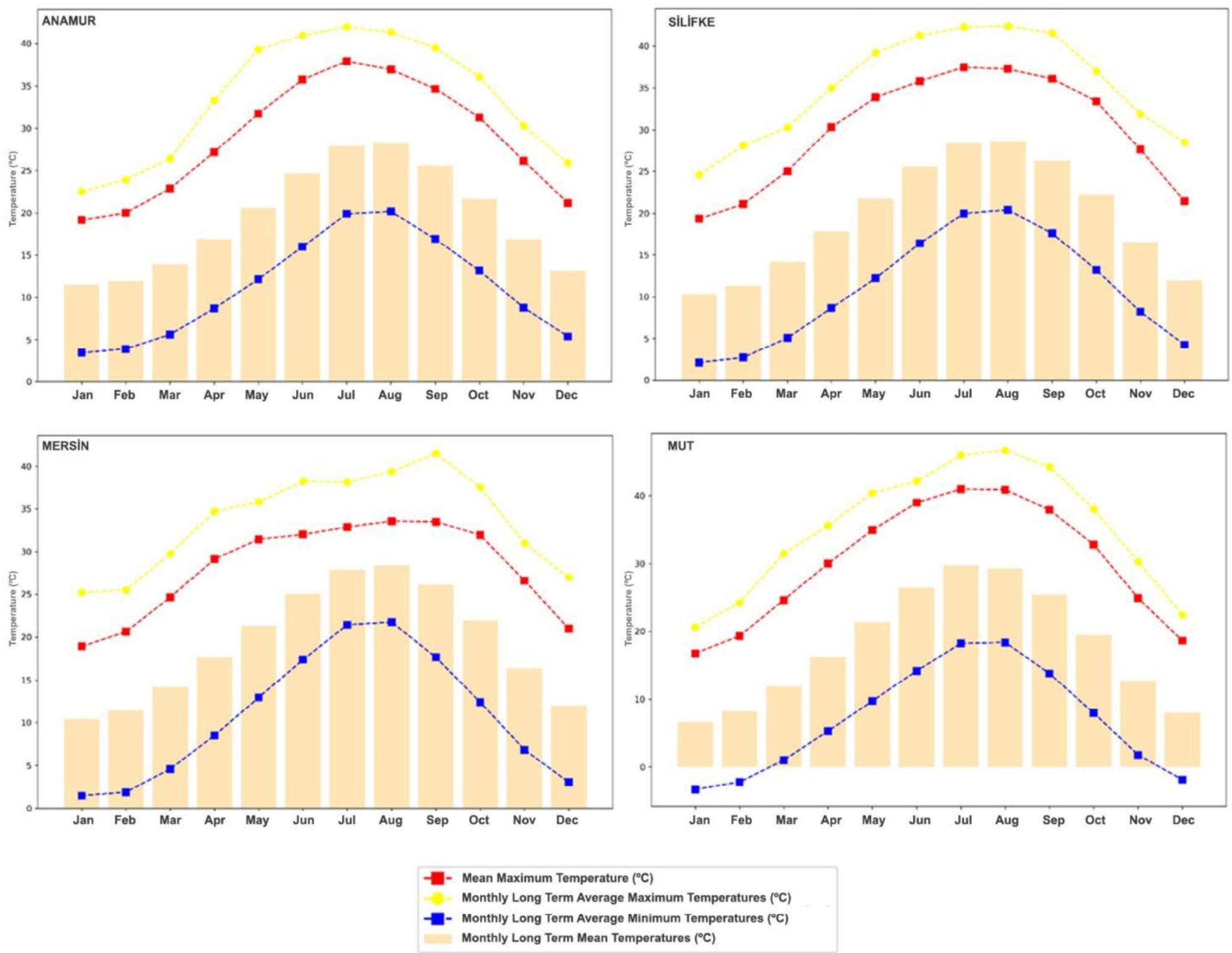


Figure 9.5: Long-term monthly average temperature distributions of Mersin province

Some statistical methods such as trend analysis are used to determine how a variable shows a trend and the intensity of the trend over time. One of the benefits of trend analysis is that it provides information about the future trend based on the assumption that the statistical properties of the past data set are preserved. Among parametric tests, the most widely used tool for the assessment of climate parameters is linear trend analysis. By applying an analysis in which the deviations (differences) of the annual average temperature data of Mersin province from the 59-year RP values are considered as an independent variable and the years as a dependent variable, the trend in the deviations of the annual average temperatures of the province and some selected districts from the long-term temperature averages both annually and seasonally is shown in Figure 9.6. When the deviations in annual averages are analyzed with time (Figure 9.6), it is seen that the slope values are around 0.05, 0.03, 0.03, 0.03 and 0.04 for Mersin, Anamur, Silifke and Mut, respectively, and the correlation coefficients (degree of relationship) are significantly high at 0.83, 0.60, 0.49, and 0.63, respectively. For Mersin and Mut, the period when the deviations from the averages were negative continued until 1994, while the deviations became positive after 1994 (annual average temperatures were higher than the long-term average annual temperature). It is also seen in the figure that the positive differences from the RD average temperatures tend to increase towards 2021. For example, for Mersin, while the positive differences around 1994-2008 hovered around 0.5-1.0^{o} C, these values can be seen to vary between 1.2-2.2^{o} C between 2008-2021. From this point of view, it can be said that annual average temperatures for Mersin province have been increasing over time and this trend will continue in the future if these RP statistical properties remain the same. In Anamur and Silifke districts, deviations of annual average temperatures from the RP values have become positive after 1996, except for a few exceptional years. For Anamur and Silifke districts, it can be seen that there has been an increase in positive values especially after 2008.

In order to examine the change of seasonal temperature averages over time, the changes of "seasonal temperature averages" for Mersin, Anamur and Mut districts and their differences from RP seasonal averages over time are shown in Figure 9.7, Figure 9.8 and Figure 9.9. For Mersin province, seasonal differences are strongly correlated with time and the trend is positive (Figure 9.7). The correlation coefficients for Mersin in winter, spring, summer and fall were 0.45, 0.65, 0.84 and 0.72, respectively. It can be said that the differences for all seasons shifted towards positive values approximately after 1994. The correlation coefficient is highest in the summer season and deviations increase up to 1.5-2^{o} C after 1994. Although the differences of the seasonal temperature averages of Anamur, Silifke, Erdemli and Mut districts from the long-term (RP) seasonal averages have been analyzed separately, only Anamur, which is a coastal district, and Mut, which is relatively farther away from the sea and has a relatively higher sea level than the others, are shown in Figure 9.8 and Figure 9.9.

Considering the changes in Anamur Winter, Spring, Summer and Fall temperature deviations over time (Figure 9.8), it is seen that there is a positive trend, although it is slightly lower than Mersin station, there is a strong positive relationship and the correlation coefficients are 0.19, 0.34, 0.62 and 0.57, respectively. The lowest relationship is observed in Winter and then in Spring, while the highest relationship is observed in Summer and then in Fall. Except for some exceptional years, it can be said that the trend shifted to a positive direction towards the end of the 1990s. It can be seen in Figure 9.9 that a similar change is also valid for Mut district. Similarly, the lowest correlation for Mut was calculated to be in Winter and Spring. It is observed that the differences of seasonal temperature averages from the long term in summer and autumn months, where the correlation is the highest with 0.52 and 0.54, have shifted to a positive trend after 1994 and 1999, respectively. Positive temperature differences can range from about 0.5 to 2.0° C for the Summer season and from about 0.5 to 2.5° C for the Autumn season.

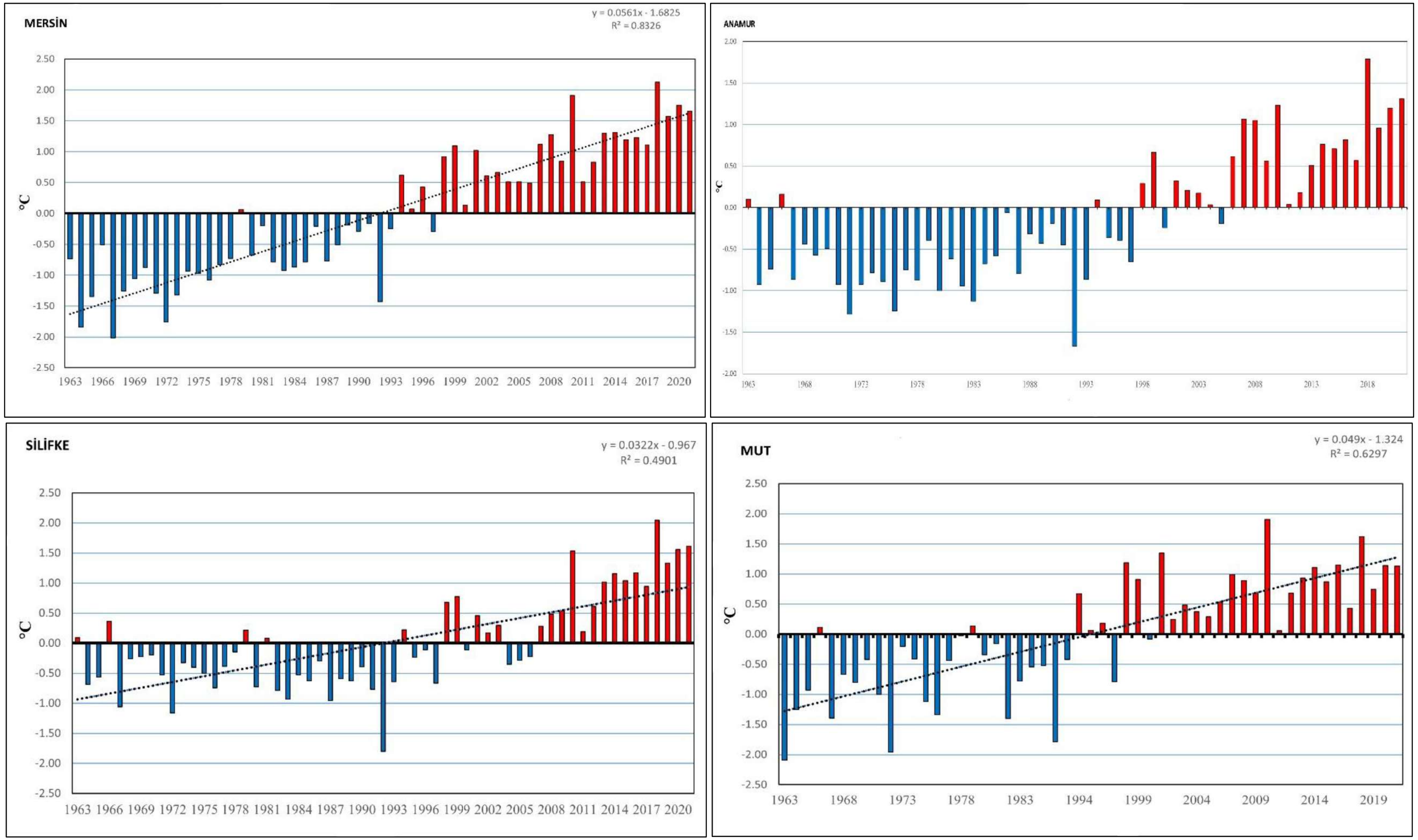


Figure 9.6: Annual average temperature deviations of Mersin districts 1963-2021 period

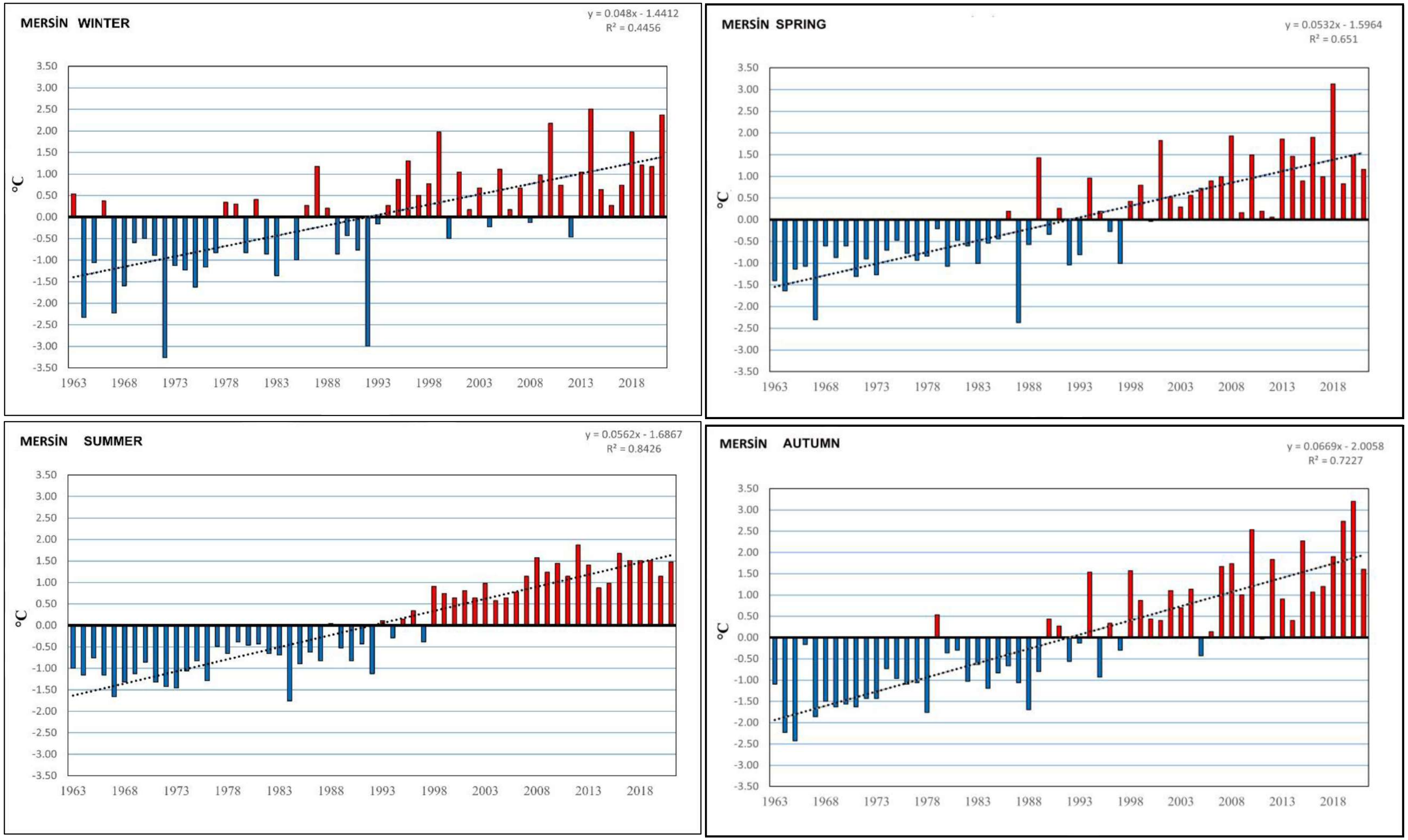


Figure 9.7: Seasonal average temperature evaluations for Mersin station for the period 1963-2021

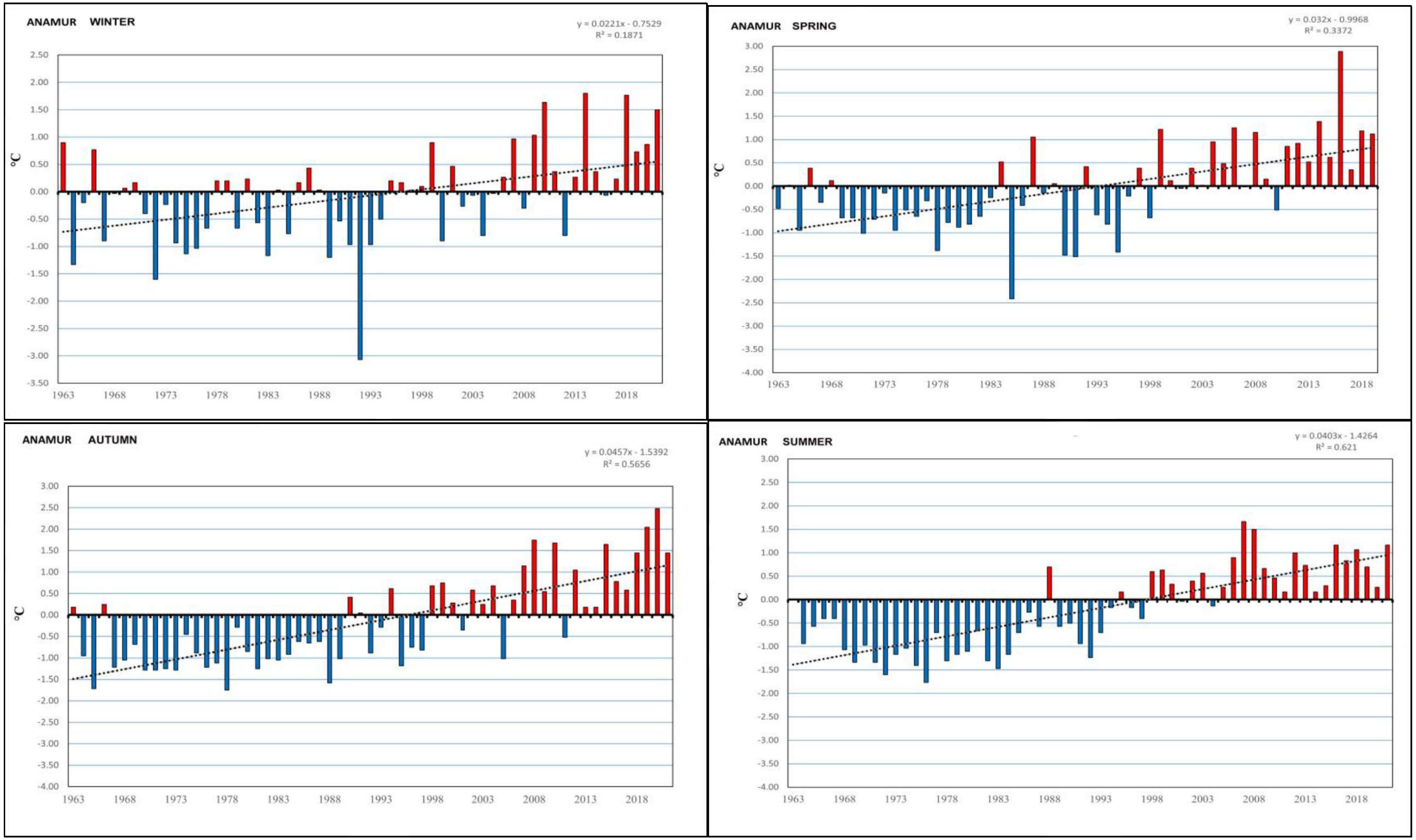


Figure 9.8: Seasonal average temperature evaluations for Anamur station for the period 1963-2021

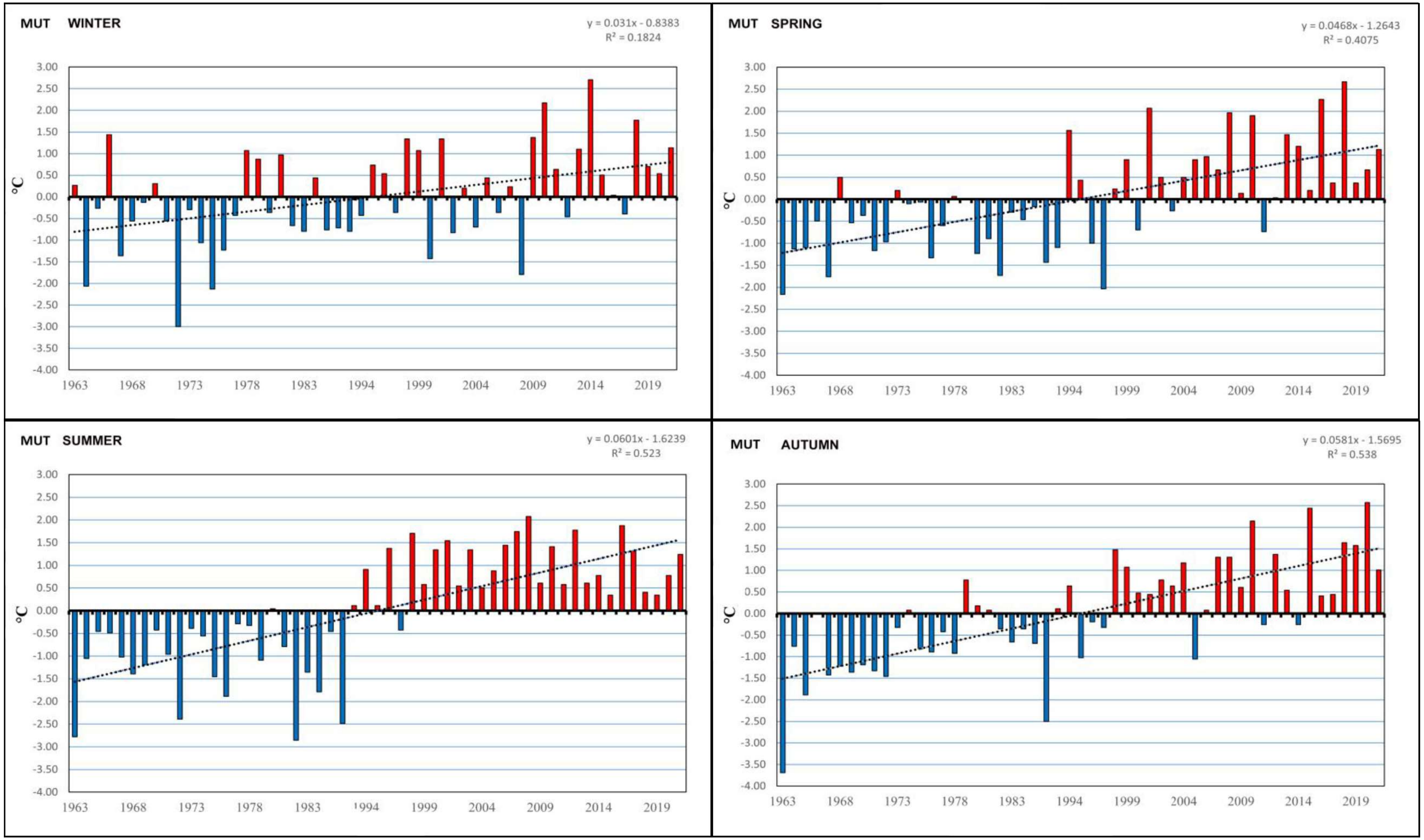


Figure 9.9: Mut station seasonal average temperature assessments for the period 1963-2021

1963-2021 RP "Long Term Average Maximum Temperature - LTAMT" and "Long Term Average Annual Maximum Temperature - LTAAMT" are calculated as 30.1^{o} C and 41.8^{o} C, respectively. "In the calculation of Long Term Average Maximum Temperature, the average of the maximum temperature values of each month for any year is calculated as the annual average maximum temperature. The "Long Term" (1963-2021) averages of these annual average maximum temperatures give us the "Long Term Average Maximum Temperature - LTAMT". In the LTAAMT calculation; the maximum temperature value occurring in any given year is considered as the maximum temperature of that year. The 1963-2021 RP average of the annual maximum temperature values calculated in this way gives the LTAAMT. The change in the difference of maximum temperatures from their long-term averages over time is important as it is one of the characteristics of the change in Mersin climate. Considering the temperature increases that are being experienced especially in the Eastern Mediterranean basin and predicted by climate projections, it becomes important to know the direction and severity of the change in maximum temperatures.

The seasonal variation of LTAMT and LTAAMT values of Mersin and Anamur districts over time is shown in Figure 9.10 and Figure 9.11. Although similar figures were prepared for Silifke, Erdemli and Mut districts, the analyses were carried out for Anamur and Mersin since the seasonal characteristics of the LTAMT and LTAAMT variables of Silifke and Erdemli districts are similar to those of Anamur district and the LTAMT and LTAAMT values of Mut district do not show a significant trend over time. Mersin LTAMT values have been positive and increasing in the summer season since the late 1990s. It is observed that the annual averages of the monthly maximum values show increases of up to 2-3^{o} C compared to the long-term averages; again, it is seen that LTAAMT values have continuously taken positive values for the summer season since the beginning of the 2000s and increases of up to 2 – 5^{o} C. For Mersin, it is observed that the differences remain positive in the fall season, especially since the beginning of the 2000s, and LTAMT and LTAAMT values increase up to 4^{o} C and 7^{o} C, respectively. It can be said that both LTAMT and LTAAMT values for the winter season have remained positive since the 2000s, albeit slightly. In the spring season, deviations hovered around positive and negative values, with LTAMT values slightly more positive.

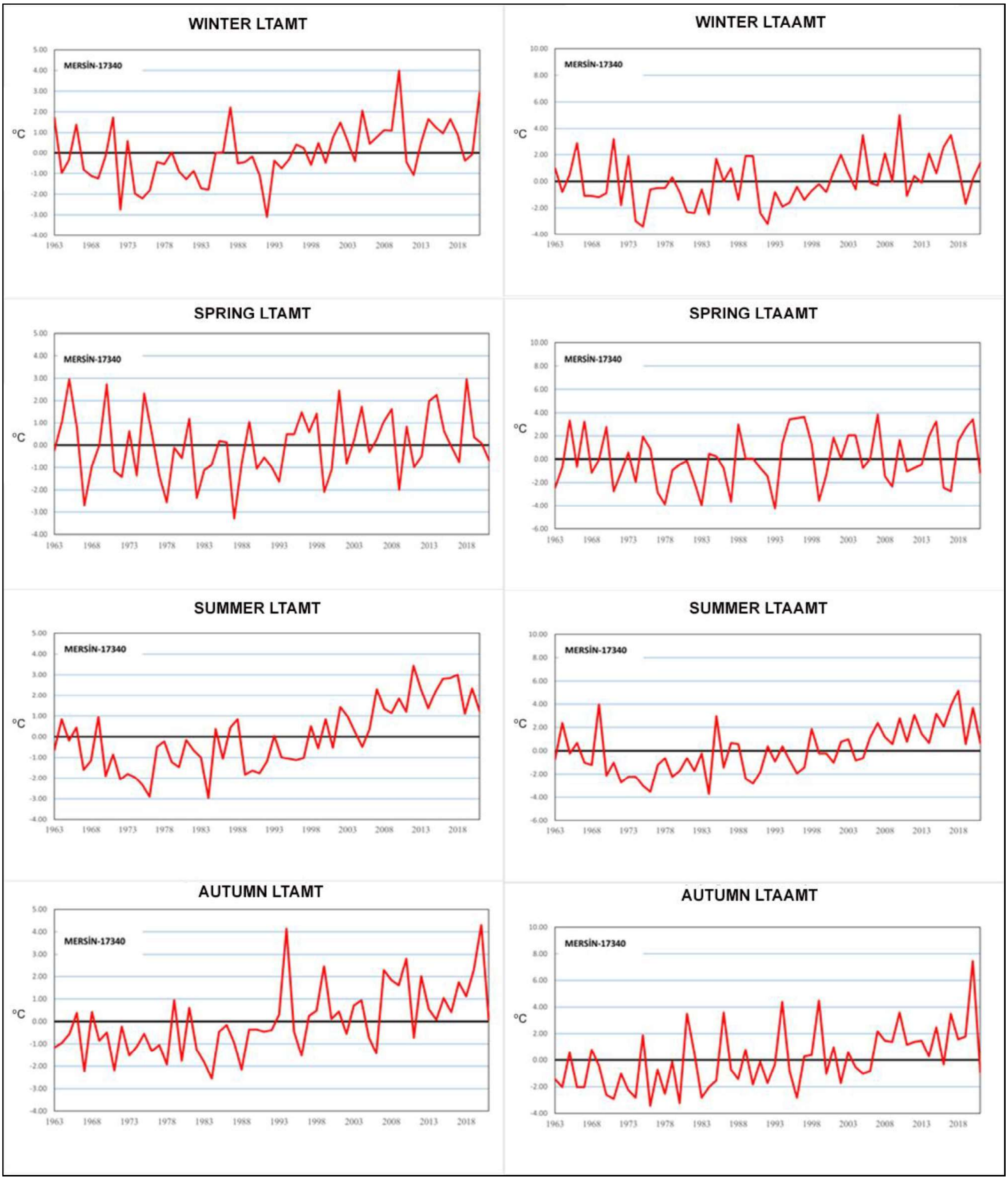


Figure 9.10: LTAMT and LTAAMT values for Mersin station

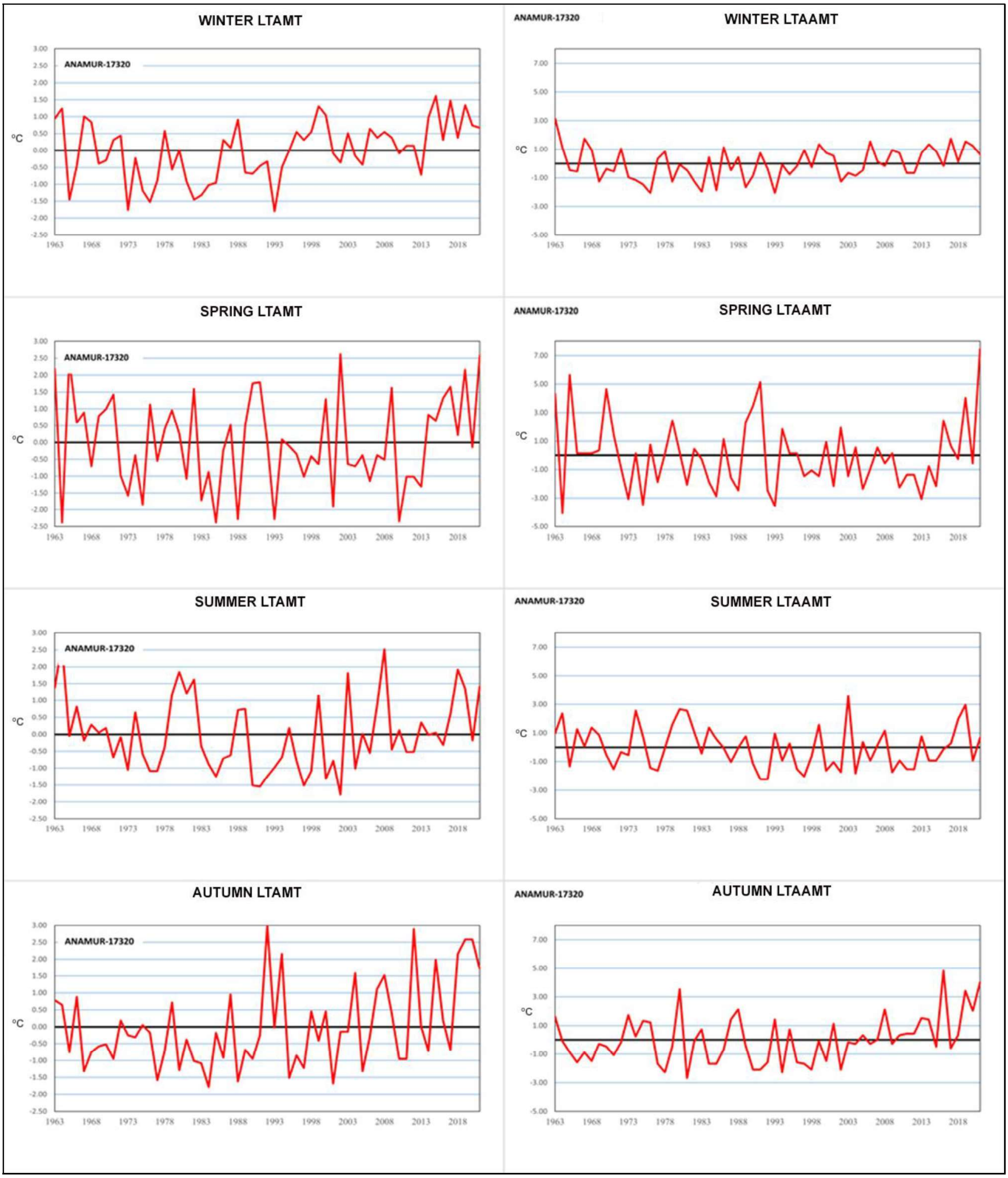


Figure 9.11: LTAMT and LTAAMT values for Anamur station

The time variation of seasonal LTAMT and LTAAMT values of Anamur district is given in Figure 9.11. It is observed that summer LTAMT values have been peaking up to 1.5-2°C since 2000s and generally remain positive. It can be said that a similar change is not the case for the LTAAMT. Annual maximum temperatures are found to oscillate around the long-term maximum temperature. In the fall, it is noteworthy that the peaks in the positive direction of the LTAMT values are much larger than the peaks in the negative direction. Positive LTAMT values go up to around 2-2.5° C, while negative

LTAMT values only stay around minus 0.5°C. Autumn LTAAMT values, on the other hand, have been in a positive phase since the 2000s and deviations of up to 3-5°C can be observed. For Anamur (for Silifke, Erdemli and Mut), it is seen that there is no downward or upward trend in LTAMT and LTAAMT variables in winter and spring seasons. It is observed that the differences in maximum temperatures tend to increase more significantly in Summer and Autumn.

9.1.2 Precipitation

In order to reveal the precipitation amount and regime of Mersin province, the data of MGM meteorological observation stations within the borders of Mersin province were taken into consideration. The observation periods for Anamur, Mersin, Silifke and Mut are 1948-2022, 1948-2021, 1930-2021 and 1959-2011, respectively. The evaluations were made for the central district of Mersin, Akdeniz, Anamur, Silifke and Mut districts. In addition to annual rainfall totals, deviations of seasonal rainfall totals from their long-term averages were also calculated. In addition, the ratio of the monthly maximum total precipitation value to the total precipitation of the relevant year, which may be a sign of irregularity in precipitation (the effect/contribution of heavy downpours to total precipitation), was calculated for the long term.

As shown in Table 9.3, the long-term averages of total annual precipitation at Anamur, Mersin, Silifke and Mut stations are 941.9 mm, 599.6 mm, 563.6 mm and 395.6 mm, respectively. The long-term averages of monthly maximum precipitation were calculated as 293.6 mm, 196.1 mm, 180.6 mm and 122.4 mm for Anamur, Mersin, Silifke and Mut, respectively. It is observed that Anamur has much higher values than other districts in both total precipitation and maximum precipitation, with Mersin Akdeniz ranking second. The highest precipitation occurred in the winter season and these values are around 553.8 mm, 342.1 mm, 329.3 mm and 218.2 mm in the above order. Although Anamur district is the district with the highest rainfall in all seasons except summer, it is also noteworthy that it receives the least rainfall among these four districts in the summer season. Although fall precipitation is slightly higher than spring precipitation for Akdeniz and Silifke districts, it can be said that spring and fall precipitation values are close to each other, including Mut district: Mersin (118,1-115,6 mm), Silifke (120,3-104,1 mm) ve Mut (76-85 mm). Table 9.4 provides information on seasonal minimum rainfall. The winter minimum precipitation averages for Anamur, Mersin, Silifke and Mut were 93.9 mm, 52.7 mm, 51.5 mm and 33.9 mm, respectively. The summer minimum precipitation averages were 3.1 mm, 5.4 mm, 4.6 mm and 4.9 mm, respectively, and the fall and spring minimum precipitation averages were close to each other

Table 9.3: Annual and seasonal total precipitation data in Mersin Province

Stations	Long-term Average of Annual Totals	Long-term Average of Monthly Maximum Observed Precipitation	Monthly Maximum Precipitation / Long-term Average of Total Annual Rainfall Rates	Fall Seasonal Total Rainfall Average	Winter Seasonal Total Average Precipitation	Spring Seasonal Total Average Precipitation	Summer Seasonal Total Average Precipitation
Anamur	941.89 (1948-2022)	293,55	0,3145	190,08	553,75	160,61	7,38
Mersin (Akdeniz)	599.61 (1948-2021)	196,12	0,3162	118,11	342,08	115,61	21,10
Silifke	563.56 (1930-2021)	180,59	0,3234	120,27	329,26	104,08	9,96
Mut	395.63 (1959-2011)	122,44	0,3096	75,97	218,23	84,91	16,52

Table 9.4: Long-term seasonal total precipitation data in Mersin Province

Stations	Fall Minimum Precipitation Long-term Average	Winter Minimum Precipitation Long-term Average	Spring Minimum Precipitation Long-term Average	Summer Minimum Precipitation Long-term Average
Anamur	18,98	93,93	17,72	3,13
Mersin (Akdeniz)	10,53	52,70	11,59	5,43
Silifke	14,53	51,52	13,46	4,62
Mut	11,66	33,91	12,06	4,89

Annual total precipitation and deviations of annual totals from the mean for Mersin Akdeniz, Anamur, Silifke and Mut Districts are shown in Figure 9.12. It is observed that the annual total precipitation in Mersin Akdeniz district averaged 600 mm in the period 1948-2018, oscillated around +/- 200 mm from the average, and reached maximum and minimum values of 1000 mm and 400 mm. Although there is no significant trend in terms of decrease or increase in the deviations (red) of long-term annual total precipitation from average values, it was determined that annual precipitation totals were above the averages in the 2008-2018 period. The total annual precipitation of Anamur district is around 1000 mm and it is observed that maximums up to 1500-1700 mm and minimums up to 500 mm occur from time to time. It can be said that there is no noticeable deviation from the averages, no positive or negative trend. For Silifke, which has around 560 mm of long-term annual total precipitation, and Mut, which has around 400 mm, there is no decreasing or increasing trend in total annual precipitation over time.

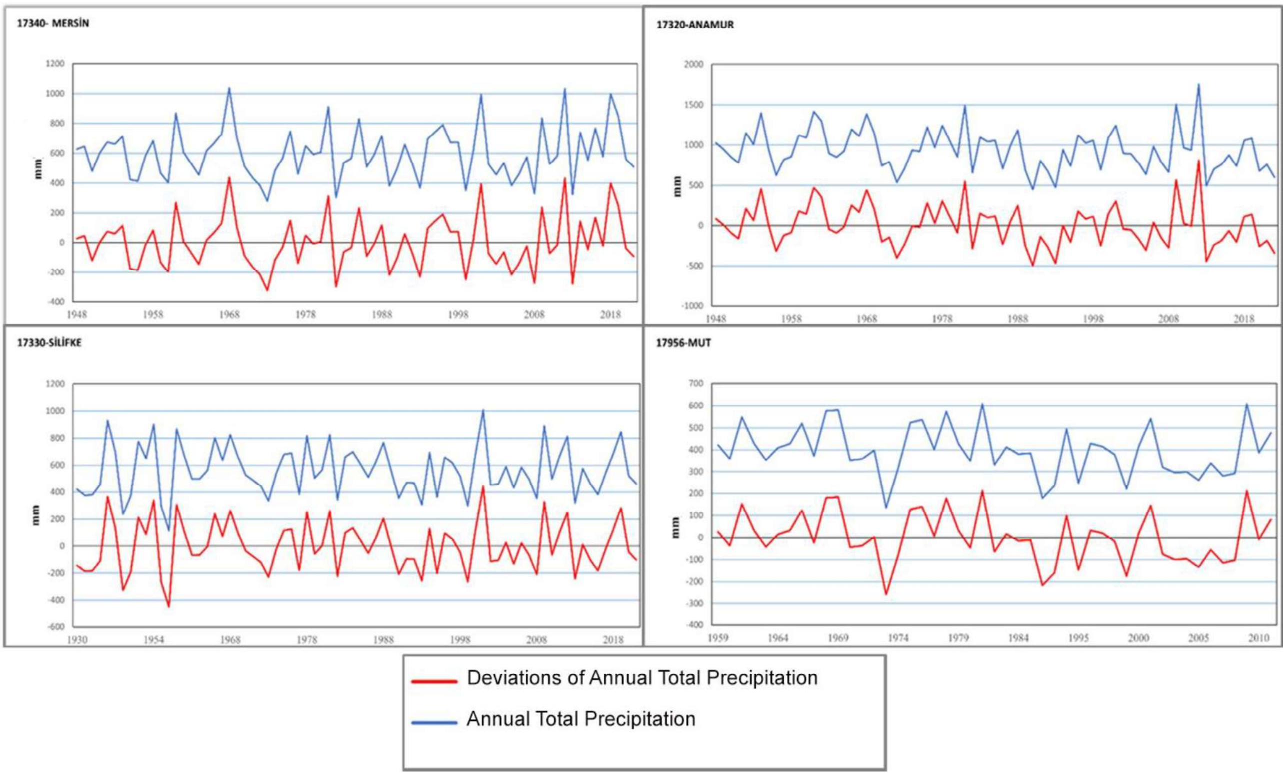


Figure 9.12: Annual total precipitation and deviations of annual totals from the mean in Mersin province

It is desirable that the precipitation falls regularly throughout the year, that it does not come in the form of sudden heavy downpours that will cause floods and overflows, and that there is no or minimal loss of life and property. Monthly maximum precipitation values occurring throughout the year were found using the long-term monthly total precipitation dataset, and then time series were created by determining the ratio of these values to the total precipitation occurring throughout the year ("RATIO" - Monthly maximum precipitation observed during the year / annual total precipitation). Figure 9.13 shows the annual observed monthly maximum precipitation, the ratio of maximum to annual total precipitation and the annual total precipitation. Table 9.3 shows the long-run averages of "RATIOs" for each district. The maximum monthly precipitation observed for Mersin Akdeniz reaches 350 mm and in some cases 500-650 mm. The contribution of these maxima to the total annual precipitation is shown in blue as "RATIO". Keeping in mind that the long-term average precipitation in Mersin is approximately 600 mm, it can be seen that maxima of 300 mm and above will cause "RATIOs" of 0.5 and above. It can be evaluated that the contribution of monthly maximum precipitation to the high amount of total precipitation occurring during the year will be large. If we give examples of extremes; it can be seen that 45%, 68% and 50% of the total annual precipitation exceeding 1000 mm in 1968, 2000 and 2018 occurred within a month. Abundant annual precipitation with low "RATIOS" (blue) is desirable and indicates that precipitation occurs more regularly throughout the year. The long-term average of "RATIOs" for Mersin is calculated as 0.31, and it can be said that the number of years with "RATIOs" of 0.4 and above is also considerable. Similar analyses were conducted for Anamur, Silifke and Mut.

Figure 9.13: Annual maximum precipitation data for Mersin province

It is seen that the long-term (1948-2022) average of the "RATIO" of Anamur monthly maximum precipitation to total annual precipitation is 0.31; however, in some years, the ratios can exceed 0.35, even up to 0.6. For example, for the years 1974, 1991 and 2022, the "RATIOs" reached approximately 0.5, 0.55 and 0.6, and 425 mm, 440 mm and 460 mm of the total precipitation of approximately 950 mm, 800 mm and 770 mm, respectively, occurred within a mnth. For Silifke and Mut districts, the average of these "RATIOs" is around 0.32-0.31, similar to Anamur, and in some rare years the "RATIOS" exceed 0.4. Considering that the largest contribution to the total annual precipitation is the precipitation that occurs in the winter season, examining the deviations of the average precipitation in the winter season from the long-term averages will further clarify the regularity-irregularity of precipitation discussed above. Figure 9.14 shows the deviations of winter precipitation totals from the mean for these four districts. For Mersin (red), which has an average annual precipitation value of approximately 600 mm, deviations take extreme values for many years, exceeding 300 and even 400 mm. Compared to Mersin, the frequency of extreme positive oscillations for Anamur district is less frequent and their severity is more limited considering that the total annual average precipitation value is around 1000 mm. For Silifke, the frequency is high but the severity is lower than in Mersin, and for Mut, both the frequency and severity of positive deviations are low. In the light of these data, in general, it can be said that Anamur, Silifke and Mut receive relatively more regular precipitation than Mersin Akdeniz.

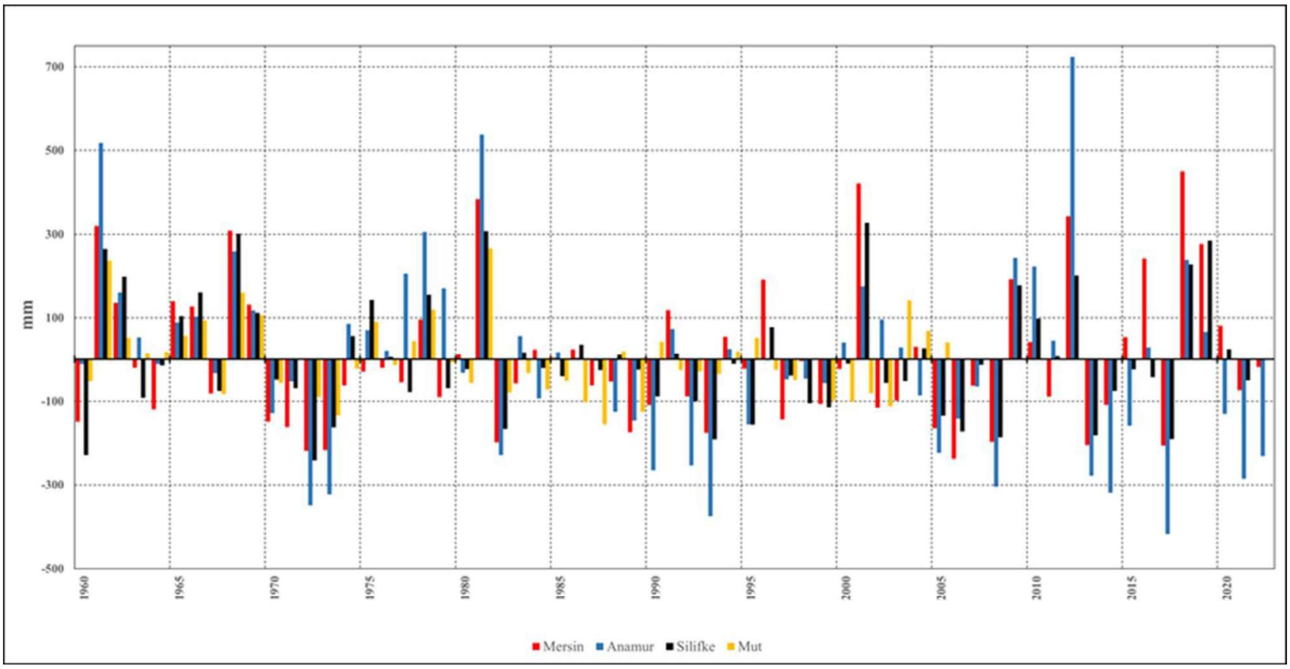


Figure 9.14: Deviations of winter precipitation totals of four districts from the mean

9.1.3 Sea Surface Temperature

According to the long-term data of the Mediterranean Sea between 1940 and 2015, annual mean sea surface temperature change and anomaly values compared to the reference period of 1940-1970 are given between Figure 9.15 and Figure 9.18. Sea surface temperature in the Mediterranean Sea increased in all seasons compared to the reference period.

ERA 5 re-analyses were used to analyze the changes in sea surface temperatures for Mersin province. ERA 5 is a climate dataset developed by the European Joint Research Center (ECMWF). The re-analyses data sets are suitable for analyzing weather and climate phenomena around the world. ERA 5 provides high resolution (0.25º) data over a wide time span (from 1979 to the present) of various parameters such as atmosphere, sea surface and ice cover. The spatial distribution of the model calculation points for the Mersin assessment is given in Figure 9.19. The temporal variation of sea surface temperature at these points is given in Figure 9.20. The sea surface temperature trend of the province was estimated by applying an analysis in which model outputs are an independent variable and years are a dependent variable. The annual average sea surface temperature slope indicates an increase at all points.

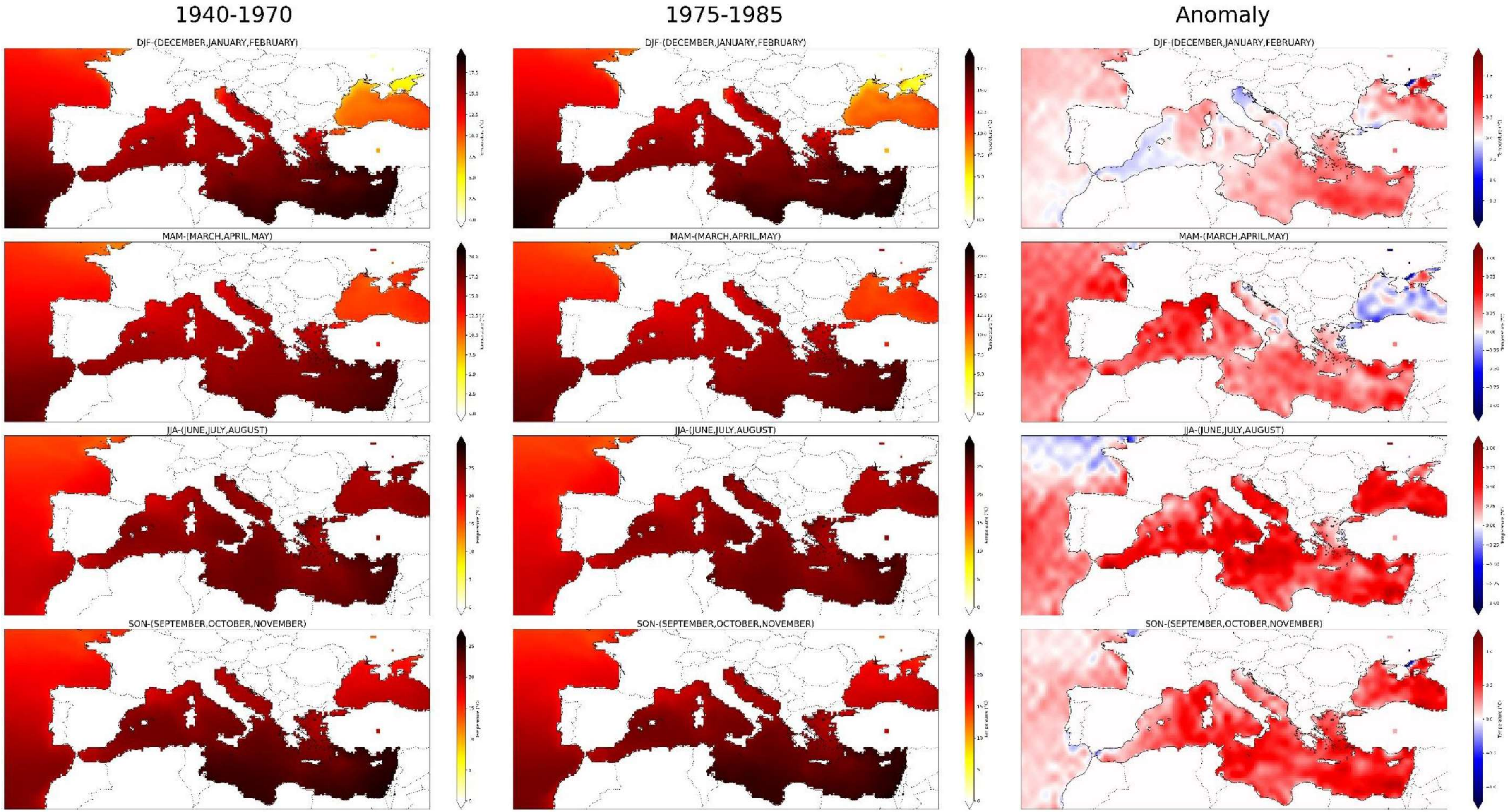


Figure 9.15: Mediterranean SST change between 1975-1985 (Ref: 1940-1970)

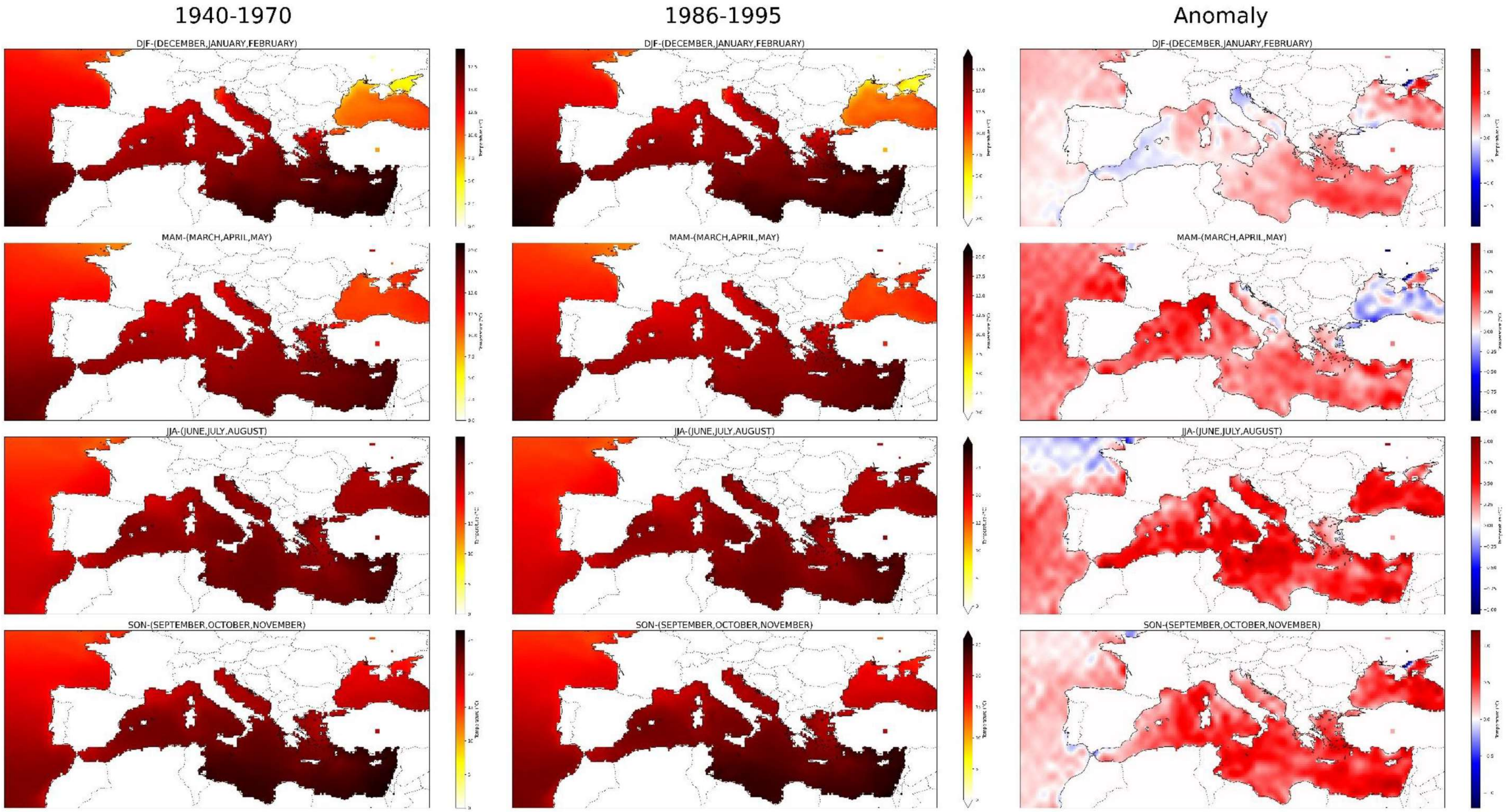


Figure 9.16: Mediterranean SST change between 1986-1995 (Ref: 1940-1970)

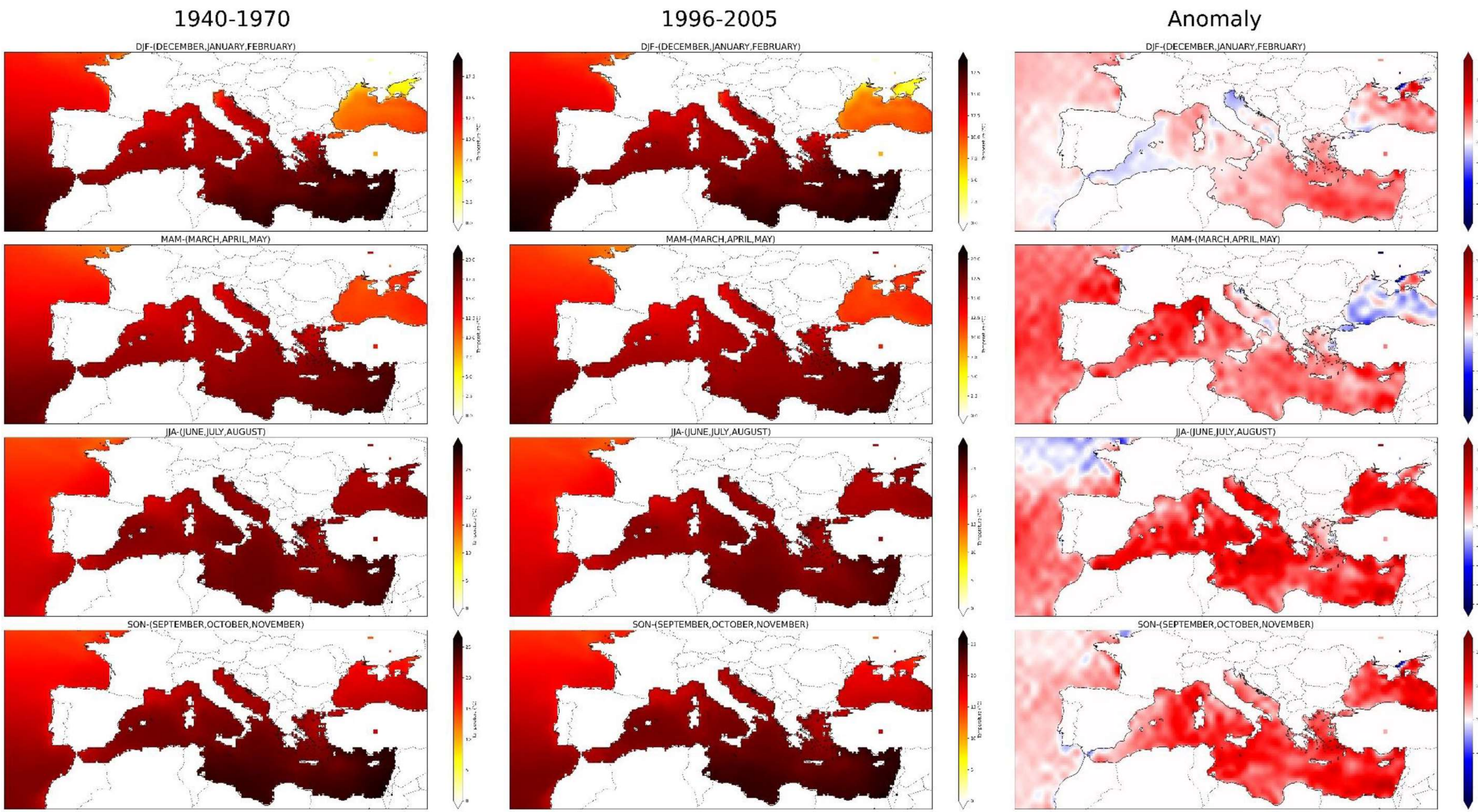


Figure 9.17: Mediterranean SST change between 1996-2005 (Ref: 1940-1970)

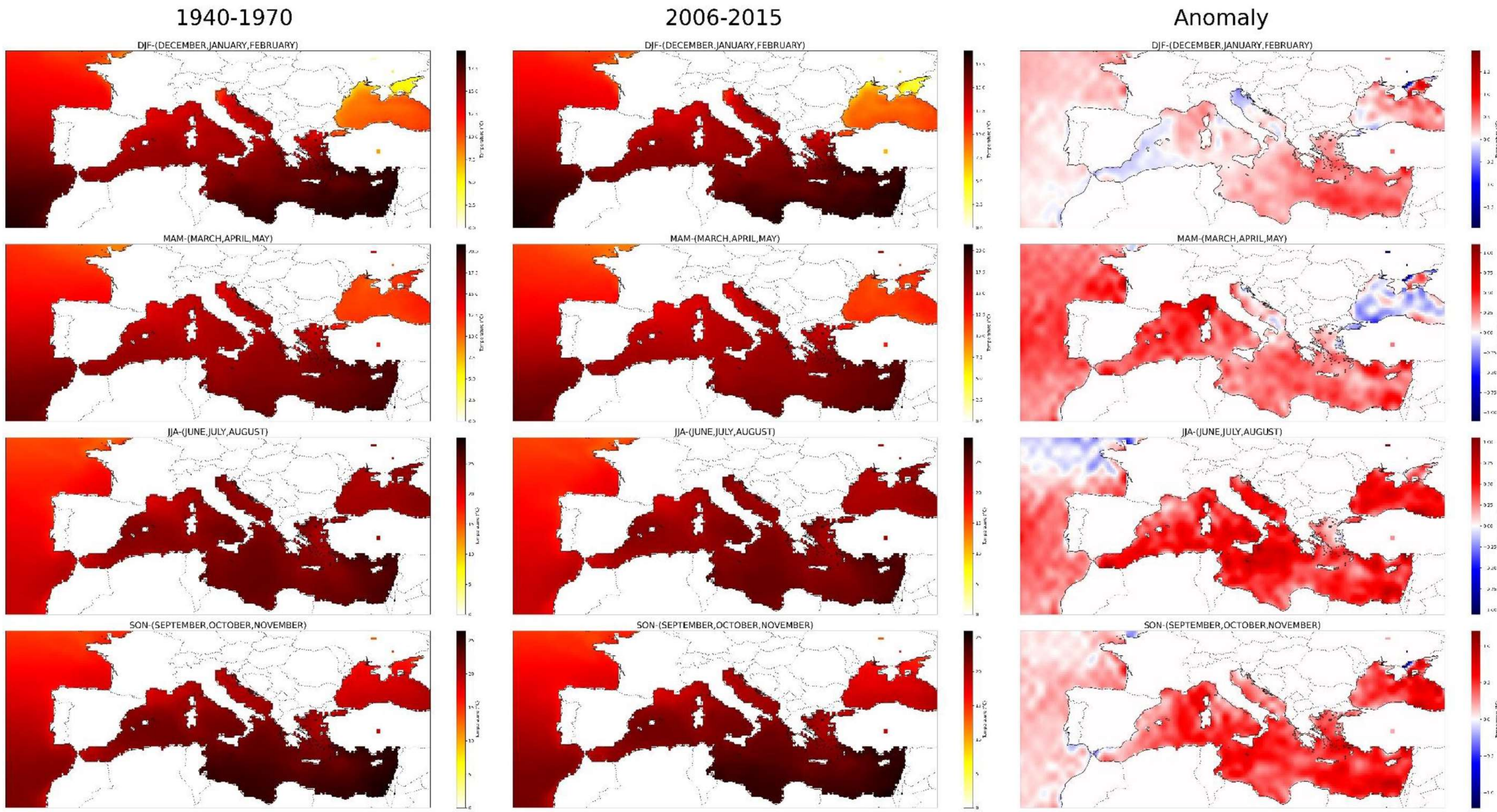


Figure 9.18: Mediterranean SST change between 2005-2015 (Ref: 1940-1970)

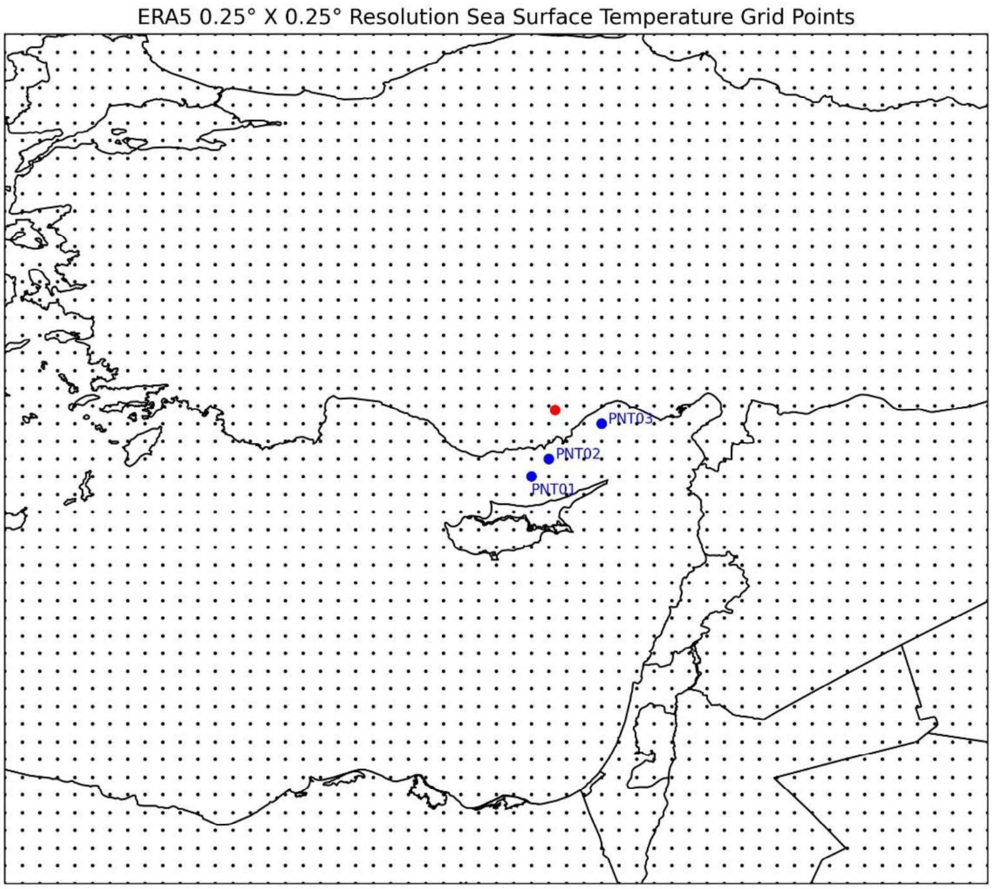


Figure 9.19: ERA5 Model calculation points selected for Mersin

Figure 9.20: Sea surface temperatures at the determined grid points

9.1.4 Extreme Events

Determining the characteristics of long-term past meteorological extreme events (such as type, frequency, duration and severity) is important in determining the adaptation measures of the sectors operating in Mersin province against climate change and taking the necessary measures and minimizing the loss of life and property of the people in the region. In this context, the change in the frequency of hail, floods, storms, meteorological frost, drought, lightning strikes, tornadoes, landslides and forest fires over time, obtained from MGM and covering the years 1975-2021, was analyzed. Figure 9.21 shows the change in the number of extreme events over time. It can be seen that most of these incidents were rare until the 2000s. It is seen that the number of hail, flood and storm events remained low until the 2000s and has been increasing since the 2000s, with a rapid increase especially between 2018-2021. Although tornadoes were reported only 4 times until 2010, they occurred approximately 40 times between 2011 and 2021. Hail and flood events have also been on the rise since the 2000s and have accelerated further since 2018. In general, it can be seen that there has been a noticeable increase in all extreme events since the 2000s and that these increases have accelerated even more in 2018.

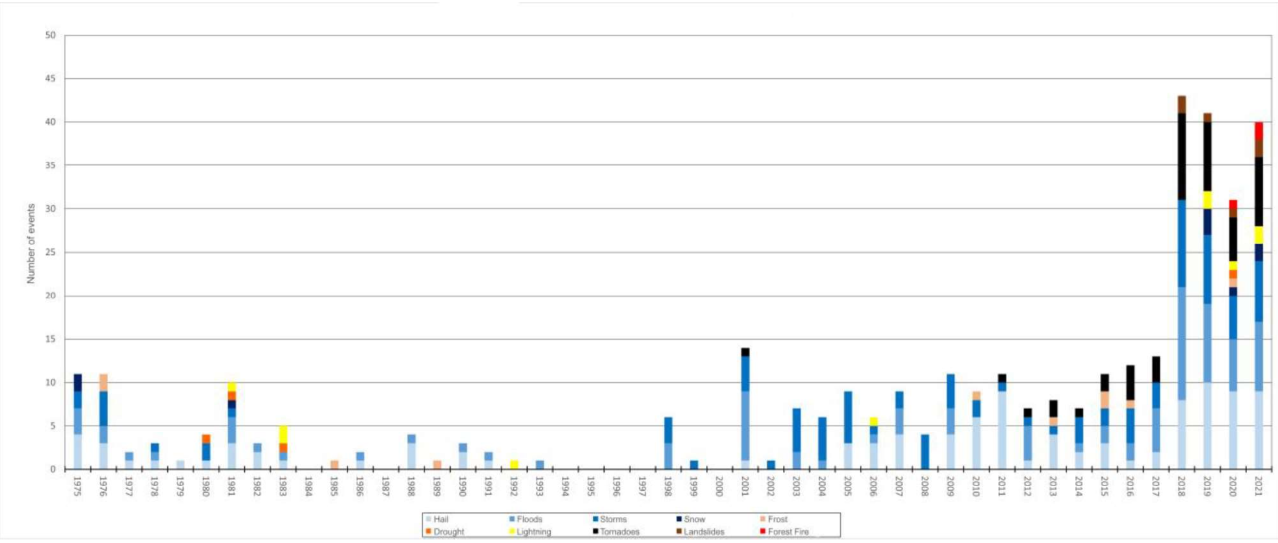


Figure 9.21: Extreme weather events occurring across Mersin

9.2. Analysis of Climate Projections

9.2.1 Changes in Major Climate Parameters

Global Circulation or Climate Models are developed by the IPCC to determine the extent and possible impacts of anthropogenic-induced climate change and scenarios are produced and their results are compared. These scenarios are constructed from optimistic scenarios with low emissions to pessimistic scenarios with high emissions and are named RCP2.6, RCP 4.5, RCP 6.0 and RCP 8.5. Within the scope of the "Strengthening Climate Change Adaptation Action in Turkey Project", climate projections were carried out for the Mediterranean Region using HADGEM-2 ES, MPI-ESM-MR and CNRM-CM5.1 climate model (SYGM, 2016; MoEUCC, 2020).

Within the scope of RCP 4.5 Scenario, HADGEM-2 ES Climate Model projected that the average temperature of the region, which was 12.8 °C between 1971-2000, will increase by 1.9 °C in 2021-2040, 2.4 °C between 2041-2060, 3 °C in 2080 and 3.3 °C in 2100. According to the MPI-ESM-MR model, the average temperature increase will be 1.2 °C in 2040 and will reach 1.8 °C in 2100. The CNRM-CM5.1 climate model predicts an increase in the average temperature of the Mediterranean Region by 0.9 °C in 2040, 1.3 °C in 2060 and 2.2 °C in 2100. According to the RCP 8.5 Scenario, which is the pessimistic scenario, HADGEM-2 ES Climate model predicts that the temperature of the region will increase by 2 °C in 2040 and 5.5 °C in 2100. The MPI model predicts a 4.2°C increase towards 2100, while the CNRM model outputs predict increases above 4°C by the end of the century.

According to the HADGEM-2 ES Climate model within the scope of the RCP 4.5 Scenario, the Mediterranean Region, which had a total annual precipitation value of 660.9 mm between 1971-2000, is calculated to decrease by 6.3% in 2021-2040, 5.6% between 2041-2060, 14.1% in 2080 and 14.6% in 2100. The MPI-ESM-MR model predicts that total precipitation will decrease by 11.8% in 2040 and 11.6% in 2100. The CNRM-CM5.1 climate model calculates that the precipitation change in the basin will be 3% in 2040, 4.3% in 2080 and 8% in 2100. According to the pessimistic RCP 8.5 Scenario, the HADGEM-2 ES Climate model predicts that the basin precipitation will decrease by 1% in 2040 and 16.4% in 2100. While the MPI model calculates a very significant decrease of 25.7% towards 2100, the CNRM model outputs indicate that precipitation will decrease by 10.8% in the basin by the end of the century. Both scenarios and all three models for the Mediterranean Region predict a significant decrease in precipitation; however, the decrease in the RCP8.5 scenario is much more drastic than in the RCP4.5 scenario.

In addition, within the scope of IPCC studies, climate projections are made with 40 different global climate models in the CMIP5 (Fifth Coupled Model Intercomparison Project) experiment. In this study, RCP2.6, RCP4.5, RCP6.0 and RCP8.5 scenarios for Mersin and the average of the projections obtained from the CMIP5 experiment were used.

For the climate projection analysis of Mersin province, projections for the years 1900-2100 were evaluated and climate projections were given for the parameters of average temperature (°C) and average annual precipitation (mm/day). Temperature data for all scenarios show an increase since 2000 (Figure 9.22).

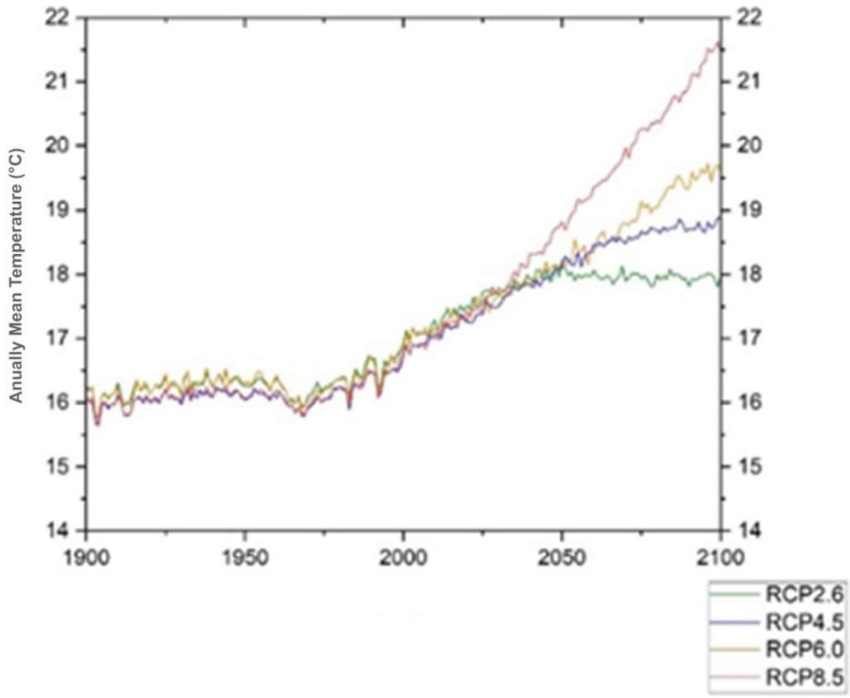


Figure 9.22: Average temperature change between 1900-2100 in Mersin province (°C)

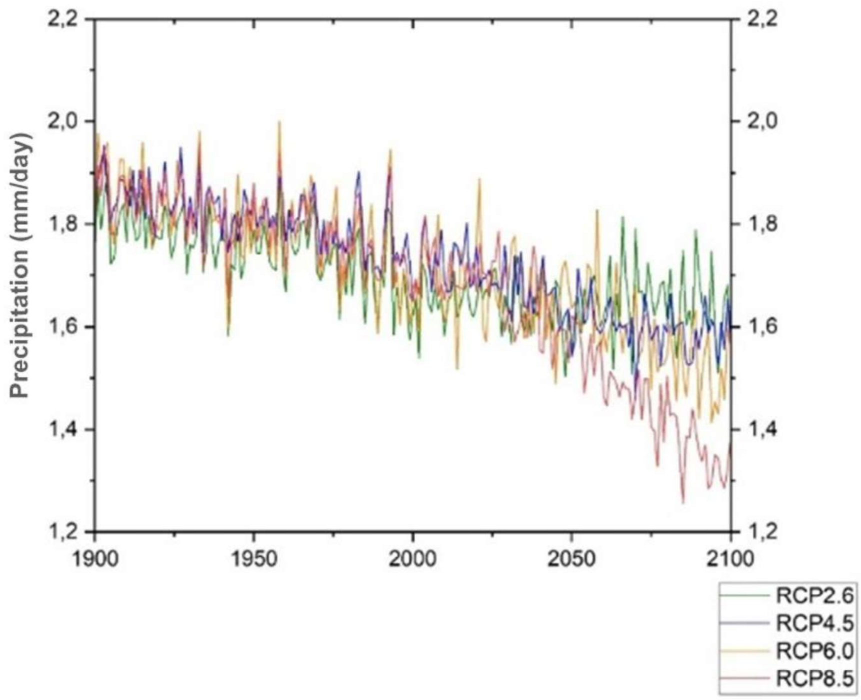


Figure 9.23: Annual average precipitation change between 1900-2100 in Mersin province (mm/day)

According to the model results, a decrease in average annual precipitation is predicted for all scenarios (Figure 9.23).

Climate projections with a resolution of 0.2º-0.2º (~ 20 km horizontal resolution) within the scope of the "Turkey Climate Projections and Climate Change with New Scenarios - TR2015-CC, 2015" project carried out by the General Directorate of Meteorology in 2015 were used in the analysis. HadGEM2-ES, MPI-ESM-MR and GFDL-ESM2M global climate models were run using RCP4.5 and RCP8.5 scenarios and temperature and precipitation projections were produced for a period covering 2016-2099. The regional climate model grids within Mersin province and the districts of Akdeniz, Anamur, Mut, Silifke and Tarsus are shown in Figure 9.24. Considering the closest model grid points to these districts, the changes of average temperature and total precipitation values with time depending on three different global models (MPI, HadGEM and GFDL) are analyzed and given in Figure 9.25 - Figure 9.34 for Anamur, Mut, Mersin Akdeniz and Tarsus districts. In some cases, there are significant differences between the models.

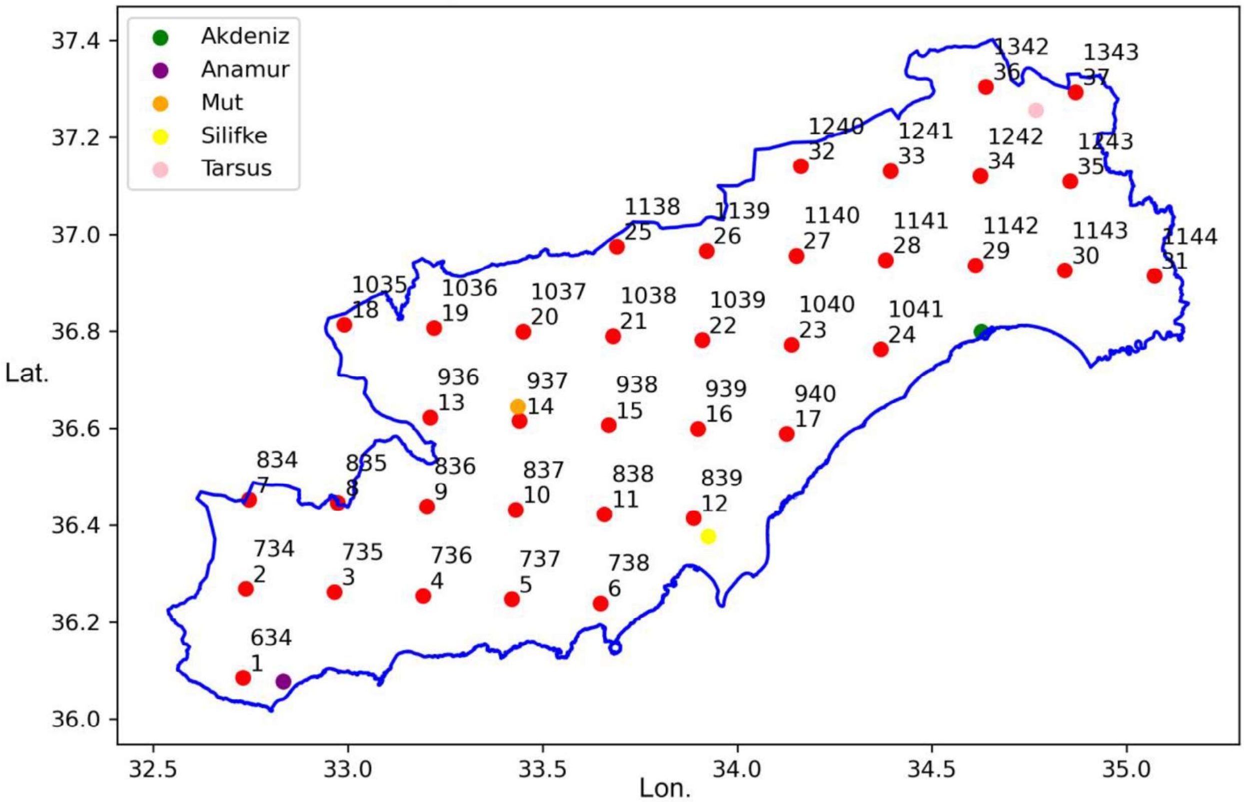


Figure 9.24: Grid points in Mersin province in MGM climate projections

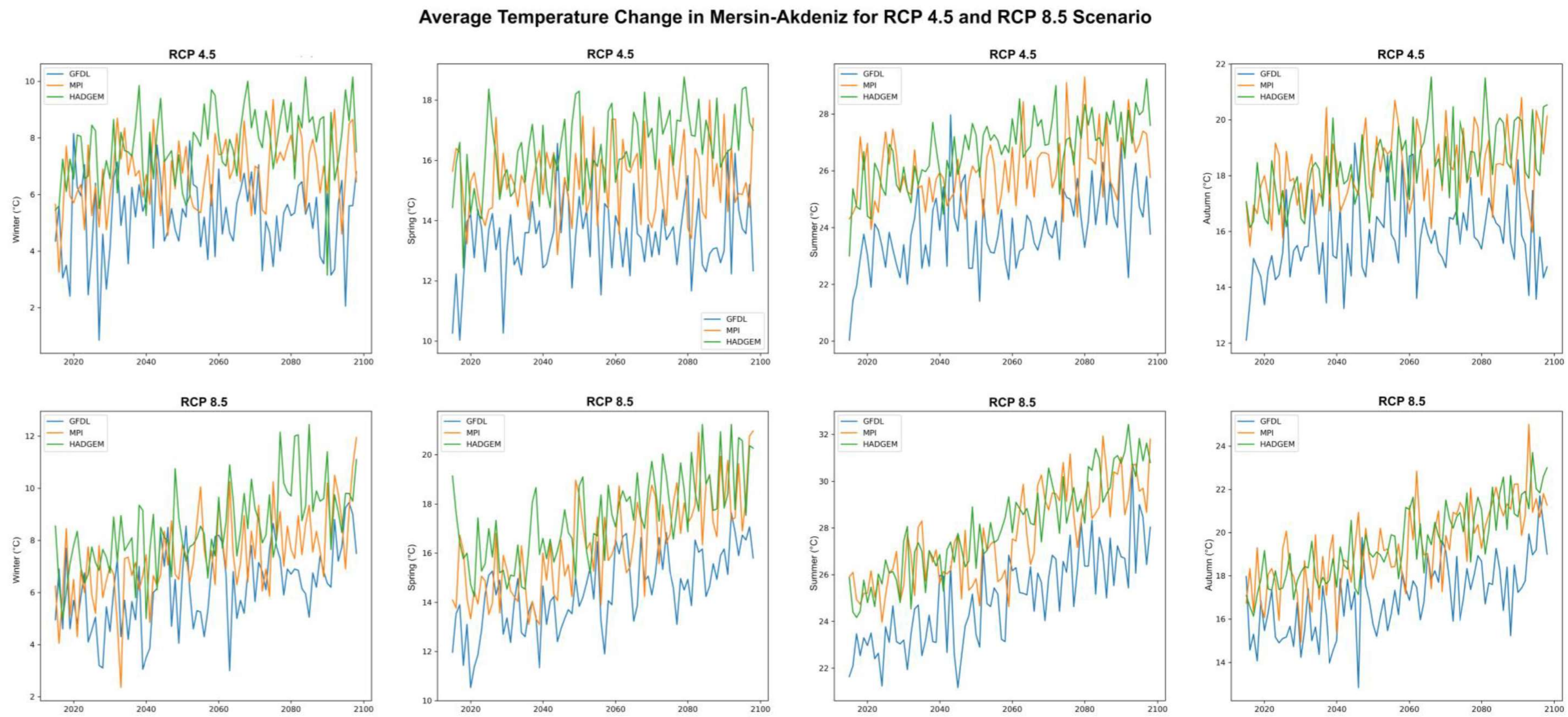


Figure 9.25: Projection of average temperature change in Mersin Akdeniz district (°C)

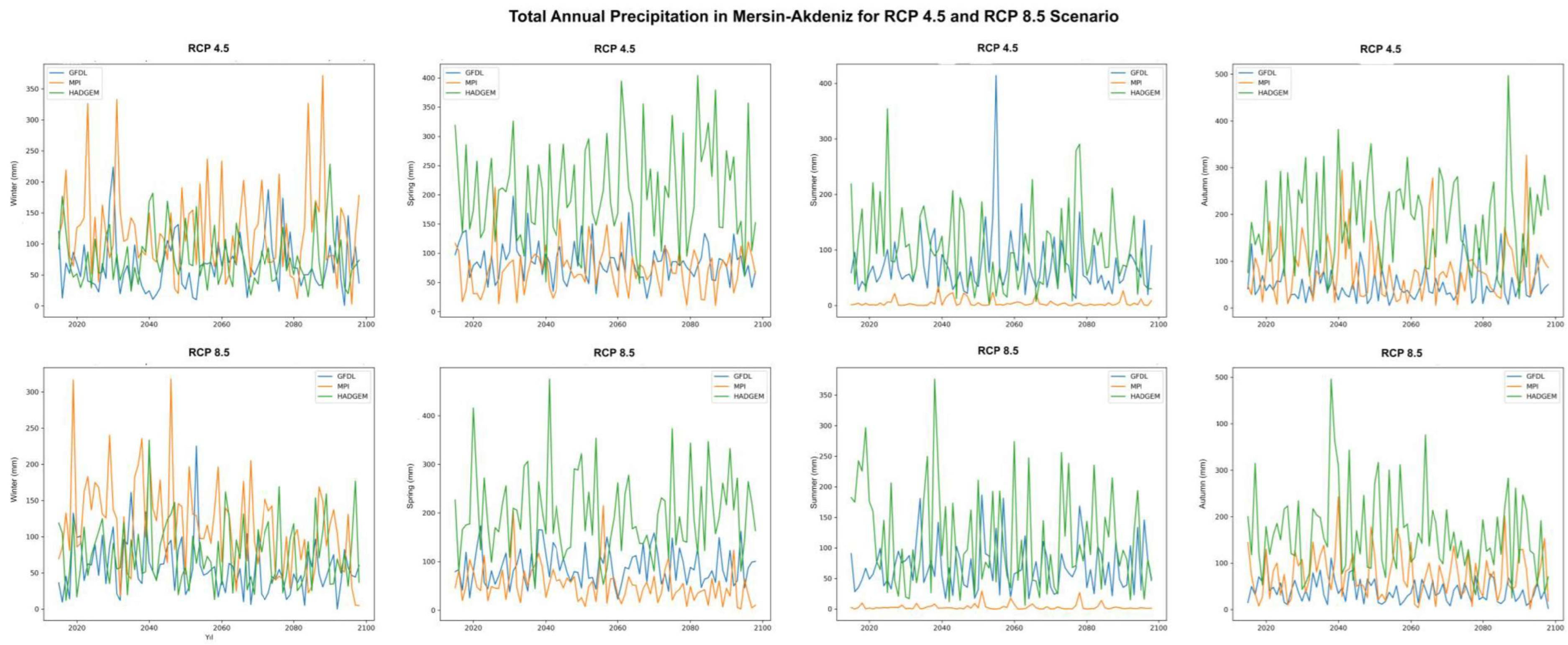


Figure 9.26: Projection of total annual precipitation in Mersin Akdeniz district (mm)

Average Temperature Change in Mersin-Tarsus for RCP 4.5 and RCP 8.5 Scenario

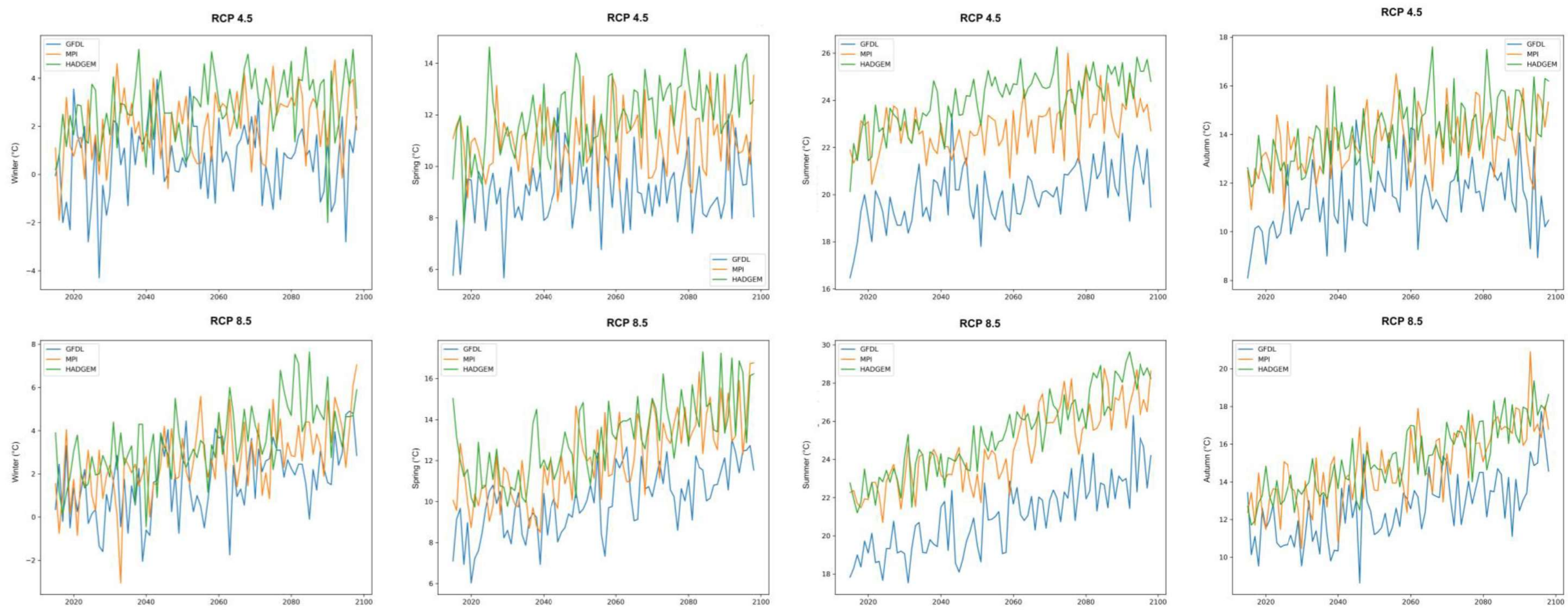


Figure 9.27: Projection of average temperature change in Tarsus district (°C)

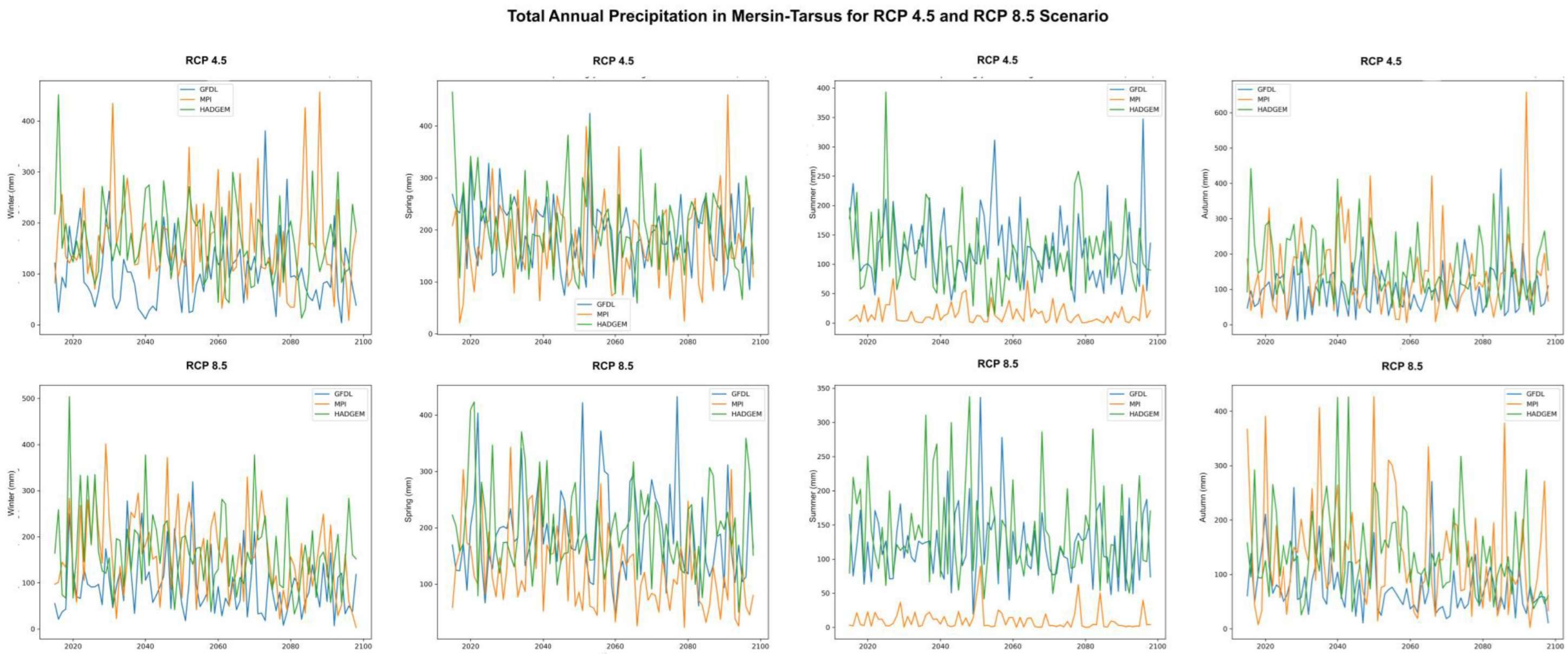


Figure 9.28: Projection of total annual precipitation in Tarsus district (mm)

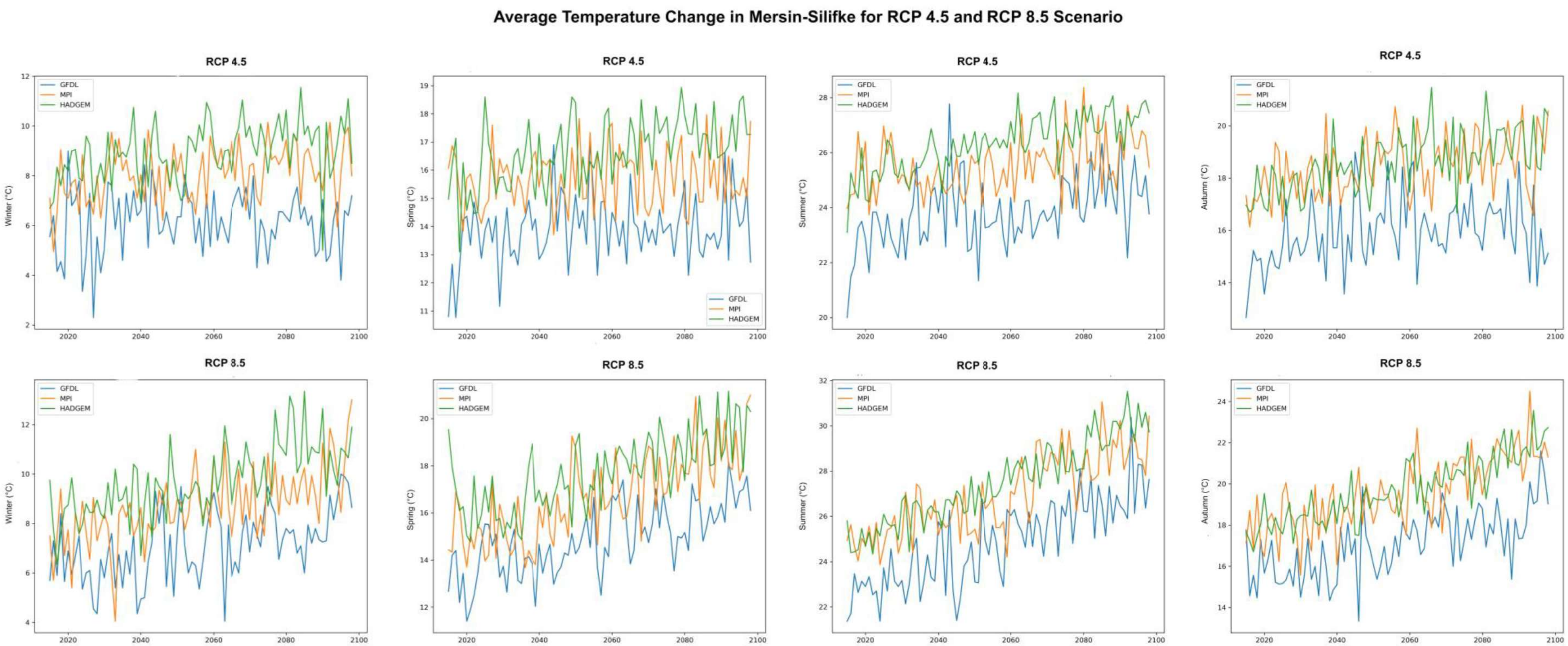


Figure 9.29: Projection of average temperature change in Silifke district (°C)

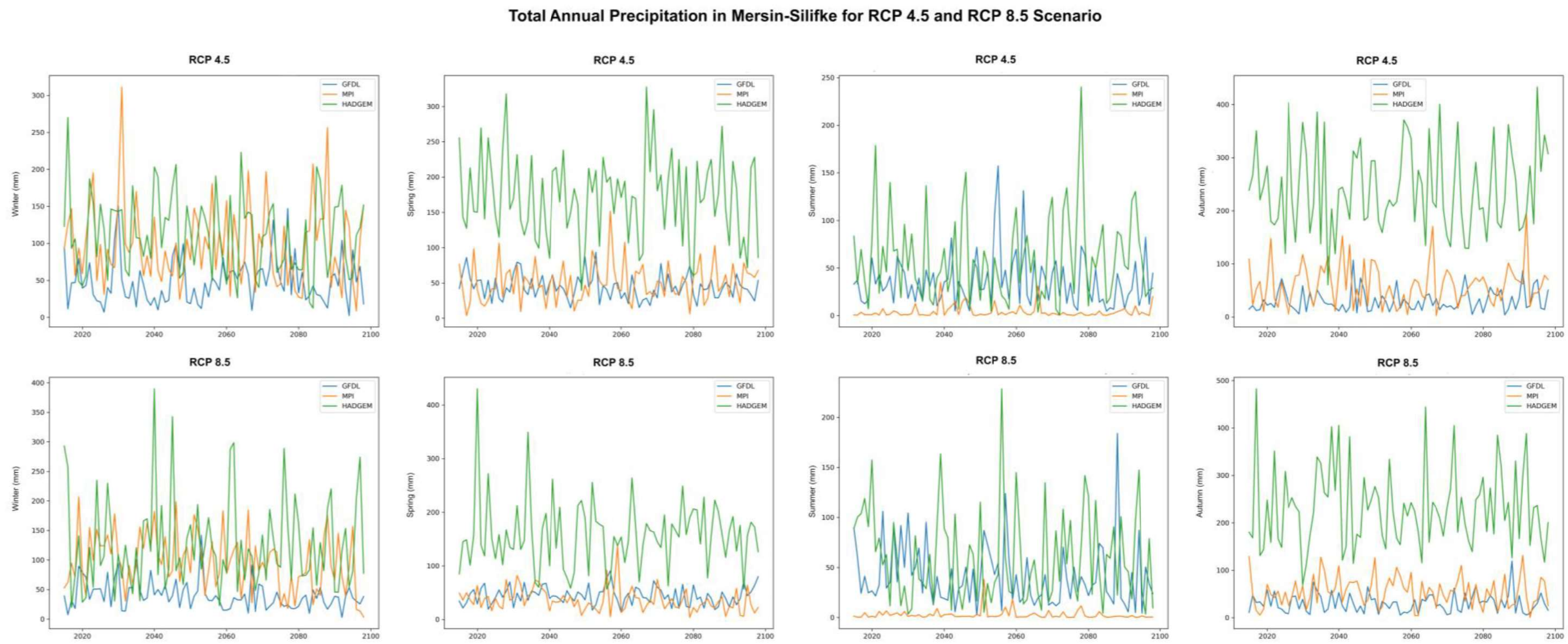


Figure 9.30: Silifke district annual total rainfall projection (mm)

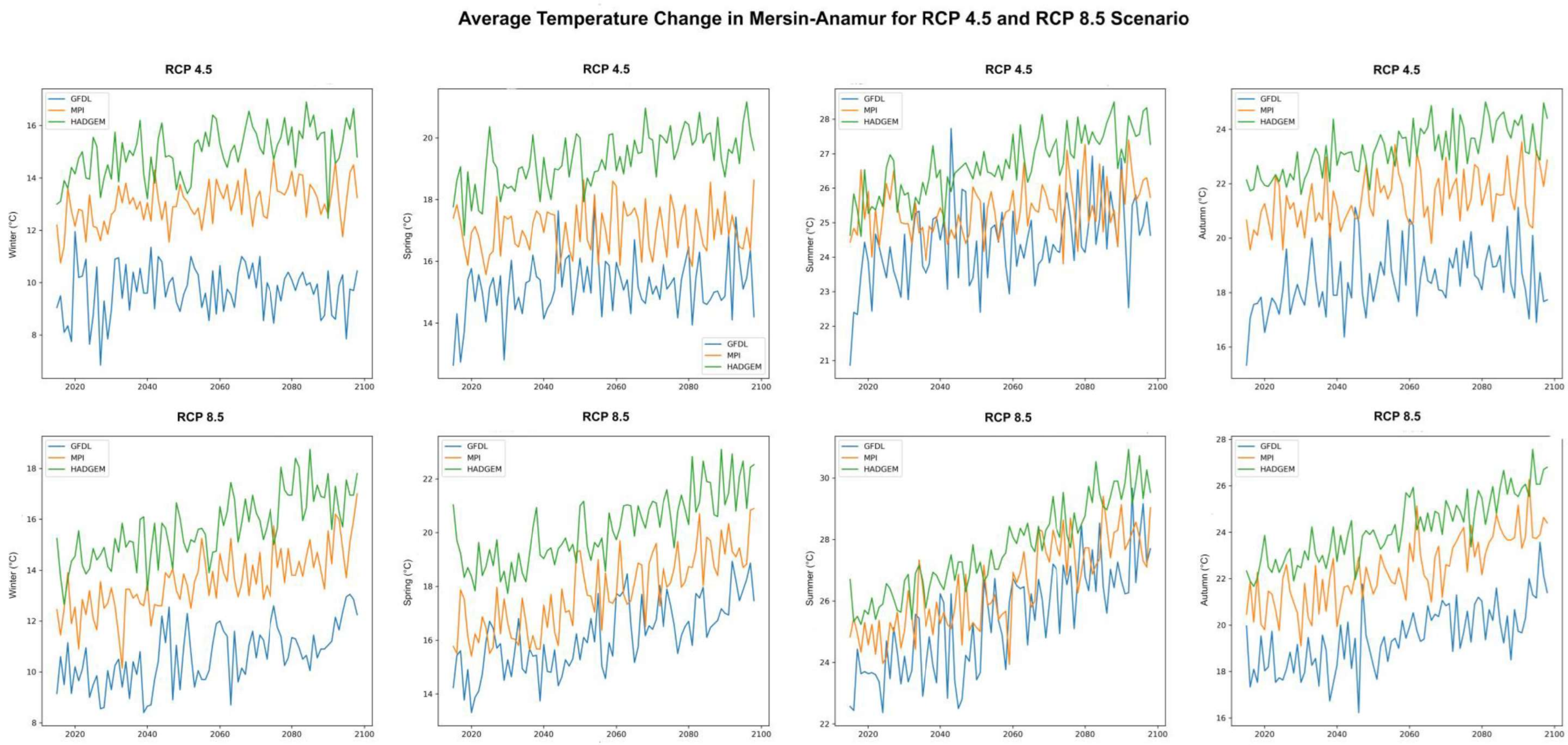


Figure 9.31: Projection of average temperature change in Anamur district (°C)

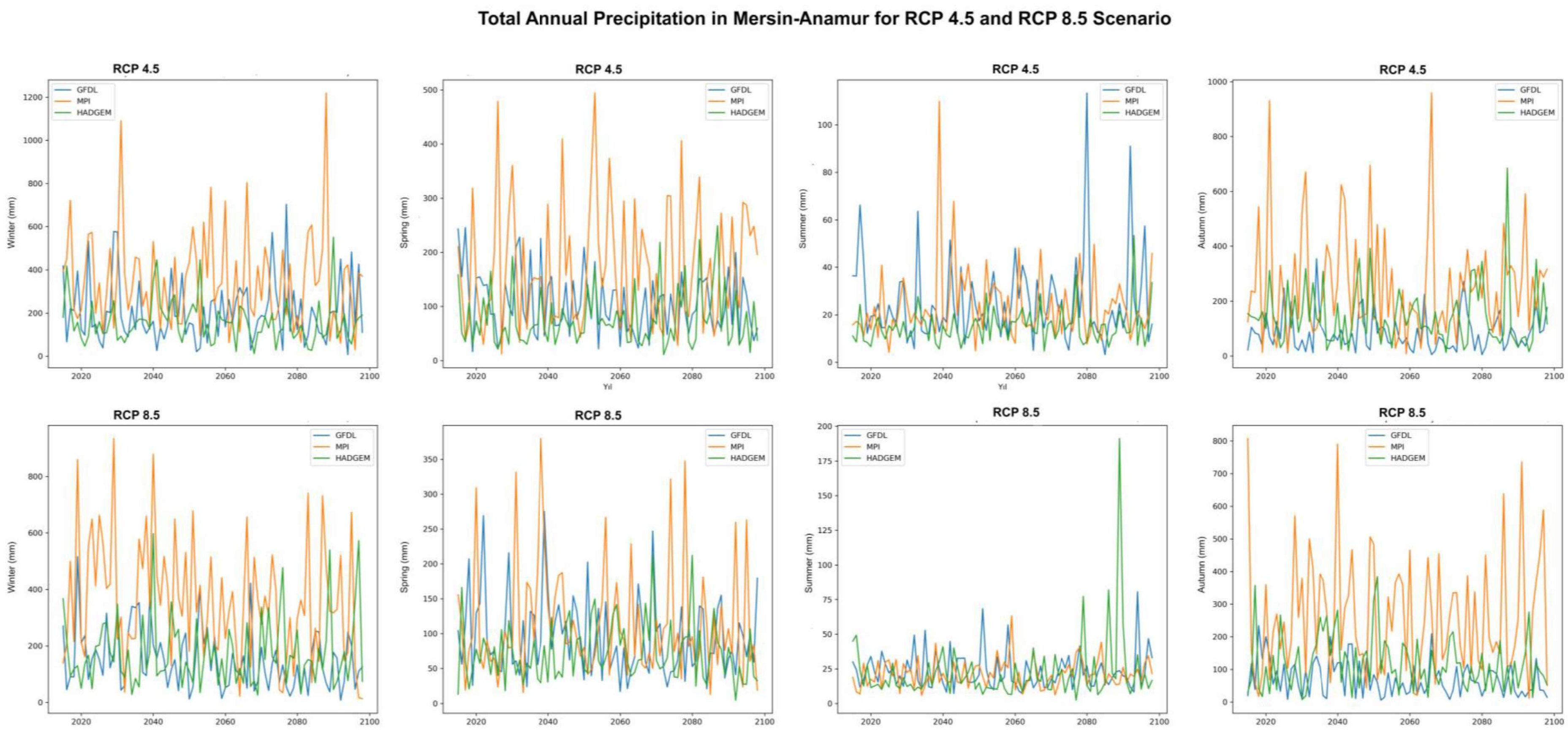


Figure 9.32: Projection of total annual rainfall in Anamur district (mm)

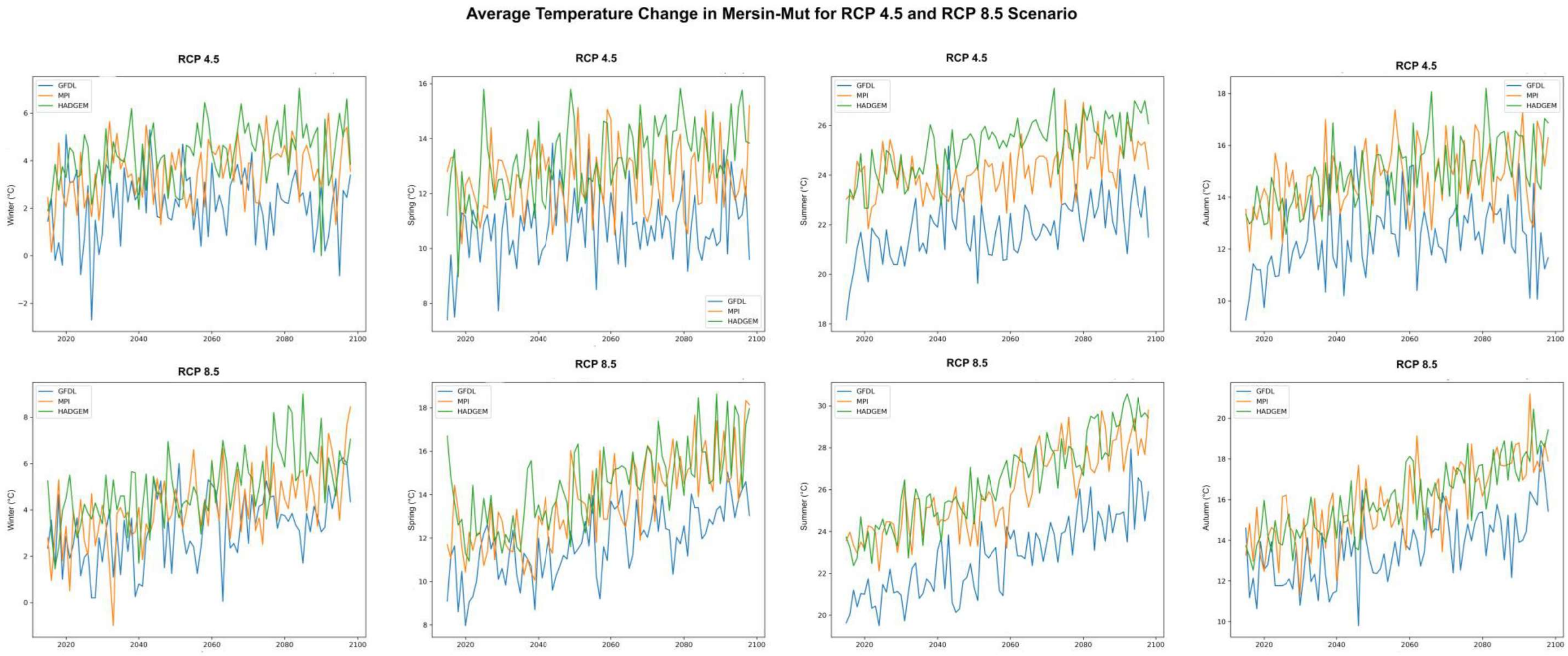


Figure 9.33: Projection of average temperature change in Mut district (°C)

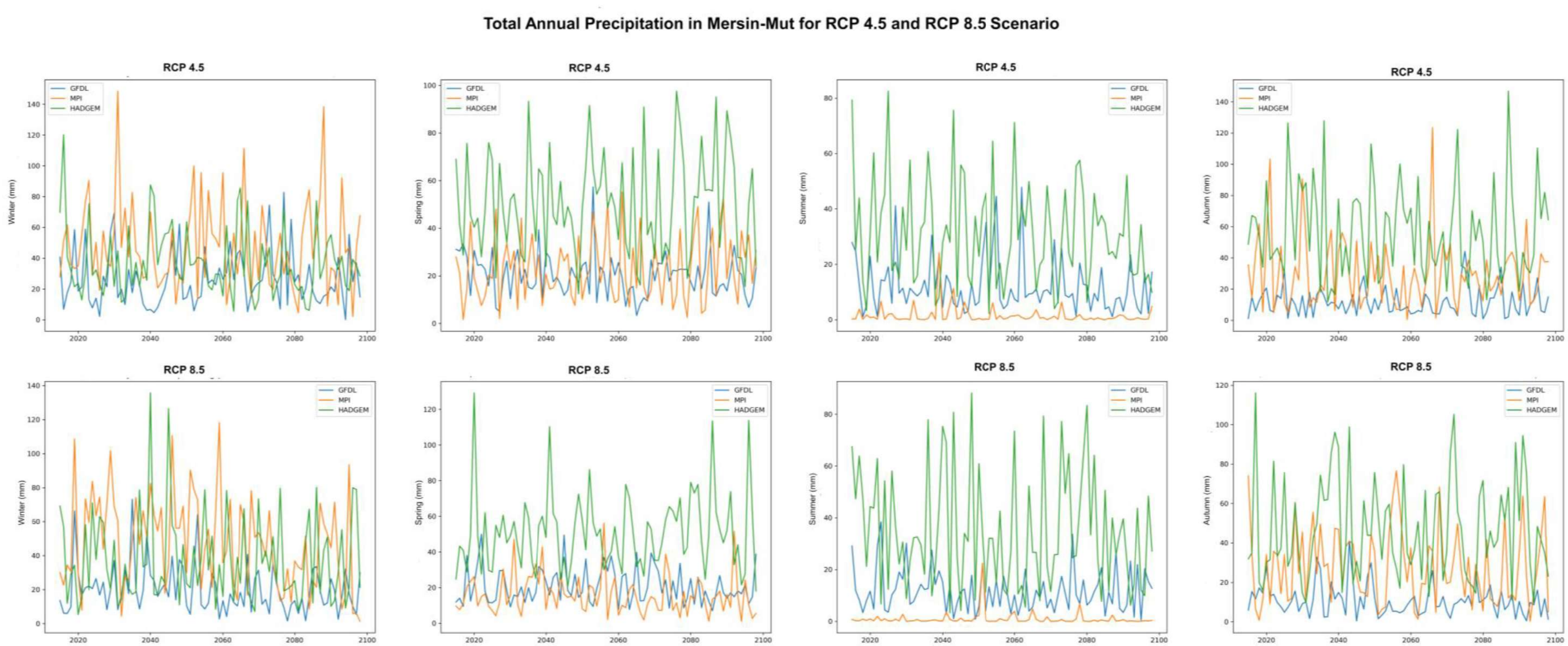


Figure 9.34: Mut district annual total rainfall projection (mm)

For Mersin Akdeniz, all 3 models predict significant increases in temperatures by 2100. According to the RCP8.5 scenario, this increase is projected to be about 4 C° for the Akdeniz winter, 4-6 C° for spring, 4-6 C° for summer and 2-3 C° for fall. In 2020, the winter season temperature will be about 6° C, while in 2100 it will be about 9° C; temperatures of 12-14° C in the spring season will rise to 16-20° C; 22-26° C in the summer season will rise to 28-30° C; and 16-17° C in the fall season will rise to 20-22° C.

According to the projections, there are significant differences in Mersin and Tarsus temperatures. Projections show that Tarsus will have lower temperatures than Mersin Akdeniz. Temperatures in 2020 are projected to increase from about 1-2° C in winter to about 2-4° C in 2100; spring temperatures of 9-11° C will increase to about 11-14° C; summer temperatures of 19-22° C will reach 24-28° C; and fall temperatures of 11-13° C will reach 14-16° C.

Anamur 2020 winter temperatures are approximately 10° C, 12° C and 14° C, taking into account the differences between the models, and towards 2100, temperatures will increase to 12° C, 14° C and 17° C; spring 14° C, 16° C and 19° C to 17° C, 18° C and 21° C; summer 24° C and 25° C to 27° and 30° C; and fall 18° C, 20° C and 22° C to 20° C, 24° C and 26° C. For each model, temperature increases between 2020-2100 are projected to be about 2 C°, 2 C°, 3 - 5 C° and 2 - 6 C° for winter, spring, summer and fall, respectively.

Since Mut district is located approximately 50 km inland from the coast, it is estimated that the changes in temperature and precipitation will be relatively different compared to other districts. It is expected that Mut will be colder than Akdeniz in all seasons. Winter temperatures of 2020 are projected to increase from 2 – 3° C to 4 – 6° C, spring temperatures from 11 – 12° C to 12 – 16° C, summer temperatures from 20 – 24° C to 24 – 28° C and fall temperatures from 12° C – 14° C to 16° – 18° C. Seasonal temperature increases are projected to be in the range of 2 – 3° C, 1 – 4° C, 4° C and 4° C for winter, spring, summer and autumn, respectively.

Looking at the projections of the seasonal total precipitation for the aforementioned districts of Mersin, it is seen that there are significant differences between the 3 models from time to time. According to all models, it is predicted that there will be a noticeable decrease in precipitation in Mersin Akdeniz district in winter season, while there will be no significant change in terms of decrease or increase trend in spring, summer and fall seasons. Although there are differences between the models, it is predicted that winter precipitation may decrease from 75-150 mm to 50-100 mm.

It is observed that Anamur precipitation will be higher than Mersin Akdeniz in all seasons except summer. According to GFDL-HadGEM and MPI models, it is predicted to vary around 150 mm and 400 mm in winter, 75 mm and 150 mm in spring, 25 mm in summer, and 75 mm and 200 mm in fall, respectively. Total seasonal precipitation shows significant fluctuations between years, with significant differences between models.

It is seen in all models that Mut will receive less precipitation than Mersin and Anamur. Seasonal precipitation does not change much over time. Precipitation in winter, spring, summer and fall seasons is expected to be around 20-60 mm, 20-40 mm, 5-20 mm and 5-40 mm, respectively. It is observed that there are very significant differences in precipitation projections between the models.

Tarsus precipitation is predicted to be higher than Mersin Akdeniz and it is shown that this difference will occur mostly in the winter season. Winter and spring precipitation is expected to decrease slightly over time. Winter precipitation is expected to decrease from approximately 100-250 mm to 75-150 mm. It is seen that spring precipitation will decrease from approximately 150-200 mm to 100-150 mm. In general, there is no significant change in summer and fall precipitation in terms of increasing or decreasing trend. According to MPI, GFDL and HadGEM model outputs, summer precipitation is expected to be around 10-20 mm, 200 mm and 225-250 mm, respectively, while in the fall season it is expected to be around 125 mm, 75 mm and 100 mm, respectively. Changes in precipitation between years in terms of significant increases and decreases should be noted.

9.2.2 Changes in Extreme Climate Parameters

As a result of climate change, it is observed that there is a significant increase in extreme weather events in terms of both severity and duration. Many sectors are directly or indirectly affected by this situation. The most important parameter taken into account during the evaluation of extreme weather events in climate change studies are climate indices used in many different disciplines. For index calculations, a total of 27 basic climate indices related to temperature, precipitation and period have been determined as a result of the joint work of the World Meteorological Organization Climate Commission and Climate and Ocean - Variability, Prediction and Change (CLIVAR). 20 of these indices were taken into account in the study. Within the scope of IPCC studies, climate projections are made with 40 different global climate models in the CMIP5 (Fifth Coupled Model Intercomparison Project) experiment. In this study, RCP4.5, RCP6.0 and RCP8.5 scenarios for Mersin and the average of the projections obtained from the CMIP5 experiment were used. The average results of the models run as Ensemble are analyzed for 20 extreme climate parameters for Mersin (Mersin Akdeniz and Anamur districts). Although the resolution of the models is relatively low (1º and 2.5º), the fact that the projections are obtained by running about 15 to 25 models together is very valuable. Figure 9.35 shows the CMIP5 grid points (red) and the locations of Anamur, Silifke, Mut, Akdeniz and Tarsus districts (blue). Projections of extreme climate parameters for Mersin Center and Anamur districts were calculated.

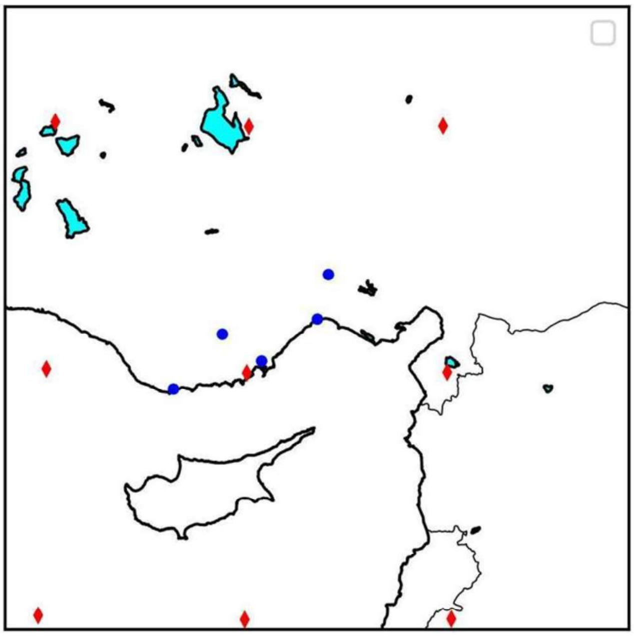
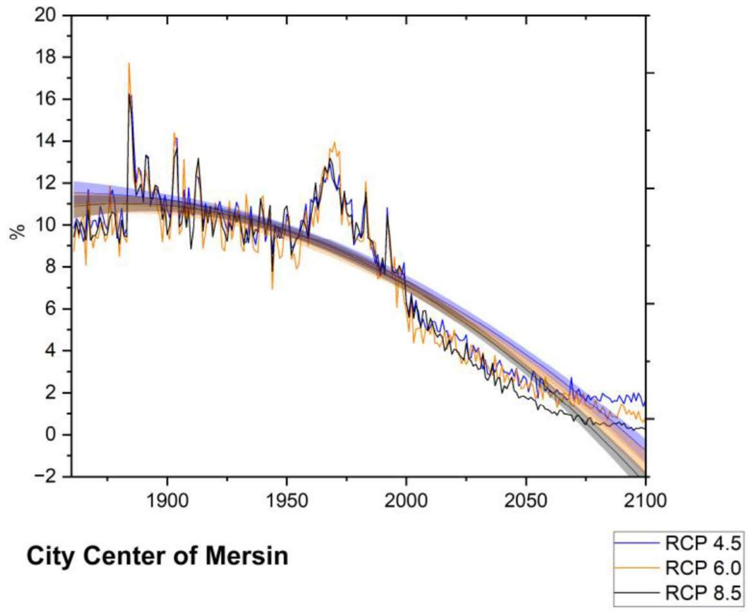


Figure 9.35: CMIP5 Grid points (red)

Cool Days (days when Tmax < 10% of normal)

The indicator, which is the percentage expression of the number of days when the daily maximum temperature is within the 10th percentile, refers to the cold extreme. According to the outputs of the ensemble of 24 models (Figure 9.36), while the indicator was 8% in the early 2000s, it is predicted to decrease to 2% and 0% in the RCP4.5 and RCP8.5 cases towards the end of the 21st century.



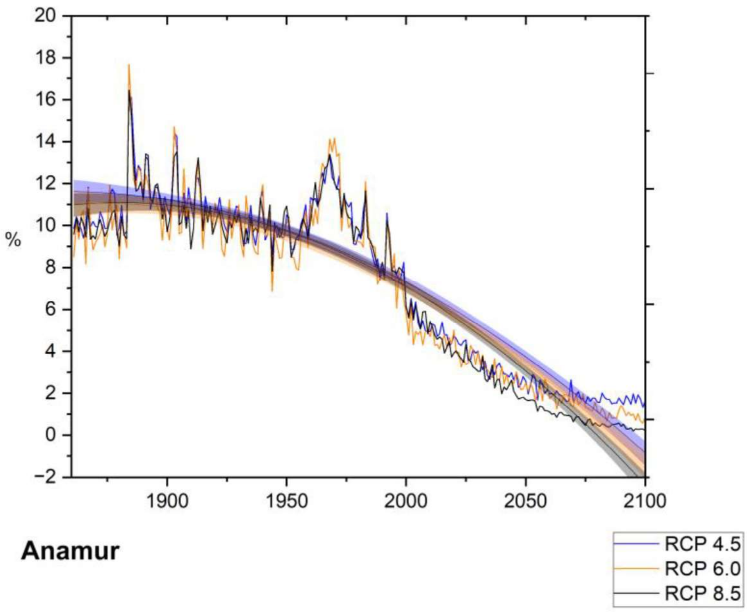
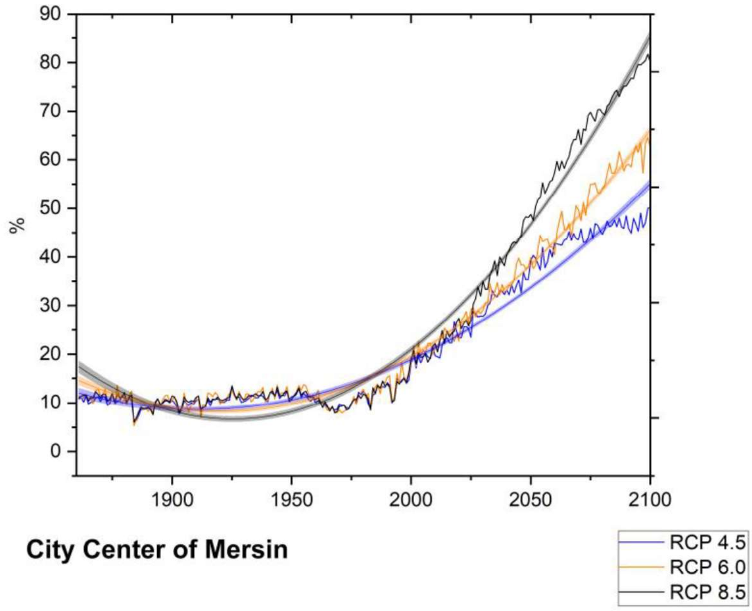


Figure 9.36: Change in cool days in Mersin between 1900-2100 (%)

Warm days (Tmax > 90% of normal)

The Hot Days indicator, which refers to the number of days when the daily maximum temperature is above the 90th percentile, represents hot extremes, and according to the ensemble model projections consisting of 24 models (Figure 9.37), the indicator, which was 14% at the beginning of the 2000s, is projected to increase rapidly towards the end of the century, reaching 47%, 63% and 80% at RCP4.5, RCP6.0 and RCP8.5, respectively.



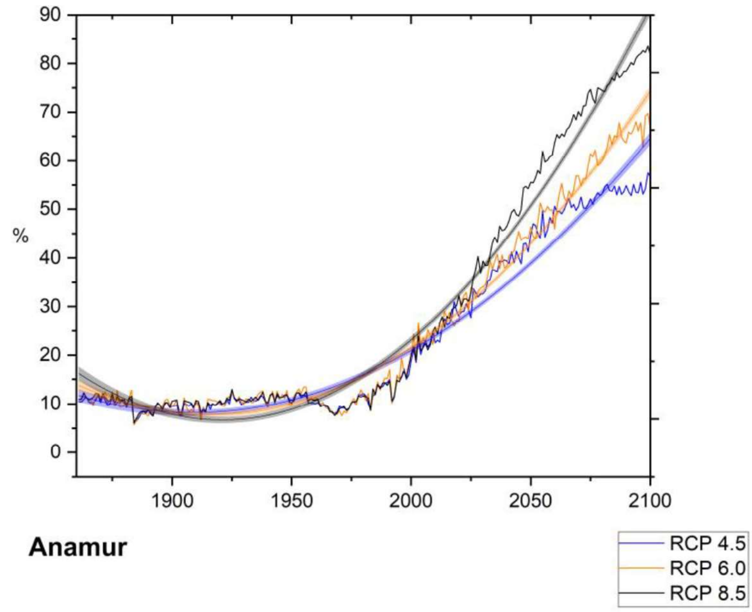
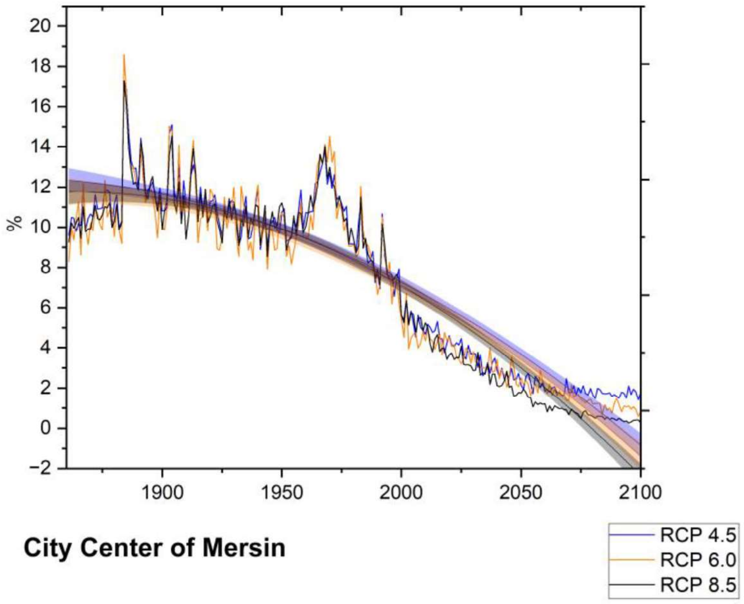


Figure 9.37: Change in hot days between 1900-2100 in Mersin (%)

Cool nights (days when Tmin < 10% of normal)

Percentage of days with daily minimum temperature within the 10th percentile, representing cold extremes. For RCP4.5, RCP6.0 and RCP8.5 scenarios, 25, 15 and 24 different models, respectively, were used to generate ensemble model projections (Figure 9.38). According to indicator projections, cool nights in the early 2000s are around 7%, while by the end of the century the indicator drops to around 1%.



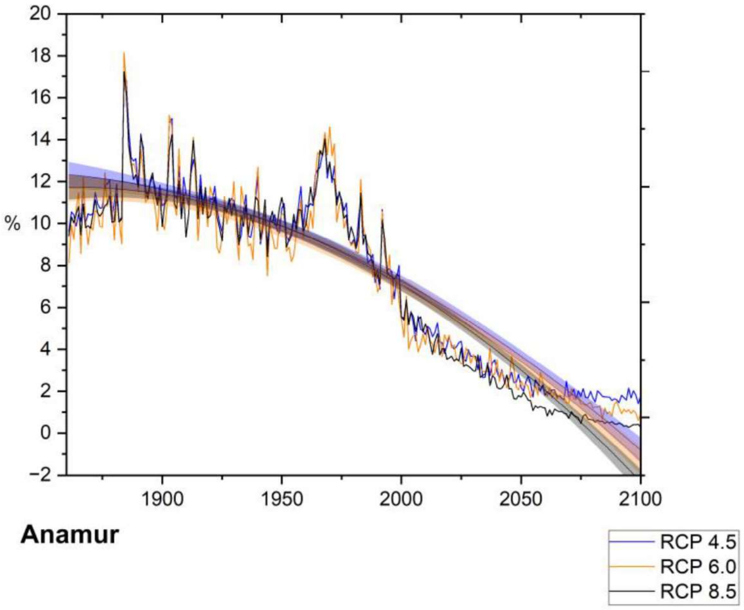


Figure 9.38: Change in cool nights in Mersin between 1900-2100 (%)

Warm nights (days when Tmin > 90% of normal)

The index, expressed as the percentage of days with a daily minimum temperature above the 90th percentile, represents the warm extreme. According to the ensemble model projections consisting of 25, 15 and 24 different models for the RCP4.5, RCP6.0 and RCP8.5 scenarios, respectively (Figure 9.39), the Warm Nights index, which is around 20%, is projected to increase to 55%, 65% and 82% by 2100, respectively, according to the scenarios.

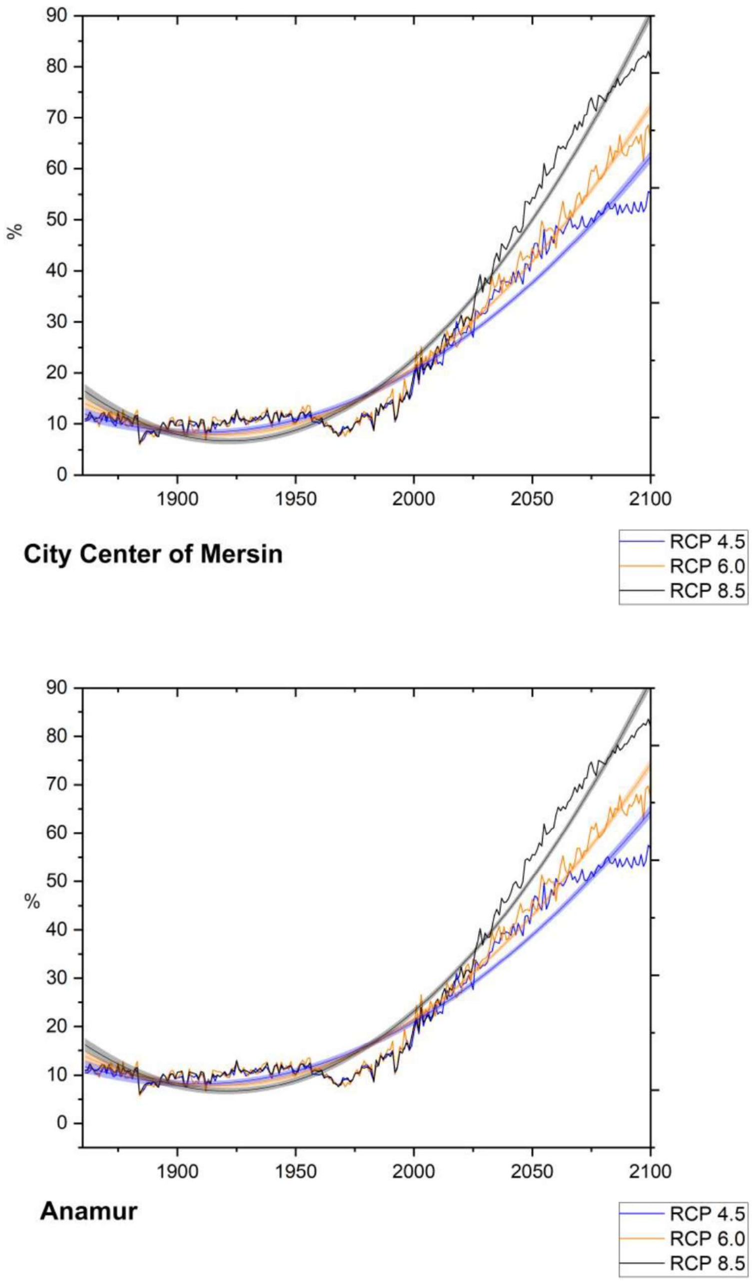


Figure 9.39: Change in warm nights in Mersin between 1900-2100 (%)

Annual Minima of Daily Maximum Temperatures

The indicator, expressed as the annual minima of daily maximum temperatures, has shown relatively close changes in the RCP4.5 and RCP6.0 scenarios, and is projected to increase from 4.2° C in the 2000s to 7° C by the end of the century, according to the ensemble model projections consisting of 25, 15 and 24 different models (Figure 9.40). This value is projected to be about 9° C for RCP8.5.

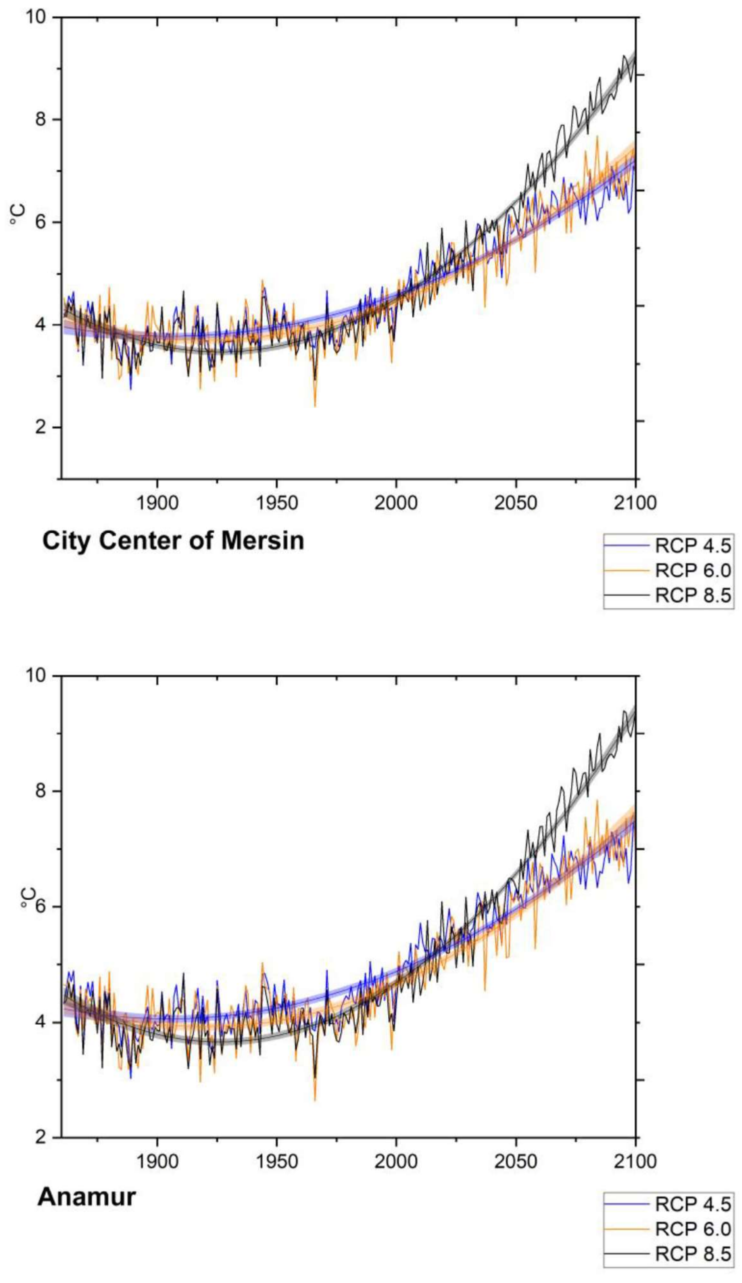
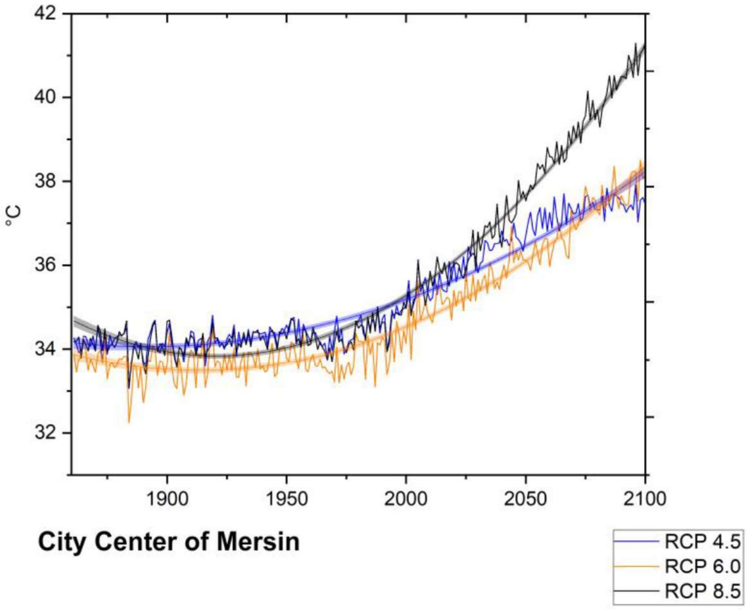


Figure 9.40: Annual minima of daily maximum temperatures between 1900-2100 in Mersin (°C)

Annual Maxima of Daily Maximum Temperatures

Annual maximum of daily maximum temperatures, representing the warmest daily maximum of the year. Ensemble runs consisting of 23 models for RCP4.5, 13 models for RCP6.0 and 3 different models for RCP8.5 were used to generate the projections. According to the projections of the Annual Maximum of Daily Maximum Temperatures indicator (Figure 9.41), the index is projected to increase from about 34.5° C in the early 2000s to 37.8° C for RCP4.5 and RCP6.0 and 41° C for RCP8.5 by the end of the 21st century.



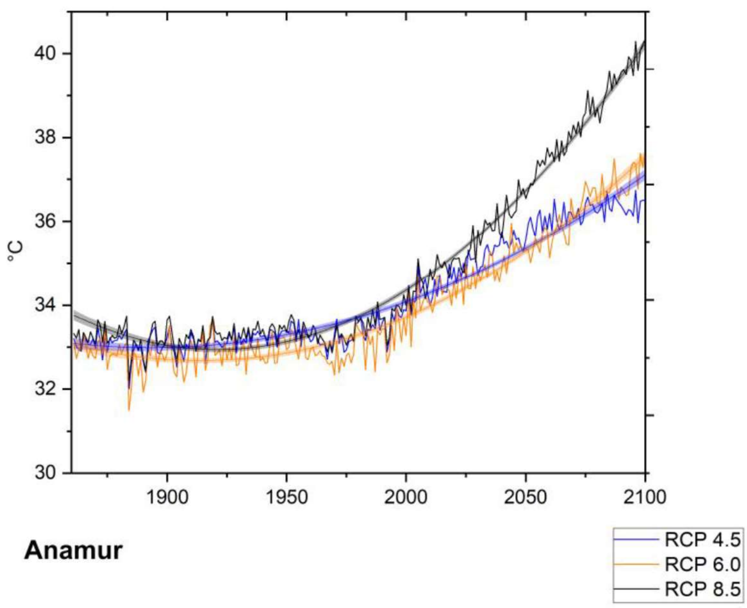


Figure 9.41: Annual maxima of daily maximum temperatures between 1900-2100 in Mersin (°C)

Annual Minima of Daily Minimum Temperatures

For the projections of the indicator representing the coldest temperature of the year, ensemble runs consisting of 25, 15 and 24 different models were used for RCP4.5, RCP6.0 and RCP8.5 scenarios, respectively (Figure 9.42). In the early 2000s, the index value was 0° C according to RCP4.5 and RCP8.5 scenarios and 1° C according to RCP6.0, while by 2100, the indicator projections are projected to be 2.5° C, 4° C and 4.2° C according to RCP4.5, RCP6.0 and RCP8.5 scenarios, respectively.

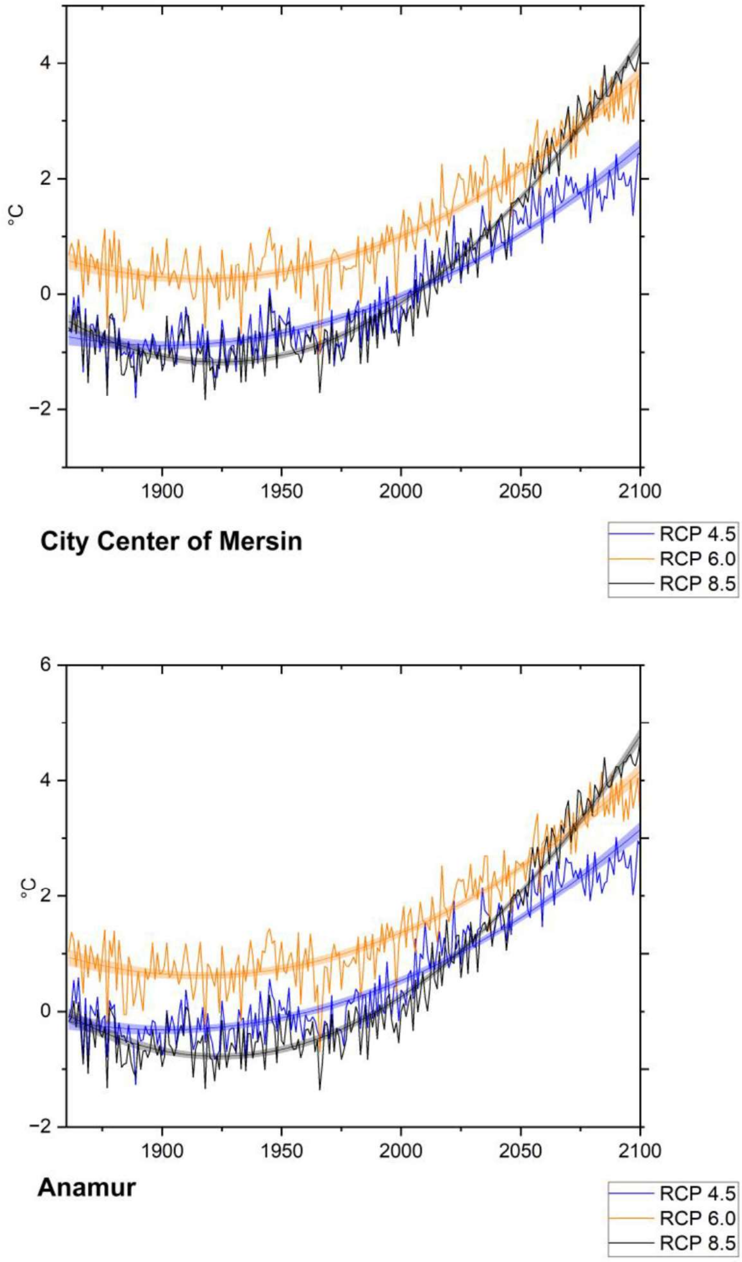
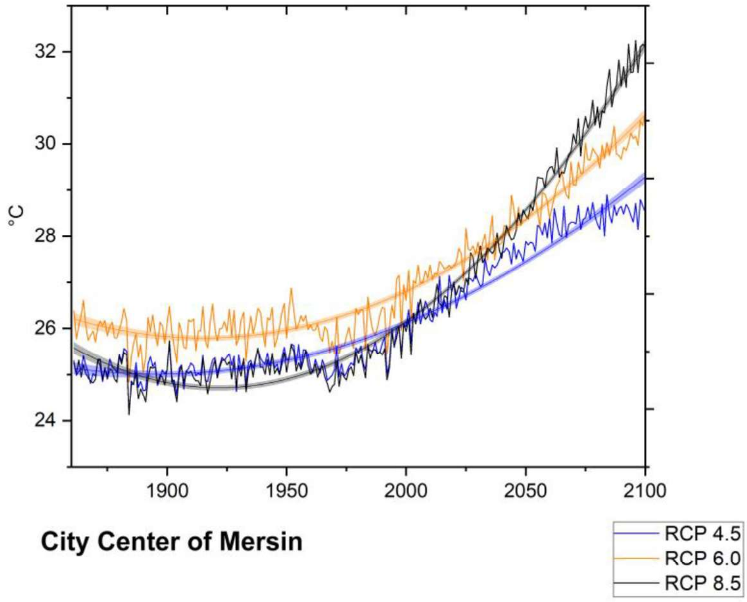


Figure 9.42: Annual minima of daily minimum temperatures between 1900-2100 in Mersin (°C)

Annual Maxima of Daily Minimum Temperatures

It is the annual maximum of daily temperatures and is a climate parameter representing the maximum temperatures of the year. Ensemble runs consisting of 23, 13 and 3 different models for RCP4.5, RCP6.0 and RCP8.5 scenarios, respectively, were used to calculate the projections. According to the ensemble projections (Figure 9.43), in the early 2000s the index is projected to reach 26° C for RCP4.5 and RCP8.5 and 27° C for RCP6.0, while by the end of the century it is projected to reach 28.5° C, 30.3° C and 32° C, respectively.



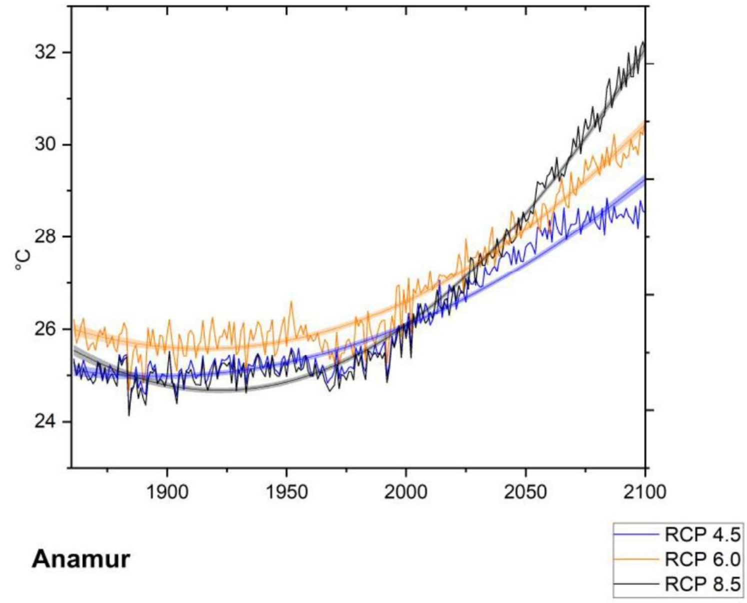
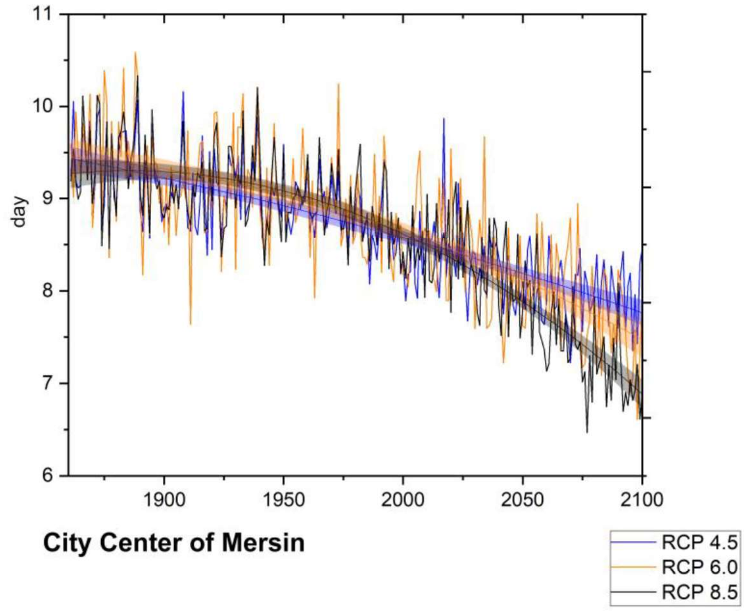


Figure 9.43: Annual maxima of daily minimum temperatures between 1900-2100 in Mersin (°C)

Warm Spell Duration Indicator

For the calculation of the index, ensemble models consisting of 25, 25 and 24 different models were run for RCP4.5, RCP6.0 and RCP8.5 scenarios, respectively (Figure 9.44). The indicator for the number of at least 6 consecutive days with maximum temperatures of 90% or more is projected to decrease from about 8.5 in the early 2000s to 8, 7.5 and 7 by 2100 for RCP4.5, RCP6.0 and RCP8.5, respectively.



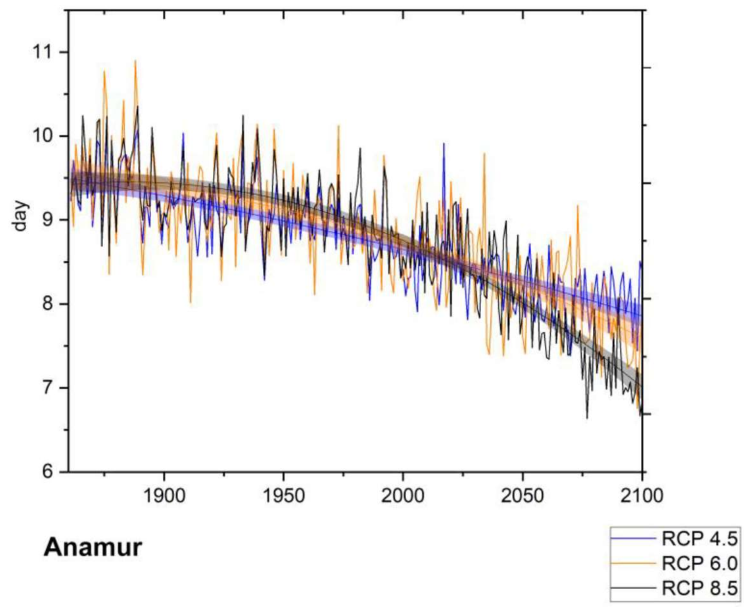


Figure 9.44: Change in warm spell duration indicator values between 1900-2100 in Mersin (days)

Cold Spell Duration Indicator

The projections of the number of cold spell duration indicator (Figure 9.45), which expresses the number of at least 6 consecutive days with a minimum temperature of 10% of normal, are the projections generated by running ensemble runs consisting of 25, 15 and 24 different models for the RCP4.5, RCP6.0 and RCP8.5 scenarios, respectively. It is observed that there is not much of a noticeable difference between the scenarios in terms of the indicator. Towards the end of the century, it is projected that the value will drop to 0 (zero), down from about 3 in the 2000s.

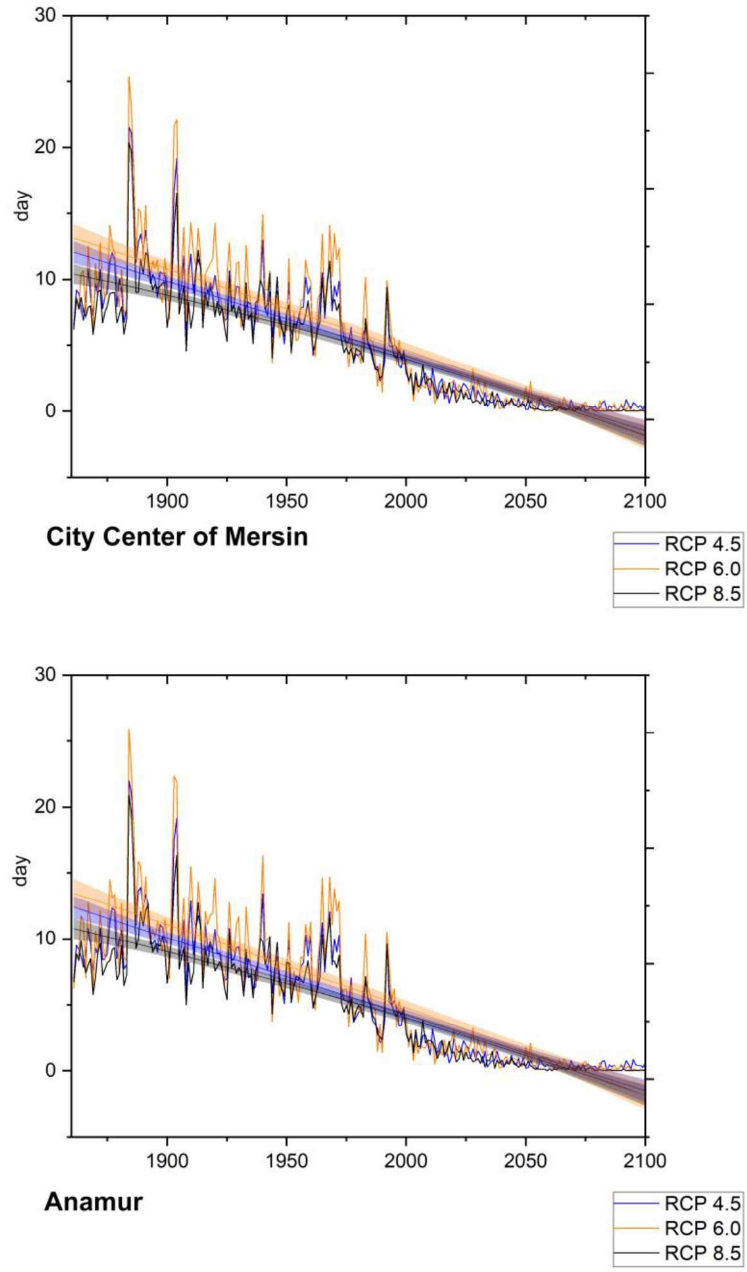


Figure 9.45: Change in cold spell duration indicator values between 1900-2100 in Mersin (days)

Number of ice days

Number of days with daily maximum temperature below 0°C and projections are shown in Figure 9.46. In the 2000s, the index takes the values of approximately 13, 16.5 and 10 at RCP4.5, RCP6.0 and RCP8.5, respectively, while by the end of the century, these values are projected to be 7.5, 10 and 4, respectively.

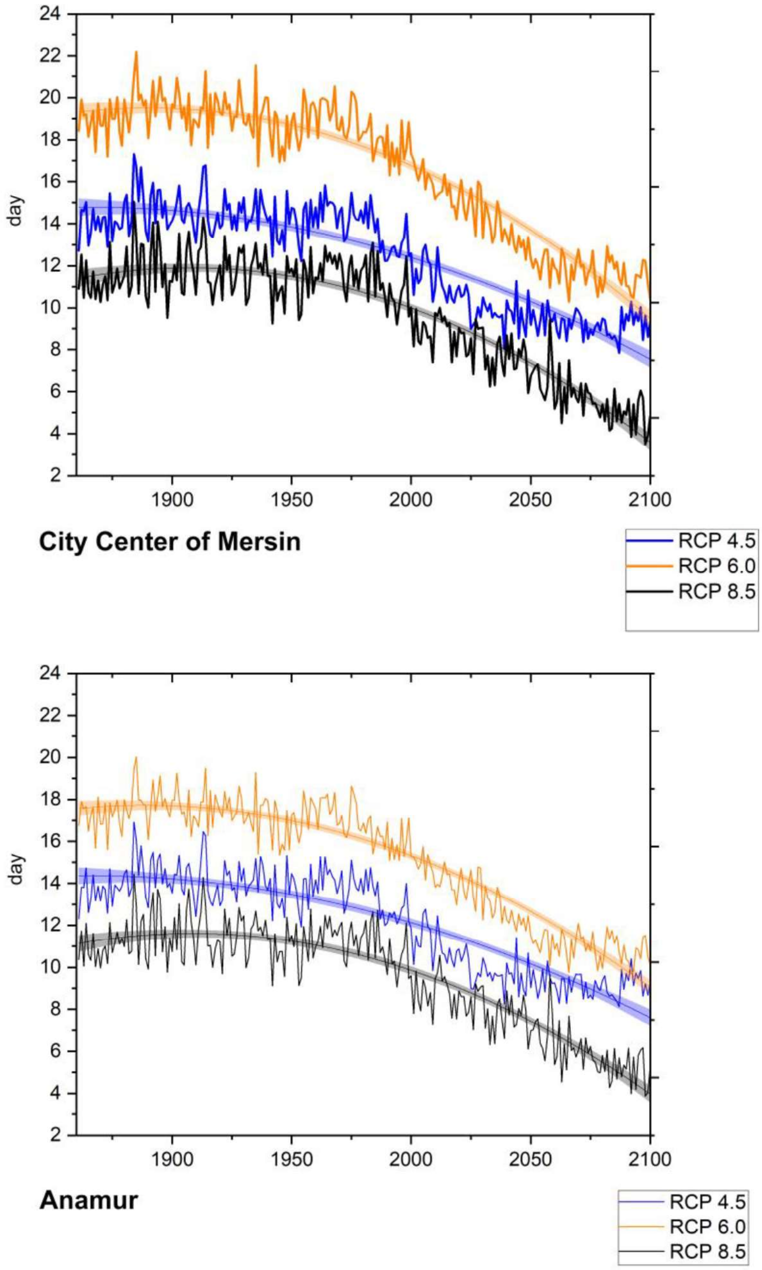


Figure 9.46: Number of ice days in Mersin province between 1900 and 2100 (days)

Growing Season Length

The length of the growing season, which is the sum of the days between the first 6 days when the temperature is greater than 5ºC and the first 6 days when the temperature is less than 5Cº, is shown in Figure 9.47. Plant growing season length increases according to each scenario. According to the projections calculated by the ensemble runs using 25, 15 and 24 different climate models based on the RCP4.5, RCP6.0 and RCP8.5 scenarios, respectively, the length of the growing season in the early 2000s is almost the same for each scenario and is approximately 350 days. By the end of the century, these values are projected to be approximately 360 days or more.

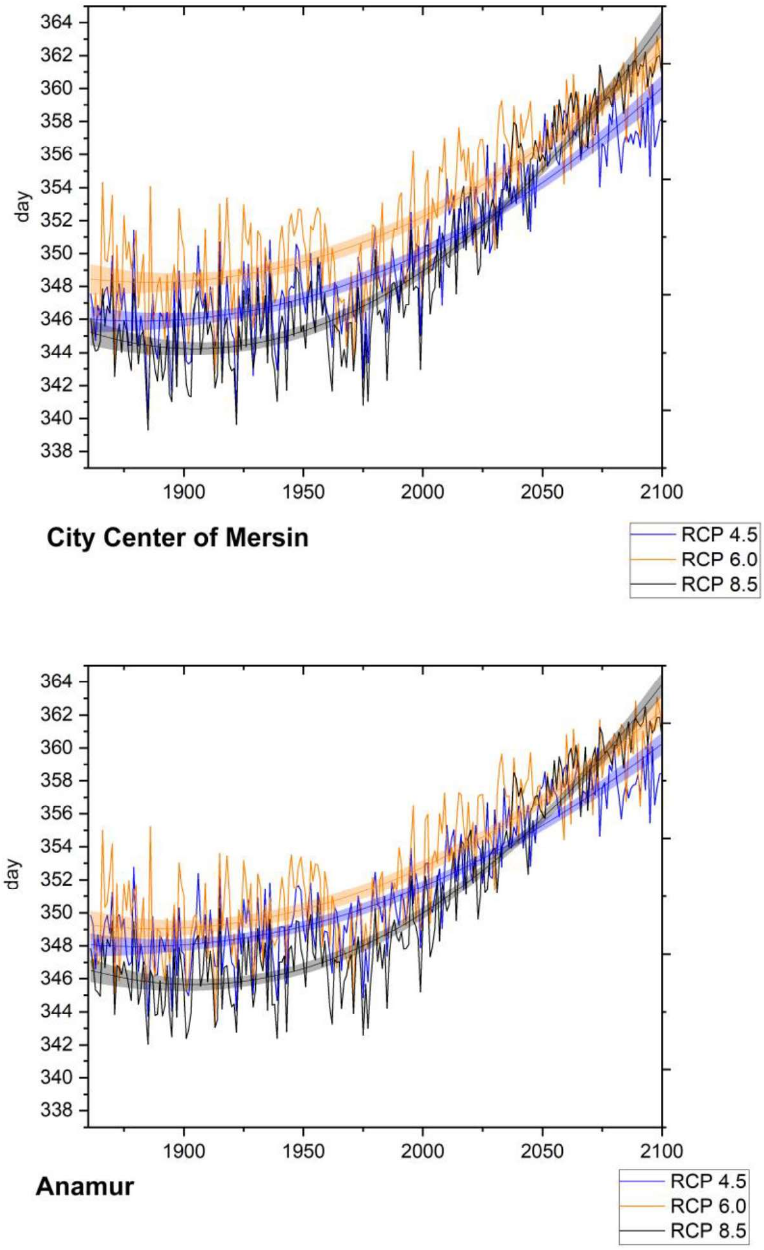
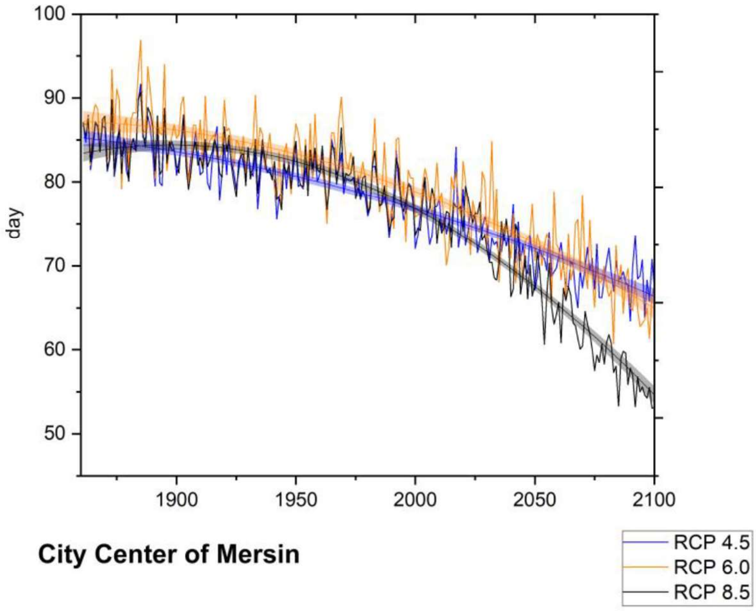


Figure 9.47: Growing season length values (days) in Mersin between 1900-2100

Number of Days with 1mm or More Precipitation

Indice represents the lowest 1-day precipitation during the year. Projections were calculated for RCP4.5, RCP6.0 and RCP8.5 scenarios by running ensemble runs of 25, 15 and 24 different climate models, respectively (Figure 9.48). The number of days with the lowest 1-day precipitation is projected to decrease from about 80 days in the 2000s to about 67 days in the RCP4.5 and RCP6.0 cases and to about 55 days in the RCP8.5 scenario by the end of the century.



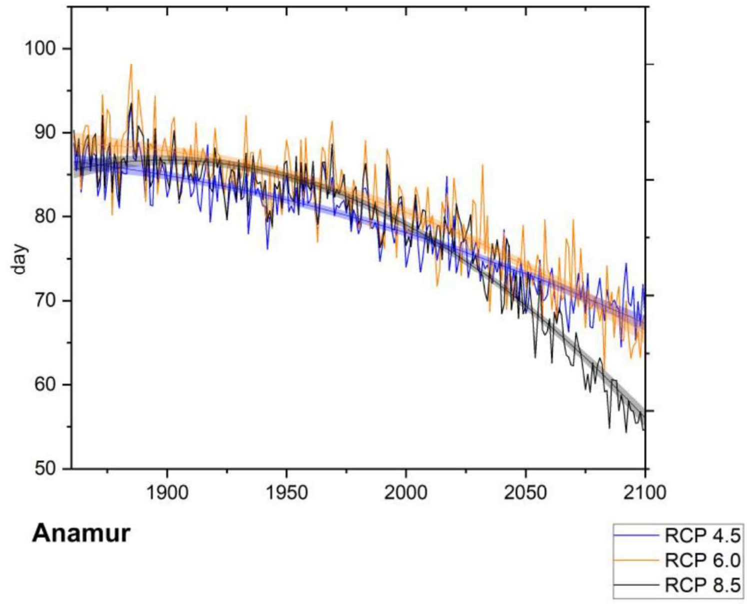
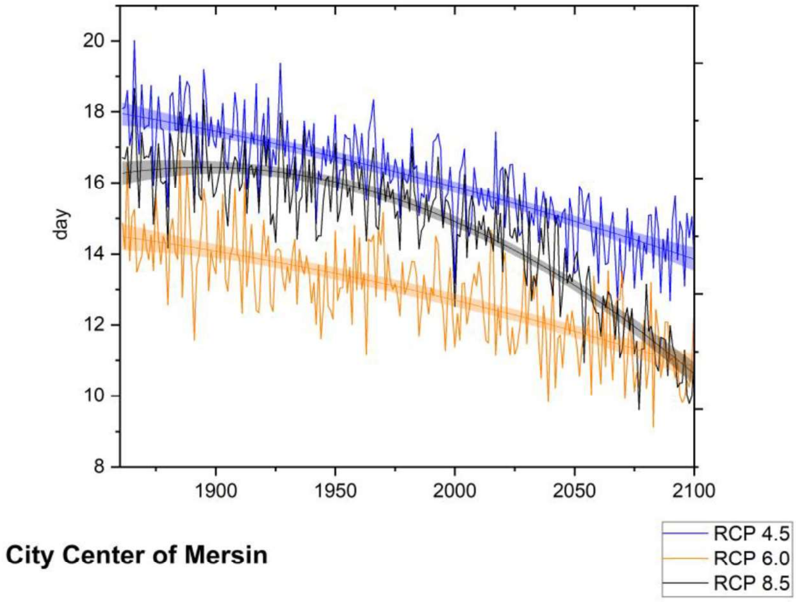


Figure 9.48: Number of days with 1 mm or more precipitation between 1900-2100 in Mersin (days)

Number of Days with 10mm or More Precipitation

The number of consecutive days with precipitation of 10 mm or more is calculated by running ensemble runs of 25, 25 and 24 different models for 3 different scenarios and is shown in Figure 9.49. In the early 2000s, the number of days with precipitation of 10 mm or more for the RCP4.5, RCP6.0 and RCP8.5 scenarios will be approximately 16, 13 and 15, respectively, while by the end of the century, these values are projected to decrease to approximately 14 for RCP4.5 and 10.5 for RCP6.0 and RCP8.5.



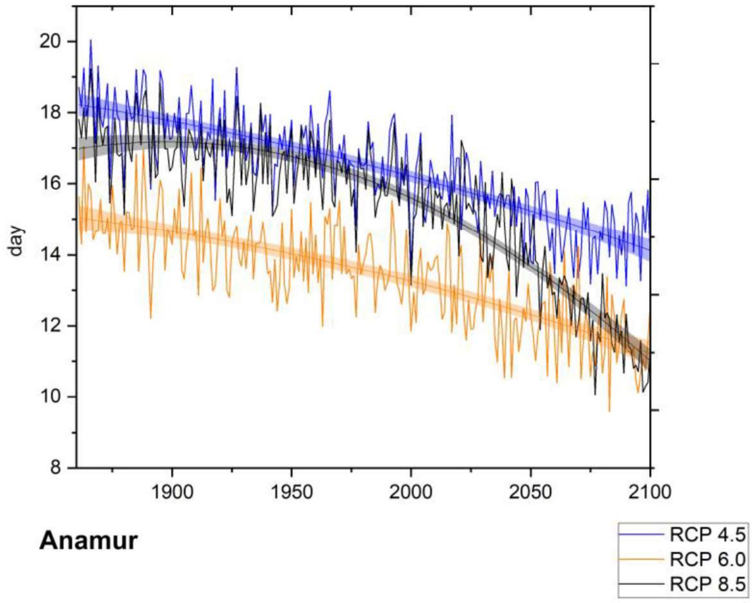
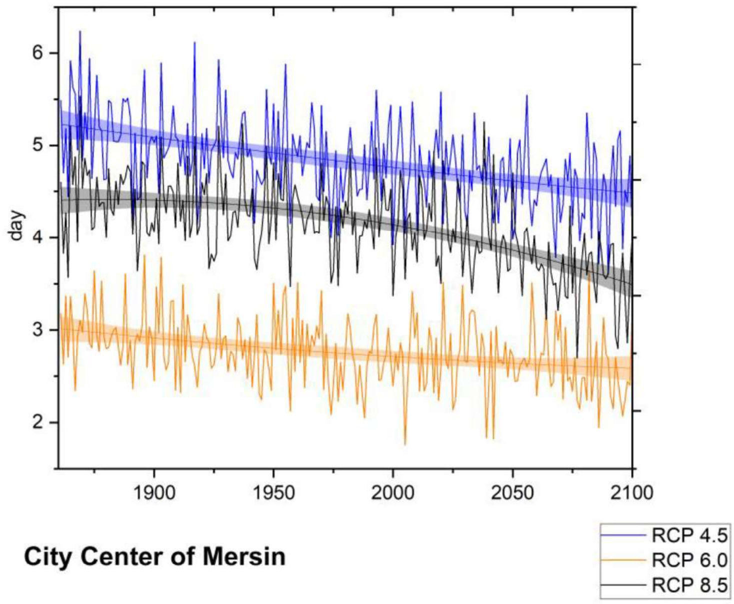


Figure 9.49: Number of days with 10 mm or more precipitation between 1900-2100 in Mersin (days)

Number of Days with 20mm or More Precipitation

Ensemble model projections generated from a similar number of models as above are shown in Figure 9.50. In the early 2000s, according to the RCP4.5, RCP6.0 and RCP8.5 scenarios, the values of the index are approximately 4.5, 4 and 2.5 days, respectively, while by 2100 it is projected to decrease to approximately 4.5, 2.5 and 3.5 days, respectively.



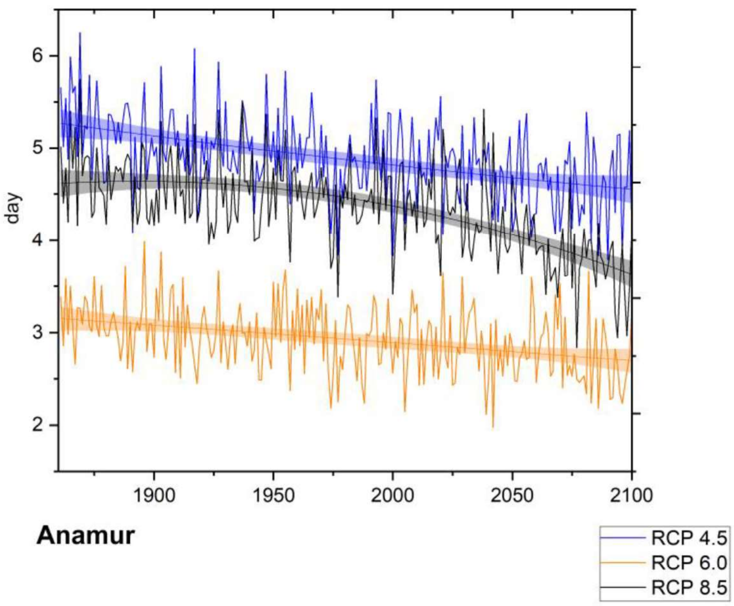
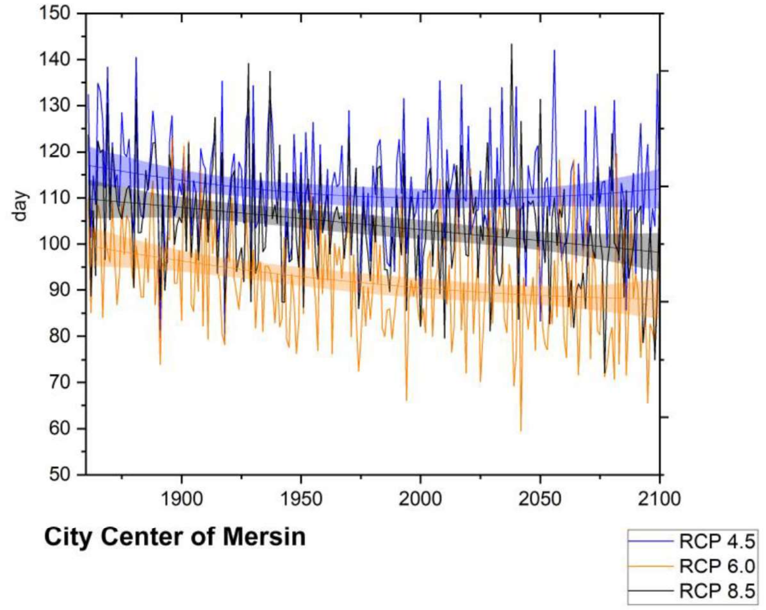


Figure 9.50: Number of days with 20 mm or more precipitation between 1900-2100 in Mersin (days)

Number of Heavy Precipitation Days

For days with precipitation of 1 mm or more, it expresses the annual sum of the precipitation of days with precipitation above the 95th percentile. Ensemble projections generated from 25, 15 and 24 different models according to the scenarios are shown in Figure 9.51. According to the RCP4.5, RCP6.0 and RCP8.5 scenarios, the index in the early 2000s is approximately 110 days, 90 days and 102 days, respectively. There is a slight decrease in index values towards the end of the century. There is a slight increase in the index compared to the RCP4.5 scenario, while the other two scenarios show little change.



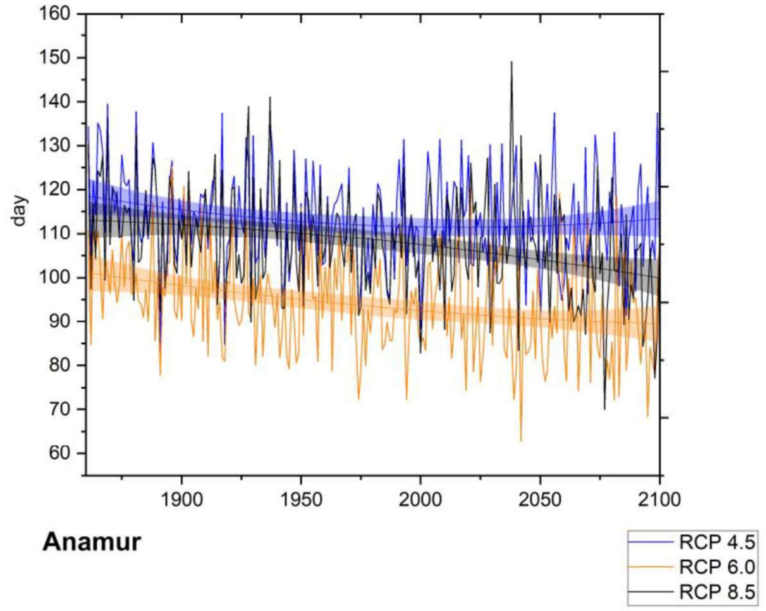
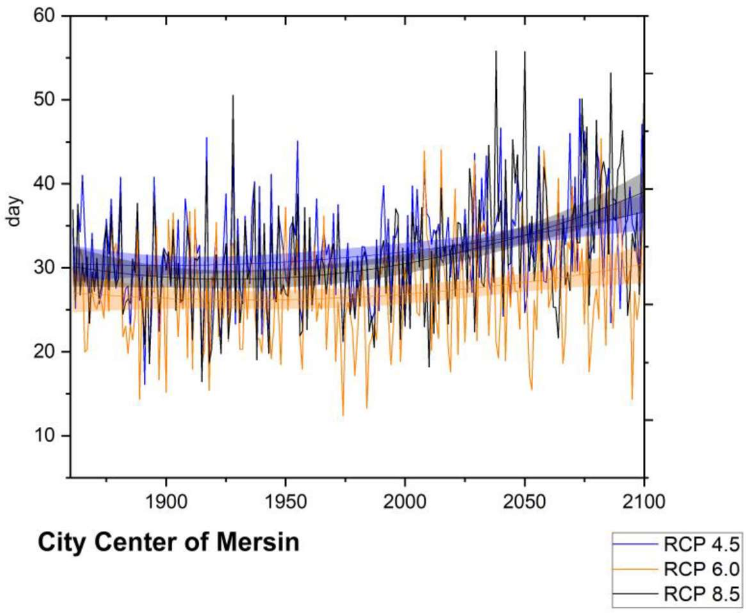


Figure 9.51: The amount of precipitation for heavy precipitation days between 1900-2100 in Mersin (mm/yıl)

Number of Very Heavy Precipitation Days

In the calculation of the projections of the index, which expresses the annual sum of the precipitation of days with precipitation above the 99th percentile for days with precipitation of 1 mm or more, ensemble projections consisting of 25, 15 and 24 different models were prepared depending on the scenarios (Figure 9.52). Although values have varied widely over the years, a general increase is predicted towards the end of the century. In the early 2000s, the index takes values of 33 days, 27 days and 30 days, respectively, according to the scenarios. By late 2100, these values are projected to increase to approximately 36, 30 and 38, respectively.



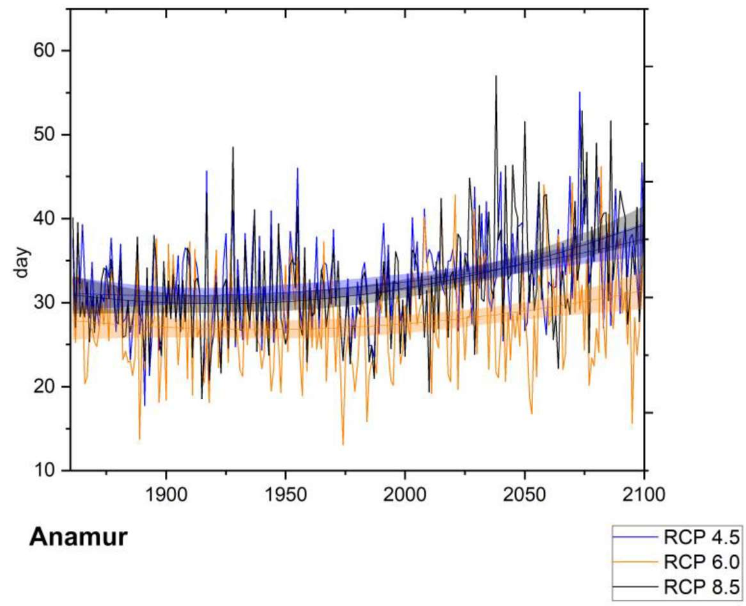
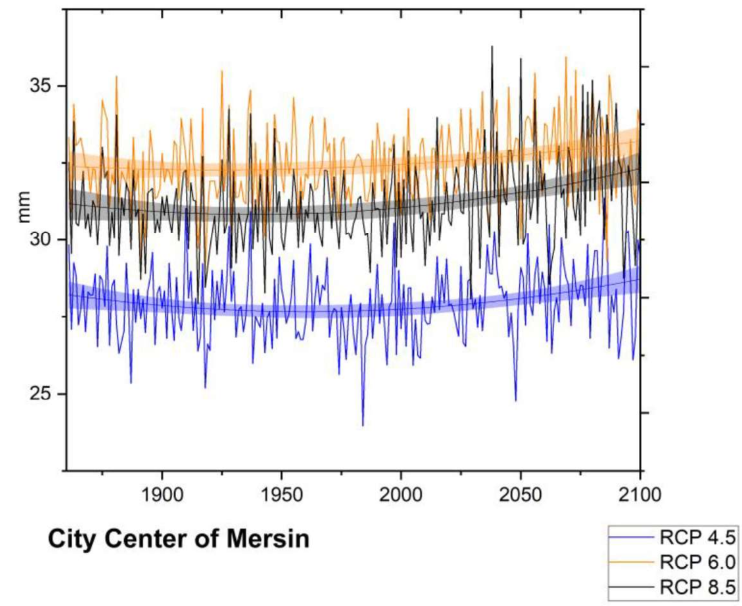


Figure 9.52: The amount of precipitation for very heavy precipitation days between 1900-2100 in Mersin (mm/yıl)

Maximum 1-day Precipitation

Similar to above, different ensemble model projections were used in the calculation of the projections of the index expressing 1-day maximum precipitation (Figure 9.53). In general, little change in the indicator is foreseen towards the end of the century. In the 2000s, according to the scenarios, the indicator will be about 28, 32.5 and 31.5 mm/day, respectively, while by the end of the century, the indicator is projected to be about 28, 33.5 and 32 mm/day, respectively.



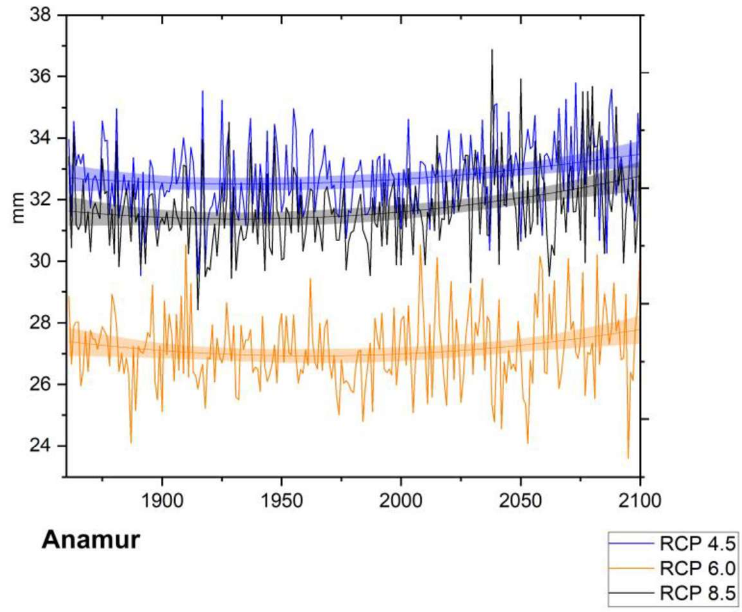


Figure 9.53: Maximum 1-day precipitation between 1900-2100 in Mersin (mm/gün)

Maximum 5-day Precipitation

Projections of the 5-day consecutive maximum precipitation indicator (Figure 9.54) were obtained by applying the ensemble runs and it is predicted that there will be slight decreases in the indicator over time. According to the RCP4.5, RCP6.0 and RCP8.5 scenarios, the indicator is projected to be 73, 60 and 66 by the end of the century.

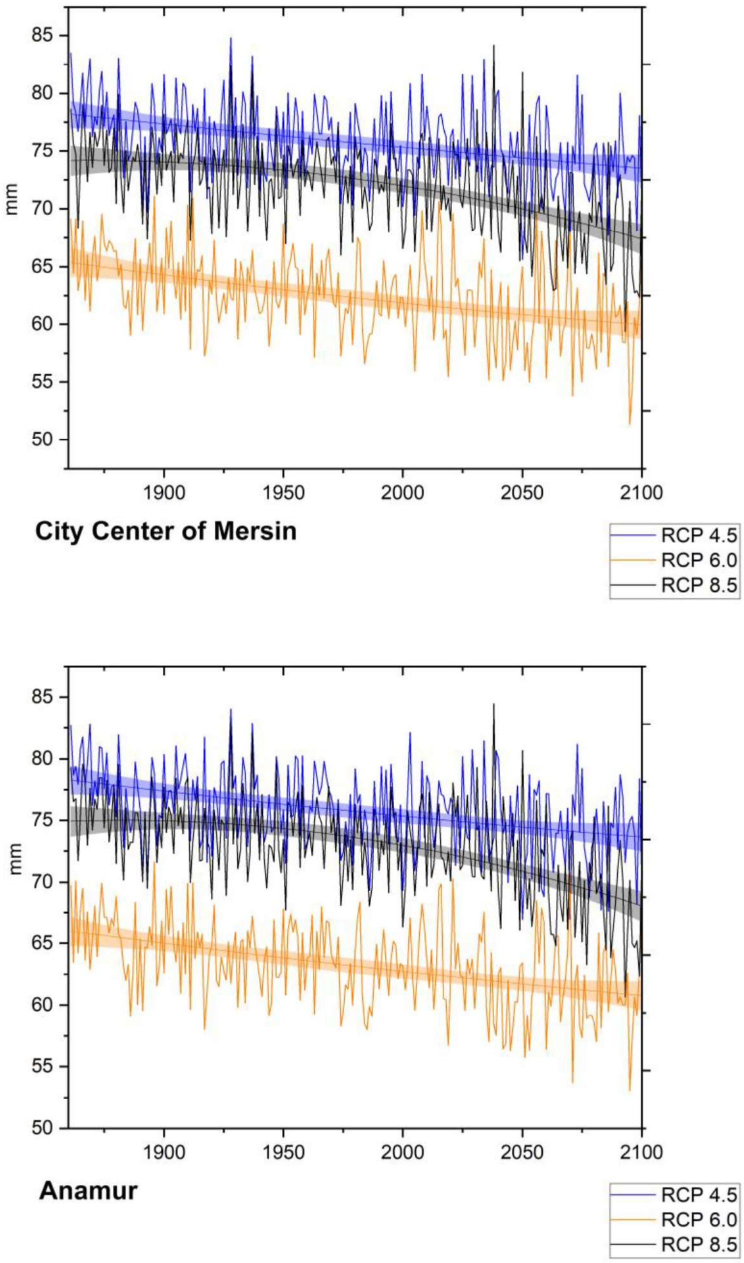
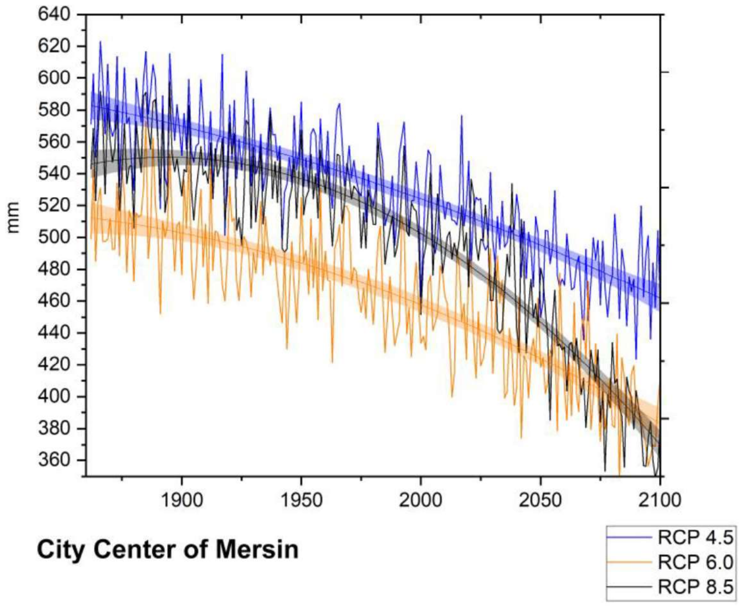


Figure 9.54: Maximum 5-day precipitation between 1900-2100 in Mersin (mm/gün)

Annual Total Precipitation

Ensemble projections consisting of 25, 15 and 24 different climate models were realized according to RCP4.5, RCP6.0 and RCP8.5 scenarios (Figure 9.55). If we look at the projections of the change in Annual Total Precipitation over time, it can be said that the fastest and sharpest decline will be starting from 2025 under the RCP8.5 scenario. Although the decreases in precipitation according to the RCP6.0 scenario take similar values compared to the RCP8.5 scenario, it can be seen that the slope in the decrease is slightly less. In the early 2000s, Annual Total Precipitation for RCP4.5, 6.0 and RCP8.5 is projected to be around 520 mm, 460 mm and 505 mm, respectively, while by the end of the century it is projected to decrease to 470 mm, 370 mm and 360 mm, respectively.



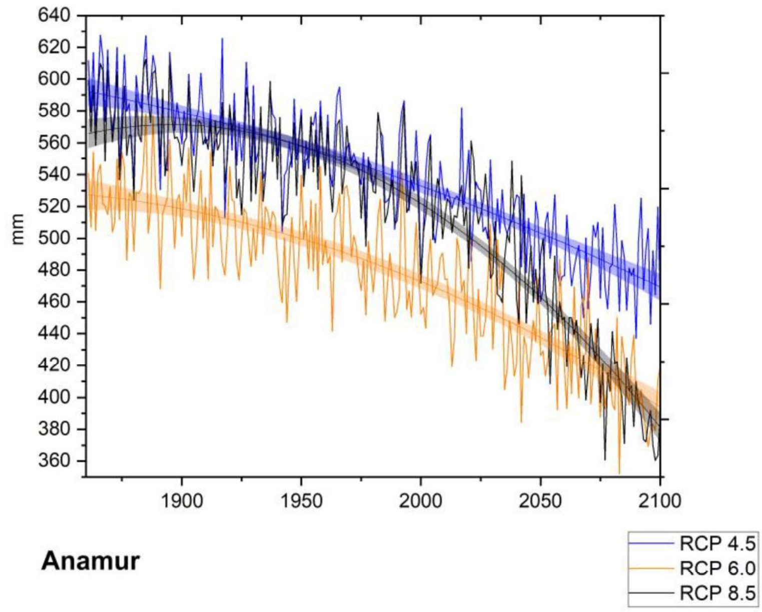


Figure 9.55: Annual Total Precipitation between 1900-2100 in Mersin (mm)

9.2.3 High Resolution Regional Climate Model Projections (MPI-CSC-REMO2009)

Climate projections generated by dynamically downscalled high-resolution regional climate models using global climate model outputs as initial conditions enable a better understanding of local climate change impacts, more comprehensive risk assessments, and the correct operation of sectoral planning and decision-making processes. The European Union Program of Copernicus (https://www.copernicus.eu/en/copernicus-services) provides data supply and analysis and services in many other areas such as atmosphere, sea, land, climate change, security and emergency and disasters. The results of the 0.05° - 0.05° high-resolution (~ 5 km horizontal resolution) climate projection, in which the MPI-ESM-LR global climate model developed at the Max Planck Institute and the Dutch CSC-REMO2009 regional climate model are coupled with each other, are analyzed for Mersin. The differences of the projected values of the main climate variables of temperature (air temperature at 2 m height) and total precipitation in the time periods between 2011-2040, 2041-2070 and 2071-2100 compared to the reference period 1970-2010 were analyzed. Precipitation changes, unlike temperature changes, are expressed as percentages instead of values. Figure 9.56 ve Figure 9.57 show the differences of monthly temperature projections from the reference period considering RCP4.5 and RCP8.5 scenarios. In the 2011-2040 period, according to the RCP4.5 scenario, temperatures are projected to increase by approximately 1°C, with the highest increase in April, while according to the RCP8.5 scenario, temperatures are projected to increase by approximately 1.5° - 2°C, with the highest increase in August. In the 2041-2070 period, according to the RCP4.5 scenario, temperatures are projected to increase by 0.5° – 1°C in all months compared to the previous period, with the highest increase of 2.5° – 3°C in August compared to the reference period. According to the RCP8.5 scenario for the same period, it is seen that the increases in temperature will be much higher than in the previous period, with the maximum increase of approximately 3.5° – 4°C in August. In the 2071-2100 period, it is observed that there is no significant increase in temperatures in the RCP4.5 scenario compared to the previous period, whereas there is a significant increase in temperatures in all months in the RCP8.5 scenario. The maximum increase is observed in August and April, respectively, and the increase in temperature in August reaches approximately 7°C.

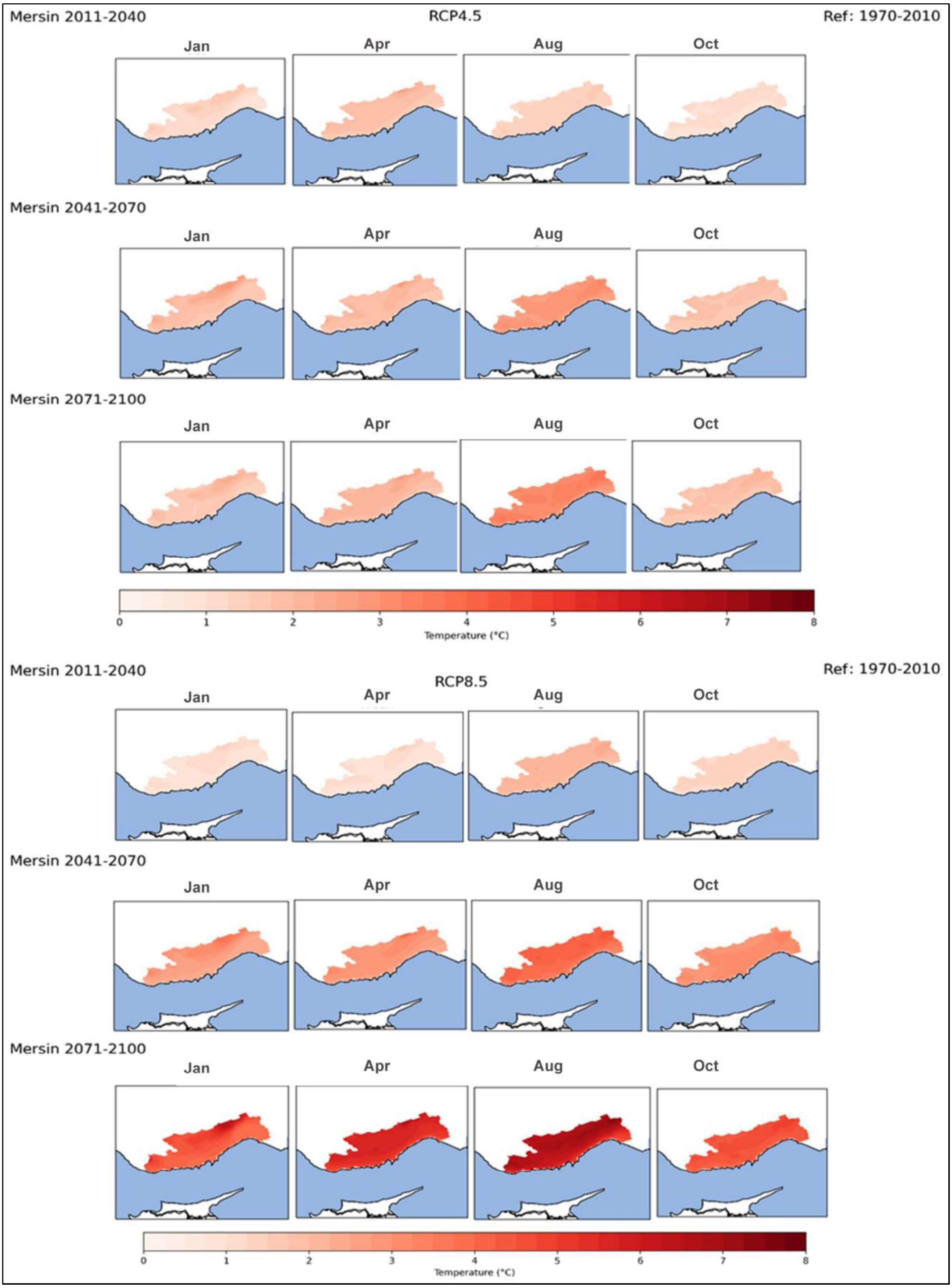


Figure 9.56: Temperature changes in Mersin according to RCP 4.5 and RCP 8.5

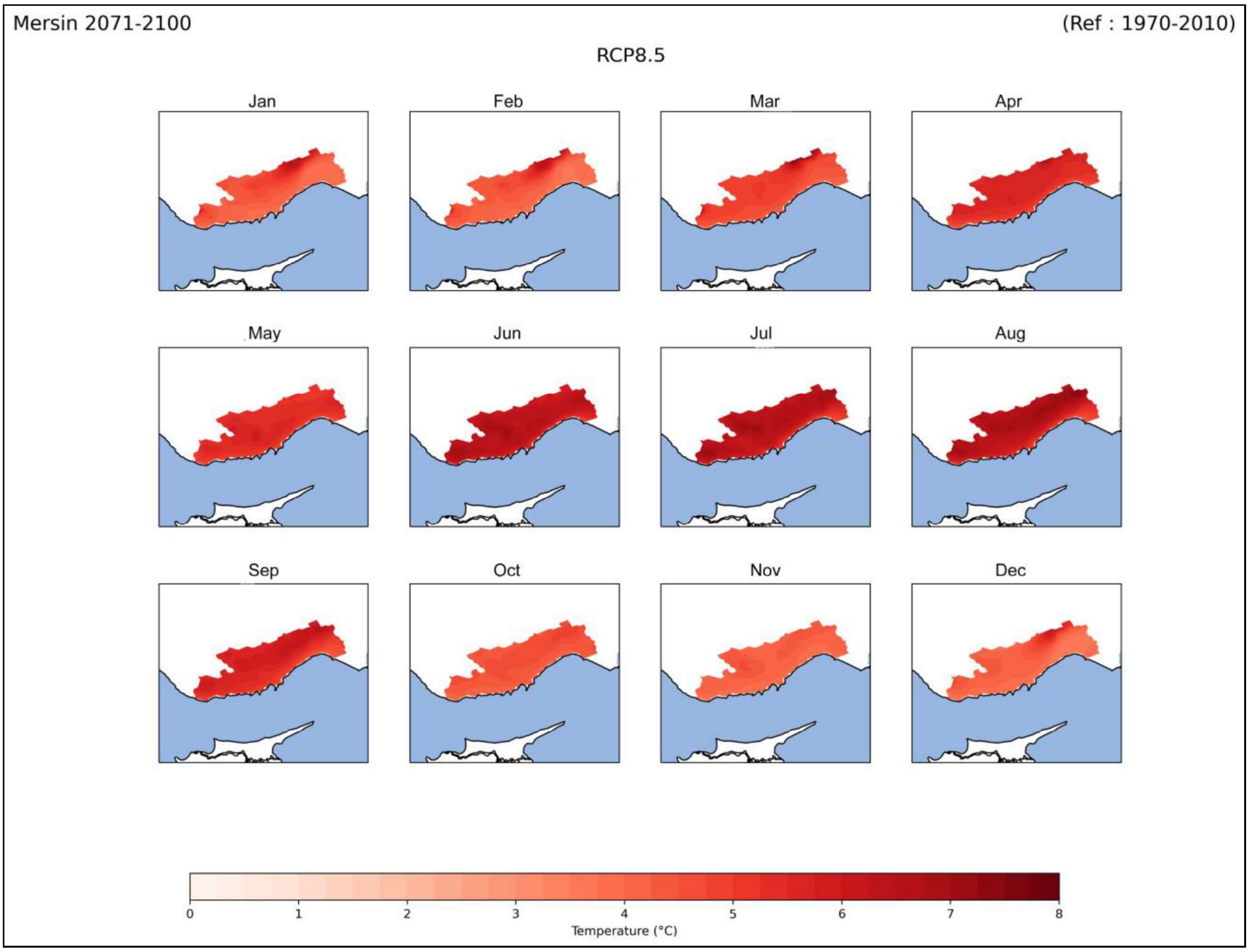


Figure 9.57: Monthly temperature changes in Mersin according to RCP 8.5

Considering the change in precipitation (Figure 9.58), it is seen that there is either not much change in precipitation in January, April and August or there is a partial decrease in percentage according to RCP4.5 scenario in the period 2011-2040. In October, it is seen that there will be an increase of up to 60% in precipitation. In the same period, according to the RCP8.5 scenario, a slight decrease of around 10-15% is expected for almost all of Mersin in August, while a slight increase or decrease in precipitation (-+10-15%) is expected in the other months. In the period 2041-2070, it is predicted that there will be a significant increase in precipitation in October, but there will be significant decreases (-30-40%) in other months, especially in August. According to the RCP8.5 scenario for the same period, the significant increase in precipitation in October in RCP4.5 is replaced by either a decrease or an increase in low values (+20%). The greatest decrease in precipitation occurs in August, by about 50% and up to 60% in some coastal areas. When it comes to the period of 2071-2100, according to the RCP4.5 scenario, it is predicted that the increase in precipitation in October will continue around 50%, while there will be a decrease in precipitation in January, April and August by 10-15%, 30-40%, and 10%, respectively. According to the RCP8.5 scenario for the same period, there will be significant decreases in January, April and August, and these decreases will be the highest in August and especially along the coastline. Precipitation decreases in January, April and

August are generally around 30%, 30% and 60% respectively. In October, it is predicted that there will be an increase of 30-40% in precipitation as in previous periods.

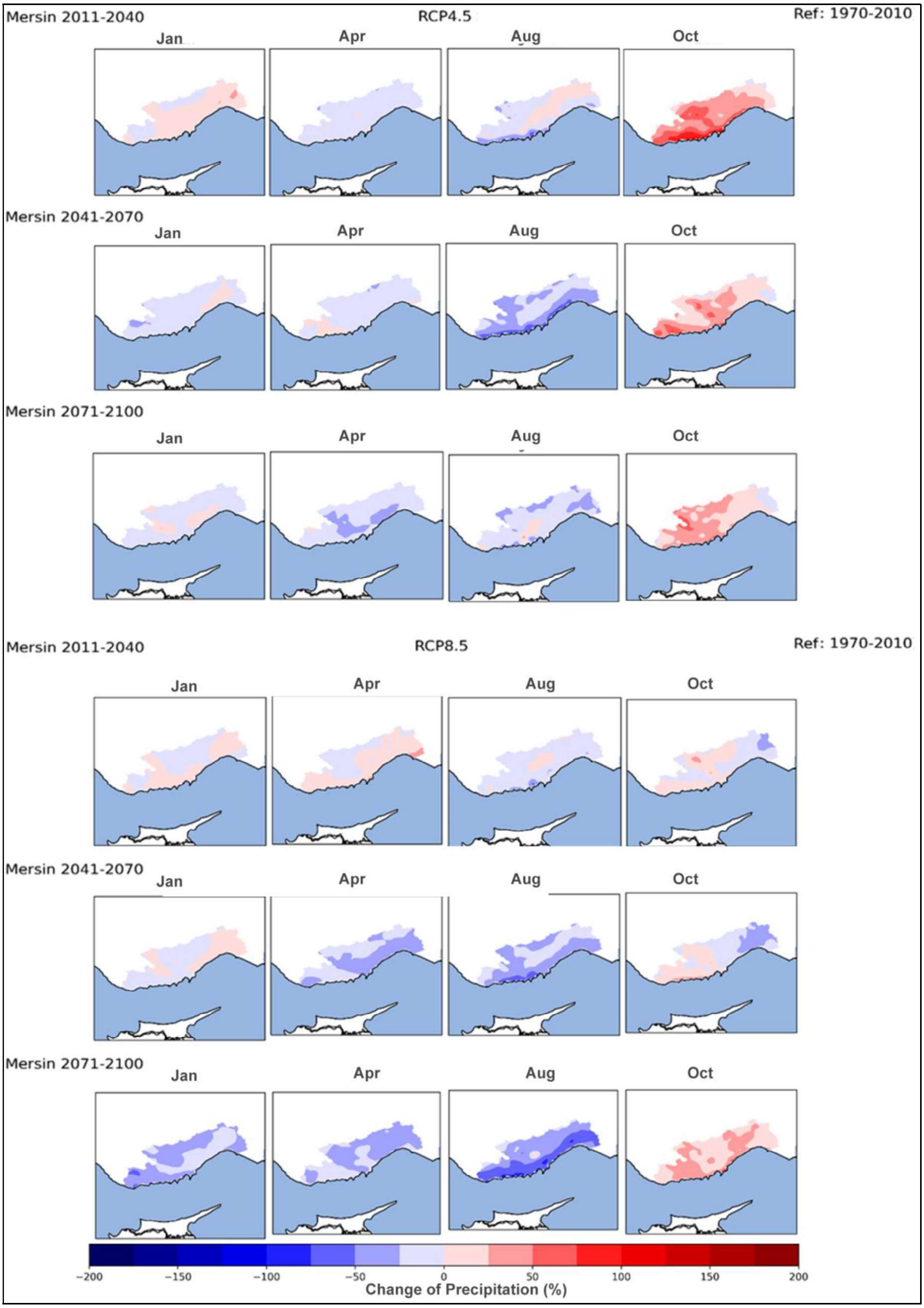


Figure 9.58: Changes in precipitation in Mersin according to RCP 4.5 and RCP 8.5

9.3. Assessment of Vulnerability

Climate change risk analysis includes the steps of identifying the climate change risks that provinces may face, assessing the impacts of these risks, prioritizing the risks, identifying strategies to manage the risks and implementing these strategies. The details of these steps are as follows:

1. Identifying Climate Change Risks

Climate change can affect provinces in different ways. For example, warmer weather, more rainfall, severe storms and flooding. Therefore, when identifying climate change risks in a settlement area, the climatic conditions of the region and climate change scenarios are taken into account.

2. Assessing the Impact of Risks

Each risk can have a different impact. For example, excessive rainfall can cause flooding, while high temperatures can cause urban heat islands. It is therefore important to assess the sector-specific impact of each risk.

3. *Prioritization of Risks*

Not all risks are equally important. Prioritization of risks specific to a residential area ensures that these risks are addressed in order of importance.

4. Identifying Strategies to Manage Risks

There are many strategies to mitigate climate change risks. For example, taking measures for infrastructure against flooding, planning for the increase in energy demand due to higher temperatures. Local governments can identify appropriate strategies to mitigate these risks. In this step, appropriate strategies are identified to mitigate the identified risks.

5. Implementation of the Risk Management Plan

Implementing risk management strategies increases the resilience capacity of local governments to climate change. This makes provinces safer, healthier and more livable. This step ensures the implementation of the identified strategies and determination of performance criteria for these strategies.

6. Reviewing and Updating the Risk Management Plan

Climate change is a constantly changing process and therefore it is important to regularly review and update the risk management plan. Local governments can update the risk management plan using information such as new scientific research and climate change scenarios. This step ensures that local governments are continuously prepared for climate change risks.

The steps mentioned above are the basic steps for conducting climate change adaptation risk analysis for residential areas. By following these steps, local governments can ensure that provinces become more resilient to climate change. Local governments can better cope with possible adversities in the future by identifying strategies to mitigate climate change risks according to the results of the risk analysis.

The Intergovernmental Panel on Climate Change (IPCC) recommends a three-dimensional framework for climate change risk assessment that takes into account the interaction between hazard, exposure and vulnerability (Figure 9.59). The IPCC defines a hazard as "the probable occurrence of a natural or human-induced physical event or trend that could cause loss of life, injury or other health effects, as well as damage to and loss of property, infrastructure, livelihoods, service provision and ecosystems". Therefore, a climate-related event (e.g. extreme weather events) or a trend in climate variables (e.g. increase in average temperatures) can be classified as a climate hazard. Exposure, the second component of risk assessment, is defined by the IPCC as "the presence of people; livelihoods; species or ecosystems; environmental functions, services and resources; infrastructure; or economic, social, environmental or cultural assets in places and environments that may be adversely affected". Therefore, while elements at risk (e.g. citizens, infrastructure, assets) can be identified for exposure assessment, changing the degree and duration of exposure can lead to increased or decreased risk (e.g. population density in coastal areas). Vulnerability, the final component of risk assessment, defined by the IPCC as "the tendency or predisposition to be adversely affected", encompasses various concepts and elements such as susceptibility to harm and lack of capacity to cope and adapt. Vulnerability incorporates two different characteristics: sensitivity, which depends on physical, social and economic factors (e.g. age distribution, type of materials used for infrastructure projects), and adaptive capacity, which depends on the ability of citizens and organizations to cope with and adapt to climate change-related impacts (e.g. availability of early warning systems, local knowledge) (IPCC, 2020).

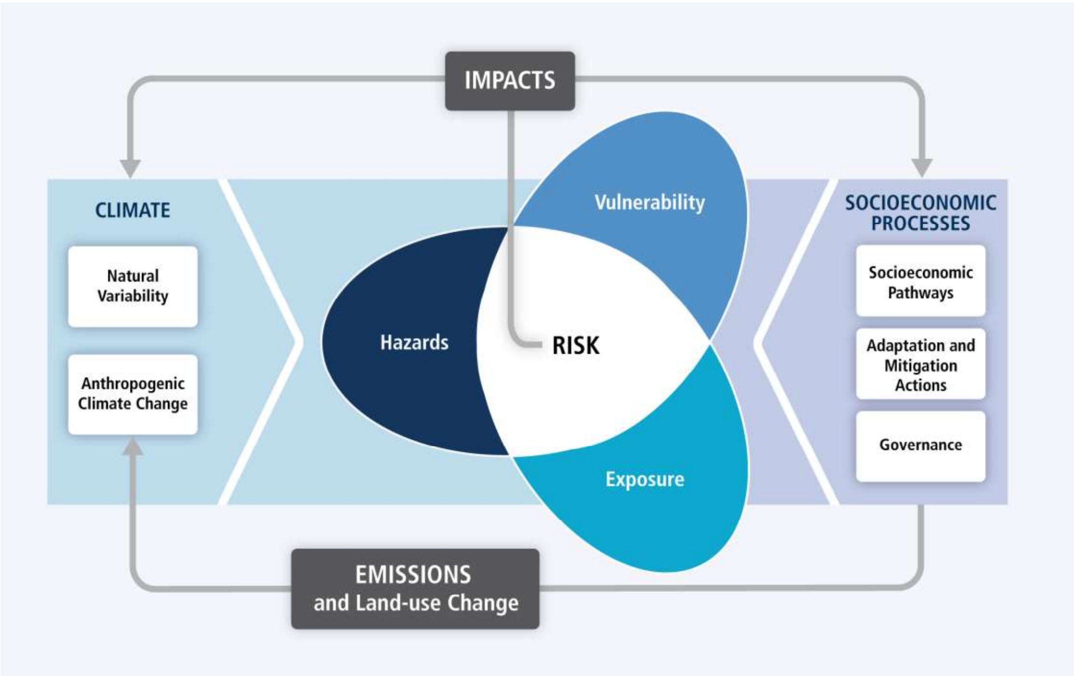


Figure 9.59: IPCC risk assessment framework

In the climate change impact and vulnerability analysis to be carried out within this framework, firstly, the impacts of climate change on the relevant infrastructure and services should be determined in the light of past meteorological data (average temperature increase, total precipitation, etc.), previous disasters (extreme weather events, forest fires, etc.) and national climate projections (temperature, amount and type of precipitation, etc.) for the relevant region. Afterwards, vulnerability areas that are expected to be most affected by climate change should be identified and risk assessments should be made for these areas. Figure 9.60 shows the studies that can be carried out in this context and some examples.

Impact and vulnerability analysis

- Identifying impacts in the light of regional climate projections
- Identifying the infrastructures expected to be most affected by climate change
- Risk and vulnerability assessment (probability and impact matrix) and prioritization of impacts

Evaluation of adaptation measures

- Identification and assessment of possible measures, e.g;
  - Grouping; 'soft' measures (flexible working hours on heatwave days etc.), 'grey' measures (strengthening infrastructure etc.), 'green' measures (increasing green areas etc.))
  - Exemplification (evaluation of existing good practices)

Identification of adaptation measures

- Assessment of possible measures (to what extent will the measure increase adaptive capacity and what are the other impacts of the measure (socio-economic, environmental, etc.)?
- Conduct cost/benefit analysis (CBA) and/or multi-criteria analysis (MCA)
- Prioritization of adaptation measures ('win-win': flood and flood management, green roofs, 'no-regret': e.g., new buildings built away from riverbeds, 'low-regret': e.g., construction of communal water reservoirs in risk areas, protection of natural areas)
- Determining the realization period of the action and key performance indicators on the basis of the measure

Figure 9.60: Climate change adaptation assessment

9.3.1 Determination of the Current Situation: Collection of Climate Data

In order to determine the probability of occurrence of climate risks, it is necessary to determine the frequency of occurrence of past events. For this reason, in order to determine the frequency of occurrence of climate risks in Mersin province, historical climatological data, weather reports and climate projections were evaluated.

9.3.2 Identifying Climate-Related Threats

Data on extreme weather events that occurred in Mersin province in the last 20 years are given in Figure 9.61. Hail has been recorded as the most common weather event in the region in recent years. After hail, storms and tornadoes, rainfall and flooding can be listed as other extreme weather events.

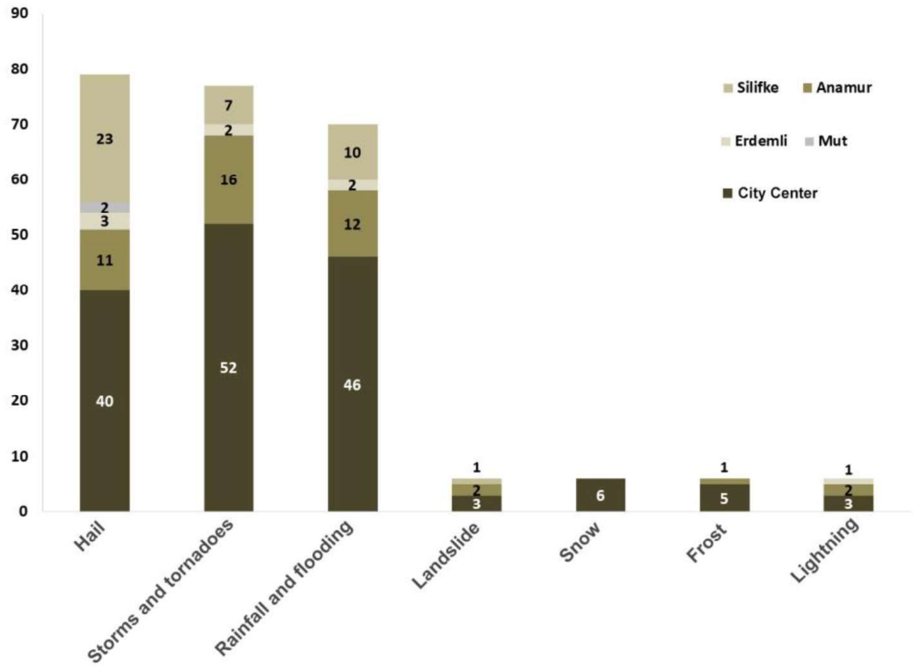


Figure 9.61: Extreme events in Mersin in the last 20 years

Mersin province has been assessed against climate risks of temperature increase, drought, extreme precipitation and flooding, storms and tornadoes, hail, snow, meteorological frost, forest fire and sea level rise.

9.3.2.1 Temperature Increase

High temperatures have many negative impacts on cities. During periods of high temperatures, excessive use of air conditioning and other cooling systems directly increases the need for energy consumption. Temperature increases can lead to heat stroke, dehydration and other health problems in the elderly, children and individuals with chronic health problems. High temperatures can also lead to reduced water supplies, difficulties in obtaining drinking water and adversely affect agricultural activities. Temperature increases also lead to the formation of photochemical pollutants, such as ozone, and lower air quality levels. Temperature increases in the region are seen in the temperature trend analysis results and climate projections given under the climatological analysis heading in Chapter 6. During periods when daily maximum temperatures exceed 32ºC, these risks are more likely to ocur.

Climate projection data were utilized to determine the vulnerability of the region to the risk of temperature increase in the coming years. Climate projections with a resolution of 0.2° - 0.2° (~ 20 km horizontal resolution) within the scope of the "Turkey Climate Projections and Climate Change with New Scenarios - TR2015-CC, 2015" project carried out by the General Directorate of Meteorology in 2015 were evaluated in the analyzes. HadGEM2-ES global climate model was run by MGM using RCP4.5 and RCP8.5 scenarios and temperature and precipitation projections were produced for a period covering 2016-2099. Maximum temperature projections for Akdeniz, Silifke, Anamur and Mut districts are given in Figure 9.62. Maximum temperatures are expected to increase in all scenarios and districts.

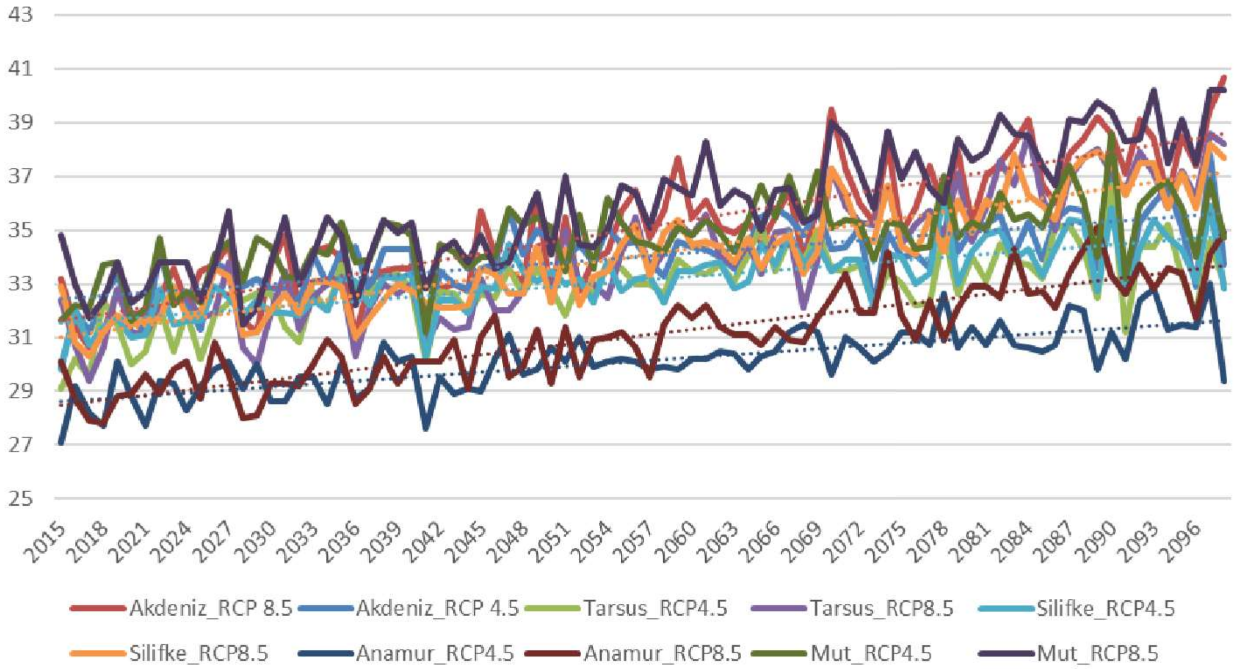


Figure 9.62: Forecasts of maximum temperatures

When temperature and humidity are combined, the level of warmth that people feel changes. Therefore, the apparent temperature or heat index is calculated by combining temperature and humidity to measure the thermal sensation of indoor conditions (Steadman RG, 1984). This index was developed by R. G. Steadman and is widely used to describe human thermal comfort. According to Steadman, the amount of moisture near the surface regulates the processes of evaporation and perspiration. Therefore, humidity level is as important as temperature in determining human comfort. However, as greenhouse gas concentrations in the atmosphere increase, tropospheric water vapor concentrations will also increase. This increase poses another threat to the human comfort range as increased humidity levels (Unal, Y., Tan, E., Mentes, S.S., (2013). Sensible temperature is an important tool used to determine the thermal sensation of indoor conditions.

According to the RCP4.5 and RCP 8.5 scenarios, sensible temperature values were calculated using the model's prediction values for the coming years and are given in Figure 9.63. According to the results, the sensible temperature is predicted to push 50 ºC. It is determined that the upward trend in sensible temperatures will continue in the future.

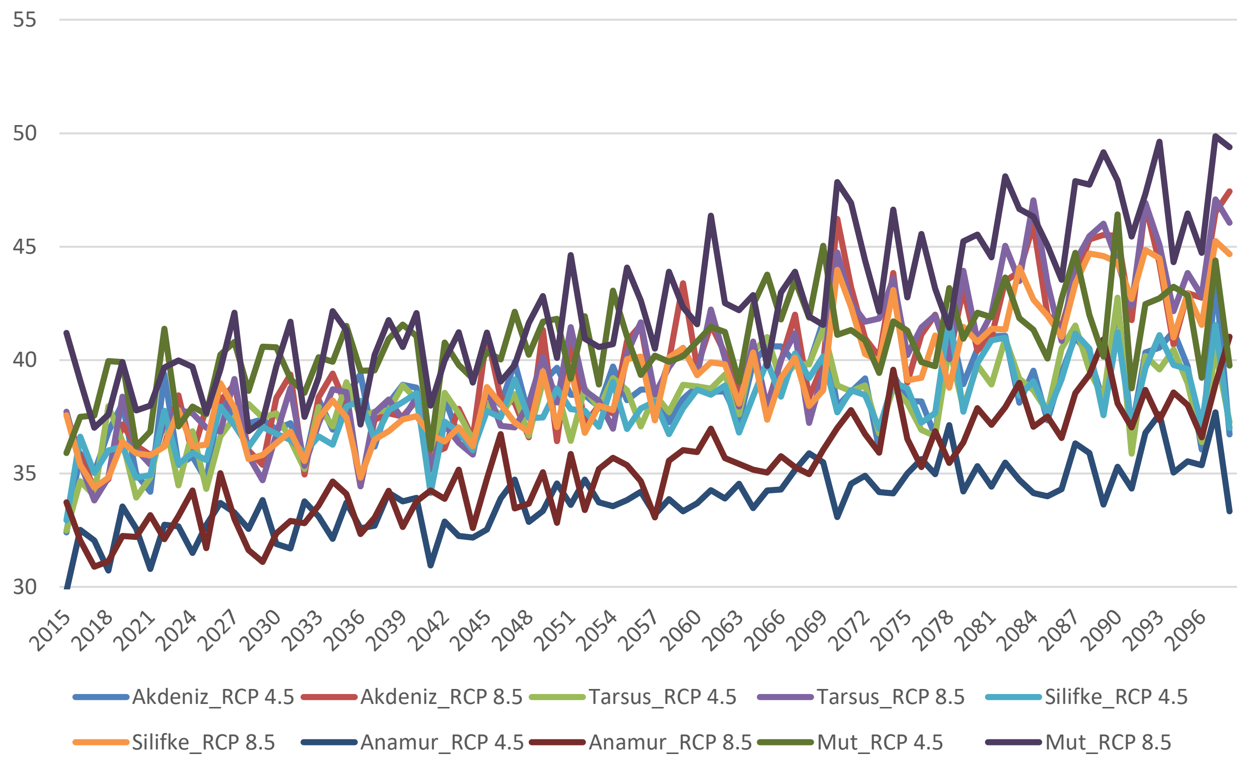


Figure 9.63: Sensible temperature forecasts

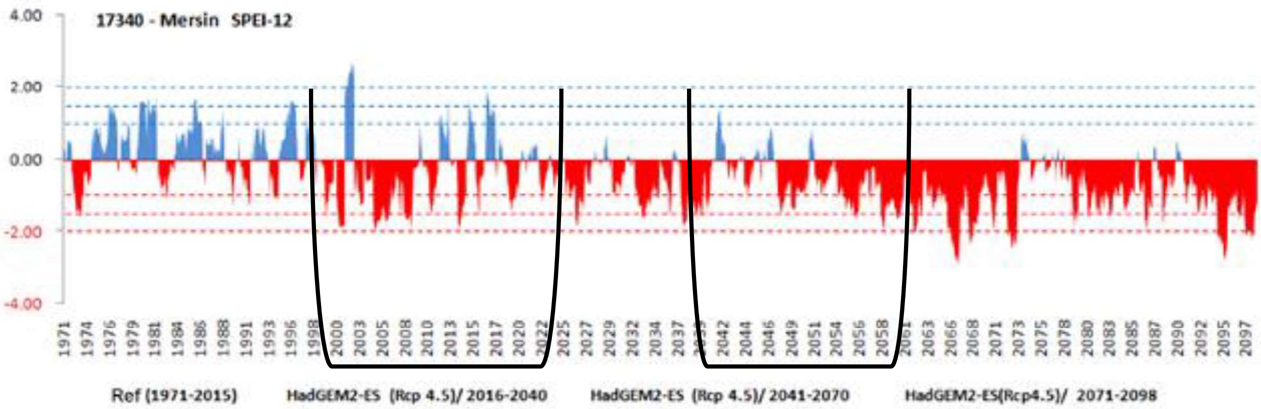
9.3.2.2 Drought

Another climate risk identified for Mersin is drought. It is a climate risk that Mersin is likely to be exposed to due to the increasing average temperatures and decreasing precipitation trend in the region. According to the Turkey Drought Projections Report (MGM_b, 2021), the importance of a drought index based directly or indirectly on temperature inputs is increasing due to global warming. In this case, meteorological drought events that have occurred and are likely to occur across Turkey were analyzed. The analysis was examined in spatial and temporal dimensions using the Standardized Precipitation-Evapotranspiration Index (SPEI) method. Since the SPEI method is based on the climatic water balance (Precipitation - Evapotranspiration), it is recommended for the identification of dry periods (Vicente-Serrano et al., 2010). The classification of SPEI index values is defined as 2.00 and above (extremely humid), 1.50 -1.99 (very humid), 1.00 - 1.49 (moderately humid), 0-0.99 (slightly humid), 0 - (-0.99) (slightly arid), (-1.00) - (-1.49) (moderately arid), (-1.50) - (-1.99) (severely arid), (-2.00) and below (extremely arid).

SPEI drought index time series graphs provide information about the conditions or environment (semi-arid, arid, semi-humid, humid, or humid, etc.) in terms of climatic conditions. In order to evaluate the changes of humid and arid periods of the stations, the time series graphs of the current observations and HadGEM2-ES (RCP4.5) projection at SPEI-12-month scales are taken from the relevant report and shared in Figure 9.64. According to the 12-month evaluations of the SPEI value stated in the report, it is predicted by the projection studies that the region, which is currently defined as moderately arid, will continue to be moderately arid in the 2050 period. Municipal authorities may need to consider many measures to cope with drought, including water conservation, alternative water sources, water reuse and irrigation planning during drought periods.

Drought duration is the length of the period starting from when SPEI values are negative (including the starting month) and ending when they are equal to 0 (zero) consecutively (not including the ending month). More precisely, the number of months of drought from the start of the drought to the end of the drought is expressed by the drought duration.

In addition, drought severity is the cumulative SPEI values obtained by summing the remaining index values over the drought period. Drought severity refers to the magnitude of the drought. In other words, the drought severity experienced during the drought period indicates how severe the drought is. Therefore, it is important to consider factors such as drought duration and drought severity in drought analysis.



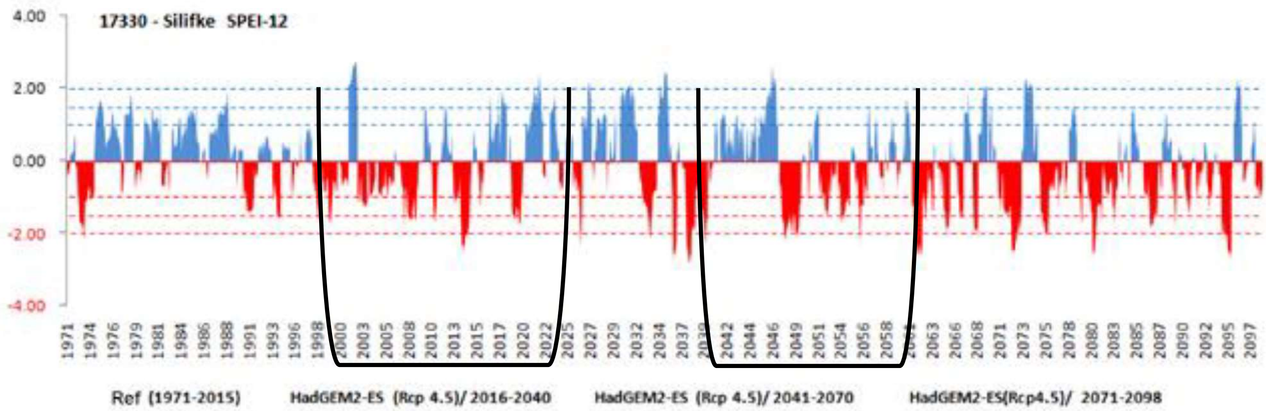


Figure 9.64: SPEI-12 Time-dependent Changes of HadGEM2-ES (RCP4.5) Projection at Mersin and Silifke Stations at Monthly Scales (MGM, 2021)

Drought maps representing the past situation and future projections prepared for Turkey are given. According to the results obtained from the relevant report, the total drought severity calculated as (-80) - (-62) for Mersin between 1971-2015 is projected to be (-218) - (-174) between 2041-2070 according to the HadGEM2-ES model RCP4.5 scenario (Figure 9.65). With an average drought duration of 66-76 days, the province has a 20% frequency of dry day risk. For 2050, a significant increase in the number of dry days is expected in the region (161-228) and the probability of encountering risk is predicted to be 62% (Figure 9.66).

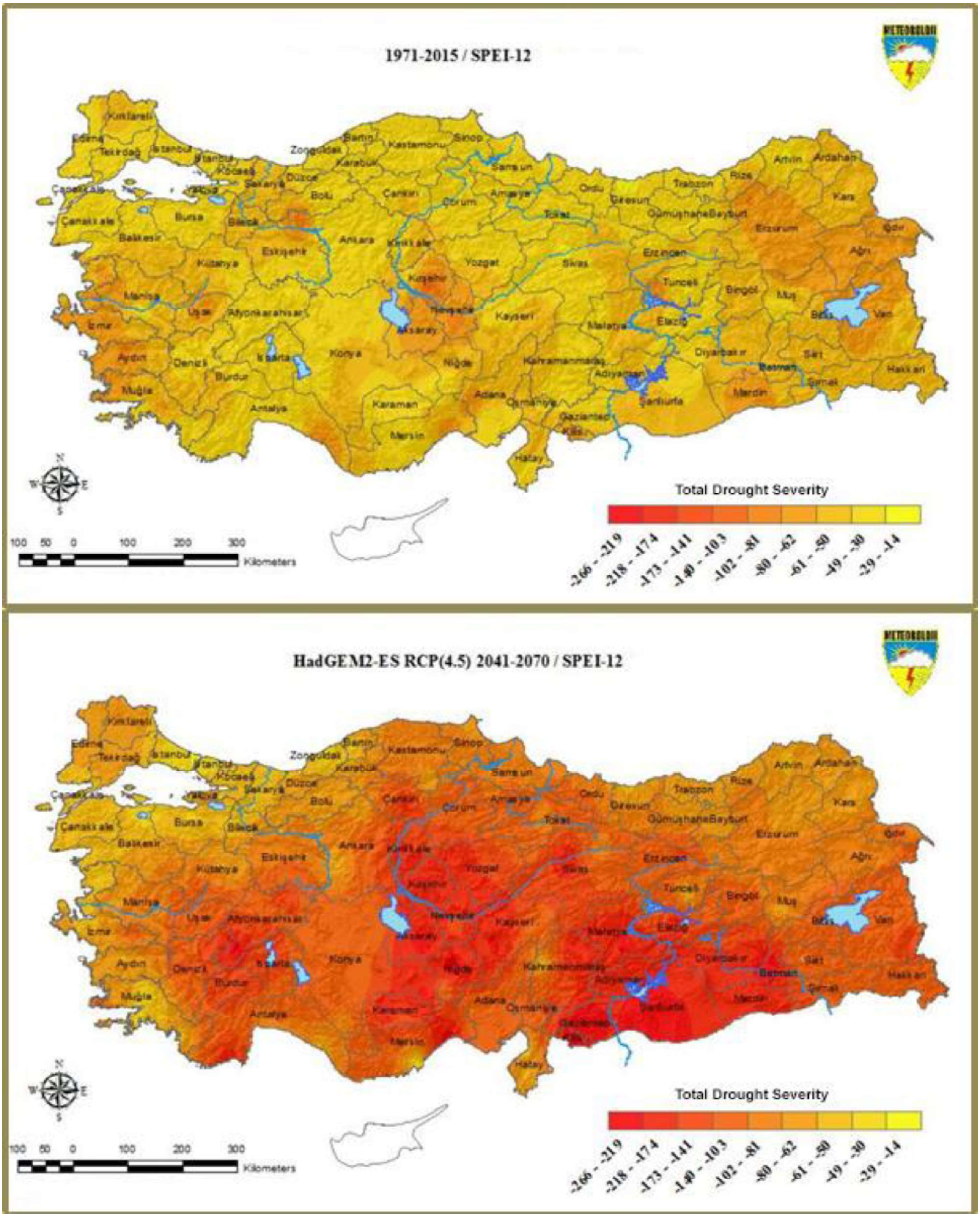


Figure 9.65: SPEI-12 (1971-2015) Total Drought Severity and (2041-2070) HadGEM2-ES (RCP4.5) Total Drought Severity (MGM, 2021)

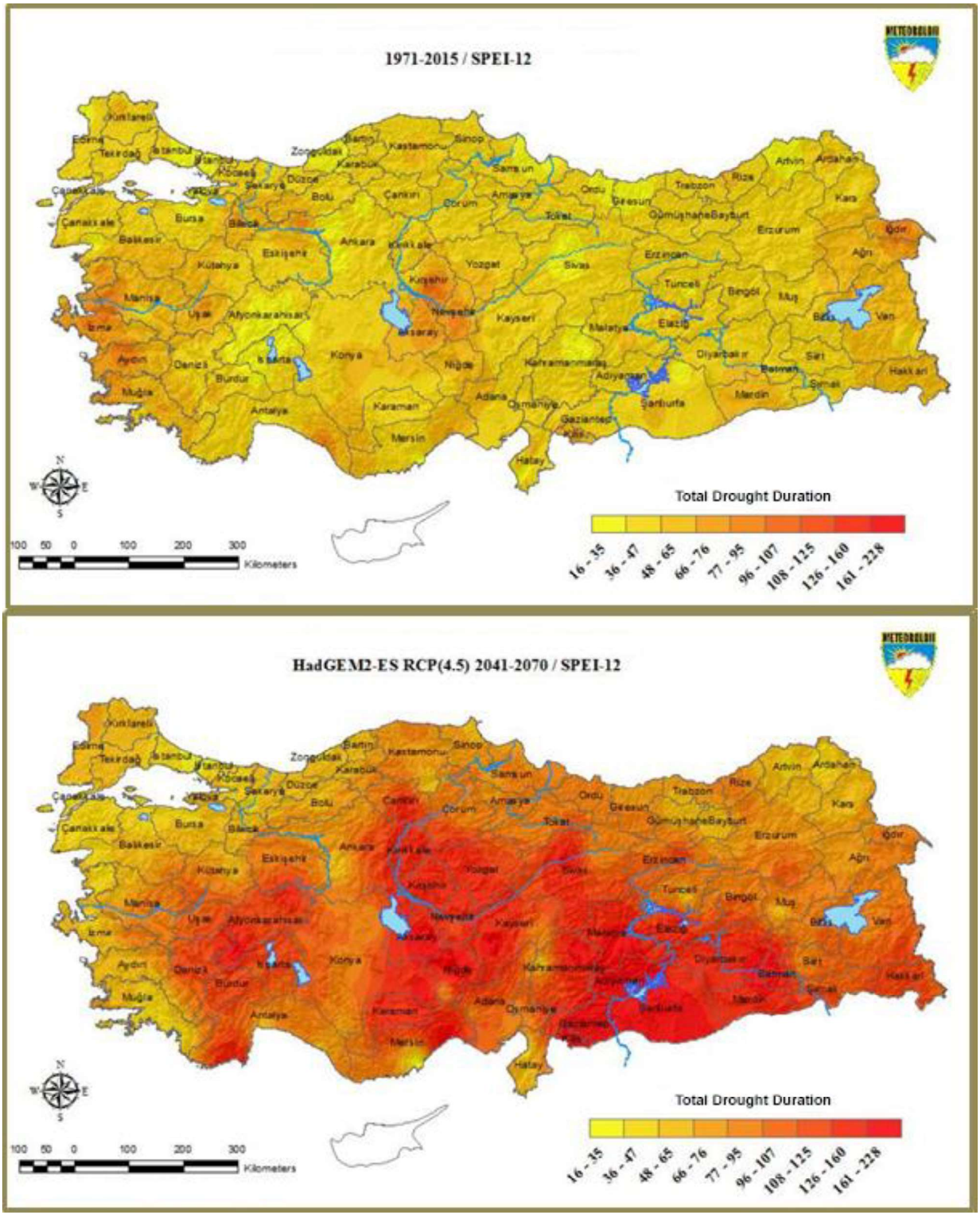


Figure 9.66: SPEI-12 (1971-2015) Total Drought Duration and (2041-2070) HadGEM2-ES (RCP4.5) Total Drought Duration (MGM, 2021)

9.3.2.3 Heavy Rainfall and Flooding

Extreme rainfall and floods are a major climatic phenomenon for residential areas and can strain the city's infrastructure, cause serious damage to homes and businesses, and even lead to loss of life. These impacts can be manifested in various ways, such as damage to buildings by flood waters, inundation of infrastructure, collapse of roads and bridges. To combat extreme rainfall and flooding, it is important for cities to establish effective disaster management plans and strengthen infrastructure. These efforts should include measures such as managing flood waters, improving storm water drainage systems, and creating areas with permeable surfaces to reduce the impacts of floods. It is also crucial to increase the capacity for rapid response in the event of a disaster. In this way, loss of life and damage can be minimized.

According to the Eastern Mediterranean Basin Flood Management Plan prepared by the abrogated Ministry of Agriculture and Forestry General Directorate of Water Management (MoAF, 2019), the flood risk areas in Mersin were identified and the risk levels of the flood areas were determined by evaluating them in terms of health, environment, cultural heritage and economy according to the severity and recurrence interval of the flood. Flood impacts in these areas were also evaluated in terms of the population to be affected and the results are given in Table 9.5. In the economic evaluation, it was determined that Tarsus district will suffer the most damage and Silifke is the highest district in terms of the population to be affected.

Table 9.5: Flood risk assessment of Mersin

District	Flood Risk Level	Maximum Population Affected (%)
Tarsus	Very High	18,44
Akdeniz	High	13,26
Silifke	Medium	34,94
Toroslar	Low	0,25
Yenişehir	Low	2,00
Bozyazı	Very Low	13,33
Erdemli	Very Low	9,96
Mezitli	Very Low	1,71
Anamur	Very Low	3,47
Aydıncık	Very Low	0,24
Çamlıyayla	Very Low	0

Berden Stream, Kanal 1-2-3-6, Kuskun stream, Tarsus 1-2 streams, Kocadökük stream, Kocadere and Karabucak stream in Tarsus have been identified as very high in terms of priority of measures and measures for passage structure improvement, bed adjustment and cleaning, and embankment arrangement are recommended in the Eastern Mediterranean Basin Flood Management Plan (MoAF, 2019). It is stated in the report that similar measures should be taken for Deliçay, Kesikköprü Stream, İçme Stream, Çomaklı Stream and Melemez Stream in Akdeniz district in high priority class. In Silifke, which is in the medium priority class, it is recommended to take measures for Taşucu Stream, Yeşilovacık Stream, Şehirler Stream, Akarca Stream, Bebek Stream, Afşar Stream, Yeşilovacık Stream, Şehitler Stream, Göksu River and Susanoğlu Stream.

When we look at the disaster data of MGM for the last 20 years (Figure 9.61), the frequency of encountering extreme precipitation and flood disasters at least once a year is determined as 55% in the central districts of Mersin, while it is calculated as 60% in other districts. As shown in Figure 9.50, when we examine the climate projections for 2050, it is seen that 20 mm/day of precipitation, which is defined as heavy precipitation by MGM, will fall in the region for more than 4 days on average per year. In Figure 9.53, it is determined that the average maximum precipitation amount to be experienced in 1 day is more than 30 mm/day. For the year 2050, the frequency of extreme precipitation and flood risk is predicted to be high when the relevant projections are analyzed.

The spatial distribution map of extreme precipitation and flood events in Mersin prepared by the European Severe Weather Center based on the information and data observed, reported or obtained from various news sources and verified during the period 2000 - 2022 is given in Figure 9.67.

Figure 9.67: Areal distribution of extreme precipitation events in Mersin (ESWD, 2023)

9.3.2.4 Storms and Tornadoes

Storms and tornadoes can cause damage to buildings, trees and infrastructure in cities, as well as power outages, flooding and transportation problems. Winds above 34 knots are defined as storms by MGM. It is extremely important for cities to be prepared to deal with storms and tornadoes. Creating a good emergency plan, providing accurate information to the public and taking advanced infrastructure measures can increase resilience to such events. It is also crucial that buildings are constructed and regularly maintained to withstand the risk of storms and tornadoes. To minimize the impacts of storms and tornadoes on cities, it is necessary to follow meteorological forecasts, use early warning systems and raise public awareness. In this way, it may be possible to ensure the safety of people and minimize potential damages. It is also important to create a comprehensive disaster management strategy that includes recovery and recovery processes. In this way, cities can become more resilient and cope with disasters more effectively. When we look at MGM's disaster data for the last 20 years (Figure 9.61), the frequency of encountering storm and tornado disasters at least once a year is 90% in Mersin's central districts and 70% in other districts.

The areal distribution map of storm and tornado events in Mersin prepared by the European Severe Weather Center based on the information and data observed, reported or obtained from various news sources and verified during the period 2000 - 2022 is given in Figure 9.68. While tornadoes are more common in Silifke and Anamur regions, thunderstorms are generally recorded in Erdemli region. In the current situation, the probability of encountering storms and tornadoes is very high and it is predicted that the probability of encountering them at least once a year will continue in the future. The increasing intensity and impact of storms and tornadoes are closely related to changing climatic conditions. Increased surface and lower atmospheric temperatures, increased evaporation and increased water vapor content of the atmosphere lead to an increase in the formation of tornadoes. For this reason, it is predicted that the frequency of storms and tornadoes may increase in the coming periods.

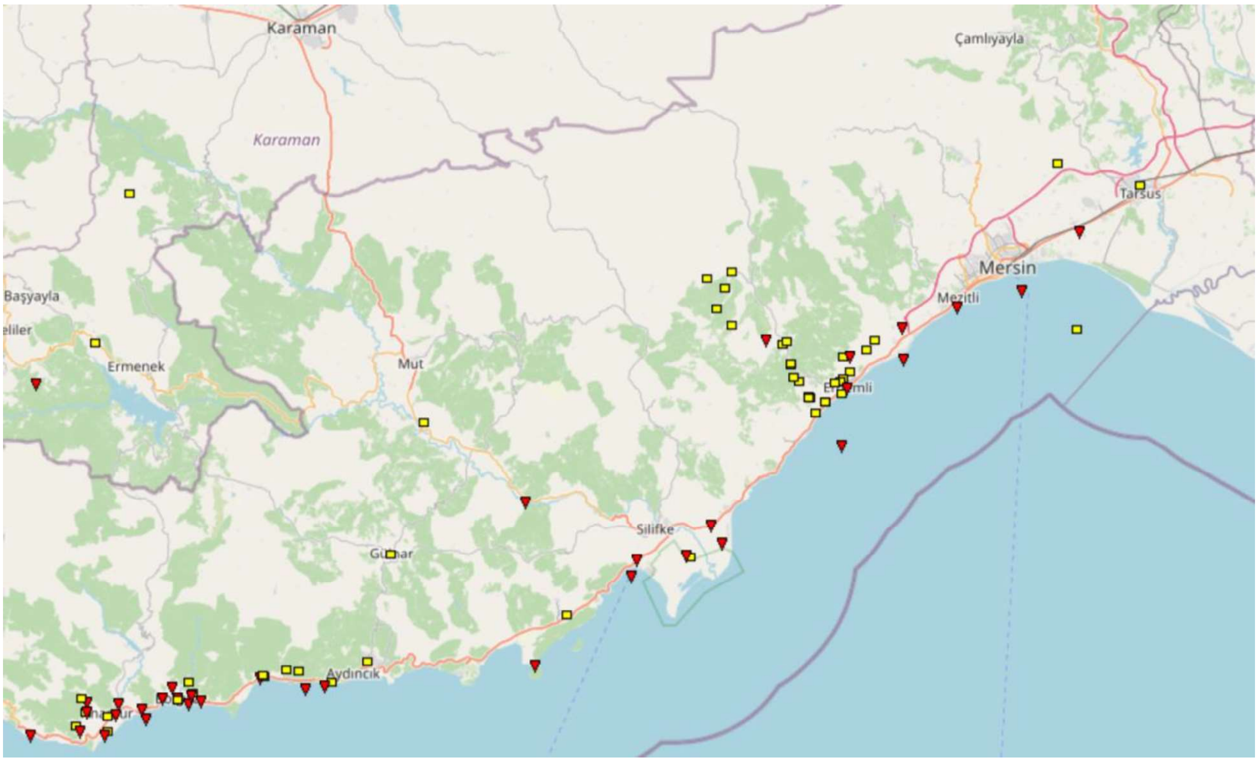


Figure 9.68: Areal distribution of storm and tornado events in Mersin (Yellow: Storm, Red: Tornado) **(ESWD, 2023)**

9.3.2.5 Hail

In the formation of hail, cooled water droplets in Cumulonimbus (Cb) clouds are carried by upward movements and rise above the freezing level and freeze into ice. High intra-cloud circulation causes hailstones to grow. Fast upward drafts in the cumulonimbus are a sign of very warm air on the ground and cold air at the upper levels. The temperature difference between the cloud base and the top is large. For this reason, hail events are usually observed in warm seasons. They are very rare in the colder months when the freezing level is at or near the ground.

Hail events can cause serious damage to structures and facilities in the city. Hail can also damage power lines and infrastructure. In addition, hail can also have negative impacts on the agricultural sector. It can damage agricultural products and disrupt the harvest period.

When we look at MGM's extreme weather events for the last 20 years (Figure 9.61), the frequency of encountering hail at least once a year is determined as 50% in Mersin's central districts, while it is calculated as 75% in other districts. The spatial distribution map of hail events in Mersin prepared by the European Severe Weather Center based on the information and data observed, reported or obtained from various news sources and verified during the period 2000 - 2022 is given in Figure 9.69. It can be seen that hail events are mostly experienced in Erdemli, Silifke and Tarsus regions.

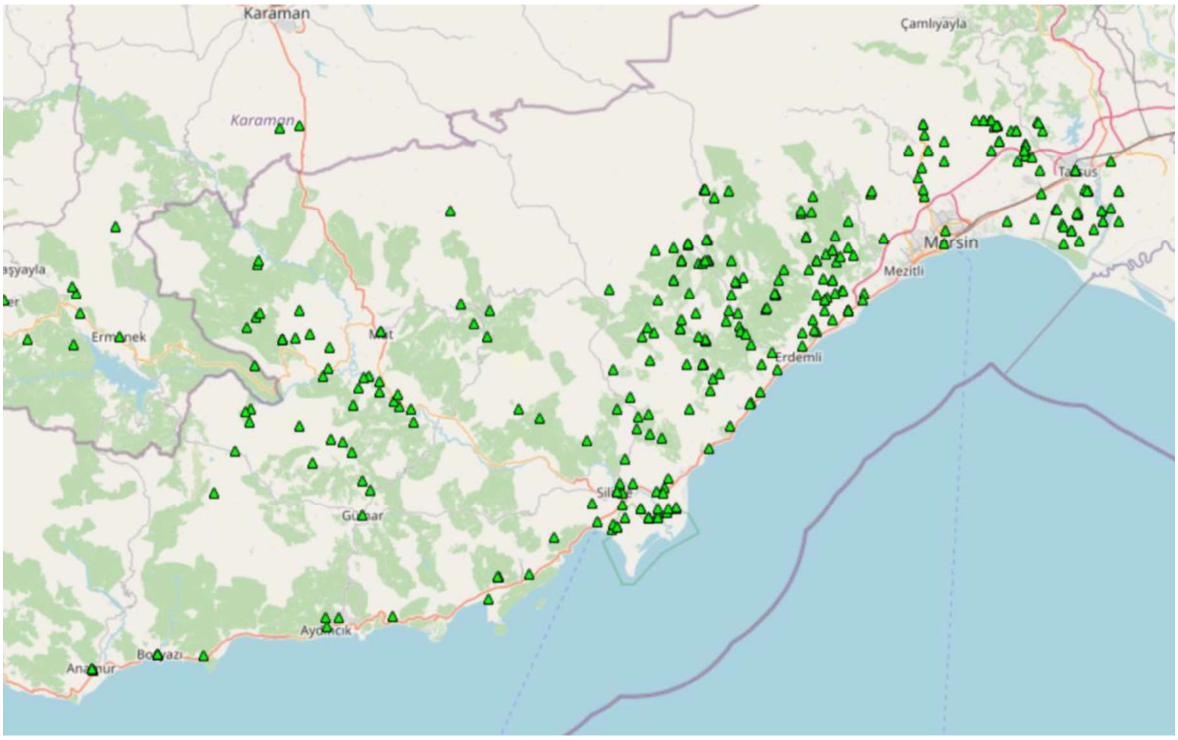


Figure 9.69: Areal distribution of hail events in Mersin (ESWD, 2023)

It is predicted that the probability of encountering hail events in the region today will continue with high frequency in the future periods due to high increases in surface temperatures and sudden changes to be experienced.

9.3.2.6 Snow

Snowfall is usually formed by stratiform clouds. However, if it is in the form of showers, it comes from cumuliform clouds. Temperature is important for snowfall to occur. The temperature at ground level must be close to 0°C, at or below zero degrees Celsius.

Heavy snowfall is one of the events that adversely affects life in many aspects, especially transportation in cities. When we look at MGM's disaster data for the last 20 years (Figure 9.61), we see that there has been no recorded snow event except for the central district. In the central districts of Mersin, the frequency of encountering snow disasters at least once a year is determined as 15%. As shown in Figure 9.42 and Figure 9.46, the number of icy days approaches 0 in each scenario, and the minimum of minimum temperatures rises above 0°C.

It is predicted that the probability of encountering snow and icing events experienced in the region today will not increase in the future periods due to high increases in surface temperatures and sudden changes to be experienced.

9.3.2.7 Lightning Strike

Lightning is a high-voltage electrification between the cloud and the ground. It is caused by the potential difference between the cloud and the ground, which have different electrical charges. Lightning occurs in vertically developed cumulonimbus (Cb) clouds, sometimes from the cloud to the ground and sometimes from the ground to the cloud. Lightning, thunder and downpours are symptoms of cumulonimbus clouds.

Lightning strikes can cause various adverse effects in urban areas, such as damage to buildings, fire risk, power outages and human health impacts. Lightning strikes can damage electrical systems in buildings, damaging roofs, walls and other components. Lightning strikes can also cause fires in buildings or surrounding vegetation. Lightning strikes can damage power lines or substations, leading to power outages. In addition to these effects, the energy waves generated by lightning strikes can harm people, causing electric shocks, burns and other serious injuries. Therefore, it should be taken into account that lightning strikes can cause serious problems in cities and necessary safety measures should be taken.

When we look at MGM's storm data for the last 20 years (Figure 9.61), the frequency of encountering storm and tornado disasters at least once a year in Mersin's central districts is determined as 15%, while it is calculated as 10% in other districts. Figure 9.70 shows the spatial distribution map of lightning strikes in Mersin prepared by the European Severe Weather Center based on the information and data observed, reported or obtained from various news sources and verified during the period 2000 - 2022. The number of lightning disasters recorded in the province is very low.

Currently, the increasing trend in the probability of encountering lightning strikes in the region is not significant. However, it is assumed that it will continue with similar frequency in the future due to high increases in surface temperatures and sudden changes in other climatic parameters.

Figure 9.70: Areal distribution of lightning strikes in Mersin (ESWD, 2023)

9.3.2.8 Wildfires

The Fire-Weather Index is an approach for estimating the intensity of fire danger and the size of potential fires, produced by considering as inputs the variables of air temperature, relative humidity, wind speed of 10 meters, and total precipitation in the previous 24 hours for each day. For the data calculated and published by Copernicus Climate Service, the 3-hour outputs of various global and regional climate models are used. These climate models consist of several models developed by EURO-CORDEX. With the RCA4-RCM model, the necessary evaluations for the indices are made and the critical values required for the calculation of the index are produced. The use of the index provides guidance on developing firefighting strategies and responding more effectively to fire incidents. This information has been compiled for Mersin province and the fire weather index and the number of days with fire hazard are presented in Figure 9.71 and Figure 9.72 for future years according to different scenarios.

If the fire weather index is between 38-50, the fire risk is defined as "very high"; if it is above 50, it is defined as "extreme". When the calculation results are analyzed, Mersin is characterized as one of the provinces with "very high" fire risk. Again, when the model results are evaluated, it is expected that there will be an increase in the number of days with forest fire risk for Mersin in the future. These results are important for firefighting teams to direct their resources more effectively and to be better prepared for fire hazards.

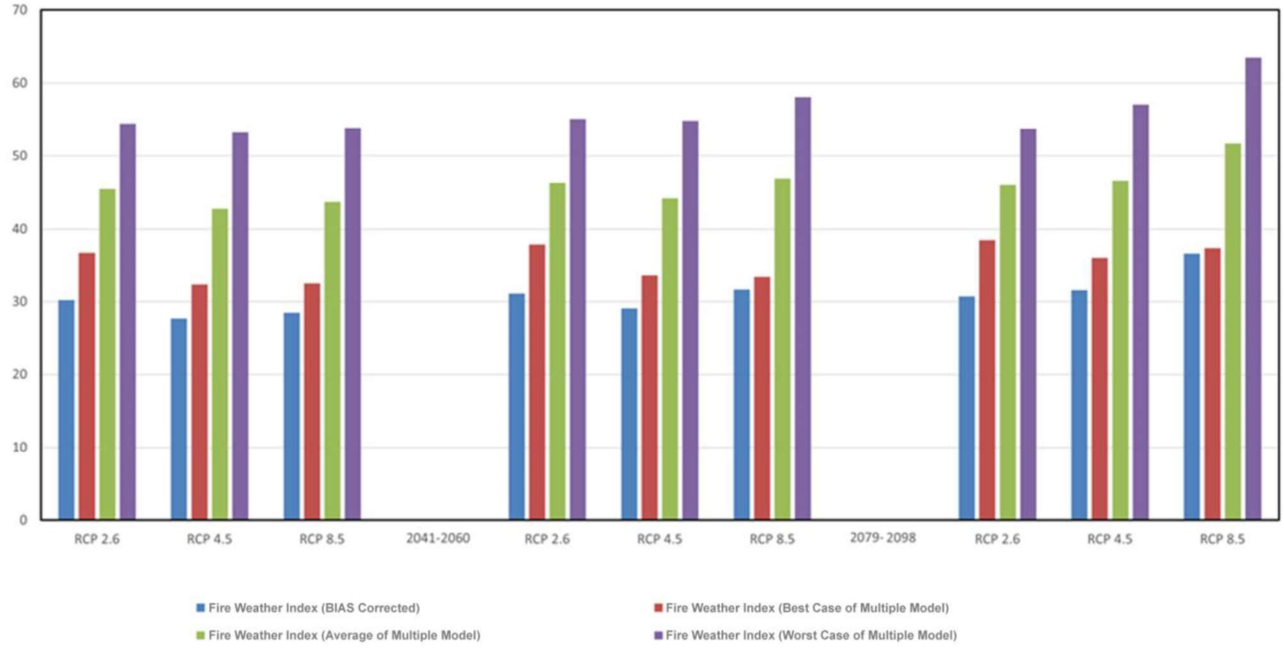


Figure 9.71: Average Fire Weather Index for Fire Season

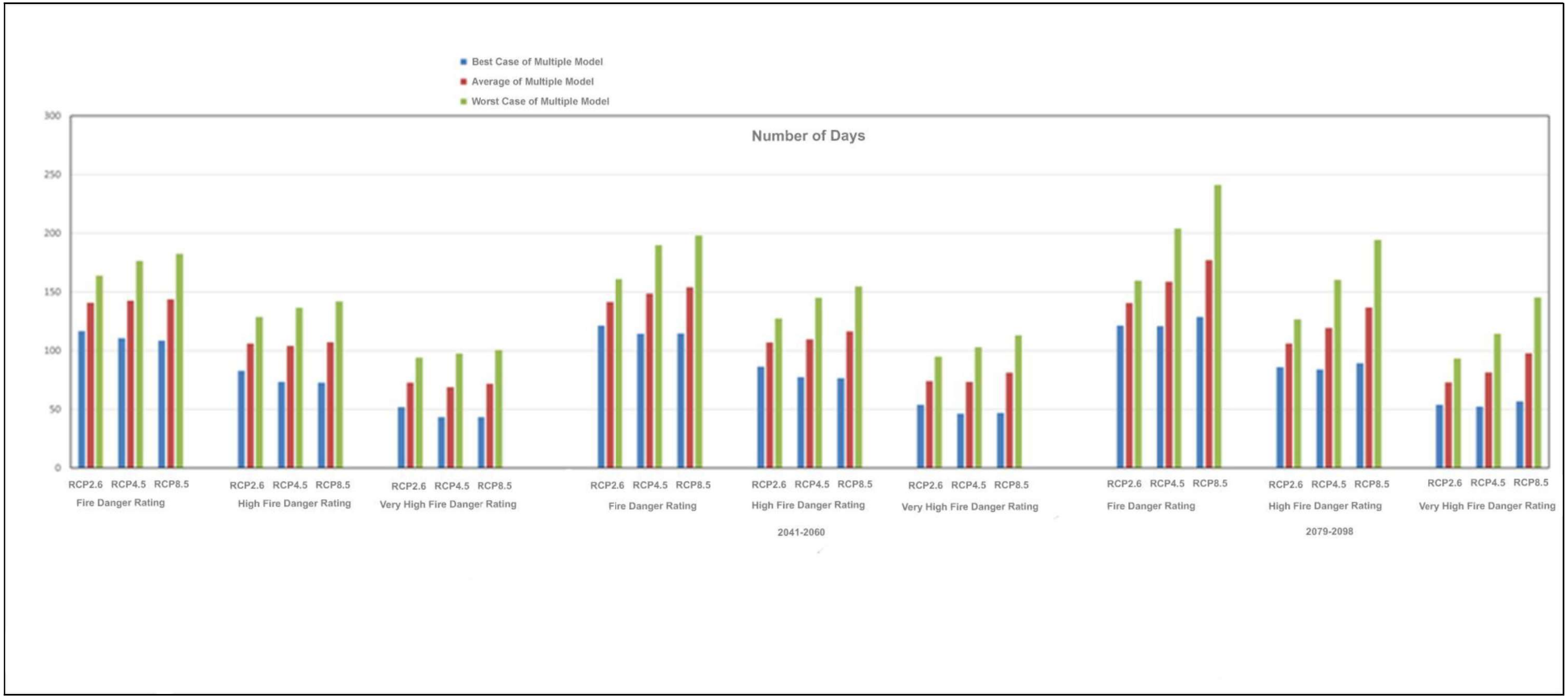


Figure 9.72: Number of days foreseen according to the Fire Danger Rating during the year

9.3.2.9 Sea Level Rise

According to the IPCC 6th Assessment Report, it is predicted that the melting of glaciers will increase with global warming and that these effects will be felt more severely especially at the poles. It is stated that water forms below sea level will also be affected by these effects and an increase in sea levels is expected. Global average sea level increases vary regionally. Since the 1970s, a rapid increase in sea level has been observed with the increase in anthropogenic impacts. The rise values, which were 1.4 mm/year in the 1901-1990 period, were observed as 2.1 mm/year in the 1970-2015 period and 3.2 mm/year in the 1993-2015 period. In the 2006-2015 period, this increase was observed to be 3.6 mm/year. According to the RCP 8.5 scenario, a sea level rise of 10-20 mm/year is predicted until 2100. Therefore, based on the information obtained, the negative situations that may be caused by sea level changes and storm waves in our country are as follows. The assessments within the scope of the study were made to cover Mersin and the Eastern Mediterranean coastline. IPCC 6th Assessment Report and NASA's "Sea Level Change and Projection Tool" were used as data sets. Results were obtained according to various SSP simulations with reference to the period 1995-2014. A reference point (Latitude: 36º, Longitude 34º) representing Mersin and the Mediterranean coastline was selected. The simulation results of the sea water level change at the selected location for the most pessimistic scenario (SSP5-8.5), the most optimistic scenario (SSP1-2.6) and the middle path (SSP2-4.5) are shown in Figure 9.73.

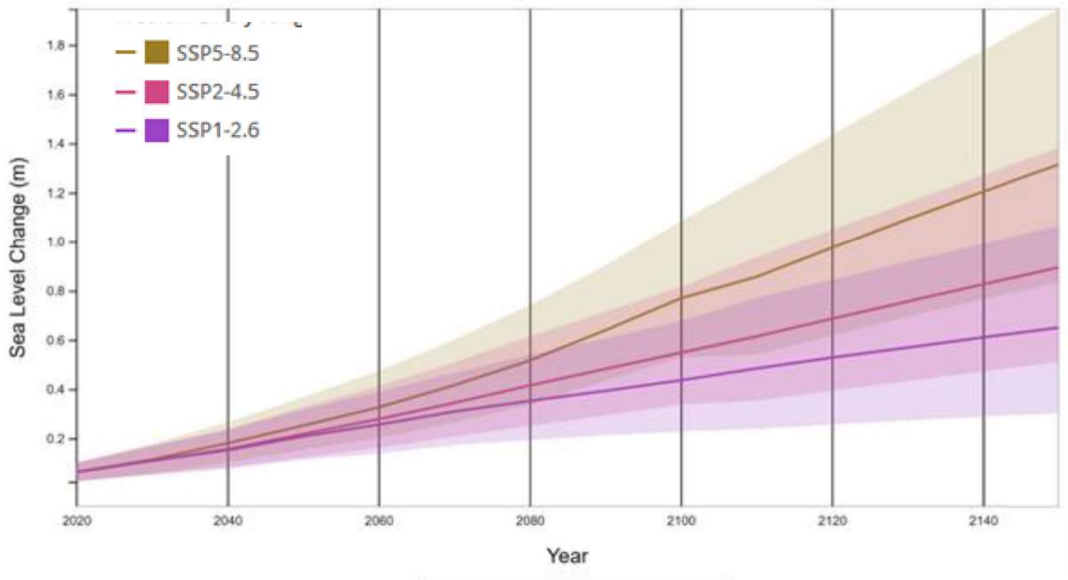


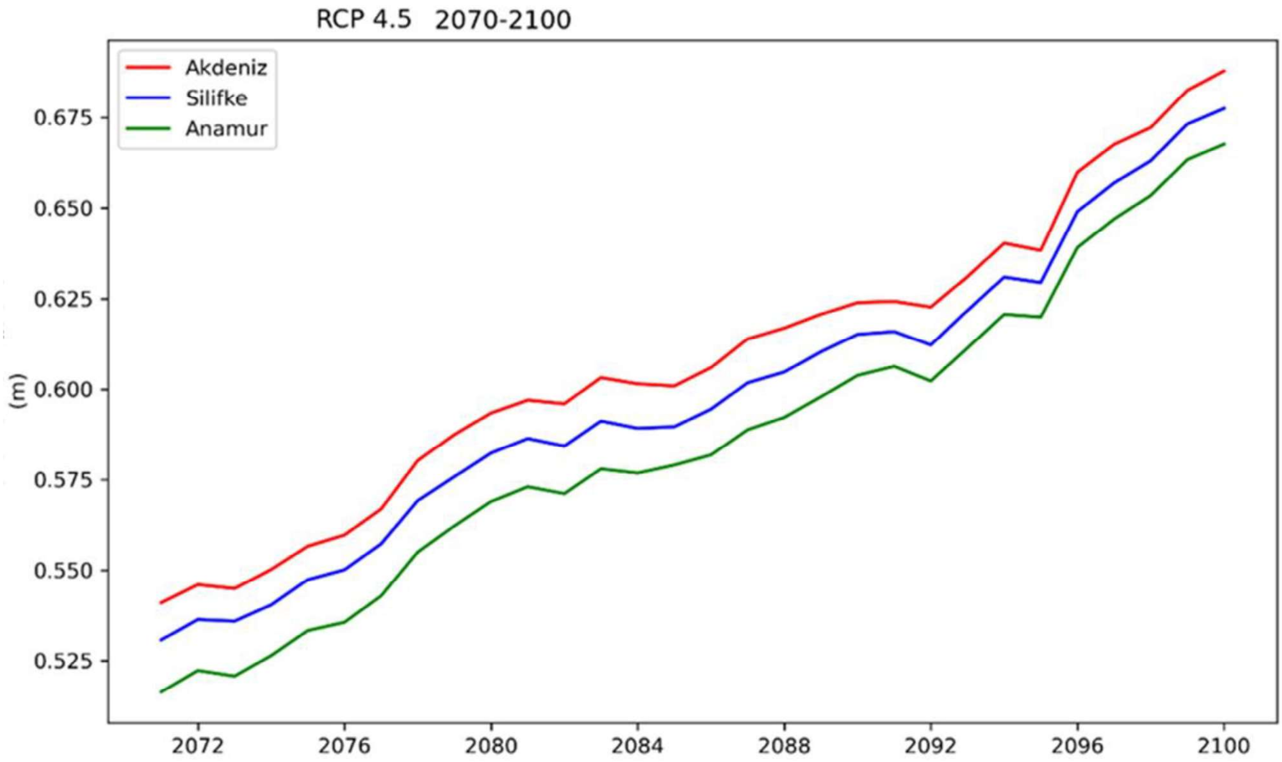
Figure 9.73: Sea level change according to SSP simulations

The change in the graph in Figure 9.73 for all scenarios and by years is given in detail in Table 9.6. According to the assessments, in the most optimistic scenario, the sea level in the region is projected to rise by approximately 0.2 m in 2050 and 0.35 m in 2100. In the worst case scenario, this increase is estimated to reach 0.25 m in 2050 and 0.8 m in 2100.

Table 9.6: Change values and total change amounts at the selected location point according to the SSP scenarios

	SSP1-1.9	SSP1-2.6	SSP2-4.5	SSP3-7.0	SSP5-8.5	SSP1-2.6 Low Confidence	SSP5-8.5 Low Confidence
Total Change (m) (2030)	0.11 (0.03–0.18)	0.11 (0.05–0.17)	0.11 (0.06–0.17)	0.11 (0.04–0.17)	0.11 (0.06–0.18)	0.11 (0.05–0.18)	0.12 (0.05–0.19)
Total Change (m) (2050)	0.18 (0.06–0.31)	0.21 (0.11–0.32)	0.22 (0.12–0.33)	0.23 (0.13–0.34)	0.25 (0.15–0.37)	0.21 (0.11–0.35)	0.26 (0.15–0.43)
Total Change (m) (2090)	0.35 (0.15–0.57)	0.39 (0.21–0.61)	0.48 (0.29–0.71)	0.56 (0.37–0.80)	0.64 (0.43–0.90)	0.40 (0.21–0.69)	0.71 (0.43–1.24)
Total Change (m) (2100)	0.35 (0.14–0.60)	0.44 (0.23–0.68)	0.55 (0.34–0.81)	0.66 (0.43–0.95)	0.77 (0.53–1.08)	0.45 (0.23–0.78)	0.88 (0.53–1.51)
Total Change (m) (2150)	0.53 (0.18–0.93)	0.65 (0.30–1.06)	0.90 (0.51–1.38)	1.13 (0.69–1.67)	1.31 (0.83–1.95)	0.70 (0.30–1.26)	1.96 (0.83–4.81)
Change Value (mm/yıl) (2040-2060)	4.0 (1.0–7.0)	5.0 (2.0–8.0)	5.0 (3.0–8.0)	6.0 (3.0–9.0)	7.0 (4.0–10.0)	5.0 (2.0–9.0)	7.0 (4.0–15.0)
Change Value (mm/yıl) (2080-2100)	2.0 (0.0–5.0)	4.0 (1.0–7.0)	6.0 (3.0–10.0)	9.0 (5.0–14.0)	11.0 (7.0–17.0)	4.0 (1.0–9.0)	15.0 (7.0–30.0)

Following the IPCC based time series, the period 2041-2070 was simulated for RCP 8.5 and the period 2071-2100 for RCP 4.5 using GTSM 3.0, Danish Meteorological Institute, EC-EARTH (GCM), HIRHAM5 (RCM) model configuration with various radiative forcing values (RCP 4.5 and RCP 8.5). The resolution on the coastline is specified as 0.1°x0.1°. In Mersin province, 3 points were selected to evaluate these simulation results. By entering the coordinates of Akdeniz (Center), Silifke and Anamur district center, the closest grid point on the sea was determined by the closest distance method and time series were plotted and given in Figure 9.74. At all 3 points, despite the optimistic scenario, a rise in sea level exceeding 0.6 meters is expected in 2100.



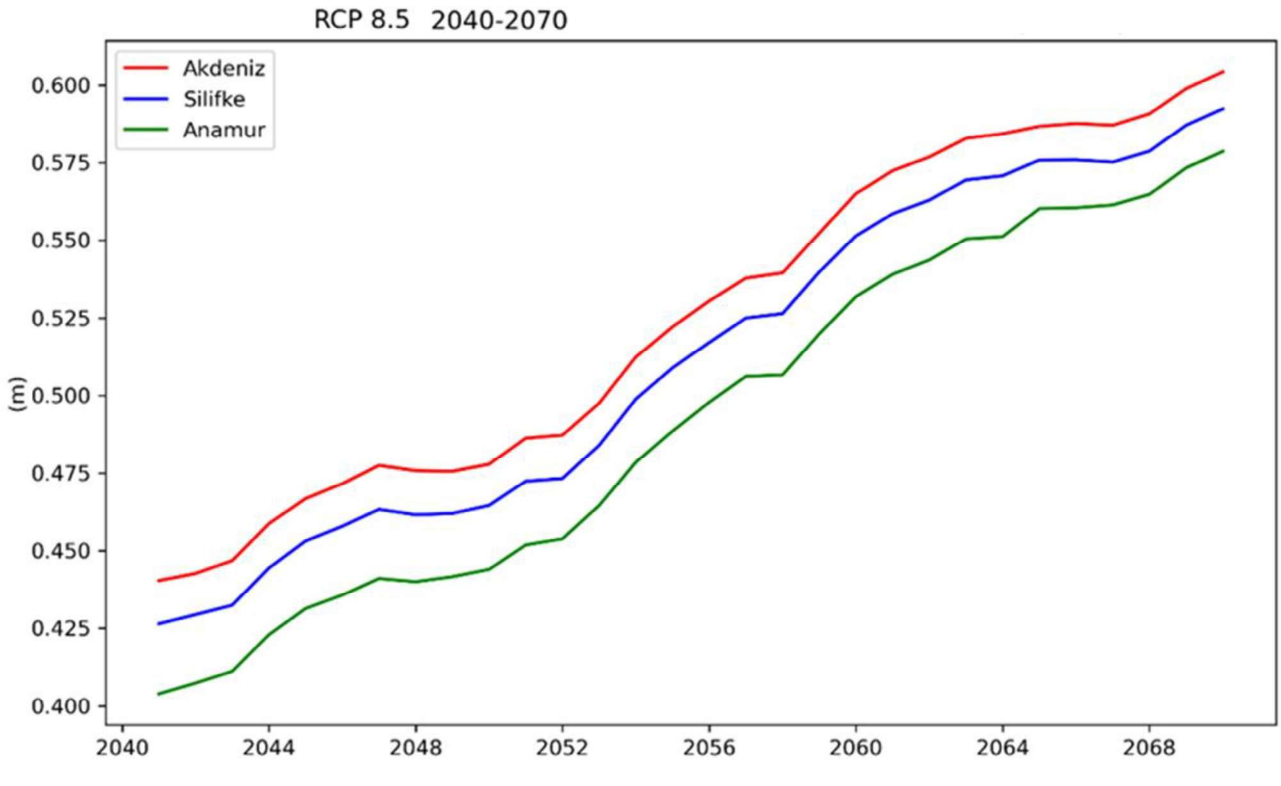


Figure 9.74: District-based sea level change according to RCP 4.5 (2070-2100) and RCP 8.5 (2040-2070) scenarios

As a result of two different assessments, the areas that will be affected in the province in case of a possible 0.8 m rise in sea level by 2100 are shown in Figure 9.75. It is thought that the sea level rise of approximately 0.8 m will affect Anamur and Silifke districts. Especially the Göksu Delta is predicted to be under risk.

Figure 9.75: Areas that would be affected if sea level rises by 0.8 m (Climate Central, 2023)

The expected changes in Eastern Mediterranean sea levels were obtained from Copernicus Climate Change Service based open access datasets. The purpose of these outputs is to predict sea level heights and to analyze the coastal changes such as coastal flooding and coastal erosion. The years 1951-1980 are taken as the reference period and the level changes in the target years are shown. According to the GTSM3.0-EC-EARTH-HIRHAM5 global climate model with RCP 8.5 scenario, the projected elevation values that will occur in the region by the end of 2050 are given in Figure 9.76.

According to this scenario and model, it can be said that by the end of 2050, up to 0.5 meters of rise in the coastline is predicted.

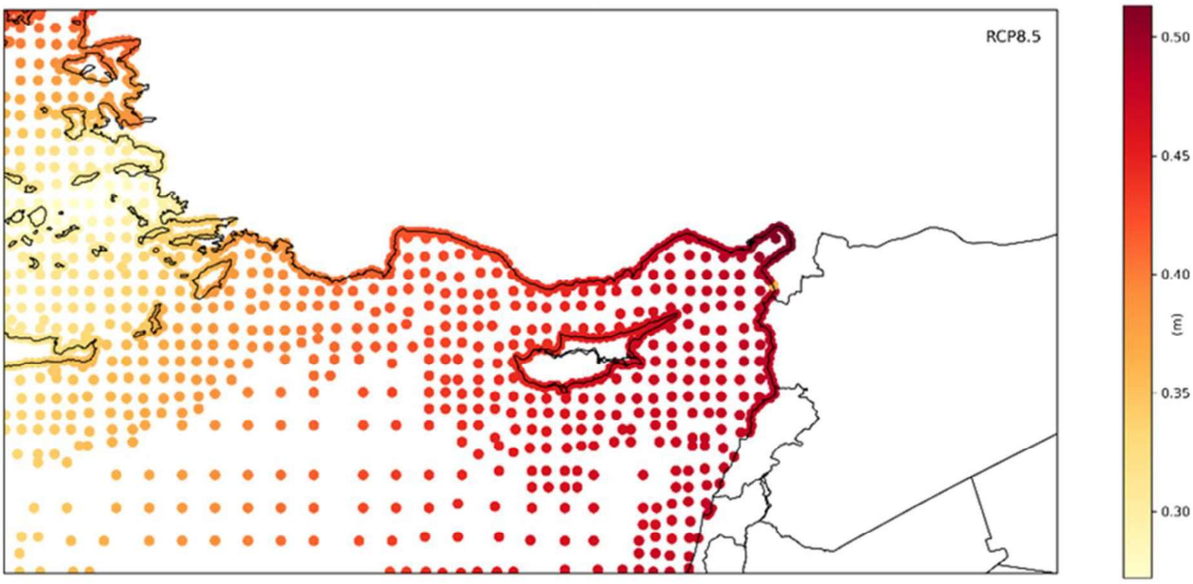


Figure 9.76: GTSM3.0-EC_EARTH_HIRHAM5 model sea level change in 2050

As a result of international studies, the increase in storm occurrences as a result of global climate change draws attention. "Storm surge" events, which are defined as storm waves, especially affect the settlement areas on the coastlines. Therefore, changes in sea levels and increases or decreases in the height of storm waves are important for coastal flooding. Storm wave heights are given in Figure 9.77. Although the wave heights caused by storms are generally distributed over the area in an increasing trend, especially in HadGEM3-based results as seen in Figure 9.77, it is also predicted to decrease in some places. Although the increases in these wave heights are quite limited compared to sea level rise, even the smallest increases in these waves are important in terms of coastal flooding and coastal erosion.

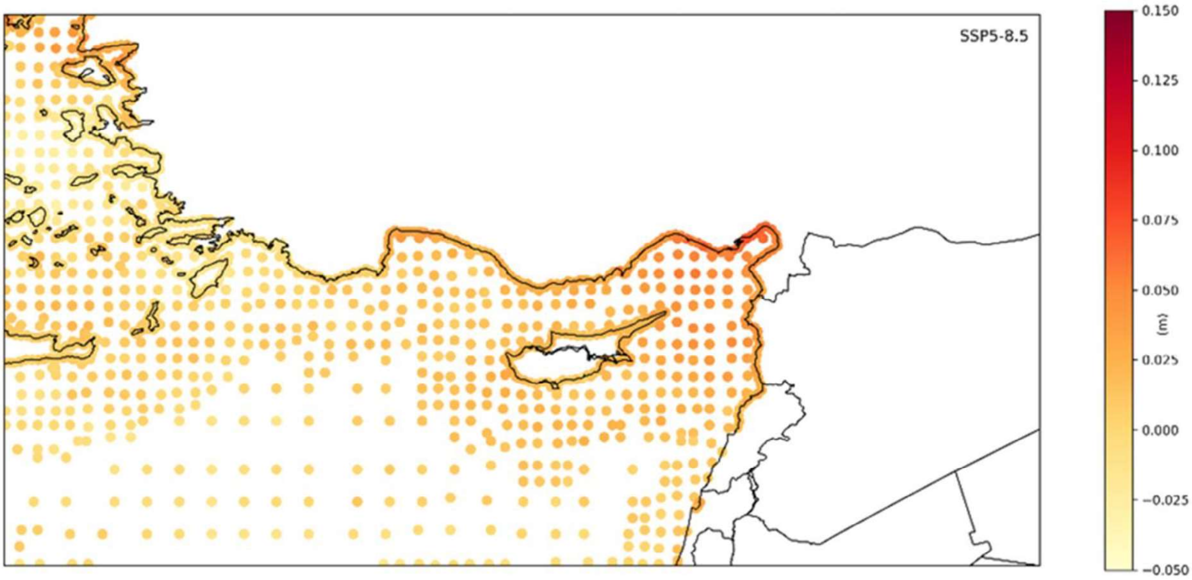


Figure 9.77: HadGEM3-GC31-HM-SST 2050 storm surge change

The projected increase in sea level and storm-induced wave heights in the region is expected to affect many sectors such as people living on the coastal line, commercial activities, transportation lines near the coast. According to the information obtained in most coastal flooding studies, digital elevation maps are used to define areas and simulate flood water heights and sea level rise along the coastline (Sande et al., 2012). Coastal flood risk analyses are performed by correlating the probability of flooding with the elevation obtained from the digital elevation map and the ratio of land/sea distribution on the coastline, as well as the socio-economic activities on the coastline. While conducting these analyzes, the lowest height level for risk management and identification of risky areas in coastal areas is taken as 5m (Elco et al., 2023). It is important to identify areas above and below 5 meters. In addition, taking into account the medium-scale weather movements that may occur on the coastline and storm-induced waves, which are called sea swell and are highly observed on the coastlines, it is very important to identify areas between 5m-10m and observe their distance to the shore. It was determined that the recurrence period was 1/200 years and a sea level rise of 2 meters increased the coastal flooding rate by 21% compared to the SRTM data (Elco. et al., 2022). However, it is also stated that simulations or risk analyzes created with digital elevation maps make high predictions compared to real events. In this context, areas likely to be affected by sea level and storm waves such as the topography and coastal flood risk map created for Mersin province in Figure 9.78 have been identified.

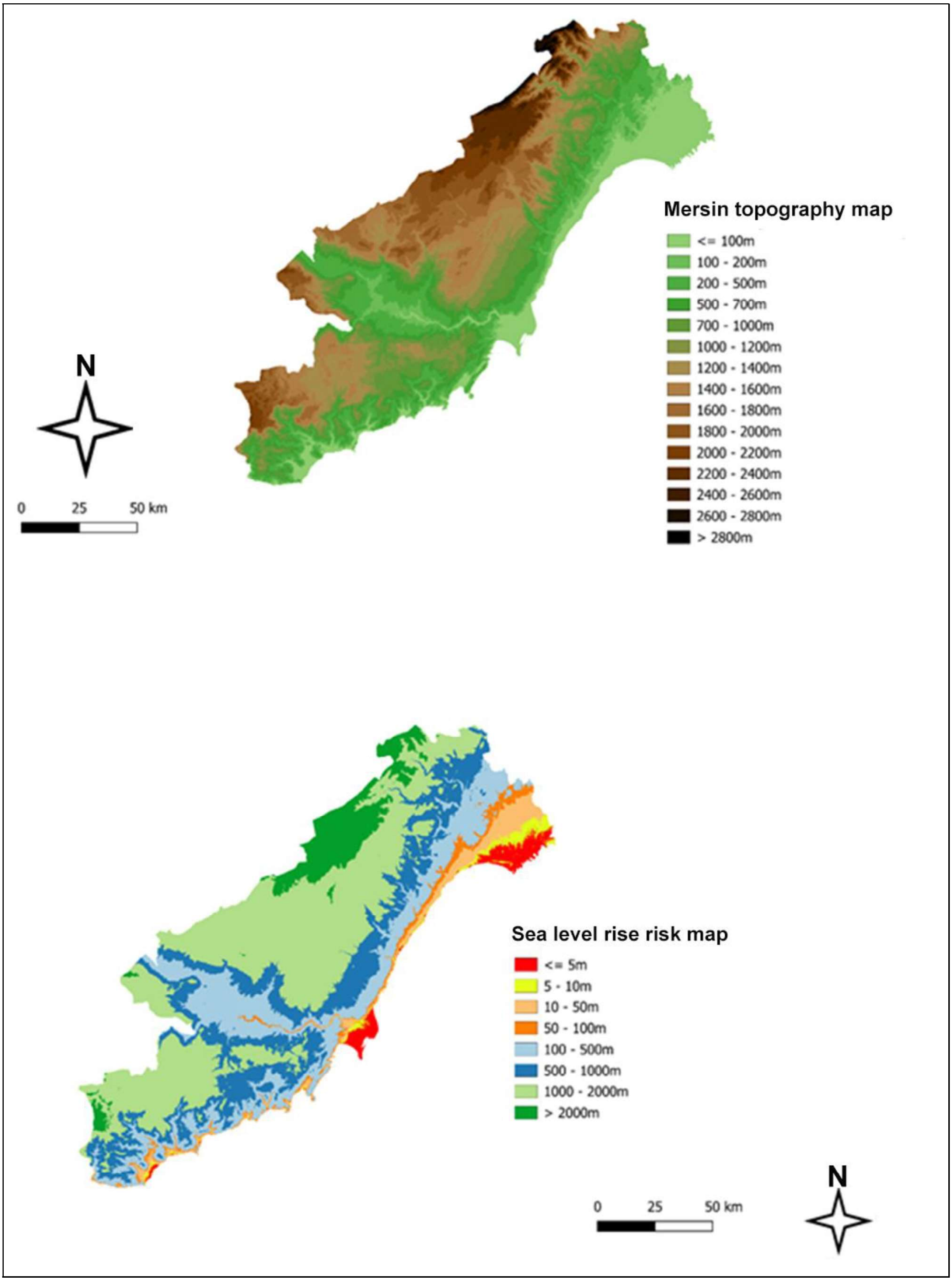


Figure 9.78: Mersin topography map and sea level rise risk map

Rises in sea level cause flooding of coasts and land, rise in groundwater levels and salinization in coastal plains, disruption of ecological balance, coastal erosion and soil loss. In addition to the physical effects of these impacts on coastal settlements, uses, marine structures, and agricultural production, there is a risk of multifaceted consequences on ecosystem and socio-economic processes.

9.3.3 Determination of the Probability of Occurence of Each Climate Risk

Identifying climate risks requires knowing the frequency of events that occurred in the past. For this reason, past climatological data, reports, model results and other data sources are evaluated to determine the risks of climate change. These data also help to produce anticipations about how the climate will change in the future. Thus, identifying climate risks should be considered as a valuable input in shaping future policies and strategies.

For the probability scoring of the climate risks identified within the scope of the study, an assessment was made according to the number of times these events were encountered at least once a year in the past years and the probability of encountering these risks once a year in the coming period. This assessment is based on the frequency of events in past years and future probabilities.

This assessment is an important step to determine the likelihood of climate risks and to be prepared for them. The number of times this event has occurred in previous years shows how often it has occurred. The likelihood of encountering these risks in the coming period is a factor that should be taken into account in future planning and risk management strategies.

The probability table obtained as a result of the frequency of occurrence of climate risks for Mersin province is given in Table 9.7. Weather reports published by the General Directorate of Meteorology, meteorological station data, regional climate projections of MGM (HadGEM2-ES) and average values of the results of all global climate models were obtained and used in the studies. When the results are analyzed, temperature increase, storms and tornadoes, forest fires, excessive rainfall and flooding are identified as the most likely climate risks. Drought, on the other hand, is not seen as a serious first risk for today, but it will most likely be a risk that the Mersin will face in 2050.

Table 9.7: Probability of climate risks occurring in Mersin

Climate Risks	Evaluation Criteria	2023 Likelihood Level	2050 Likelihood Level	Change
Temperature Increase	Maximum Temperature, Warm Period Duration	**5** (Very High Probability)	**5** (Very High Probability)	↔
Drought	Number of Dry Days, SPEI 12	**2** (Low Probability)	**4** (High Probability)	↑
Extreme Rainfall and Flooding	Number of events, Number of days with more than 20mm/day rainfall, Daily max. rainfall	**4** (High Probability)	**5** ((Very High Probability)	↑
Storm and Tornadoes	Number of Events	**5** ((Very High Probability)	**5** ((Very High Probability)	↔
Hail	Number of Events	**4** (High Probability)	**4** (High Probability)	↔
Snow	Number of Events, Number of Icy Days and Min. Min. of Temperatures Climate Indices	**1** (Very Low Probability)	**1** (Very Low Probability)	↔
Lightning Strike	Number of Events	**2** (Low Probability)	**2** (Low Probability)	↔
Forest Fires	Fire Weather Index	**4** (High Probability)	**4** (High Probability)	↔
Sea Level Rise	Sea level height	**1** (Very Low Probability)	**3** (Possible)	↑

9.3.4 Identification of Sectors and Critical Infrastructures

Critical infrastructure refers to networks, assets, systems, structures or combinations thereof that may have impacts on the health, safety and economy of citizens due to the adverse effects of possible partial or complete loss of function on the environment, community order services (AFAD, 2014).

When identifying the sectors and critical infrastructures that will be affected by climate change in cities, it should be taken into account which sectors and infrastructures will be more at risk. The vulnerability of sectors and infrastructures to climate change and their role in meeting the basic needs of society and economic growth are important. The authority and capacity of local governments to adapt sectors and infrastructures to climate change and increase their resilience should also be determined.

onsidering these criteria, sectors and critical infrastructures that will be affected by climate change have been identified and given in Table 9.8.

Table 9.8: Sectors and critical infrastructures assessed within the scope of adaptation measures

Sectors	Critical Infrastructure
Urban life	• Residential buildings • Public buildings • Hospital buildings and other health institution buildings • Education buildings • Hotels • Commercial premises • Construction activities
Energy and Industry	• Thermal power plants

Sectors	Critical Infrastructure
	• Renewable energy plants • Energy transmission and distribution network • Pipelines • Industrial facilities • Organized Industrial Zones • Raw material supply chain • Energy supply • Logistics • Water use • E-Commerce • Staff
Transportation infrastructure	• Roads, bridges and tunnels • Road transportation • Rail system lines • Rail transportation • Ports and piers • Sea transportation
Solid waste and wastewater management	• Waste storage facilities • Solid waste biological processing plants • Waste incineration plants • Wastewater treatment plants • Waste recovery and recycling facilities • Medical waste sterilization facilities
Agriculture and livestock	• Animal presence • Meadow and pasture lands • Agricultural land • Agricultural enterprises
Water resources	• Surface and groundwater resources • Basins • Dams • Water tanks • Water and wastewater treatment plants • Drinking water transmission lines, sewerage system and wastewater discharge lines
Forest areas	• Forest areas • National Parks • Flora • Fauna • Land ecosystem
Coastal areas	• Ports • Other transportation structures • Marinas • Tourism facilities • Commercial buildings • Energy and industrial facilities • Water and wastewater infrastructure • Coastal settlements
Fisheries	• Fishing shelters • Fishing fleet • Fish farming facilities • Fish farms • Processing and evaluation facilities
Tourism and cultural heritage	• Accommodation facilities • Coastal areas and beaches • Historical and cultural touristic areas

Sectors	Critical Infrastructure
	• Museums and cultural centers • Theaters and cinemas • Travel agencies

9.3.5 Assessment of the Impacts of Climate Risks by Sector

Climate change has become a rapidly increasing problem in recent years and the impacts of these changes on urban infrastructures are also increasing. These impacts vary for each sector and critical infrastructure. For example, increasing temperature and energy demand in cities can negatively affect energy infrastructure. Therefore, power generation based on renewable energy sources and infrastructure improvements can be made to increase energy efficiency. Climate change may lead to reduced water resources and increased flooding. Therefore, infrastructure improvements can be made to protect water resources in cities, strengthen water collection and storage systems, and ensure more efficient use of water. In addition, more frequent heavy rains can cause roads to become flooded. This can make it difficult to maintain safe transportation. In conclusion, the impacts of climate risks on sectors and their critical infrastructures vary considerably and may have different consequences on each critical infrastructure. The dimensions of these impacts were asked in the survey and it was requested to determine the impact of climate risks on the sector to which they relate. Impacts were evaluated on a scale of 1 (Very Low Impact) to 5 (Very High Impact) and the impact table prepared following the survey results is given in Table 9.9.

Table 9.9: Scale of impact of climate risks on sectors

	Temperature Increase	Drought	Extreme Rainfall and Floods	Storms and Tornadoes	Hail	Snow	Lightning strike	Forest Fires	Sea Level Rise
Water Resources	5	5	3	2	3	3	2	4	3
Coastal Areas	4	4	3	3	3	3	2	4	5
Waste Management	4	4	3	2	3	3	2	4	3
Public Health	4	4	3	3	3	3	3	4	3
Agriculture, Livestock and Fisheries	5	5	4	4	4	3	2	4	4
Land Use, Ecosystem and Biodiversity	5	5	4	3	3	3	2	5	4
Transportation and Logistics	4	4	4	4	4	3	2	4	4
Buildings	4	4	4	3	4	3	3	4	4
Energy Generation and Transmission	4	4	4	4	3	3	3	4	3
Industry	4	4	4	3	3	2	2	4	3
Culture and Tourism	4	4	4	4	3	3	2	4	4

9.3.6 Risk Assessment

Risk matrices have been prepared to assess the potential climate risks for Mersin province and their potential impacts on sectors. A risk matrix is used to assess risk by considering the likelihood of an event occurring and weighing it against its corresponding impact. When creating a risk matrix, each potential impact is assigned a risk rating based on its likelihood of occurrence and what the consequences (severity) would be if it were to occur. In the risk matrix prepared within the scope of the study, the risk is classified in 3 categories as High, Medium and Low. Table 9.10 shows the 2023 risk matrix and Table 9.11 shows the 2050 risk matrix obtained as a result of the probability-impact assessment conducted for Mersin.

As a result of the risk and vulnerability analysis, temperature increase, storms and tornadoes, hail, heavy rainfall and flooding create high risks on critical infrastructures. In 2050, drought is categorised under high risk category for the region. Heavy snowfall and lightning strikes are climate events in the low risk category for the region. Sea level rise, which is defined as low risk in the current situation analysis, increases to medium risk class in the 2050 analysis. It has been determined that urban life, transport infrastructure, agriculture and animal husbandry are the sectors most affected by climate events today. However, it is predicted that coastal areas will also be included in this class in the future. All sectors are at high risk of being affected by different climate events. Therefore, actions to mitigate these risks should be implemented by local administrations. For this purpose, actions that will strengthen the adaptation capacity of Mersin province against climate change and increase its resilience are proposed for all sectors included in the analysis.

Table 9.10: Current situation risk matrix for Mersin

Climate Risks	Sectors									
	Urban Life	Energy and industry	Transportation infrastructure	Solid waste and wastewater management	Agriculture and livestock	Water resources	Forest areas	Coastal areas	Fisheries	Tourism and cultural heritage
Temperature Increase	High	High	High	High	High	High	High	High	High	High
Drought	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Heavy Rainfall and Flooding	High	High	High	Medium	High	Medium	High	Medium	High	High
Storms and Tornadoe	High	High	High	Medium	High	Medium	High	High	High	Medium
Hail	High	Medium	High	Medium	High	Medium	Medium	Medium	Medium	Medium
Snow	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Lightning Strike	Medium	Medium	Low	Low	Low	Low	Low	Low	Low	Low
Wildfires	High	High	High	High	High	High	High	High	Medium	High
Sea Level Rise	Low	Low	Low	Low	Low	Low	Low	Medium	Low	Low

Table 9.11: Risk matrix for Mersin in 2050

Climate Risks	Sectors									
	Urban Life	Energy and industry	Transportation infrastructure	Solid waste and wastewater management	Agriculture and livestock	Water resources	Forest areas	Coastal areas	Fisheries	Tourism and cultural heritage
Temperature Increase	High	High	High	High	High	High	High	High	High	High
Drought	High	High	High	High	High	High	High	High	High	High
Heavy Rainfall and Flooding	High	High	High	High	High	High	High	High	High	High
Storms and Tornadoe	High	High	High	Medium	High	Medium	High	High	High	High
Hail	High	Medium	High	Medium	High	Medium	Medium	Medium	Medium	Medium
Snow	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Lightning Strike	Medium	Medium	Low	Low	Low	Low	Low	Low	Low	Low
Wildfires	High	High	High	High	High	High	High	High	Medium	High
Sea Level Rise	Medium	Medium	Medium	Medium	Medium	Medium	Medium	High	Medium	Medium

10. MITIGATION AND ADAPTATION ACTIONS

10.1. Actions for Greenhouse Gas Mitigation

In the light of the Greenhouse Gas Emission Inventory (Chapter 4) and Greenhouse Gas Emission Projections and Mitigation Analyses (Chapter 8) prepared for Mersin province, mitigation actions have been determined in general terms and the action scopes have been detailed by taking into consideration the interviews with the project stakeholders and the previous planning studies prepared in Mersin. In this framework, information on priority actions and sub-actions determined on sectoral basis are given in Table 10.1 - Table 10.9. While detailing the action contents, information on the institutions that may be responsible for the implementation of the action and the stakeholders that may contribute to the implementation, the implementation period of the action, performance indicators, risks and opportunities that may occur during implementation are also included in the tables. During the stakeholder meetings held in Mersin on 24-25 August 2023, stakeholders' opinions on the responsible and relevant institutions, performance indicators and targets for the mitigation actions determined within the scope of the action plan were received through verbal notifications and the actions were finalised.

Table 10.1: Stationary energy – Action AS1

ACTION AS1	**Increasing energy performance with thermal insulation applications in existing and new buildings**
Sub-actions	AS1.1: To prepare a building inventory in order to determine the current situation
	AS1.2: To establish incentive mechanisms for obtaining energy identity certificates for existing buildings and for carrying out thermal insulation works for low EPC class buildings (e.g. reduction in taxation procedures, development and promotion of low-interest loan facilities)
	AS1.3: To examine buildings of Mersin Metropolitan Municipality in terms of energy performance, to create a system for monitoring energy consumption and to prepare a road map for the transformation of these buildings
Responsible departments of MBB	Mersin Metropolitan Municipality (Directorate of Climate Change and Zero Waste, Directorate of Housing and Urbanisation, Directorate of Technical Works, Directorate of Studies and Projects)
Main stakeholders of the implementation	District Municipalities (responsible), Mersin Governorship, Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, Çukurova Development Agency, Chamber of Architects, Chamber of Civil Engineers, Chamber of Mechanical Engineers, Chamber of Electrical Engineers, property owners
Implementation period	Short-medium
Performance indicators	- GIS based building inventory - Number of training and awareness-raising activities - Number of incentive mechanisms - Number of houses benefiting from incentive mechanisms - Amount of area under urban transformation - Municipality buildings energy consumption monitoring system - Roadmap for the transformation of municipal buildings - Number of buildings undergoing transformation

Performance goals	- By the end of 2025, a GIS-based building inventory will be established where all inventories of provincial and district municipalities will be brought together. - At least 2 events (workshops, awareness-raising meetings, etc.) will be organised every year on EPC and thermal insulation applications. - By the end of 2035, half of the existing buildings will fulfil the requirements of EPC Class C. - By the end of 2025, a system (which can be considered within the scope of ISO 50001 Energy Management System certification) will be established to monitor the energy consumption of municipal buildings. - By the end of 2025, a roadmap for the transformation of municipal buildings will be prepared. - By the end of 2026, investments will be made to improve energy performance (e.g. thermal insulation) in 2 selected buildings.
Sources of funding	- National budget (Ministry of Environment, Urbanisation and Climate Change), Budget of Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, provincial and district municipalities' own revenues, Çukurova Development Agency, national (İlbank) and international bank loans, property owners
Risks	- Difficulties in obtaining funding - Insufficient human resources
Opportunities	- Urban transformation works - Supports provided within the scope of energy efficiency in residential buildings - Contribution to the Sustainable Development Goals (SDGs 7, 11 and 13) - Contribution to 2053 goals and Green Development Revolution

Table 10.2: Stationary energy – Action AS2

ACTION AS2	**Reducing coal consumption in residential and commercial buildings, using efficient heating, cooling and lighting systems**
Sub-actions	AS2.1: To extend the use of natural gas throughout the province
	AS2.2: To encourage the use of alternative energy sources such as solar energy, geothermal energy, heat pumps, waste heat/hot water from industrial plants, etc. for heating and water heating purposes
	AS2.3: To carry out awareness-raising activities for promoting the use of energy-efficient lighting and household appliances in residential and commercial buildings, to use alternative systems for street lighting
	AS2.4: To increase the installed capacity of renewable energy production facilities within Mersin Metropolitan Municipality
Responsible departments of MBB	Mersin Metropolitan Municipality (Directorate of Technical Works, Directorate of Climate Change and Zero Waste, Directorate of Human Resources and Training)
Main stakeholders of the implementation	District Municipalities (responsible), Mersin Governorship, Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, Mersin Provincial Directorate of Industry and Technology, Mersin Water and Sewerage Administration (MESKİ), Çukurova Development Agency, chambers of agriculture, Chamber of Mechanical Engineers, Chamber of Electrical Engineers, Chamber of Architects, property owners, Toroslar Electricity Distribution Company, Aksa Natural Gas Çukurova General Directorate
Implementation period	Short-medium

Performance indicators	- Rate of access to natural gas - Number of natural gas subscribers - Increase in natural gas consumption rate - Number of households and workplaces using coal - Amount of coal consumed in residential and commercial buildings - Number of incentive mechanisms - Number of events organised and participation rate - Proportion of renewable energy in domestic consumption - Number of awareness-raising activities - Amount of efficient lighting systems purchased - Quantity of home appliances purchased with higher energy efficiency - Change in electricity consumption in residential buildings - Amount of energy consumption for lighting purposes - Number of advanced street lighting systems (e.g. LED, solar-based systems) - Installed capacity of renewable energy facilities - Amount of electricity generated - Number of R&D projects developed for renewable energy production - Number of feasibility studies developed on alternative energy sources
Performance goals	- By the end of 2025, support mechanisms for natural gas infrastructure investments will be proposed in cooperation with organisations providing coal aid and natural gas distribution companies. - As of 2035, coal will not be used in residential buildings. - At least 1 event (workshop, awareness raising meeting, etc.) will be organised every year for the use of alternative energy sources. - By the end of 2025, events will be organised in cooperation with the municipality and private companies in order to bring together the companies carrying out the installation of renewable energy facilities and the public. - By the end of 2025, at least one awareness-raising campaign (advertising film or billboard design, etc.) will be organised on energy efficiency in residential buildings. - At least 2 events (workshop, awareness-raising meeting, etc.) will be organised every year on energy efficiency in residential buildings. - At least one pilot study will be carried out each year for renewable energy applications. - By the end of 2025, feasibility studies will be carried out for renewable energy facilities planned to be established within the framework of municipal subsidiaries and buildings. - By the end of 2026, areas (e.g. coastline, landscape areas, water reservoirs, Climate and Environment Science Centre) that may be suitable for the installation of roof and/or ground mounted solar panels throughout Mersin will be evaluated. - By the end of 2027, total installed renewable energy capacity of Mersin Metropolitan Municipality facilities will be increased by 10% compared to 2022. - By the end of 2026, one R&D project will be prepared/supported for the evaluation of alternative renewable energy sources.
Sources of funding	- National budget (Ministry of Environment, Urbanisation and Climate Change, Ministry of Industry and Technology), Budget of Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, provincial and district municipalities' own revenues, Çukurova Development Agency, national (İlbank) and international bank loans, property owners
Risks	- Difficulties in obtaining funding - Insufficient human resources - Limited space for roof-mounted solar panel applications
Opportunities	- Improved air quality - Supports provided within the scope of energy efficiency in residential buildings - Contribution to the Sustainable Development Goals (SDGs 7, 11 and 13) - Contribution to 2053 goals and Green Development Revolution

Table 10.3: Transportation – Action AU1

ACTION AU1	Increasing the use of electric vehicles
Sub-actions	AU1.1: To increase the number of charging stations, implementing incentive systems to increase the rate of electric vehicle use
	AU1.2: To establish low emission zones
Responsible departments of MBB	Mersin Metropolitan Municipality (Directorate of Transportation)
Main stakeholders of the implementation	District Municipalities, Mersin Governorship, Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, Directorate of Highways Mersin 5. Regional Office, Çukurova Development Agency, Chamber of Mechanical Engineers, Chamber of Electrical Engineers, Toroslar Electricity Distribution Company, vehicle owners
Implementation period	Short-medium-long
Performance indicators	- Number and distribution of charging stations - Number of electric vehicles - Transformer capacity - Number of Low Emission Zones (LEZs)
Performance goals	- Until the end of 2025, 10 electric buses will be purchased and solar energy system supported charging station infrastructure will be established. - By the end of 2035, the number of electric buses will be increased to at least 75. - By the end of 2026, infrastructure works for electric vehicles will be prioritised by establishing cooperation with the electricity distribution company (e.g. area allocation). - By the end of 2026, LEZs will be planned. - By the end of 2030, planned LEZs will be established.
Sources of funding	- National budget (Ministry of Transport and Infrastructure), Budget of Directorate of Highways Mersin 5. Regional Office, provincial and district municipalities' own revenues, Çukurova Development Agency, national (İlbank) and international bank loans, vehicle owners
Risks	- High initial investment costs - Inadequate infrastructure
Opportunities	- Reduction of noise and air pollution from road traffic - Incentives for charging station installation

Table 10.4: Transportation – Action AU2

ACTION AU2	Increasing the efficiency of public transportation
Sub-actions	AU2.1: To expand the public transportation network, to increase the share of rail system lines in public transportation
	AU2.2: To replace vehicles used for public transportation with more efficient and clean-fuel vehicles
	AU2.3: To implement practices encouraging the use of public transportation (transfer options, discounted tickets, etc.)
	AU2.4: To complete the Public Transportation Emergency Action Plan within the scope of Mersin Transportation Master Plan
Responsible departments of MBB	Mersin Metropolitan Municipality (Directorate of Transportation)

Main stakeholders of the implementation	District Municipalities, Mersin Governorship, Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, Directorate of Highways Mersin 5. Regional Office, vehicle owners, Mersin Chamber of Drivers and Automobiles, Tradesmen, Çukurova Development Agency
Implementation period	Short-medium-long
Performance indicators	- Public transportation network length - Distribution of public transportation network throughout the province - Number of new public transportation lines - Number and length of completed rail system lines - Number of passengers using rail systems - Number of electric public transportation vehicles - Average age of public transportation vehicle fleet - Emission technology of public transportation vehicles - Fossil fuel consumption - Number of passengers using public transportation - Number of incentive mechanisms - Public Transportation Emergency Action Plan
Performance goals	- Integration studies between the rail system routes and the transportation modes to be built in the centre and other districts in line with the development of the city will be completed and new routes will be given to rural areas and neighbourhoods where access problems are experienced. - Prioritised rail system lines will be completed by the end of 2035. - By the end of 2035, sustainable actions focused on bicycle, pedestrian and rail system will be switched to park-and-ride method. - By the end of 2035, at least 50% of diesel fuelled buses will be replaced with electric and CNG fuelled buses. - The bus fleet will include 10 electric vehicles by the end of 2025 and at least 20% electric vehicles by the end of 2035. - Public transportation usage rate will be increased to 40% by the end of 2035. - By the end of 2030, old vehicles used in public transportation will be removed from the fleet. - By the end of 2025, a study will be initiated for the utilisation of scrapped vehicles (e.g. conversion to electric bicycles). - Public Transportation Emergency Action Plan will be completed by the end of 2026.
Sources of funding	- National budget (Ministry of Transport and Infrastructure), Budget of Directorate of Highways Mersin 5. Regional Office, provincial and district municipalities' own revenues, Çukurova Development Agency, national (İlbank) and international bank loans, vehicle owners
Risks	- High initial investment costs
Opportunities	- Renewal of vehicle fleet

Table 10.5: Transportation – Action AU3

ACTION AU3	**Promoting the use of bicycles and pedestrian transport**
Sub-actions	AU3.1: To expand bicycle lanes and to ensure their integration with Intelligent Transportation System (ITS)
	AU3.2: To expand Kentbis Smart Bicycle Rental System
	AU3.3: To create free bicycle parking areas
	AU3.4: To ensure the integration of bicycle transport with public transportation modes, to place bicycle carrying apparatus in public transportation vehicles
	AU3.5: To encourage the use of bicycles and to implement incentives (e.g. widespread use of bicycles during commuting)

	AU3.6: To improve pedestrian roads, to ensure road safety for pedestrians and bicycle users
Responsible departments of MBB	Mersin Metropolitan Municipality (Directorate of Transportation, Directorate of Road Construction, Maintenance and Repair)
Main stakeholders of the implementation	District Municipalities, Mersin Governorship, Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, smart bike rental system companies, Chamber of Environmental Engineers, Chamber of Urban Planners, Çukurova Development Agency, KentBis
Implementation period	Short-medium
Performance indicators	- Bicycle path length - Number of smart bicycle rent stations - Number of bicycles - Number of bicycle parking spaces - Number of KentBis members - Monthly usage of KentBis - Number of public transport vehicles equipped with bicycle carrying apparatus - Number of training/awareness raising events organised - Bicycle usage rate - Bicycle path length - Number of stations - Pedestrian path length - Number of pedestrian crossings (normal crossing, underpass, overpass) - Number of roads with traffic lights for bicycles and pedestrians - Length of shaded cycle path - Number of vehicle parking points
Performance goals	- By the end of 2024, 8 km of bicycle path work on main roads will be completed. - The integrated and continuous bicycle road project in the 4 central districts and Tarsus, which are planned to be constructed in the short term, will be completed. - According to the 2035 targets of the Bicycle and Pedestrian Master Plan completed in 2021, a total of 277 km of round-trip bicycle paths will be completed throughout the province. - A feasibility study will be completed to enable the use of KentBis through the application. - KentBis usage rate will be increased by 50% until the end of 2030. - By the end of 2025, free bicycle parking area will be increased by 10% in municipal parking lots and public transportation transfer stations. - By the end of 2035, all public transportation vehicles will be provided with bicycle carrying apparatus. - By the end of 2025, a system that will provide information about the location and occupancy rates of bicycle parks will be integrated with Intelligent Transport Systems (ITS). - At least 1 event (workshop, awareness-raising meeting, competition, etc.) will be organised every year to encourage the use of bicycles. - By the end of 2025, bicycle and pedestrian oriented "Traffic Circulation Plans" will be completed in the city centre and potential attraction centres. - Within the scope of the ongoing studies for Mersin Transportation Master Plan, Pedestrian Priority Zones will be determined until the end of 2026.
Sources of funding	- National budget (Ministry of Transport and Infrastructure), Budget of Directorate of Highways Mersin 5. Regional Office, provincial and district municipalities' own revenues, Çukurova Development Agency, national (İlbank) and international bank loans, vehicle owners
Risks	- Investment cost - Possible accidents
Opportunities	- Healthier individuals - Improvement of urban air quality

	- Reduction of noise pollution caused by road transportation

Table 10.6: Waste and wastewater management – Action AA1

ACTION AA1	Improvement of waste management
Sub-actions	AA1.1: To carry out training and awareness-raising activities with the aim of reducing waste at source
	AA1.2: To increase the production of useful products from municipal and industrial wastes
	AA1.3: To establish composting facilities (mowed grass, marketplace waste, field waste, tree pruning wastes, etc.)
	AA1.4: To rehabilitate unmanaged landfill sites and to reduce the amount of waste directed to landfill
	AA1.5: To carry out inspections and to impose penal sanctions in order to prevent uncontrolled disposal of excavation soil, construction and demolition wastes as well as pomace, vegetable waste oil, animal manure, etc.
	AA1.6: To increase the efficiency of methane recovery
Responsible departments of MBB	Mersin Metropolitan Municipality (Directorate of Climate Change and Zero Waste)
Main stakeholders of the implementation	District Municipalities (responsible), Mersin Metropolitan Municipality (Directorate of Agricultural Services, Directorate of Parks and Gardens), Mersin Governorship, Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, Mersin Provincial Directorate of National Education, universities and research centres, organized industrial zones, non-governmental organisations, recycling/recovery facilities
Implementation period	Short-medium
Performance indicators	- Number of training and awareness-raising activities - Number of people reached within the scope of activities - Number of scientific studies/projects carried out - Number of useful products obtained - Number of composting facilities - Amount of compost produced - Number of unmanaged landfills rehabilitated - Number of sanitary landfills - Amount of waste going to sanitary landfills - Amount of inert waste going to sanitary landfills - Number of inspections - Methane recovery amount - Installed capacity and number of methane recovery plants - Methane recovery efficiency
Performance goals	- Within the scope of the 2020-2024 Strategic Plan, at least 950 awareness-raising activities on waste will be completed by the end of 2024. - At least 1 study on obtaining useful products from waste will be supported every year. - By the end of 2024, 1 composting facility will be operational. - Until the end of 2024, planning will be made for the rehabilitation of unmanaged landfills. - It will be aimed to reduce the amount of waste going to landfill by at least 1% each year. - By the end of 2030, the amount of inert waste going to landfill will be reduced by 5%. - 14.700 environmental inspections will be carried out until the end of 2024. - By the end of 2024, energy production will be increased to 335,000 MWh.

Sources of funding	- National budget (Ministry of Environment, Urbanisation and Climate Change), Budget of Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, provincial and district municipalities' own revenues, Çukurova Development Agency, national (İlbank) and international bank loans
Risks	- Initial investment costs (for recovery facilities)
Opportunities	- Recovery of wastes - A cleaner environment - Clean energy generation - Prevention of possible explosions due to uncontrolled storage

Table 10.7: Waste and wastewater management – Action AA1

ACTION AA2	**Improvement of wastewater management**
Sub-actions	AA2.1: To carry out training and awareness-raising activities to reduce the amount of wastewater per capita
	AA2.2: To increase the population of municipalities served by sewerage system and wastewater treatment plant
	AA2.3: To optimise wastewater treatment plants
	AA2.4: To increase the amount of methane recovered in anaerobic fermentation/biomethanisation plants within wastewater treatment plants, to utilize treatment sludge
Responsible departments of MBB	Mersin Metropolitan Municipality and its relevant Directorates, Mersin Water and Sewerage Administration (MESKİ)
Main stakeholders of the implementation	Mersin Governorship, Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, Mersin Provincial Directorate of Agriculture and Forestry, Directorate of Highways Mersin 5. Regional Office, 6. Regional Directorate of State Hydraulic Works, universities, non-governmental organisations
Implementation period	Short-medium
Performance indicators	- Number of events organised - Number of people reached at events - Length of sewerage system - Number of wastewater treatment plants - Proportion of municipality population served - Amount of electricity consumed - Effluent quality - Treatment capacity - Amount of methane recovered - Installed capacity and number of methane recovery plants - Amount of treatment sludge going to landfill
Performance goals	- In coordination with the Provincial Directorate of National Education, comprehensive trainings on the importance of water, water cycle, water pollution, drought, importance of water in our lives and water saving will be given to kindergarten, primary and secondary school students every academic year. In this way, the amount of water used and the amount of wastewater to be generated will be reduced by instilling water saving and environmental awareness in young children. - By the end of 2030, 98% of the municipal population will be served by sewerage system and wastewater treatment plants. - By the end of 2025, unit electricity consumption in treatment plants will be reduced by at least 2%. - By the end of 2025, feasibility reports will be prepared for the installation of biomethanisation plants in all facilities.

	- By the end of 2035, biomethanisation plants will be installed in the prioritized facilities.
Sources of funding	- National budget (Ministry of Environment, Urbanisation and Climate Change), Budget of Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, provincial and district municipalities' own revenues, Çukurova Development Agency, national (İlbank) and international bank loans
Risks	- Initial investment costs - Difficulties in operation
Opportunities	- A cleaner environment - Improvement in water quality - Protection of receiving water bodies

Table 10.8: Agriculture and livestock – Action ATH1

ACTION ATH1	**Supporting green development orientated agriculture and livestock activities**
Sub-actions	ATH1.1: To promote the use of organic fertiliser
	ATH1.2: To provide incentives for the use of renewable energy (increasing agrivoltaic agriculture activities) and to increase its use
	ATH1.3: To increase the level of knowledge and awareness of producers on issues such as good agricultural practices and agricultural waste management
Responsible departments of MBB	Mersin Metropolitan Municipality (Directorate of Agricultural Services, Directorate of Climate Change and Zero Waste, Directorate of Human Resources and Training)
Main stakeholders of the implementation	District Municipalities, Mersin Governorship, Mersin Provincial Directorate of Agriculture and Forestry, 6. Regional Directorate of State Hydraulic Works, Mersin Chamber of Agricultural Engineers, Mediterranean Chamber of Agriculture, Mut Chamber of Agriculture, MENKOBİRLİK, Mersin Milk Producers Association
Implementation period	Short-medium
Performance indicators	- Amount of organic fertiliser use - Amount of synthetic fertiliser use - Number of training and awareness-raising activities - Number of incentive mechanisms - Number of events organised and participation rate - Amount of renewable energy utilisation in agriculture and animal husbandry activities - Number of training and awareness-raising activities - Number of producers that apply good agricultural practices
Performance goals	- At least 1 awareness-raising activity on organic fertiliser production and use will be carried out every year. - By the end of 2023, the existing compost production facility will be put into operation. - By the end of 2024, alternative compost production areas will be identified and the capacity of the facility will be increased by the end of 2026. - At least 1 event (workshop, awareness-raising meeting, etc.) will be organised every year on the use of alternative energy sources. - By the end of 2025, the scope of the incentive mechanism created by MBB will be expanded and support will be provided to at least 500 farmers every year." - At least 1 event (workshop, awareness-raising meeting, etc.) will be organised every year on good agricultural practices and agricultural waste management.
Sources of funding	- National budget (Ministry of Agriculture and Forestry), Budget of Mersin Provincial Directorate of Agriculture and Forestry, provincial and district municipalities' own revenues, Çukurova Development Agency, national (İlbank) and international bank loans, Agriculture and Rural Development Support Institution, cooperatives and producer unions

Risks	- Difficulties in obtaining funding - Negative change of demographic structure in rural areas
Opportunities	- Agricultural insurance diversity (village-based drought yield insurance, greenhouse insurance, etc.) - Contribution to the Sustainable Development Goals (SDGs 2, 3. 12, 13 and 15) - Contribution to 2053 goals and Green Development Revolution

Table 10.9: Awareness raising and training – Action AD1

ACTION AD1	**Realisation of awareness-raising and training activities**
Sub-actions	AD1.1: To carry out awareness-raising activities in educational institutions and public institutions on adaptation to climate change and mitigation of greenhouse gas emissions
	AD1.2: To carry out awareness-raising activities on energy efficiency in industrial facilities
	AD1.3: To prepare public service announcements that will be broadcasted on local channels, screens of public transportation vehicles or city information screens
	AD1.4: To place impressive banners on billboards with the aim of raising awareness
	AD1.5: To organize various competitions under the theme of climate change and greenhouse gas mitigation
Responsible departments of MBB	Mersin Metropolitan Municipality (Directorate of Climate Change and Zero Waste, Directorate of Press, Publications and Public Relations, Directorate of Human Resources and Training)
Main stakeholders of the implementation	District Municipalities, Mersin Provincial Directorate of National Education, Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, all relevant stakeholders
Implementation period	Short-medium
Performance indicators	- Number of training and awareness-raising activities - Number of public service announcements - Number of banners prepared for awareness raising - Number of competitions organised
Performance goals	- At least 2 events (workshops, awareness raising meetings, etc.) will be organised each year on adaptation to climate change and mitigation of greenhouse gas emissions. - At least 1 event (workshop, awareness-raising meeting, etc.) will be organised each year on energy efficiency in industrial sectors. - At least 1 promotional film will be prepared until the end of 2025. - At least 2 banners will be prepared every year. - At least 1 competition will be organised every year.
Sources of funding	- National budget, Budget of Mersin Provincial Directorate of National Education, provincial and district municipalities' own revenues, Çukurova Development Agency, national (İlbank) and international bank loans
Risks	- Insufficient ownership of the activities and failure to create awareness - Activities not reaching all segments of the society
Opportunities	- Improved energy consumption in households - Less waste and wastewater generated

10.2. Actions for Climate Change Adaptation

In the light of the Climatological Analysis and Analysis of Climate Projections (Sections 9.1 and 9.2) and the Assessment of the Current Situation and Plans (Section 6), adaptation actions have been determined in general terms for Mersin province, and the action scopes have been detailed by taking into consideration the interviews with the project stakeholders and the previous planning studies prepared in Mersin. In this framework, information on the priority actions and sub-actions identified on a sectoral basis are given in Table 10.10 and Table 10.19. While detailing the action contents, information on the institutions that may be responsible for the implementation of the action and the stakeholders that may contribute to the implementation, the implementation period of the action, performance indicators, risks and opportunities that may occur during implementation are also included in the tables. During the stakeholder meetings held in Mersin on 24-25 August 2023, stakeholders' opinions on the responsible and relevant institutions, performance indicators and targets for the mitigation actions determined within the scope of the action plan were received through verbal notifications and the actions were finalised.

Table 10.10: Urban areas – Action UK1

ACTION UK1	**Mitigating the impacts of climate change on urban areas**
Sub-actions	UK1.1: To prepare emergency action plans that ensure the sustainability of healthcare services in case of disasters
	UK1.2: To determine criterias that take climate change risks into account in licence permitting processes of buildings (e.g. identifying regions where climate risks such as urban heat islands may be effective in master plans) and to establish incentive mechanisms in cooperation with district municipalities (e.g. applying a certain discount on taxes levied on buildings that install rainwater harvesting systems against drought risk)
	UK1.3: To improve the resilience of electricity and communication lines for preventing power outages during and after extreme weather events
	UK1.4: To improve the resistance of rainwater and sewerage systems for the cases of overloading
	UK1.5: To inform the public in advance about extreme weather events, to implement applications such as remote working etc. in order to reduce exposure
	UK1.6: To increase the amount of green spaces
Responsible departments of MBB	Mersin Metropolitan Municipality (Directorate of Disaster Affairs, Directorate of Health Affairs, Directorate of Transportation, Directorate of Technical Works, Directorate of Housing and Urbanisation, Mersin Water and Sewerage Administration, Directorate of Studies and Projects, Directorate of Parks and Gardens)
Main stakeholders of the implementation	District Municipalities, Mersin Governorship, Mersin Provincial Directorate of Disaster and Emergency, Mersin Provincial Health Directorate, Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, Mersin Provincial Directorate of Social Security Institution, Mersin Provincial Directorate of Family and Social Services, Meteorology 6. Regional Office, Çukurova Development Agency, Toroslar Electricity Distribution Company, property owners
Implementation period	Short-medium
Performance indicators	- Climate change risk analyses for healthcare facilities - Number of emergency action plans - Number of healthcare facilities for which building safety assessment has been made - Number of buildings with rainwater harvesting system - Amount of rainwater storage area - Annual amount of rainwater collected

	- Urban heat island risk maps - Number of urban air quality monitoring systems - Number of meteorological monitoring systems - Check-in records to healthcare facilities due to heat waves - Length of energy transmission and distribution network moved to underground - Transformer capacity - Renewed system ratio - Ratio of maintenance/repair systems - Check-in records to healthcare facilities - Loss and damage caused by flood, hail, etc. - Amount of green spaces per capita
Performance goals	- By the end of 2024, climate risk assessment and building safety assessment will be carried out for existing healthcare facilities. - By the end of 2025, healthcare services emergency action plan will be completed. - By the end of 2026, rainwater harvesting systems will be installed for buildings with a roof area of more than 2,000 m^2 within the Municipality against the risk of drought. - By the end of 2026, rainwater harvesting capacity for buildings within the provincial borders will be determined and necessary feasibility studies will be carried out. - By the end of 2027, an incentive programme will be established for buildings that install rainwater harvesting systems. - By the end of 2026, urban heat island risk maps will be prepared for the whole province. - By the end of 2025, relevant institutions will be encouraged to carry out feasibility studies for moving energy transmission and distribution network to underground locations and increasing transformer capacity. - By the end of 2030, capacity increase, maintenance and repair works of all rainwater and sewerage systems will be completed. - By the end of 2025, necessary works will be completed in order to warn the public in advance about the risks of extreme weather events through the Municipality's information system (TEKSIN) in coordination with Meteorological Directorates. - By the end of 2024, the amount of green spaces per capita will be increased to 3.26 m^2. - Within the scope of the Green Mersin Project and Landscape Master Plan, 2.9 million planting will be realized until the end of 2024.
Sources of funding	- National budget (Ministry of Environment, Urbanisation and Climate Change, Ministry of Family and Social Services, Ministry of Health), Budget of Mersin Governorship, Budget of Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, provincial and district municipalities' own revenues, Çukurova Development Agency, national (İlbank) and international bank loans, property owners
Risks	- Difficulties in finding funding, high investment costs - Uncertainties arising from climate projections - Rapid population growth and uncontrolled internal and external migration
Opportunities	- Urban transformation works - Structural transformation process carried out within the scope of the green development revolution - Cost-effectiveness of nature-based solutions and their short-term benefits - Contribution to the Sustainable Development Goals (SDGs 3, 11, 13, 14 and 15) - Contribution to 2053 goals and Green Development Revolution

Table 10.11: Energy and Industry – Action UE1

ACTION UE1	**Improving climate resilience of energy production and industrial facilities**
Sub-actions	UE1.1: To grant building permits to new facilities by taking into account the risks posed by climate change
	UE1.2: To ensure that necessary precautions are taken within the facilities against climate change risks, to carry out regular audits

	UE1.3: To establish a Disaster Coordination and Management System under the leadership of Mersin Governorship and Mersin Metropolitan Municipality
	UE1.4: To carry out awareness-raising activities on practices for increasing efficiency in energy production facilities and cleaner production and resource efficiency applications in industrial sectors
	UE1.5: To encourage alternative practices such as the use of treated urban wastewater as cooling water
Responsible departments of MBB	Mersin Metropolitan Municipality (Directorate of Climate Change and Zero Waste, Directorate of Technical Works, Directorate of Human Resources and Training, Directorate of Housing and Urbanisation, Directorate of Disaster Affairs, Directorate of Information Technologies, Directorate of Transportation, Directorate of Road Construction, Maintenance and Repair, Directorate of Environmental Protection and Control, Mersin Water and Sewerage Administration), Mersin Governorship
Main stakeholders of the implementation	District Municipalities, Mersin Governorship, Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, Mersin Provincial Directorate of Industry and Technology, Meteorology 6. Regional Office, Directorate of Highways Mersin 5. Regional Office, 6. Regional Directorate of State Hydraulic Works, Toroslar Electricity Distribution Company, Çukurova Development Agency, Mediterranean Exporter Associations, Mersin Chamber of Commerce and Industry (MTSO), Anamur Chamber of Commerce and Industry, Erdemli Chamber of Commerce and Industry, Mut Chamber of Commerce and Industry,Silifke Chamber of Commerce and Industry, Tarsus Chamber of Commerce and Industry, Mersin Chamber of Shipping (MDTO), Mersin-Tarsus Agricultural Product Processing Specialization Organized Industrial Zone (TUIOSB), Mersin Tarsus OIZ, Mut OIZ, Tarsus Karma OIZ, Silifke OIZ
Implementation period	Short-medium
Performance indicators	- Number of vulnerability and risk assessments - Number of building permits that takes into account risks posed by climate change - Number of audits - Number of members of disaster coordination board - Number of early warning systems installed - Amount of loss and damage incurred - Number of events organised and participation rate - Number of alternative applications for the utilisation of treated urban wastewater - Amount of wastewater utilised in alternative applications - Water recovery rate - Annual amount of water consumed
Performance goals	- By the end of 2025, a vulnerability and risk assessment including energy production facilities and industrial production processes will be completed. - By the end of 2026, regular audit plans will be established (to be evaluated after the completion of the vulnerability and risk assessment study). - At least 2 events (workshops, awareness-raising meetings, etc.) will be organised each year on efficiency increase in energy production facilities and cleaner production and resource efficiency practices in industrial sectors. - At least 2 pilot applications will be initiated until the end of 2025 on the utilisation of treated urban wastewater.
Sources of funding	- National budget (Ministry of Environment, Urbanisation and Climate Change, Ministry of Industry and Technology), Budget of Mersin Governorship, Budget of Mersin Provincial Directorate of Industry and Technology, Budget of Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, provincial and district municipalities' own revenues, Çukurova Development Agency, national (İlbank) and international bank loans, private sector
Risks	- Difficulties in finding funding, high investment costs - Uncertainties arising from climate projections
Opportunities	- Structural transformation process carried out within the scope of the green development revolution - Resource savings - Contribution to the Sustainable Development Goals (SDGs 7, 9, 12 and 13) - Contribution to 2053 goals and Green Development Revolution

Table 10.12: Transportation infrastructure – Action UU1

ACTION UU1	Improving climate resilience of transportation infrastructure
Sub-actions	UU1.1: To design new investments by taking into consideration risks posed by climate change
	UU1.2: To review the existing transportation infrastructure by taking into account the land structure and climate change impacts, to carry out regular maintenance and repair works
	UU1.3: To construct water drainage systems on transportation lines against floods, to increase the resilience of areas that may be exposed to floods
	UU1.4: To replace impermeable pavements with porous asphalt, rubberised asphalt, permeable concrete or brick/block paving stones to reduce surface water run-off on pedestrianised roads, parking lots and pavements, and to construct green infrastructure
	UU1.5: To improve climate resilience of public transportation infrastructure
	UU1.6: To introduce regional restrictions at certain periods to reduce the use of private cars
	UU1.7: To prepare Sustainable Urban Mobility Plan (SUMP) and Sustainable Logistics Action Plan
	UU1.8: To prepare emergency action plans for air, road, rail and maritime transportation, including passenger evacuation, rescue equipment and activities, emergency routes and personnel planning in case of unexpected emergencies
Responsible departments of MBB	Mersin Metropolitan Municipality (Directorate of Transportation, Directorate of Disaster Affairs, Directorate of Fire Brigade, Directorate of Technical Works, Directorate of Road Construction, Maintenance and Repair, Directorate of Machinery Supply, Maintenance and Repair)
Main stakeholders of the implementation	District Municipalities, Mersin Governorship, Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, Directorate of Highways Mersin 5. Regional Office, 6. Regional Directorate of Turkish State Railways, 6. Regional Directorate of State Hydraulic Works, Mersin Provincial Gendarmerie Command
Implementation period	Short-medium
Performance indicators	- Number of vulnerability and risk assessments - Age of transportation infrastructure - Maintenance/repair completion rate - Critical investment need - Amount of loss and damage incurred - Permeable surface area - Amount of investment on green infrastructure - Emergency action plan for public transportation - Number of green stops - Car ownership - Number of regions with restricted traffic - Amount of fuel consumed - Sustainable Urban Mobility Plan - Sustainable Logistics Action Plan - Emergency action plan for air transportation - Emergency action plan for road transportation - Emergency action plan for railway transportation - Emergency action plan for maritime transportation
Performance goals	- By the end of 2025, a vulnerability risk assessment will be carried out for transportation infrastructure and investment needed throughout the province. - By the end of 2025, the existing transportation infrastructure will be reviewed and dangerous infrastructures will be identified. - The process of preparing a disaster preparedness action plan for the transportation sector will be planned taking into account climate projections. - By the end of 2025, the existing transportation infrastructure will be reviewed and critical investment needs will be determined. - Necessary revision works will be carried out in the light of climate projections of highway drainage systems until the end of 2030.

	- At least 2 green infrastructure and permeable surface projects will be implemented by the end of 2026. - The Public Transportation Emergency Action Plan will be completed by the end of 2025. - By the end of 2025, transfer stations, bus stops and parking lots will be evaluated against climate risks. - Green stops will be realized by determining suitable locations until the end of 2030. - The LEZs will be determined by the end of 2026. - The LEZs will be established by the end of 2035. - The Sustainable Urban Mobility Plan (SUMP) and Sustainable Logistics Action Plan will be completed by the end of 2026. - Preperation of disaster emergency action plans will be initiated by the end of 2025.
Sources of funding	- National budget (Ministry of Transport and Infrastructure), Budget of Directorate of Highways Mersin 5. Regional Office, Budget of Regional Directorate of Turkish State Railways, Budget of 6. Regional Directorate of State Hydraulic Works, provincial and district municipalities' own revenues, Çukurova Development Agency, national (İlbank) and international bank loans
Risks	- Difficulties in finding funding - Increase in transportation demand due to rapid population growth
Opportunities	- Contribution to the Sustainable Development Goals (SDGs 3, 11 and 13) - Contribution to 2053 goals and Green Development Revolution

Table 10.13: Waste and wastewater management – Action UA1

ACTION UA1	**Improving climate resilience of waste and wastewater management process and relevant infrastructure**
Sub-actions	UA1.1: To minimize production of waste at source and to adopt and encourage a zero waste approach
	UA1.2: To provide remote access and to establish early warning and alarm systems to enable employees to suspend critical activities in case of unexpected emergencies
	UA1.3: To construct new waste disposal and wastewater treatment facilities in protected areas or further away from potential hazards, and to take precautions in existing facilities
	UA1.4: To strengthen structures used for leachate and landfill gas management
	UA1.5: To equip all facilities with portable backup power sources independent of the grid when necessary
Responsible departments of MBB	Mersin Metropolitan Municipality (Directorate of Environmental Protection and Control, Directorate of Climate Change and Zero Waste, Department of Central Enterprises for Mersin Water and Sewerage Administration, Directorate of Information Technologies, Directorate of Disaster Affairs, Directorate of Housing and Urbanisation, Directorate of Technical Works)
Main stakeholders of the implementation	District Municipalities, Mersin Water and Sewerage Administration (MESKİ), Mersin Provincial Directorate of Environment, Urbanisation and Climate Change
Implementation period	Short-medium
Performance indicators	- Number of events organized and participation rate - Number of feasibility studies for zero waste approach - Number of facilities that can be accessed remotely - The amount of loss and damage incurred - Number of vulnerability and risk assessments - Number of inspections at existing facilities - Number of projects and feasibility studies - Increased efficiency rates - Barrier application area - The amount of area planted - Number of trees planted - Number of unmanaged landfills rehabilitated - Number of facilities with completed maintenance/repair - Number of backup power supplies - Number of feasibility reports for backup power supply installation

Performance goals	- At least 2 events (workshops, awareness meetings, etc.) will be organized every year on minimizing production of waste at source and zero waste approach. - Feasibility studies for water recovery in wastewater treatment facilities will be carried out until the end of 2025. - By the end of 2025, emergency action plans for all facilities across the province will be revised to include accident scenarios. - Vulnerability and risk assessment will be carried out for new facilities to be built by the end of 2025. - By the end of 2030, various structures such as vegetated flood protection barriers, drainage channels, rainwater pools or barriers will be constructed in the necessary facilities for flood and overflow control, or fabricated drainage structures will be established. - Until the end of 2030, measures will be taken against climate change risks in facilities where biological treatment is applied. - By the end of 2026, feasibility studies will be carried out to establish spare capacities in order to ensure that the treatment plant capacities are sufficient in the face of situations such as excessive rainfall, floods and sudden population increase. - By the end of 2026, feasibility studies will be carried out to prevent erosion, mitigate the impact of wind, reduce the risk of fire and build barriers and create buffer areas against the risks of sea level rise. - By the end of 2025, projects will be initiated to benefit from drought-resistant grasses, shrubs, trees and other rooted plants in and around facilities. - Projects will be initiated to eliminate odor problems in and around facilities by the end of 2025. - The measures to be taken as a result of the vulnerability and risk assessment to be completed for existing facilities will be inspected. - Vulnerability and risk assessment will be carried out for all waste management facilities throughout the province by the end of 2026. - By the end of 2026, the capacity of leachate collection systems will be revised according to climate projections. - At least 1 backup power supply will be provided in all facilities by the end of 2026. - Feasibility studies for renewable energy production in the facilities will be carried out until the end of 2025.
Sources of funding	- National budget (Ministry of Environment, Urbanisation and Climate Change), Budget of Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, provincial and district municipalities' own revenues, Çukurova Development Agency, national (İlbank) and international bank loans
Risks	- Difficulties in finding funding - Insufficient human resources
Opportunities	- Urban transformation works - High treatment efficiency - Contribution to the Sustainable Development Goals (SDGs 3, 6, 12, 13 and 14) - Contribution to 2053 goals and Green Development Revolution

Table 10.14: Agriculture and livestock – Action UT1

ACTION UT1	**Increasing the adaptive capacity of agricultural and livestock activities to climate change**
Sub-actions	UT1.1: To ensure animal disease prevention and control
	UT1.2: To provide support for switching to practices to improve soil quality (water retention ability) such as less tillage and plowing, use of light machinery, crop rotation
	UT1.3: To update the product inventory and to encourage the production of selected products (e.g. drought and heat resistant products) taking into account climate change projections
	UT1.4: To support the reduction of water consumption in irrigation through efficient techniques
	UT1.5: To expand practices for the use of treated wastewater in agricultural lands
	UT1.6: To support activities to prevent floods and erosion in agricultural lands
	UT1.7: To raise farmers' awareness about the impacts of climate change and good agricultural practices

Responsible departments of MBB	Mersin Metropolitan Municipality (Directorate of Agricultural Services, Directorate of Environmental Protection and Control, Directorate of Climate Change and Zero Waste, Mersin Water and Sewerage Administration, Directorate of Studies and Projects, Directorate of Human Resources and Training)
Main stakeholders of the implementation	District Municipalities, Mersin Governorship, Mersin Provincial Directorate of Agriculture and Forestry, Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, Mersin Provincial Directorate of Disaster and Emergency, 6. Regional Directorate of State Hydraulic Works, Mersin Chamber of Agricultural Engineers, Mediterranean and Mut Chamber of Agriculture, Mersin Milk Producers Association, MENKOBİRLİK, Çukurova Development Agency
Implementation period	Short-medium
Performance indicators	- Number of vulnerability and risk assessments - Number of diseased animals - Amount of loss and damage incurred - Budget allocated to protection and control activities - Number of shelters where precautions are taken - Number of animals affected by hot weather and drought - Number of feasibility reports for animal disease protection and control - Number of businesses/farmers switching to soil quality improvement practices - Amount of support provided - Number of incentive mechanisms - Rate of utilization of incentive mechanisms - The amount of area irrigated with efficient techniques - Amount of water consumed in irrigation - Amount of treated wastewater used in agricultural lands - Amount of area irrigated with treated wastewater - Number of feasibility reports for the use of treated wastewater - Number of applications for preventing erosion such as wind curtains - Number of events organized and number of participants - Number of businesses where good agricultural practices are used
Performance goals	- Vulnerability and risk assessment study will be completed by the end of 2025. - At least 1 project will be supported until the end of 2025 to evaluate the impacts of climate change on vector diseases. - A feasibility study will be developed to ensure that livestock are kept in well-ventilated shelters or shaded areas considering the impacts of climate change such as heat and drought by the end of 2030. - At least 2 events (workshops, awareness meetings, etc.) will be organized every year regarding practices to improve soil quality. - An Agriculture Campus will be established by the end of 2027, and grant/credit support will be provided to farmers in areas such as heirloom seeds, seedlings and saplings, and organic fertilizers. - At least 2 events (workshops, awareness meetings, etc.) will be organized every year on efficient irrigation techniques. - Until the end of 2025, the scope of the incentive mechanism created by MMM will be expanded and support will be provided to farmers by distributing at least 150 km-long irrigation pipes every year. - Until the end of 2024, laboratory analysis will be conducted for the use of wastewater treatment plant effluent in agricultural lands and landscape areas and, in case of suitability, a field feasibility study will be carried out. - At least 2 events (workshops, awareness meetings, etc.) will be organized every year in order to raise awareness of farmers about the impacts of climate change and good agricultural practices.
Sources of funding	- National budget (Ministry of Agriculture and Forestry), Budget of Mersin Provincial Directorate of Agriculture and Forestry, Budget of 6. Regional Directorate of State Hydraulic Works, provincial and district municipalities' own revenues, Çukurova Development Agency, national (İlbank) and international bank loans, Agriculture and Rural Development Support Institution, cooperatives and producer unions
Risks	- Difficulties in obtaining funding - Negative change of demographic structure in rural areas

Opportunities	- Agricultural insurance diversity (village-based drought yield insurance, greenhouse insurance, etc.) - Contribution to the Sustainable Development Goals (SDGs 2, 3, 12, 13 and 15) - Contribution to 2053 goals and Green Development Revolution

Table 10.15: Water resources – Action UOS1

ACTION UOS1	**Improving water-saving and prevention of water pollution**
Sub-actions	UOS1.1: To implement practices to reduce water consumption in residential and commercial buildings (regulatory bills, the use of efficient batteries, awareness-raising activities)
	UOS1.2: To prevent water losses in drinking water transmission/distribution lines
	UOS1.3: To increase water storage capacity (e.g. underground water storage)
	UOS1.4: To encourage the transition to efficient irrigation techniques in parks and gardens
	UOS1.5: To expand the separate sewage system throughout the province, to store and utilize rainwater
	UOS1.6: To replace impermeable pavements with permeable surfaces with the aim of filtering pollutants, recharging aquifers, and reducing the volume of rainwater entering the drainage system
	UOS1.7: To develop advanced water treatment techniques
	UOS1.8: To improve wastewater recovery and reuse
	UOS1.9: To control surface runoff from agricultural lands
Responsible departments of MBB	Mersin Metropolitan Municipality (Directorate of Climate Change and Zero Waste, Directorate of Environmental Protection and Control, Directorate of Parks and Gardens, Directorate of Agricultural Services, Directorate of Technical Works, Directorate of Human Resources and Training, Mersin Water and Sewerage Administration)
Main stakeholders of the implementation	District Municipalities, Mersin Provincial Directorate of Agriculture and Forestry, Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, Mersin Governorship, 6. Regional Directorate of State Hydraulic Works, Mersin Chamber of Agricultural Engineers, Mediterranean and Mut Chamber of Agriculture, Çukurova Development Agency
Implementation period	Short-medium
Performance indicators	- Number of events organized and number of participants - Water Footprint report - Amount of tap aerators distributed - Amount and rate of loss/leakage - Number and rate of lines completed with maintenance/repair - Water storage capacity - Number of feasibility reports for water storage facilities - Amount of rainwater storage area - Annual amount of rainwater harvested - Amount of fresh water used in park and garden irrigation - The amount of area switched to automatic irrigation system - Length of refuge areas that switch to automatic irrigation system - Separated sewerage system capacity throughout the province - Rainwater storage capacity - Permeable surface area - Advanced wastewater treatment rate - Number of studies on new treatment techniques - Amount of water recovered and reused - Number and area of land where control methods are applied - Usage rate of closed irrigation system
Performance goals	- At least one event (workshop, training and awareness meeting, etc.) will be organized every year to reduce water consumption in residential and commercial buildings. - An awareness study on water saving potential in pools will be carried out until the end of 2025.

	- By the end of 2025, at least 50,000 tap aerators will be distributed within the scope of awareness activities. - Until the end of 2025, awareness raising activities will be carried out to replace the taps in schools in Mersin with efficient ones within the scope of awareness activities. - By the end of 2024, the number of warehouses integrated into the SCADA system will be at least 135 and the number of pump stations will be at least 60 (MESKI Strategic Plan). - Maintenance and repair of all transmission/distribution lines will be carried out until the end of 2025. - The loss/leakage rate will be reduced to 10% by the end of 2030. - The feasibility study for the storage of surface water will be completed by the end of 2025. - By the end of 2026, rainwater harvesting systems will be installed for buildings within the Municipality with a roof area larger than 2,000 m^2 against the risk of drought. - Until the end of 2027, rainwater harvesting capacity for buildings within the provincial borders will be determined and necessary feasibility studies will be carried out. - At least 2 events (workshops, awareness meetings, etc.) will be organized every year in order to encourage the transition to efficient irrigation techniques in parks and gardens. - By the end of 2024, the amount of parks and green areas with automatic irrigation system will be 362,000 m^2. - By the end of 2024, the automatic irrigation system application area in refuges will be 120 km. - By the end of 2027, the necessary technical infrastructure will be established for the preparation and continuous monitoring of inspection plans to ensure that drilling irrigation works are carried out in a controlled manner. - A new calendar will be created to increase the frequency of maintenance, repair and cleaning periods of grills and loopholes until the end of 2024. - Separate sewerage system will be installed throughout the province by the end of 2030. - By the end of 2024, the length of the rainwater system for which projects prepared will reach 341 km (MESKI Strategic Plan). - The feasibility study will be completed by the end of 2025. - The permeable surface area will be increased by 10% by the end of 2027. - At least 1 project will be supported until 2025 within the scope of the development of advanced water treatment techniques. - By the end of 2025, the existing capacity in municipal buildings and facilities will be increased at least twofold. - At least 1 incentive mechanism will be developed to increase recycling in domestic use by the end of 2026. - Surface flow control strategy will be determined by the end of 2025.
Sources of funding	- National budget (Ministry of Agriculture and Forestry), Budget of Mersin Provincial Directorate of Agriculture and Forestry, Budget of 6. Regional Directorate of State Hydraulic Works, provincial and district municipalities' own revenues, Çukurova Development Agency, national (İlbank) and international bank loans, Agriculture and Rural Development Support Institution, cooperatives and producer unions
Risks	- Difficulties in finding funding - Insufficient human resources
Opportunities	- Urban transformation works - Contribution to the Sustainable Development Goals (SDGs 3, 6, 12, 13 and 14) - Contribution to 2053 goals and Green Development Revolution

Table 10.16: Forest areas – Action UOS2

ACTION UOS2	**Increasing the adaptive capacity of forest areas to climate change**
Sub-actions	UOS2.1: To identify residential areas at risk that are close to forest areas and to take precautions (fire barriers, etc.)
	UOS2.2: To increase capacity within the scope of fire prevention and response activities
	UOS2.3: To plant species resistant to climate change impacts and wildfires

	UOS2.4: To conduct studies on the detection and protection of species at risk of extinction UOS2.5: To carry out awareness raising activities for the protection of forest areas
Responsible departments of MBB	Mersin Metropolitan Municipality (Directorate of Housing and Urbanisation, Directorate of Disaster Affairs, Directorate of Climate Change and Zero Waste, Directorate of Fire Brigade, Directorate of Information Technologies, Directorate of Parks and Gardens, Directorate of Environmental Protection and Control, Directorate of Human Resources and Training)
Main stakeholders of the implementation	District Municipalities, Mersin Governorship, Mersin Provincial Directorate of Agriculture and Forestry, Mersin Regional Directorate of Forestry, Chamber of Forest Engineers, Directorate of Highways Mersin 5. Regional Office, Meteorology 6. Regional Office, Agriculture and Livestock Cooperatives, Çukurova Development Agency, Tarsus Regional Directorate of Forestry Research Department and National Parks
Implementation period	Short-medium
Performance indicators	- Risky structures and the number of population at risk - Number of vulnerability and risk assessments - Installed fire barriers - Number of fire crews - Number of water tanks - Number of volunteers trained - Response time to wildfires - Number of trees planted - Number of projects supported - Number of species at risk of extinction - Number of events organized and participation rate - Biodiversity map
Performance goals	- Vulnerability and risk assessment will be carried out for residential areas at risk of wildfires by the end of 2025. - Areas at risk identified by the end of 2030 will be updated in Master Plans. - Following the completion of the vulnerability and risk assessment, at least 1 forest fire barrier (water tanker, hose, pump and other necessary tools and equipment) will be placed in the determined residential areas at risk by the end of 2025. - The number of water tanks will be increased by 50% by the end of 2025. - By the end of 2025, the necessary work will be completed in coordination with General Directorate of Forestry (OGM) and General Directorate of Meteorology (MGM) in order to warn the people living in residental areas at risk in advance about the risk of wildfires through the Municipality's information system (TEKSİN). - By the end of 2025, the fire brigade capacity of the municipality will be doubled in Silifke, Gülnar and Mut districts, which have a high risk of wildfires. - By the end of 2025, structures at risk (warehouses, etc.) will be identified in residential areas close to forests and activities for risk reduction will be defined. - Training will be organized for volunteers who can work in the fight against wildfires at least once a year. - Vulnerability and risk assessment will be carried out for forest areas and sensitive areas by the end of 2025. - At least 1 research project will be supported on species suitable for changing climatic conditions until the end of 2026. - Until the end of 2026, studies will be initiated to transform species in areas at risk into fire-resistant broad-leaved trees. - By the end of 2027, at least 1 incentive mechanism will be created for the cultivation of determined resistant tree species by collaborating with cooperatives. - At least 1 project will be supported until the end of 2025 to evaluate the impacts of climate change on plant and animal species at risk of extinction. - Geographic Information Systems-based biodiversity map of Mersin province will be prepared by the end of 2026. - At least 2 events (workshop, awareness meeting, etc.) will be organized by the end of 2025 for the detection and protection of species at risk of extinction. - At least 2 events (workshops, awareness meetings, etc.) will be organized every year for the protection of forest areas.

Sources of funding	- National budget (Ministry of Agriculture and Forestry), Budget of Mersin Provincial Directorate of Agriculture and Forestry, Budget of Mersin Regional Directorate of Forestry, Budget of 6. Regional Directorate of State Hydraulic Works, provincial and district municipalities' own revenues, Çukurova Development Agency, national (İlbank) and international bank loans, Agriculture and Rural Development Support Institution
Risks	- Difficulties in finding funding - Insufficient human resources - Uncertainties arising from climate projections
Opportunities	- Conservation of natural life - Contribution to the Sustainable Development Goals (SDGs 3, 11, 13 and 15) - Contribution to 2053 goals and Green Development Revolution

Table 10.17: Coastal areas – Action UKB1

ACTION UKB1	Improving the resilience of coastal areas to climate change impacts such as sea level rise
Sub-actions	UKB1.1: To identify areas at risk in coastal areas and to prepare emergency action plans for these areas
	UKB1.2: Coastal areas should not be opened to construction as much as possible, new construction areas should be determined above sea level in Master Plans, and new buildings should not be allowed to replace old buildings that have completed their service life
	UKB1.3: To construct barriers to reduce the impacts of sea level rise along the coastline in areas at risk
	UKB1.4: To conduct studies on the identification and protection of protected areas
	UKB1.5: To establish early warning systems
Responsible departments of MBB	Mersin Metropolitan Municipality (Directorate of Disaster Affairs, Directorate of Housing and Urbanisation, Directorate of Studies and Projects, Directorate of Information Technologies)
Main stakeholders of the implementation	District Municipalities, Mersin Governorship, Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, Directorate of Highways Mersin 5. Regional Office, Çukurova Development Agency, Mersin Metropolitan Municipality (Directorate of Environmental Protection and Control)
Implementation period	Short-medium
Performance indicators	- Number of risk analysis studies - Number of emergency action plans - Number of projects - Number of vulnerability and risk assessments - Number of audits - Number of urban transformation zones - Number of feasibility reports for the construction of barriers on the coastline - Number of projects to identify protected areas - Number of TEKSİN Application users
Performance goals	- A risk analysis study will be conducted for floods caused by sea level rise until the end of 2026. - Until the end of 2025, at least 3 joint projects and/or studies will be carried out with institutions/organizations for the protection of the marine and coastal environment and marine species. - By the end of 2025, the administrative infrastructure will be prepared to revise the determined flood elevation by evaluating climate projections and risks of sea water level rise, and to supervise its implementation when granting zoning permits to buildings planned in coastal areas.

	- A road map will be determined to control and prevent illegal construction activities in coastal areas by the end of 2025. - At least 10 different Urban Transformation Areas will be determined throughout the province by the end of 2025. - It will be evaluated within the framework of the risk analysis to be prepared by the end of 2025. - A feasibility study for the construction of barriers will be carried out by the end of 2030. - Until the end of 2025, at least 1 project will be supported in which the effects of climate change are evaluated and protection measures are produced in the protection zones in coastal areas (Mersin Göksu Delta, etc.). - Ensuring the integration of weather forecast data published by General Directorate of Meteorology (MGM) into the Municipality's information system (TEKSİN) until the end of 2025 can be evaluated.
Sources of funding	- National budget, Budget of Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, provincial and district municipalities' own revenues, Çukurova Development Agency, national (İlbank) and international bank loans, property owners
Risks	- Difficulties in finding funding - Uncertainties arising from climate projections
Opportunities	- Urban transformation and infrastructure Works - Contribution to the Sustainable Development Goals (SDGs 3, 11, 13 and 14) - Contribution to 2053 goals and Green Development Revolution

Table 10.18: Fisheries – Action UKB2

ACTION UKB2	**Increasing the adaptive capacity of fisheries to climate change**
Sub-actions	UKB2.1: To take measures to prevent overfishing and to protect the fish population
	UKB2.2: To take precautions against invasive species that transported due to increases in sea water temperature and salinity and threaten native fish species
	UKB2.3: To locate of fish production facilities and shelters, taking into account the flood risk
	UKB2.4: To preserve marine ecosystems and biodiversity and to breed resistant species
Responsible departments of MBB	Mersin Metropolitan Municipality (Directorate of Environmental Protection and Control, Directorate of Disaster Affairs, Directorate of Agricultural Services, Directorate of Culture and Social Affairs)
Main stakeholders of the implementation	District Municipalities, Mersin Governorship, Mersin Provincial Directorate of Agriculture and Forestry - Branch of Fisheries and Aquaculture
Implementation period	Short
Performance indicators	- Number of feasibility reports for preventing overfishing and protecting the fish population - Number of fish markets - Fish population - Number of studies carried out for the protection of marine environments - Number of climate change vulnerability and risk assessments - Type of fish species grown - Number of feasibility reports for diversifying fish species and breeding resistant species
Performance goals	- By the end of 2024, a coordination board will be established, which will bring together all those responsible for the adaptation of fisheries to climate change.

	- Feasibility studies for determining the locations of fish markets will be completed by the end of 2025. - At least one fish market will be established by the end of 2025. - At least 1 incentive mechanism on smart fishing will be developed by the end of 2026. - Until the end of 2025, at least 2 joint studies/projects will be carried out annually for the protection of the marine and coastal environment and marine species. - At least one awareness study will be conducted to evaluate invasive species by the end of 2024. - Vulnerability and risk assessment will be carried out on shelters and fish production facilities by the end of 2025. - Until the end of 2025, at least one awareness-raising study will be carried out for the protection of marine species unique to the region.
Sources of funding	- National budget (Ministry of Agriculture and Forestry, Ministry of Environment, Urbanisation and Climate Change), Budget of Mersin Provincial Directorate of Agriculture and Forestry, Budget of Mersin Regional Directorate of Forestry, Budget of 6. Regional Directorate of State Hydraulic Works, provincial and district municipalities' own revenues, Çukurova Development Agency, national (İlbank) and international bank loans, Agriculture and Rural Development Support Institution, cooperatives and producer unions
Risks	- Difficulties in finding funding - Uncertainties arising from climate projections
Opportunities	- Ensuring the sustainability of fisheries and their activities - Contribution to the Sustainable Development Goals (SDGs 12, 13 and 14) - Contribution to 2053 goals and Green Development Revolution

Table 10.19: Tourism and cultural heritage – Action UTK1

ACTION UTK1	**Improving the resilience of tourism and cultural activities to climate change impacts**
Sub-actions	UTK1.1: To prepare the infrastructure of the province for tourism-related migration (seasonal migration) and to present the emergency action plan (operation of a systematic and effective waste and wastewater management, especially for touristic areas, facilities located on the beach and residential areas where summer houses located)
	UTK1.2: To manage the problems (waste and wastewater management, odor, etc.) caused by seasonal loads in plateau and coastal regions
	UTK1.3: To update facility-based emergency action plans against extreme weather events
	UTK1.4: To prevent constructions and other activities (agricultural activities, festivals, etc.) that damage natural and cultural heritage and are intertwined with historical ruins
	UTK1.5: To raise public awareness for the protection of cultural heritage and to make temporary payments
	UTK1.6: To carry out studies to protect cultural and ecological heritage, to identify potential conservation areas
Responsible departments of MBB	Mersin Metropolitan Municipality (Directorate of Studies and Projects, Directorate of Transportation, Directorate of Climate Change and Zero Waste, Directorate of Environmental Protection and Control, Directorate of Housing and Urbanisation, Directorate of Culture and Social Affairs, Directorate of Technical Works, Directorate of Parks and Gardens, Directorate of Human Resources and Training), District Municipalities
Main stakeholders of the implementation	District Municipalities, Mersin Water and Sewerage Administration (MESKİ), Mersin Governorship, Mersin Provincial Directorate of Environment, Urbanisation and Climate Change, Mersin Provincial Directorate of Culture and Tourism, Mersin Provincial

	Directorate of Family and Social Services, Directorate of Highways Mersin 5. Regional Office, non-governmental organizations
Implementation period	Short
Performance indicators	- Number of events organized and participation rate - Vulnerability roadmap - Waste management plan for touristic areas - Number of emergency action plans - Number of audit plans - Number of audits - Number of protected areas - Number of feasibility studies to protect cultural and ecological heritage
Performance goals	- By the end of 2024, how infrastructure systems are affected by seasonal migrations will be revealed and a road map will be determined. - A management plan for managing additional loads affecting waste and wastewater management processes during the summer seasons will be completed by the end of 2024. - By the end of 2024, how infrastructure systems (transportation, waste and wastewater management, energy, etc.) are affected by seasonal loads in plateau and coastal regions will be revealed and a road map will be determined. - Emergency action plans will be updated in all facilities by the end of 2025. - Regular inspection plans will be created until the end of 2024. - Within the scope of the 2020-2024 Strategic Plan, at least 35 events aimed at historical heritage and urban awareness will be held by the end of 2024. - Within the scope of the 2020-2024 Strategic Plan, at least 36 awareness activities will be carried out to promote the cultural heritage of the city by the end of 2024. - At least 2 events (workshops, awareness meetings, etc.) will be organized every year for the protection of cultural heritage. - A feasibility study will be carried out to identify potential conservation areas by the end of 2025. - An evaluation will be made regarding the establishment of reporting lines by the end of 2024.
Sources of funding	- National budget (Ministry of Culture and Tourism), Budget of Mersin Provincial Directorate of Culture and Tourism, provincial and district municipalities' own revenues, Çukurova Development Agency, national (İlbank) and international bank loans, private sector
Risks	- Difficulties in finding funding - Uncertainties arising from climate projections - Insufficient human resources
Opportunities	- Contribution to the Sustainable Development Goals (SDGs 3, 6, 11, 12 and 13) - Contribution to 2053 goals and Green Development Revolution

11. STAKEHOLDER PARTICIPATION

Institutions and organizations that evaluated the developments regarding the work carried out during the project and contributed to the preparation of the Mersin Sustainable Energy and Climate Action Plan are given in Table 11.1. A series of activities were organized to bring together project stakeholders. Approximately 40 people representing the project stakeholders attended the opening meeting, which was first held on September 6, 2022, and in addition to the project introduction, explanations were made within the framework of the meeting regarding the data needed and collected within the scope of the project, expectations from the stakeholders and the steps to be followed in the future.

Table 11.1: Project stakeholder list

Public institutions and organizations	Representatives of the private sector, Universities, NGOs
Mersin Metropolitan Municipality - Directorate of Climate Change and Zero Waste - Directorate of Environmental Protection and Control - Directorate of Studies and Projects - Directorate of Technical Works - Directorate of Housing and Urbanisation - Directorate of Parks and Gardens - Directorate of Transportation - Directorate of Agricultural Services - Directorate of Human Resources and Training - Directorate of Press, Publications and Public Relations - Directorate of Road Construction, Maintenance and Repair - Directorate of Machinery Supply, Maintenance and Repair - Directorate of Disaster Affairs - Directorate of Fire Brigade - Directorate of Information Technologies - Directorate of Culture and Social Affairs Mersin Water and Sewerage Administration (MESKİ) Akdeniz Municipality Anamur Municipality Bozyazi Municipality Mersin Yenişehir Municipality Mezitli Municipality Mut Municipality Silifke Municipality Tarsus Municipality Toroslar Municipality Erdemli Municipality Aydıncık Municipality Çamlıyayla Municipality Gülnar Municipality Mersin Governorship Mersin Provincial Directorate of Industry and Technology Mersin Provincial Directorate of Environment, Urbanisation and Climate Change	Mersin Chamber of Commerce and Industry (MTSO) Mersin Chamber of Shipping (MDTO) Mersin-Tarsus Agricultural Product Processing Specialization Organized Industrial Zone (TÜİOSB) Mersin Tarsus Organized Industrial Zone Mersin Chamber of Maritime Commerce Mersin Chamber of Drivers and Automobiles, Tradesmen Mersin Chamber of Agricultural Engineers Mediterranean Chamber of Agriculture Mut Chamber of Agriculture Chamber of Architects Chamber of Environmental Engineers Chamber of Civil Engineers Chamber of Urban Planners Chamber of Forest Engineers Chamber of Mechanical Engineers Chamber of Electrical Engineers Chamber of Landscape Architects Aksa Natural Gas Çukurova General Directorate Kalde Energy Electricity Generation Co. Inc. ŞİŞECAM - Soda, Glass Packaging and Flat Glass Production Facilities Eren Holding - Medcem Cement ÇİMSA - Mersin Factory İZOCAM - Glass Wool and Foamboard Production Facilities Tarsus University Mersin University Toros University Çağ University Agriculture and Rural Development Support Institution (TKDK) Mersin Tourism Operators Association (MERTİD) Entrepreneurial Business Women's Association (GIŞKAD)

Public institutions and organizations	Representatives of the private sector, Universities, NGOs
Mersin Provincial Directorate of Agriculture and Forestry Mersin Regional Directorate of Forestry Mersin Provincial Directorate of National Education Mersin Provincial Directorate of Social Security Institution Mersin Provincial Directorate of Family and Social Services Mersin Provincial Directorate of Culture and Tourism Mersin Provincial Directorate of Disaster and Emergency Mersin Provincial Health Directorate Meteorology 6. Regional Office Anamur, Mersin and Silifke Meteorological Directorates Directorate of Highways Mersin 5. Regional Office 6. Regional Directorate of Turkish State Railways TURKSTAT Adana Regional Office 6. Regional Directorate of State Hydraulic Works	Çukurova Development Agency Mersin Investor Business People Association (MERYAD) Mediterranean Exporter Associations (AKİB) Mersin Milk Producers Association Toroslar Electricity Distribution Company Mersin International Port Management (MIP) Akdeniz Clean Air Center TEMA Foundation MENKOBIRLİK Yenişehir Clean Environment Inc.

8 sectoral meetings were held between 2-5 May 2023 to determine the actions that can be implemented specifically in Mersin to mitigate greenhouse gas emissions and increase the adaptive capacity to climate change. General information about the greenhouse gas emission inventory calculated for Mersin in online meetings held on the basis of residential and commercial buildings, transportation, industry and energy production, waste and wastewater management, agriculture and livestock, forestry and water resources, tourism and cultural heritage, coastal areas and fishing areas. Details of the calculations made specific to the relevant sector were shared and the opinions and suggestions of the participants were received. Additionally, measures that could be developed for mitigation and adaptation activities based on relevant areas were discussed, and potential strategies were presented to the participants for evaluation via an online survey.

Finally, a meeting was held with stakeholder institutions on 24-25 August 2023 in order to clarify the actions that can be implemented specifically in Mersin to mitigate greenhouse gas emissions and increase the adaptive capacity to climate change. Round table meetings organized on the basis of 8 sectors were held physically in the meeting hall of Mersin Metropolitan Municipality. Approximately 90 participants representing all stakeholders attended the meetings. During the meetings, the current situation assessment of the actions determined for each sector, sub-actions defined, responsible and relevant institutions/units, implementation period, performance indicators and performance targets were discussed. Before the 4 sessions held in parallel, short informative speeches were made on behalf of Mersin Metropolitan Municipality and TUBITAK MAM teams, and the action tables created on the basis of the relevant sector were explained to the participants, with TUBITAK MAM representatives acting as table moderators, while suggestions of participants were received. Action tables have been updated, taking into account the discussion conveyed within the framework of the meeting. Afterwards, the written suggestions of the stakeholders on the actions were taken and the tables were brought to their final form.

12. IMPLEMENTATION, MONITORING AND REPORTING

Implementing climate change action plans requires long time, effort and financial resources. Whether the plan will be successfully implemented depends largely on the mobilization of stakeholders and citizens. During the implementation phase, it should be essential to ensure both good internal communication (between different units of local government, relevant public authorities and all relevant parties) and external communication (with citizens and stakeholders). In this way, by contributing to increasing awareness about climate change, citizens' knowledge about the problems is increased and the behavioral changes that are needed to combat climate change can be encouraged.

According to the guidelines published by the European Commission Joint Research Center in order to prepare a successful Sustainable Energy and Climate Action Plan within the scope of the "Global Climate and Energy Agreement of Mayors", the action plan includes strategy, emission inventory, climate change risk and vulnerability assessment and finally mitigation and adaptation actions. should be created and a framework for monitoring and evaluating the plan should be put forward (Bertoldi P., 2018).

Different types of actions and measures can contribute to achieving goals. To undertake the entire list of possible actions, the costs would often exceed local government's current capacities especially in terms of project management. Additionally, some actions may slow down another. By listing the selected measures in a table summarizing the main features of each action and including information such as implementation period, level of required resources, expected results, and associated risks in this table, it will be easier to follow the actions within a systematic framework.

The evaluation of actions and measures should be based on a careful estimate of the risks associated with their implementation. Risks may be of different nature:

- Project-related risks: cost and time overruns, contract management problems, delays in tender and selection procedures, poor communication between project parties, etc.
- Government-related risks: insufficient budgets, delays in obtaining permits, changes in laws, lack of project controls, administrative intervention, etc.
- Technical risks: inadequate design or specifications, technical malfunctions, lower than expected performance, higher than expected operating costs, etc.
- Contractor-related risks: inadequate estimates, financial difficulties, delays, lack of experience, poor management, difficulty in controlling appointed subcontractors, poor communication with other project parties, etc.
- Market-related risks: wage cuts, increase in wages, shortage of technical personnel, shortage of materials or equipment and changes in prices of various energy carriers, etc.

The implementation period, estimated cost and ranges determined for greenhouse gas reduction are given in Table 12.1.

Table 12.1: Ranges determined for the indicators included in the implementation plan

Indicator	Ranges		
Implementation period	Short: Up to 5 years	Medium: Between 5-10 years	Long: More than 10 years
Estimated costs	Low: <50 million TL	Medium: 50-200 million TL	High: >200 million TL
Mitigation potential for greenhouse gas emissions	Low: <10.000 tonnes CO_2e/year	Medium: 10.000-100.000 tonnes CO_2e/year	High: >100.000 tonnes CO_2e/year

Another important criterion for the success of action plans is the defined monitoring method. In order to determine progress on an action basis, data collection methods, timing (how often data will be collected) and who is responsible (by whom data will be collected) need to be determined. In this context, it is recommended to form a coordination team to ensure data flow between the institutions and municipal units from which data will be provided and to plan development meetings. Establishing the coordination team in question with the participation of officials from the relevant units of local governments and provincial directorates of central governments, which are among the stakeholders of the action plan, and also including consultancy companies, trade associations and non-governmental organizations working in the province, will be beneficial to achieve a more efficient management of the implementation and monitoring process. The coordination team may hold evaluation meetings periodically, with the participation of relevant stakeholders, in order to intervene in a timely manner to problems that arise during the action plan implementation process, to examine the work done and to plan future work. Performance indicators to which the actions may be related are defined in the action plan implementation calendar, and it is recommended that the progress in these indicators be evaluated every year and a monitoring report is prepared with the contributions of the coordination team members. During this reporting, information such as the obstacles encountered during implementation and the implementation status of each action may also be included.

13. CONCLUSIONS AND EVALUATIONS

Cities face significant impacts of climate change today and in near future. These impacts range from increases in extreme weather events and flooding to temperature extremes and public health problems, with potentially serious consequences on human health, livelihoods and assets, in particularly for poor populations, informal settlements and other vulnerable groups.

Adaptation is the process of preparing for and proactively adapting to climate change, and cities are often listed as the first responders. Cities, which are the main source of greenhouse gas emissions, are also an integral part of the fight against global warming because they are also the main source of innovative climate solutions. Because cities are dynamic systems facing unique climate impacts, adaptation processes must also be location-specific and tailored to local conditions. The starting point in managing risks and building long-term resilience is for a city to understand its exposure and vulnerability to a particular set of impacts and develop responsive policies and investments that address these vulnerabilities.

Today, an increasing number of cities around the world have begun to plan for climate change by developing climate action plans or by incorporating climate change as a parameter into their existing plans, policies and projects. Studies in this direction in our country have gained momentum in recent years. Local governments carry out various studies and prepare climate change action plans within the scope of both reducing greenhouse gases and adaptation to climate change. In this context, one of the most important challenges faced by urban planning processes within the scope of climate change is to reduce greenhouse gas emissions in the city, while adapting urban areas and infrastructure systems to be resilient to the expected effects of climate change. Because, in a process where global warming is being tried to be limited to 1.5°C, there is no mitigation measure that can prevent climate change from occurring in the next few decades. On the other hand, complete abandoning of mitigation efforts will lead to increased social and economic damages related to adaptation in the next period. For this reason, climate action plans prepared in the coordination of different stakeholders, where the synergy between climate change adaptation and mitigation targets are maintained, gain importance.

In this regard, within the scope of this study in which the climate change action plan was prepared for the province of Mersin, the sources of greenhouse gas emissions of the city were identified, the greenhouse gas emissions for 2019, which was determined as the reference year, and additionally for the years 2020 and 2021, were calculated in detail and the impacts of current policies in the future of total emissions on a sectoral basis were determined. It has been revealed to what extent greenhouse gas reduction can be achieved through the mitigation measures to be implemented, and awareness on this issue has been increased. It is important to evaluate the studies carried out for emission reduction, covering the years 2019-2055, in the short, medium and long term, and has also provided guidance for decision makers. In this context, the potential of greenhouse gas emissions mitigation for stationary resources (emissions arising from energy consumption in the residential and commercial buildings, industry, agriculture, livestock and forestry sectors), transportation and waste and wastewater management sectors was evaluated within the scope of 2 alternative scenarios. It is estimated that greenhouse gas emission reductions in these sectors can be achieved in the range of 25-48% in 2035 and 39-68% in 2055, compared to the reference scenario.

In addition, the mitigation measures evaluated within the scope of the scenarios were evaluated on a sectoral basis and a total of 9 actions and 37 sub-actions were listed, and information about the institutions that may be responsible for the implementation of these actions and stakeholders that can contribute to the implementation, the implementation period of the action, performance goals and indicators, and risks and opportunities that may occur during implementation are stated as indicative.

In order to evaluate the impacts of climate change across Mersin, according to the climatological analysis carried out based on long-term data between 1942 and 2019, the average temperature increase was 0.76°C for the winter period and 1.63°C for the summer period. It has been determined that there is a tendency to decrease of total precipitation especially in winter and spring seasons. In terms of climate projections, the average temperature increase is expected to be between 1.5 - 5°C in all models and scenarios towards the end of the century. In order to make Mersin resilient to climate change, sectors that are sensitive to the impacts of climate change were evaluated and what actions should be taken to improve adaptive capacity were determined on the basis of prioritized areas. In this framework, a total of 10 actions and 60 sub-actions are listed, and information about the institutions that may be responsible for the implementation of these actions and stakeholders that can contribute to the implementation, the implementation period of the action, performance goals and indicators, and risks and opportunities that may occur during implementation are stated as indicative.

With this study conducted for Mersin province, the city's priority areas regarding greenhouse gas reduction and adaptation to climate change were determined and a detailed technical document was provided that could help decision makers on what path should be followed in the coming period.

In combating climate change, the efforts of cities, which are responsible for approximately 70% of natural resource and energy use and 75% of global greenhouse gas emissions, are of great importance. It should not be forgotten that after the preparation of climate change action plans, the implementation process of the determined actions and the monitoring and evaluation process must be carried out profoundly. It is recommended to establish a coordination board in which the work carried out to combat climate change throughout the province is coordinated and which includes representatives of the governorship, special provincial administration, other public institutions, municipalities, non-governmental organizations, universities and private sector representatives operating in the province.

Considering that the main factors causing climate change, the impacts of which we feel strongly today, are caused by anthropogenic activities, every segment of the society should be aware of this issue and it should be taken into consideration that it is important to carry out awareness-raising activities. Increased sharing of experience and information between local governments in the planning process will also help on building the consensus during planning process and contribute to raising the level in terms of scope and quality.

GRAND MOSQUE

APPENDIX

ANNEX 1 - Greenhouse Gas Emission Factors

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ANNEX 1

Greenhouse Gas Emission Factors

EMISSION FACTORS*						
STATIONARY ENERGY						
Sector/Area	**Sub-sector**	**Fuel type**	**Unit**	**Emission factors**		
				CO_2	**CH_4**	**N_2O**
Manufacturing and Construction Industries, Residentail and Commercial Buildings, Agriculture, Livestock and Fishing Activities	General	Domestic coal	kg/TJ	106,620	0.7	0.5
		Hardcoal	kg/TJ	96,890	0.7	0.5
		Imported coal	kg/TJ	94,580	0.7	0.5
		Natural gas	kg/TJ	53,670	5	0.1
		Fuel oil	kg/TJ	76,970	10	0.6
		Diesel	kg/TJ	72,280	10	0.6
		Gasoline	kg/TJ	69,300	10	0.6
		LPG	kg/TJ	63,070	5	0.1
		Wood	kg/TJ	111,800	300	4
		Kerosene	kg/TJ	72,280	10	0.6
		Biyofuels	kg/TJ	54,630	-	-
Electricity and Heat Production	General	Hardcoal - Pulverised	kg/TJ	96,890	0.7	0.5
		Imported coal - Pulverised	kg/TJ	94,580	0.7	0.5
		Hardcoal - Fluidized bed	kg/TJ	96,890	1	61
		Imported coal - Fluidized bed	kg/TJ	94,580	1	61
		Natural gas	kg/TJ	55,500	4	1
		Fuel oil	kg/TJ	76,970	0.8	0.3
		Diesel	kg/TJ	72,280	0.9	0.4
TRANSPORTATION						
Sector	**Sub-Sector**	**Fuel Type**	**Unit**	**Emission Factors**		
				CO_2	**CH_4**	**N_2O**
Transportation	Aviation	Jet Fuel	kg/TJ	70,657	1.2	2.4
	Road Transport	Gasoline	kg/TJ	69,300	25	8.0
		Diesel	kg/TJ	72,278	3.9	3.9
		LPG	kg/TJ	63,067	62	0.2
		CNG	kg/TJ	53,671	92	3.0
	Water-Borne Navigation	Fuel-Oil	kg/TJ	76,970	7	2
		Diesel	kg/TJ	72,278	7	2

AGRICULTURE AND LIVESTOCK						
Sub categories	Type		Unit	Emission factors		
				CO_2	CH_4	N_2O
Enteric Fermantation	Cattle	General	kg/head/year		60.7	
		Dairy cattle	kg/head/year		83.3	
		Non-dairy cattle	kg/head/year		47.3	
	Sheep	General	kg/head/year		5.1	
		Domestic	kg/head/year		5.0	
		Merino	kg/head/year		6.5	
	Swine	Swine	kg/head/year		1	
	Other Livestock	General	kg/head/year		0.2	
		Buffalo	kg/head/year		55.0	
		Camels	kg/head/year		46.0	
		Goats	kg/head/year		5.0	
		Horses	kg/head/year		18.0	
		Mules and Asses	kg/head/year		10.0	
		Poultry	kg/head/year		-	
Manure Management	Cattle	General	kg/head/year		7.9	0.4
		Dairy cattle	kg/head/year		19.6	1
		Non-dairy cattle	kg/head/year		1.0	0.2
	Sheep	General	kg/head/year		0.1	0.1
		Domestic	kg/head/year		0.1	0.1
		Merino	kg/head/year		0.2	0.1
	Swine	Swine	kg/head/year		3.8	
	Other Livestock	General	kg/head/year		0.0	0.0
		Buffalo	kg/head/year		1.5	0
		Camels	kg/head/year		1.9	0.1
		Goats	kg/head/year		0.1	0.1
		Horses	kg/head/year		1.4	0.3
		Mules and Asses	kg/head/year		0.7	0.1
		Poultry	kg/head/year		0.016	0.001
Rice Cultivation	Irrigated	Continuously Flooded	g/m^2		11.6	
		Intermitently Flooded – Single Aeration	g/m^2		7.1	
		Intermitently Flooded – Multiple Aeration	g/m^2		6.3	

Sub categories	Type		Unit	Emission factors		
				CO_2	CH_4	N_2O
Direc and indirect N_2O emissions from agricultural lands	Direct N_2O Emissions	Inorganic – N Fertilizer	kg N_2O-N/kg N			0.010
		Organic – Animal Manure	kg N_2O-N/kg N			0.010
		Organic– Sewage sludge	kg N_2O-N/kg N			0.010
		Organic – Other	kg N_2O-N/kg N			0.010
		Urine and dung	kg N_2O-N/kg N			0.013
		Loss of soil organic matter	kg N_2O-N/kg N			0.010
		Cultivation of organic soil	kg N_2O-N/kg N			8.000
	Indirect N_2O emissions	Atmospheric depositin	kg N_2O-N/kg N			0.010
		Nitrogen leaching	kg N_2O-N/kg N			0.008
	Fractions	$Frac_{GASF}$	-			0.100
		$Frac_{GASM}$	-			0.200
		$Frac_{LEACH-(H)}$	-			0.015
Biomass burning	Cereals	Wheat	g/kg		2.7	0.07
		Barley	g/kg		2.7	0.07
		Corn	g/kg		2.7	0.07
		Other	g/kg		2.7	0.07
		Rice	g/kg		2.7	0.07
	Yanma Faktörü, C_f	Wheat	-		0,9	0,9
		Barley	-		0,9	0,9
		Corn	-		0.8	0,8
		Rice	-		0.8	0.8
CO_2 emissions from carbon-containing fertilizers	Application of urea fertilizers		t CO_2-C/t	0.2		
WASTE AND WASTEWATER						
Sub-Category	**Type**		**Unit**	**Emission factors**		
				CO_2	CH_4	N_2O
Wastewater Treatment	Domestic Wastewater		kg/kg DC		0.07	
			kg N_2O-N/kg N			0.01
	Industrial Wastewater		kg/kg DC		0.01	
	Other parameters	Protein Consumption			40.4	
		Nitrogen fraction of protein	kg/person/yr		0.2	
		$F_{NON-CON}$			1.4	
		$F_{IND-COM}$			1.3	
		T_{PLANT}			42.1	

*: Emission factors are compiled from National Greenhouse Gas Emission Inventory Report of Türkiye.

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İKLİM DEĞİŞİKLİĞİVE SIFIR ATIK DAİRESİ
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