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T.C.
Turkish State Meteorological Service,
Ankara, Türkiye

ANALYSIS OF ANKARA'S SECTORAL CLIMATE INDICES: AGRICULTURAL FROST, HAIL, FLOOD, DROUGHT DAMAGES AND PROTECTION RECOMMENDATIONS

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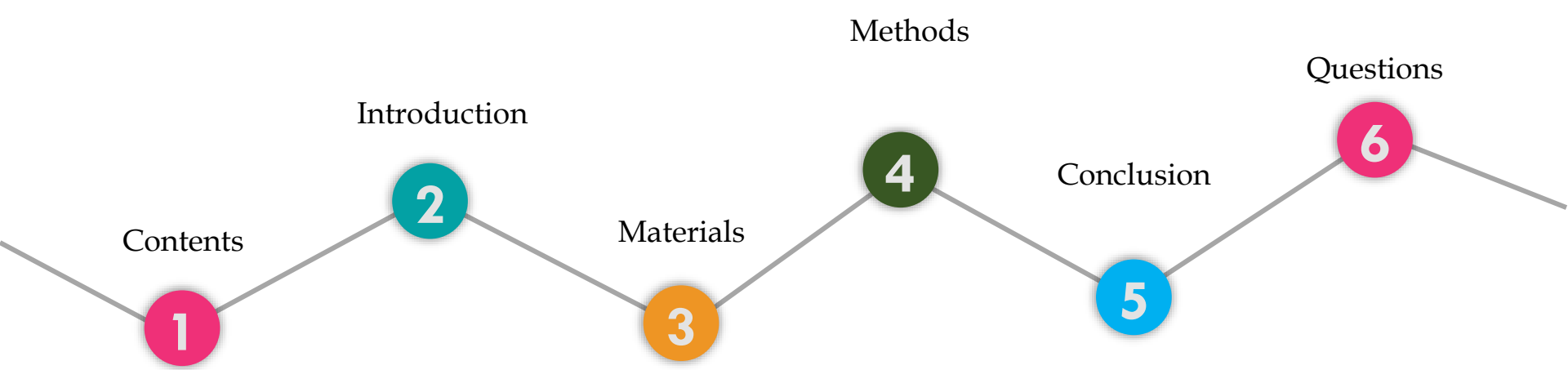
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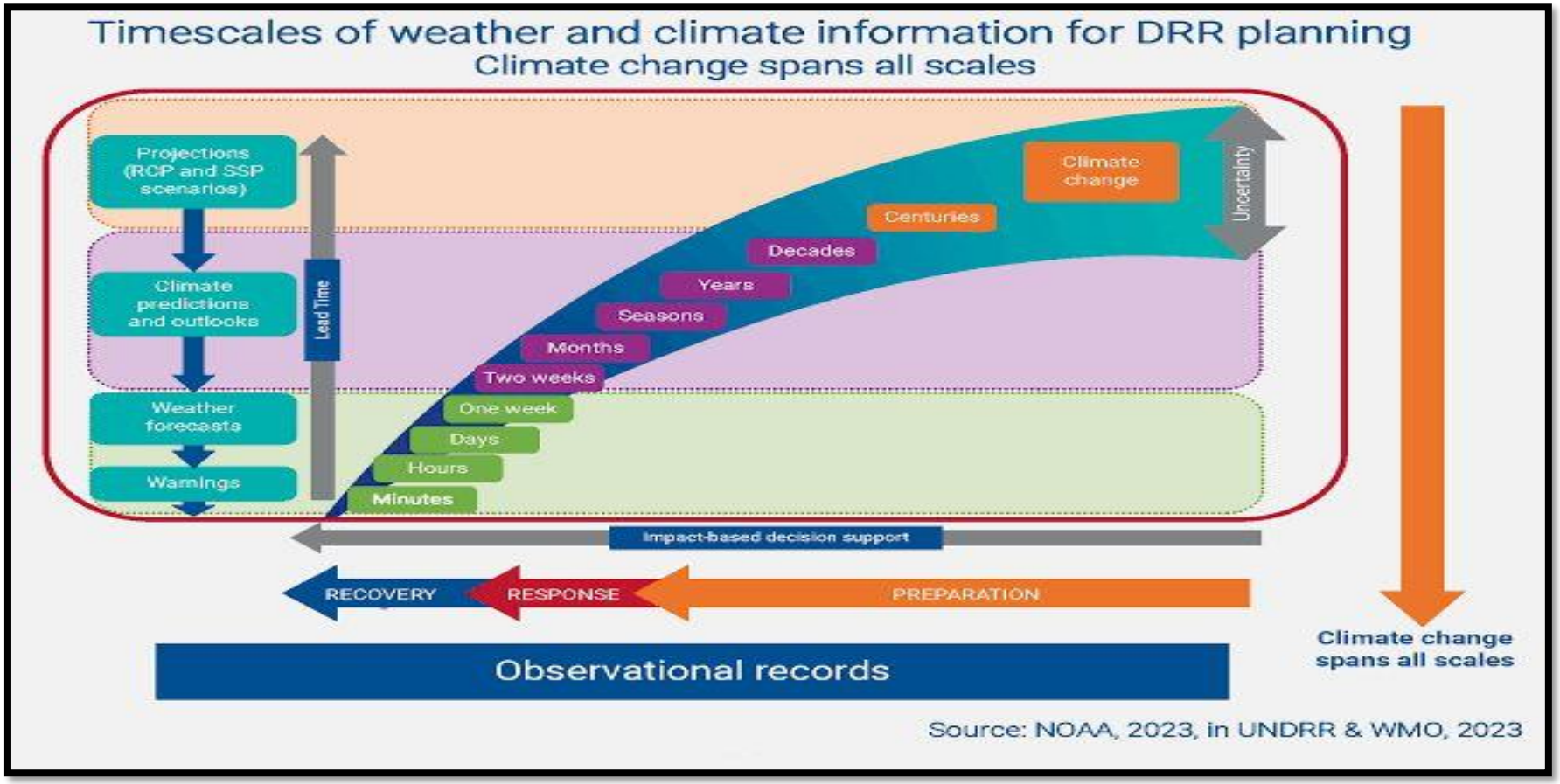
INTRODUCTION

Climate

- Extreme events lasting longer than a week are considered part of the climate system.
- Climate change is one of the most significant challenges facing humanity in the 21st century.
- Global climate change directly and indirectly affects agricultural ecosystems.



Introduction

- Changes in temperature, precipitation and atmospheric carbon dioxide (CO_2) levels and increases in extreme climate events change plant growth, water needs, yield, quantity and quality of production, supply of production materials such as seeds, seedlings, saplings and harvest times.

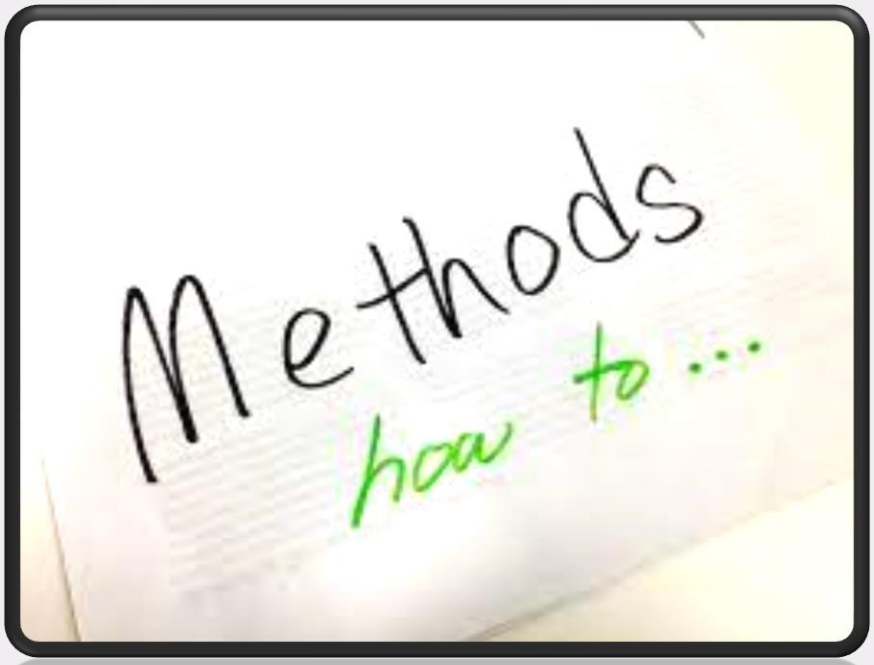
- Product losses increase due to more frequent and severe droughts or excessive rainfall. These changes in production quantities affect costs.

- Plant diseases and pests increase, more pesticides are needed, the number of sprayings and the resulting residue problem increase, and the spraying period is extended according to the production calendar. Animal production is directly or indirectly affected by climate change. The increase in temperature disrupts the balance between heat production and heat use in animals (Anonymous, 2023).

MATERIALS

CITIES EVALUATED IN THE STUDY

Ankara



METHODS

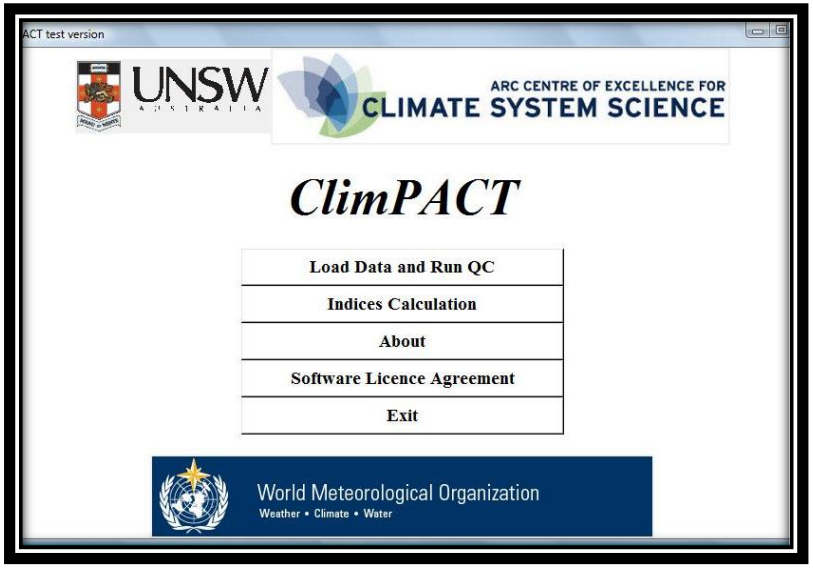
- Climate indices: Indicators that give an idea about climate change.

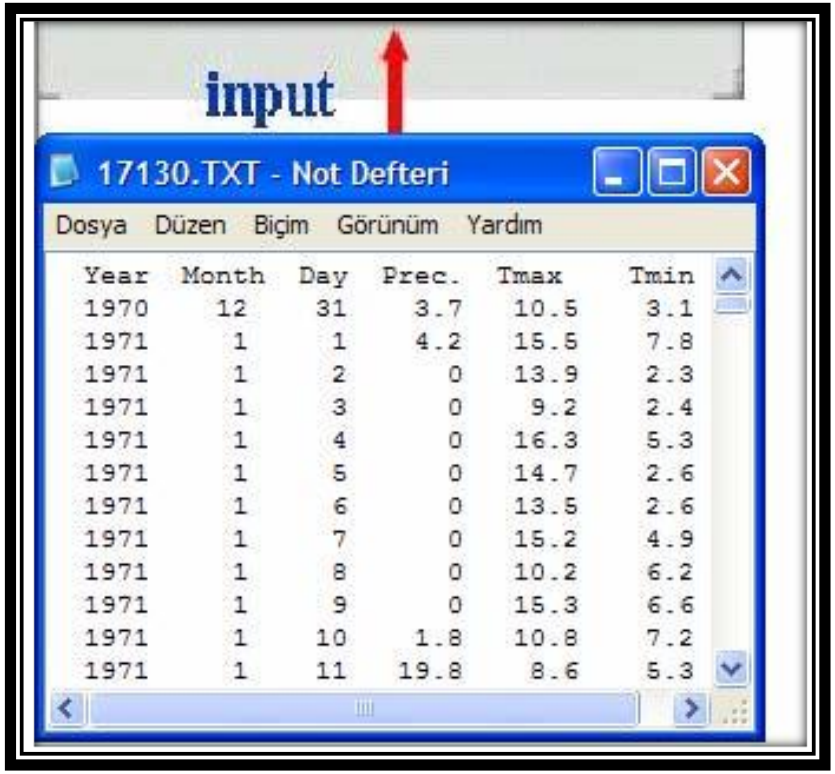
- In the study, data obtained from the General Directorate of Meteorology for 3 cities in Türkiye between 1971 and 2020 were processed with **CLIMPACT** software.

- Accordingly, The 50-year trend of GDD, which is a parameter of 71 climate indices, was determined for each city separately

- CLIMPACT -

SECTOR SPECIFIC CLIMATE INDİCES





Year	Month	Day	Prec.	Tmax	Tmin
1970	12	31	3.7	10.5	3.1
1971	1	1	4.2	15.5	7.8
1971	1	2	0	13.9	2.3
1971	1	3	0	9.2	2.4
1971	1	4	0	16.3	5.3
1971	1	5	0	14.7	2.6
1971	1	6	0	13.5	2.6
1971	1	7	0	15.2	4.9
1971	1	8	0	10.2	6.2
1971	1	9	0	15.3	6.6
1971	1	10	1.8	10.8	7.2
1971	1	11	19.8	8.6	5.3

- Ankara’s climate has been evaluated with 4 different methods.
  - Erinc climate classification: Semi-arid
  - DeMartonne climate classification: Semi-arid-humid
  - Trewartha climate classification: cool winters and hot summers
  - Thornthwaite climate classification: semi-arid - less humid

CLIMATE OF ANKARA

Figure 1.2. Ankara climate according to Aydeniz climate classification

(Anonymous, 2025a)

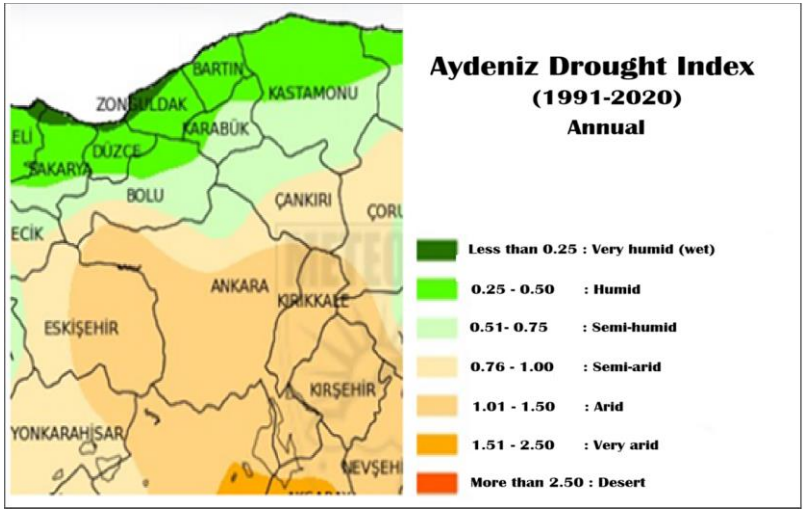


Table 1.1. Ankara's long-term climate data (Anonymous, 2025b)

ANKARA	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Average Temperature (°C)	0,3	1,8	5,8	11,3	16,1	20,0	23,4	23,5	19,0	13,2	7,3	2,6	12.0
Average Highest Temperature (°C)	4,3	6,5	11,5	17,4	22,4	26,7	30,3	30,5	26,1	20,0	13,1	6,6	17.9
Average Lowest Temperature (°C)	-3,1	-2,2	0,7	5,5	9,7	13,0	15,9	16,1	11,9	7,2	2,6	-0,7	6.4
Average Sunshine Duration (hours)	2,6	3,8	5,1	6,4	8,2	9,8	11,1	10,7	9,2	6,7	4,6	2,6	6.7
Average Number of Rainy Days	12,22	11,04	10,79	11,05	12,36	8,85	3,54	2,70	4,00	6,82	8,15	11,68	103.2
Monthly Total Rainfall Average (mm)	40,0	34,9	39,6	41,7	52,0	36,9	14,1	12,6	17,8	26,8	31,6	44,3	392.3
Highest Temperature (°C)	18,4	21,3	27,8	31,6	34,4	37,0	41,0	40,5	39,1	33,3	24,7	20,4	41.0
Lowest Temperature (°C)	-24,9	-24,2	-19,2	-7,2	-1,6	3,8	4,5	5,5	-1,5	-9,8	-17,5	-24,2	-24.9

Figure 3.9. Temporal Distribution and Trend of Ankara Annual Average Temperatures

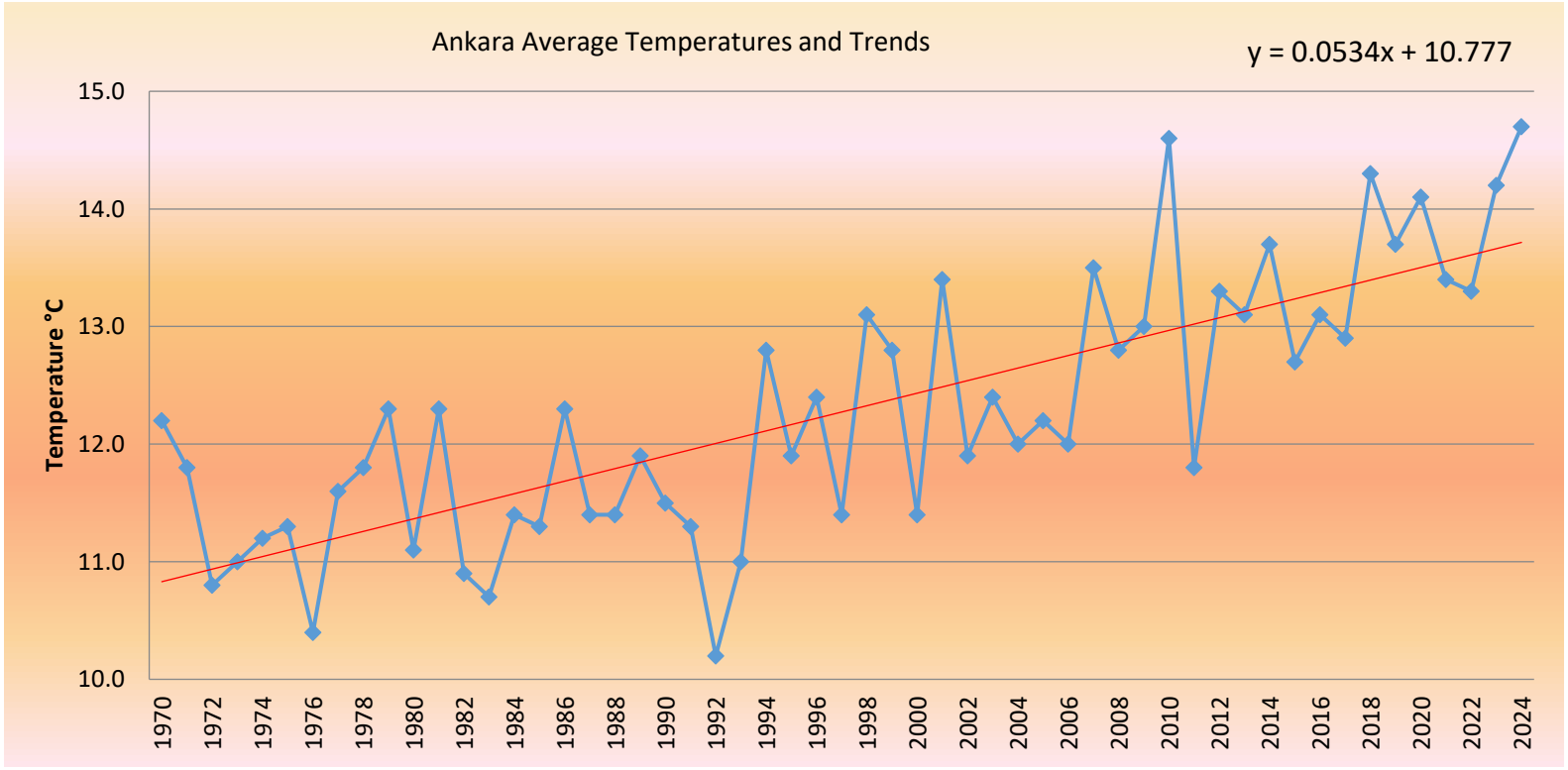
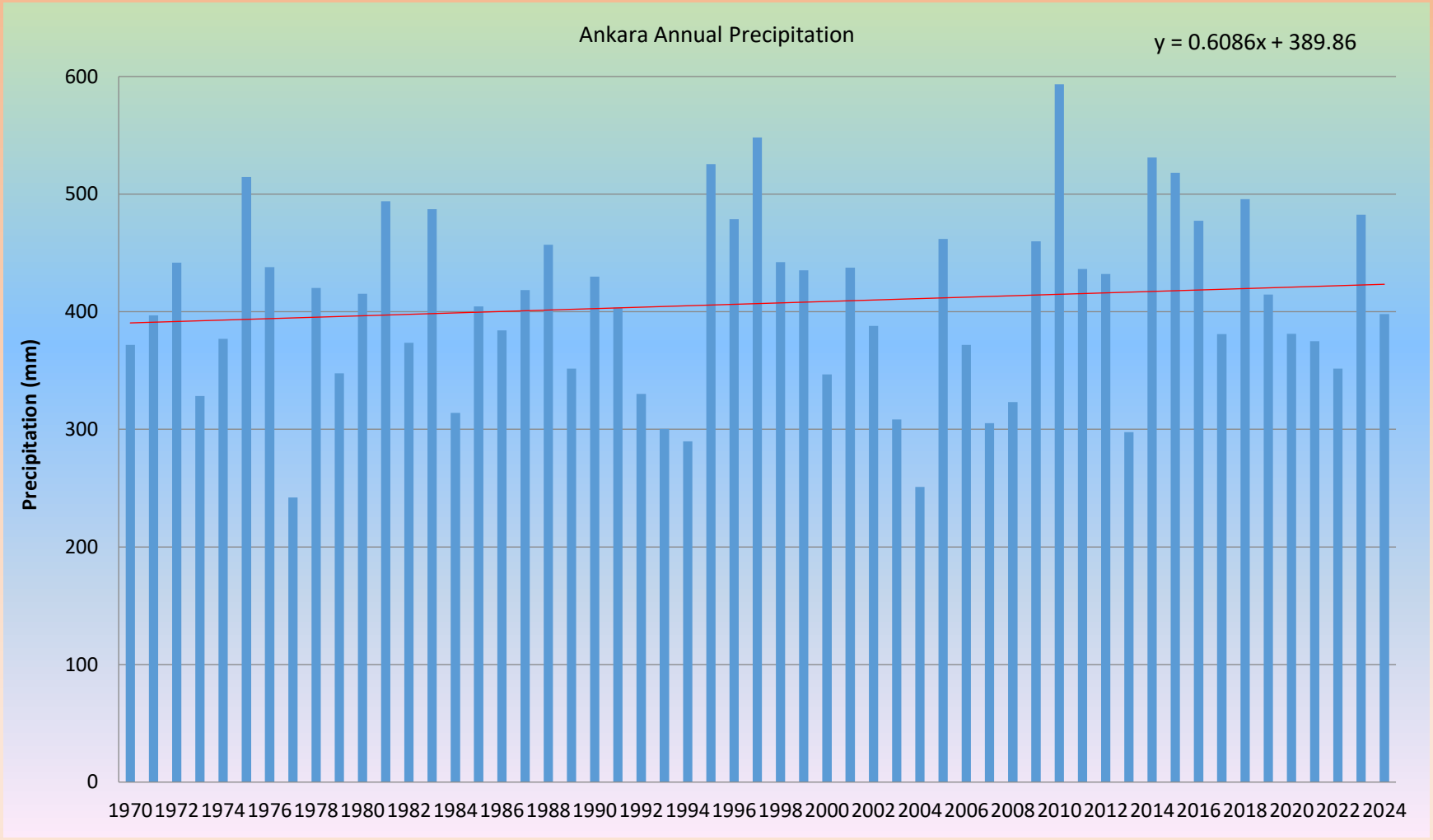
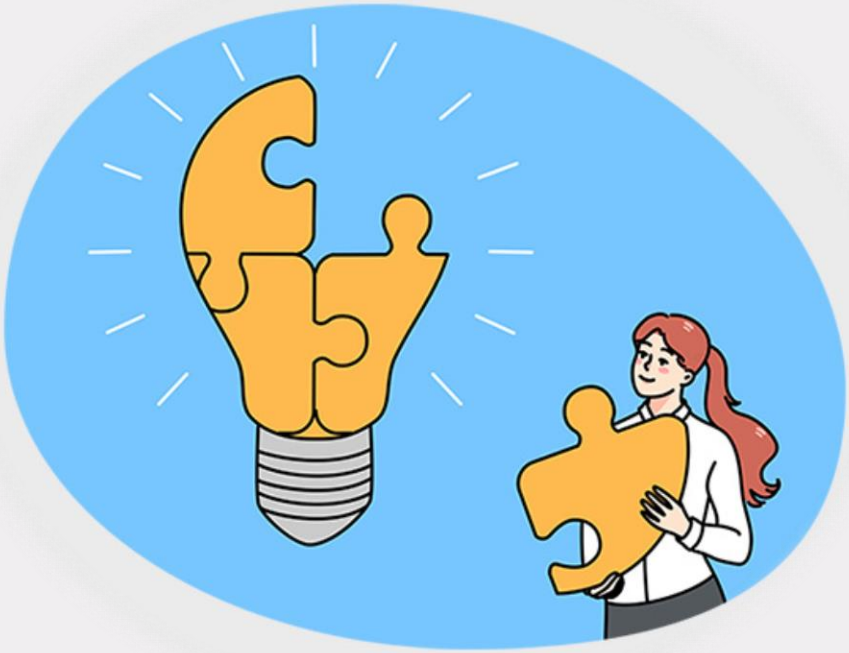


Figure 3.10. Temporal distribution and trend of annual areal precipitation in Turkey

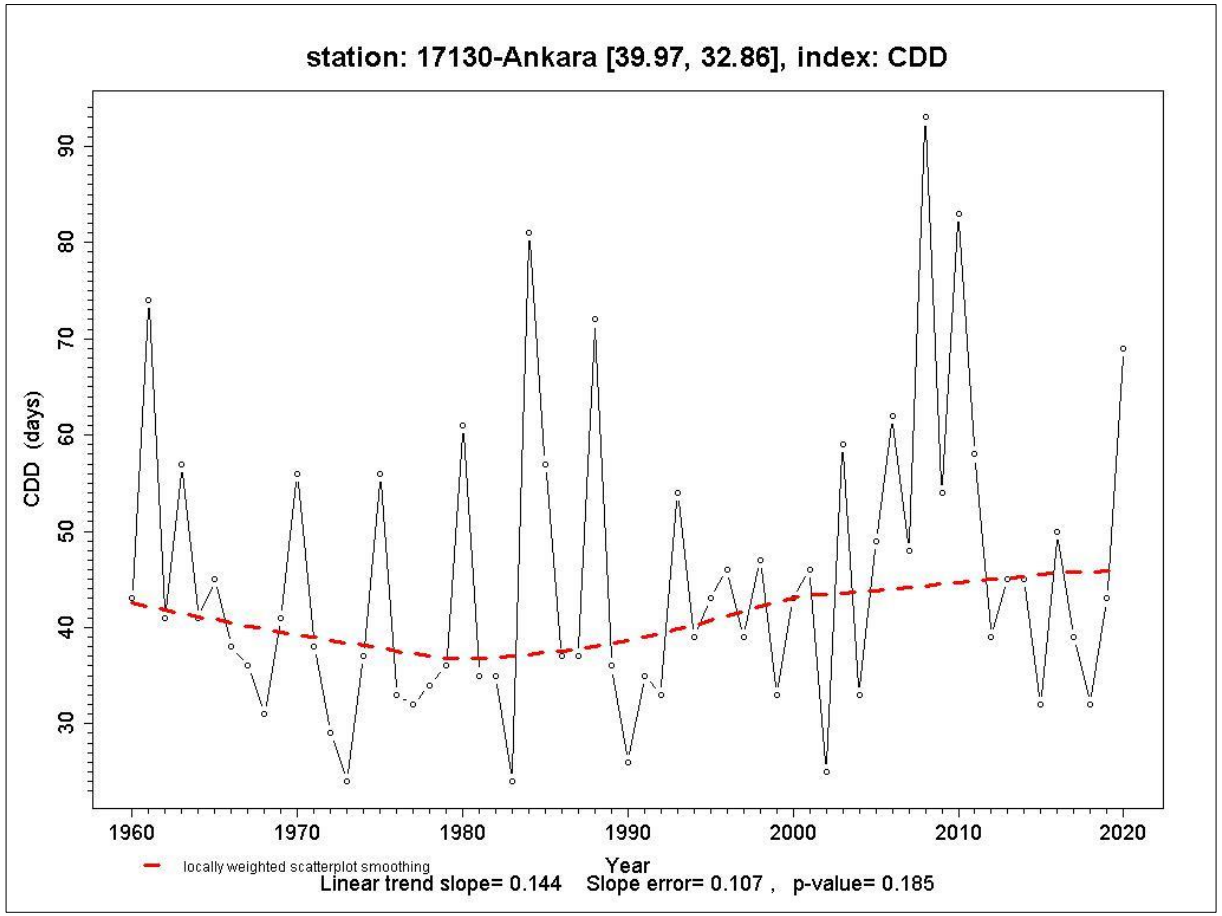




DISCUSSION AND CONCLUSION

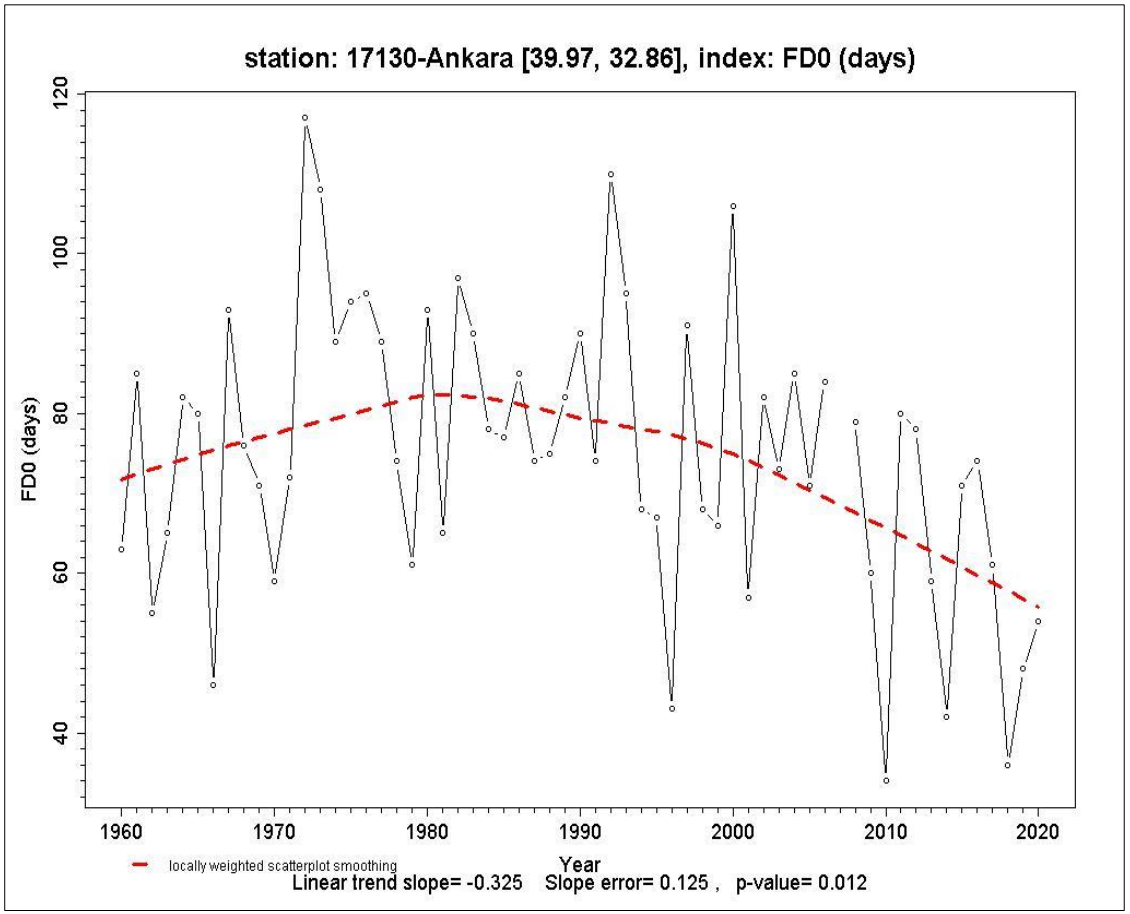
SECTORAL CLIMATE INDICES OF ANKARA

Figure 1. Ankara Consecutive Dry Days Trend



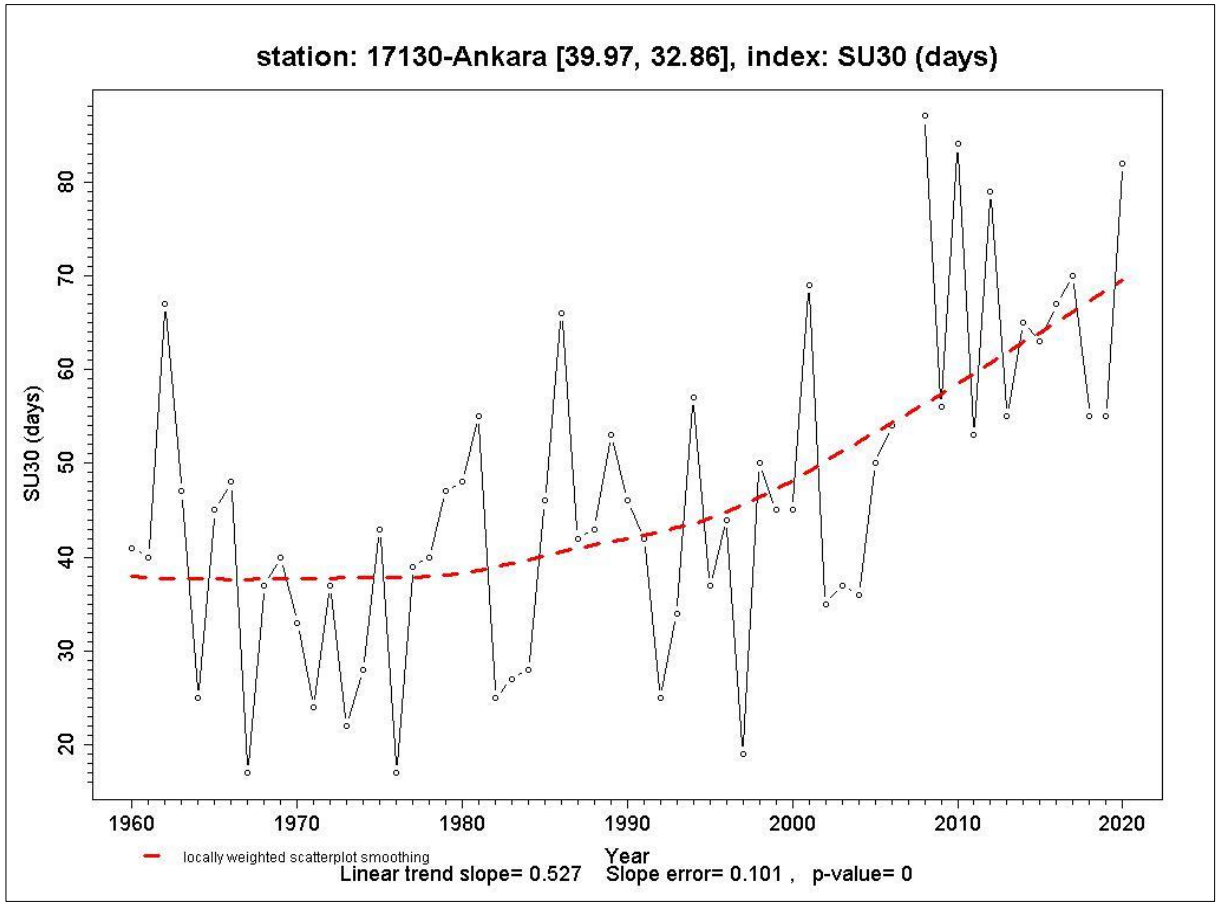
Consecutive dry days are the maximum number of days with precipitation < 1 mm. It is very important for risk management and damage reduction studies in agriculture, health and water sectors (Alexander et al., 2013).

Figure 2. Ankara Number of Days of Frost trend



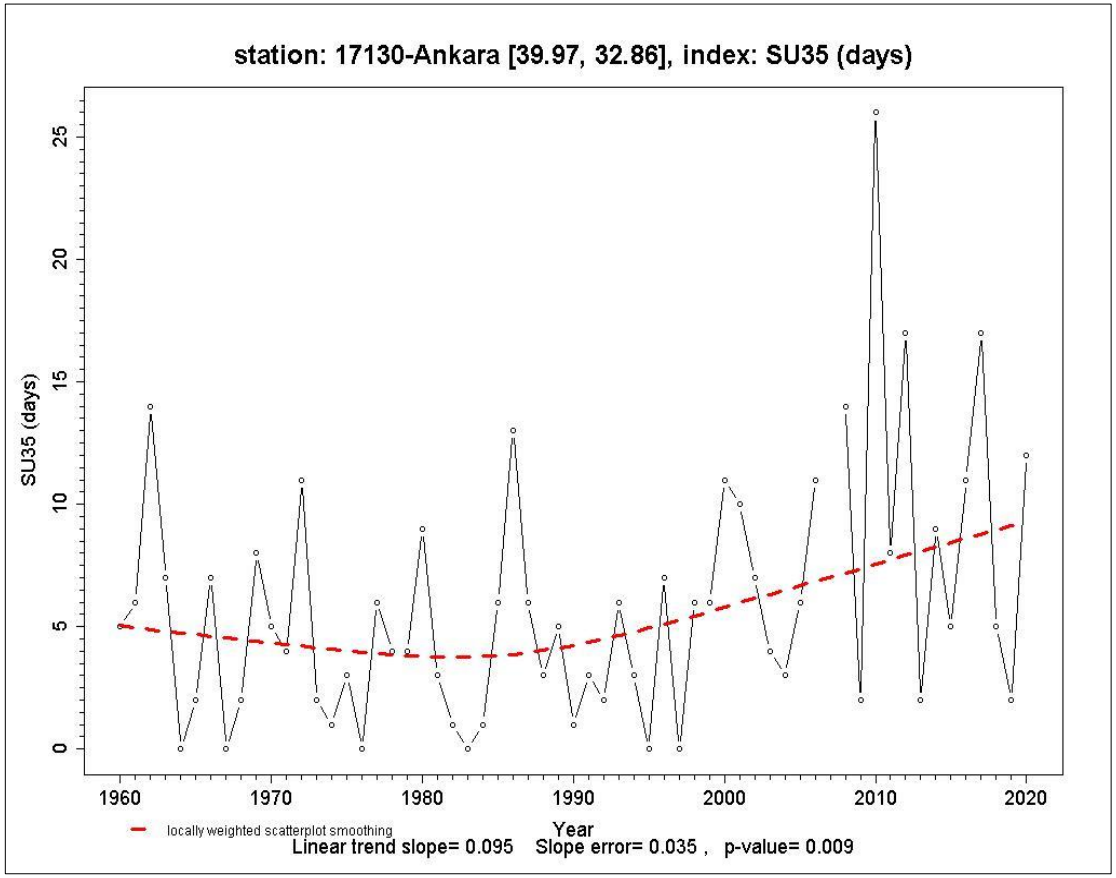
Frosty days are days when minimum temperatures are < 0°C. They are very important for risk management and damage reduction studies in Agriculture and Food Safety and the health sector

Figure 3. Ankara Tropical Days Trend



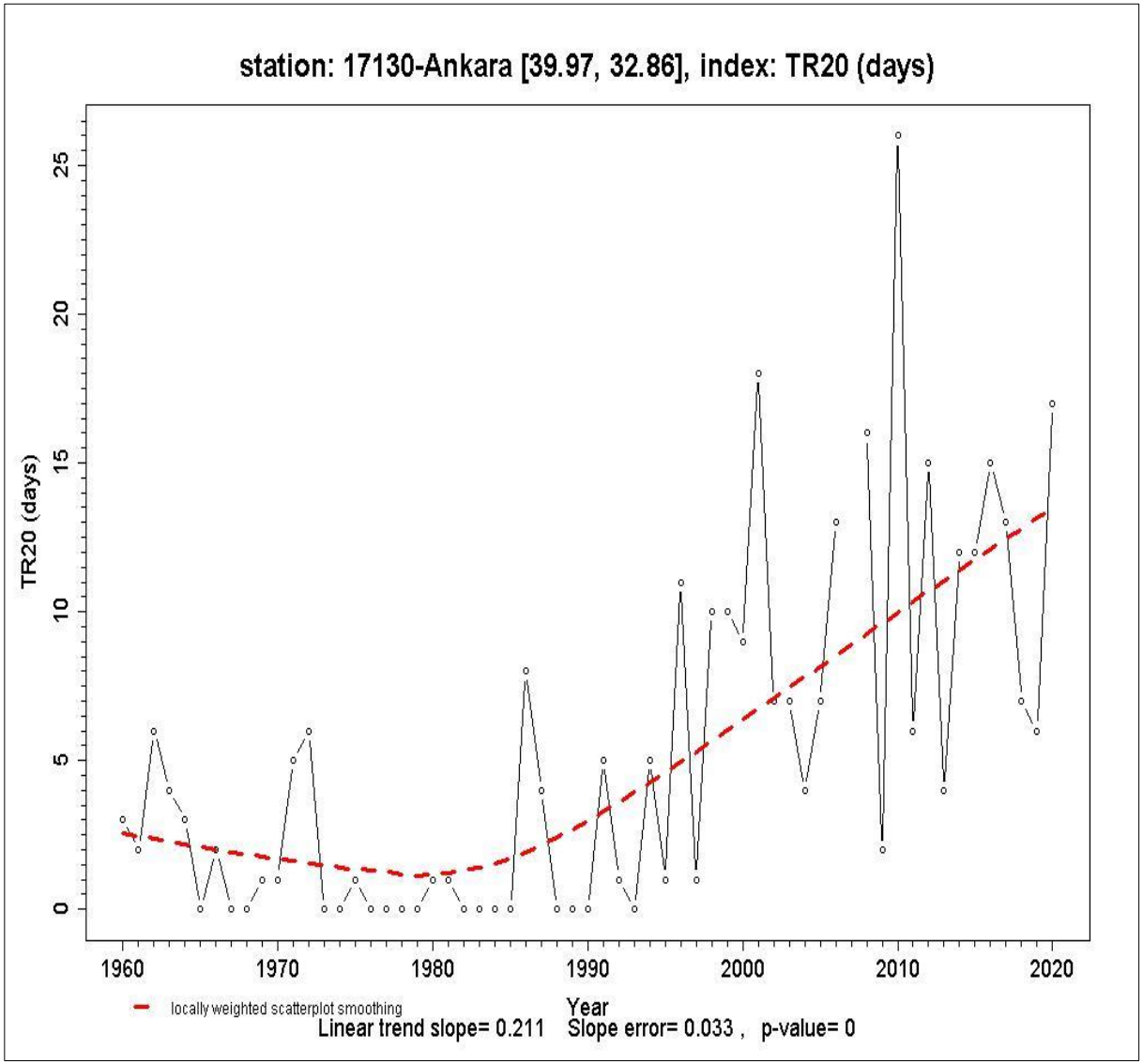
Tropical days are days when maximum temperatures are >= 30°C. They are very important in terms of agriculture and food safety and health sectors (Alexander et al., 2013).

Figure 4. Ankara Very Hot Days Trend



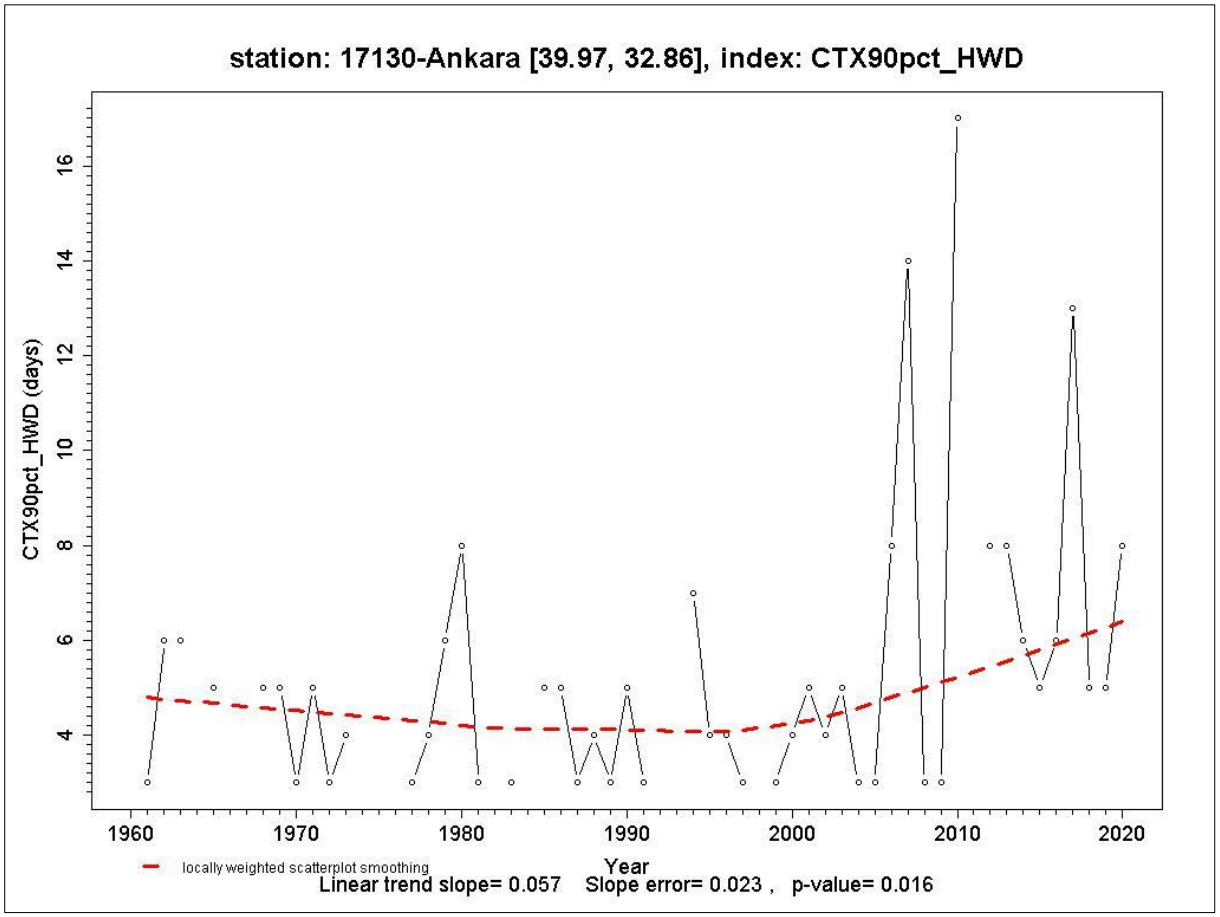
Very hot days are days when maximum temperatures are >= 35°C. They are very important for the Health, Agriculture and Food Safety sectors (Alexander et al., 2013).

Figure 5.Ankara Tropical Nights Number Trend



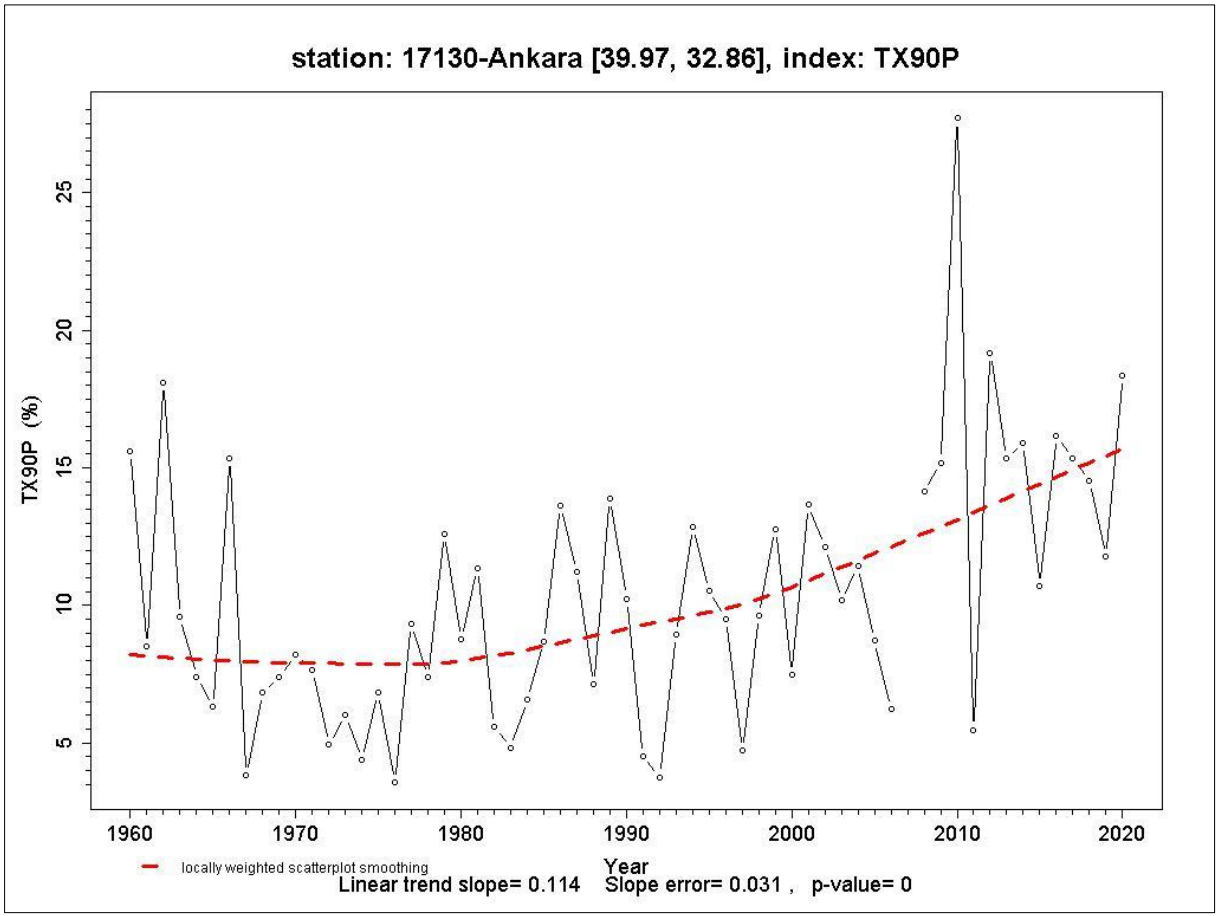
Tropical nights are uncomfortable nights where minimum temperatures exceed 20°C. They are very important for the Health, Agriculture and Food Safety sectors (Alexander et al., 2013).

Figure 6. Ankara Heat Wave Duration Trend



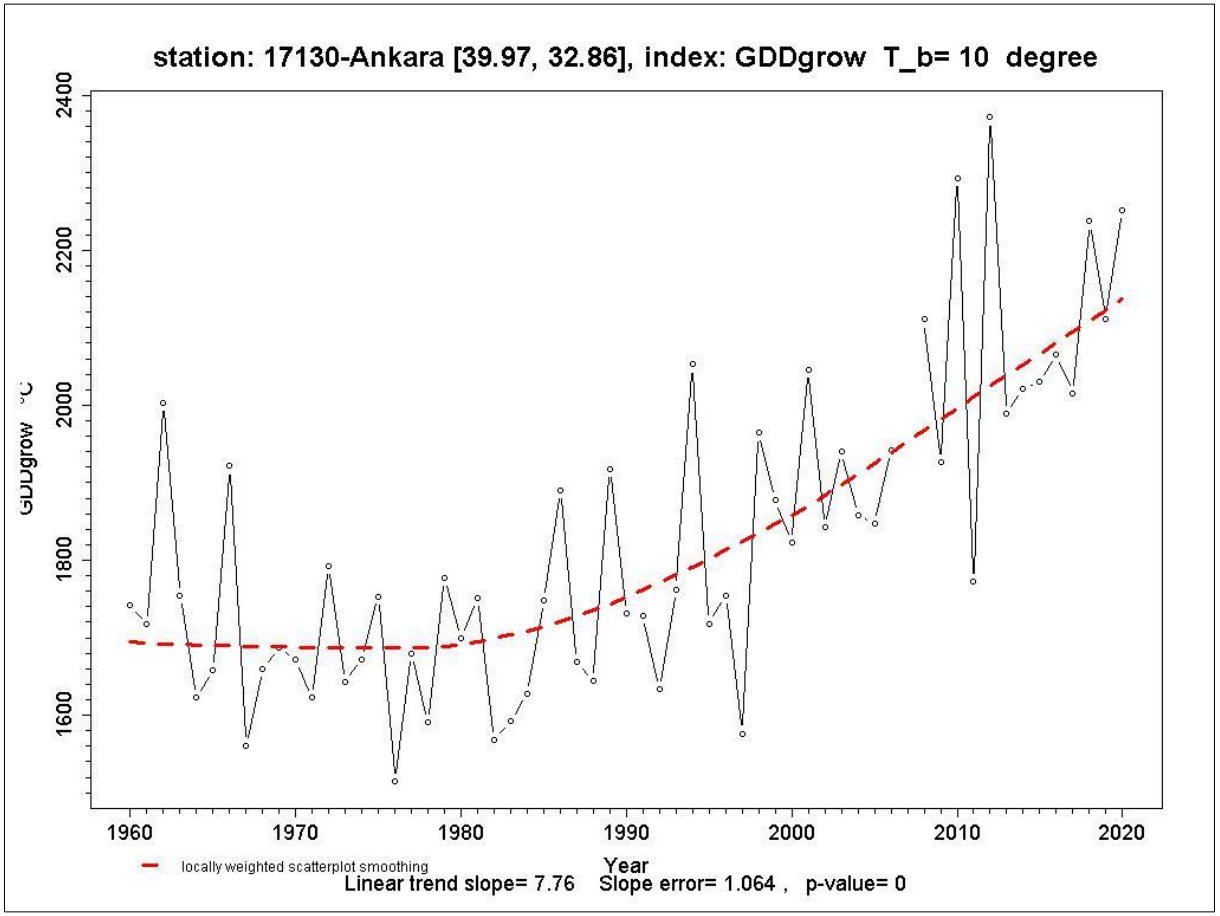
A Heat Wave is a situation where maximum temperatures exceed 90% for at least 3 days between May and September in the Northern Hemisphere. It is very important in terms of agriculture and food security, health and water resources sectors (Alexander et al., 2013).

Figure 7. Ankara Hot Days trend



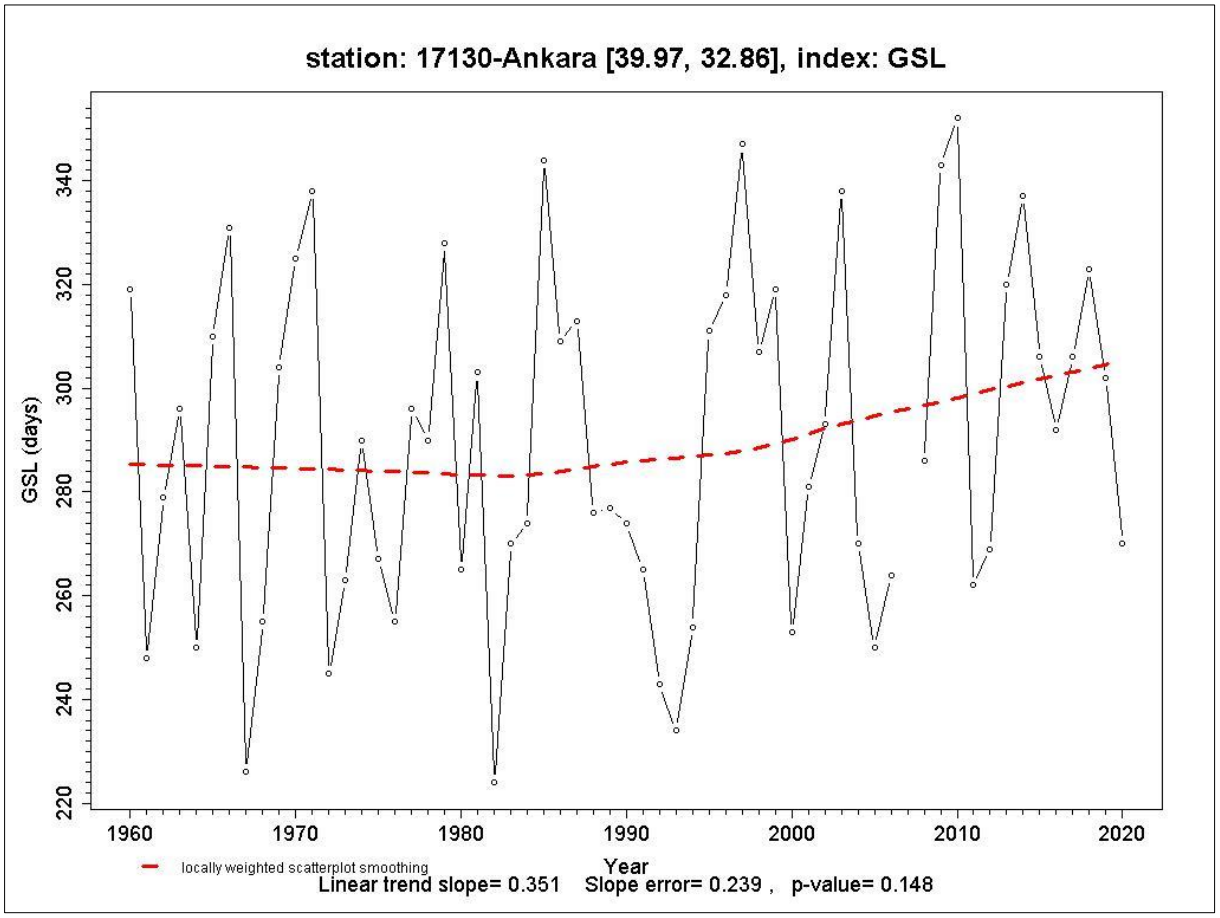
Hot days are days when maximum temperatures exceed 90%. They are very important in terms of Agriculture and Food Safety and Health sectors (Alexander et al., 2013

Figure 8. Ankara Growth Day-Degrees trend



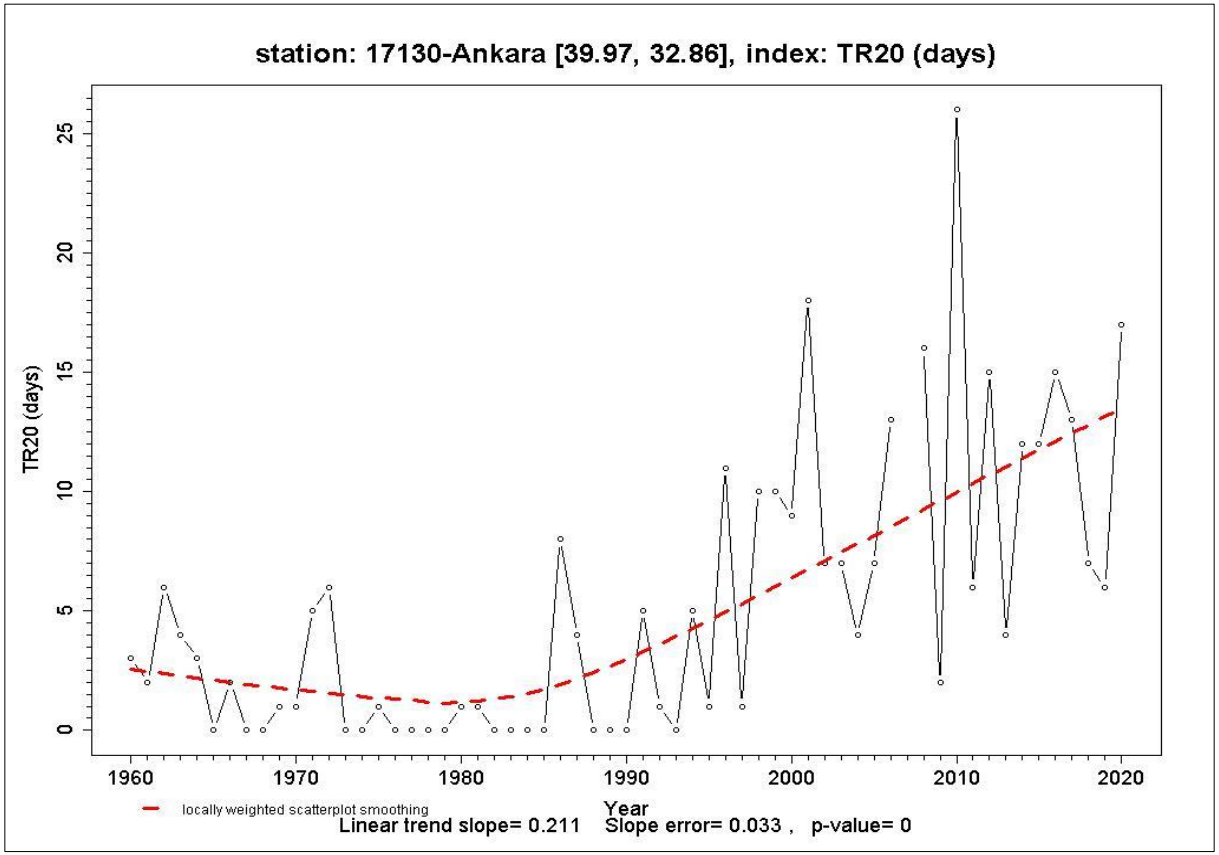
Growth day-degrees are the annual total of Tort - 10°C, which contributes to plant growth. It is very important in terms of agriculture and food safety and health sectors (Alexander et al., 2013).

Figure 9. Ankara Growing Season Length Trend



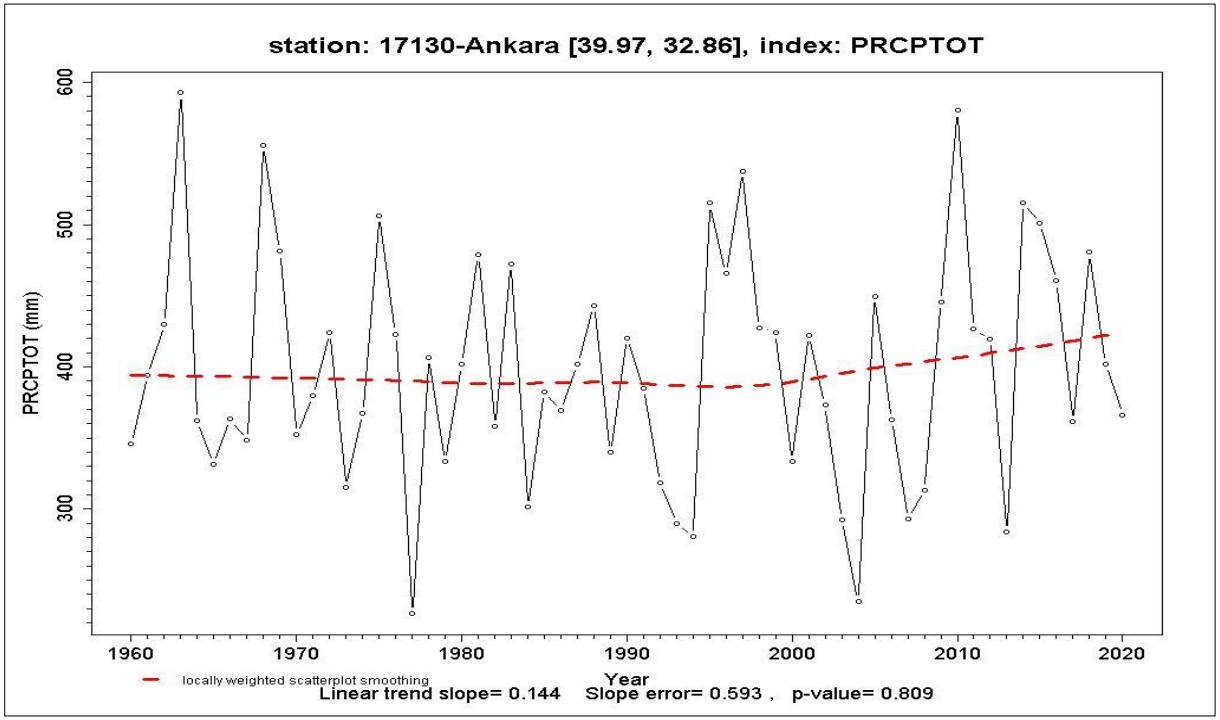
Growing season length is the sum of the number of days between the first 6 days with T > 5°C and the first 6 days with T < 5°C. It is very important for the agriculture and food safety sector (Alexander et al., 2013). Increasing temperatures support plant growth in mid-latitudes (Kadıoğlu et al., 2000).

Figure 10. Ankara heavy rainy day trend



The number of days when precipitation is >= 20 mm. It is very important in terms of Agriculture and Food Security, Hydrology and Water Resources (Alexander et al., 2013).

Figure 11. Ankara Annual precipitation total trend



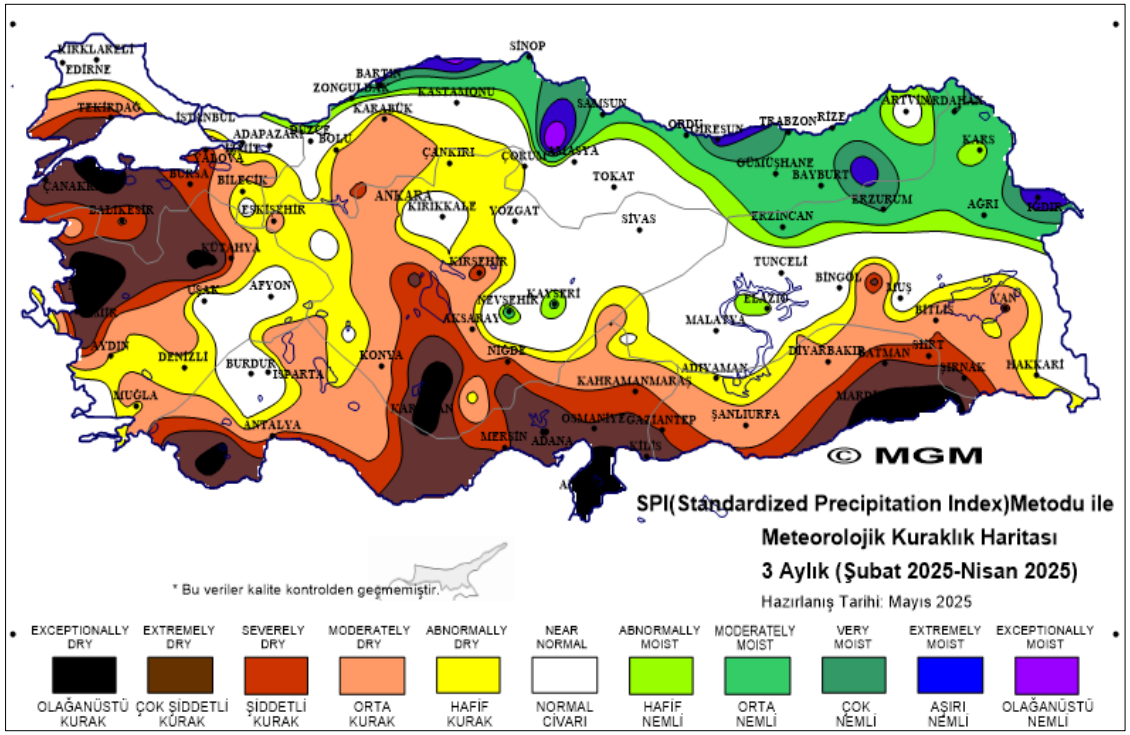
It is the annual total of rainfall on rainy days (P>=1mm). It is very important in terms of Agriculture and Food Security, Hydrology and Water Resources (Alexander et al., 2013)

CLIMATE CHANGE-DISASTER RELATIONSHIP

Turkey is located in the Mediterranean Basin, where the negative effects of climate change are most visible. Today, the effects of climate change have begun to be seen in our country as well as all over the world.

1. Drought and Protection Ways

Figure 1.1. Turkey February 2025-April 205 3-month SPI method drought map



Ways to protect from drought:

1. Efficient use of water
2. Reducing water footprint
3. Purifying wastewater
4. Harvesting water
5. Switching to drip/sprinkler irrigation in agriculture
6. Preferring plants that consume less water

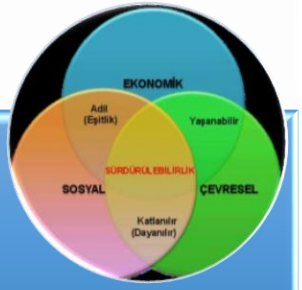
2. Heavy rain, flood

Figure 2.1. Heavy rain and floods in Ankara on 30.06.2022

- Get up-to-date information about the latest meteorological conditions
- Follow flood warnings on radio and TV. Get information from the Meteorology by phone
- Predicting floods depends on the type and nature of the events that trigger them.
- Remember that short-term heavy rainfall will cause sudden floods, and long-term rainfall will cause rivers to overflow.

Ways to protect yourself from floods

- Remove valuables and important documents at home to high places.
- Take a disaster first aid kit with you if you have one.
- Take items that can cause damage or be damaged inside.
- Make sure you have spare drinking water, as water sources can be contaminated
- Remember that water can enter the house from anywhere it leaves it. Provide sandbags.
- Stay away from places such as ditches, ditches, valleys and canyons that floods can use
- If you are in an open area, go up the hill so that you are not the highest object.

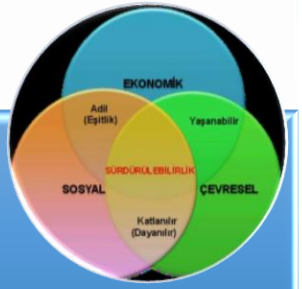


Before the flood

- Go to high places.
- Never drive in flood water. Remember that 80% of deaths occur in vehicles.
- Pull your vehicle to a place that will not be affected by the flood.
- Do Do not try to walk in flood water, currents, or rivers.
- Keep in mind that fast-flowing water of 15-20 cm depth can knock a person over.
- If you need to evacuate your home or workplace, turn off electricity, natural gas, etc.
- Do Do not travel unless absolutely necessary.

During the flood

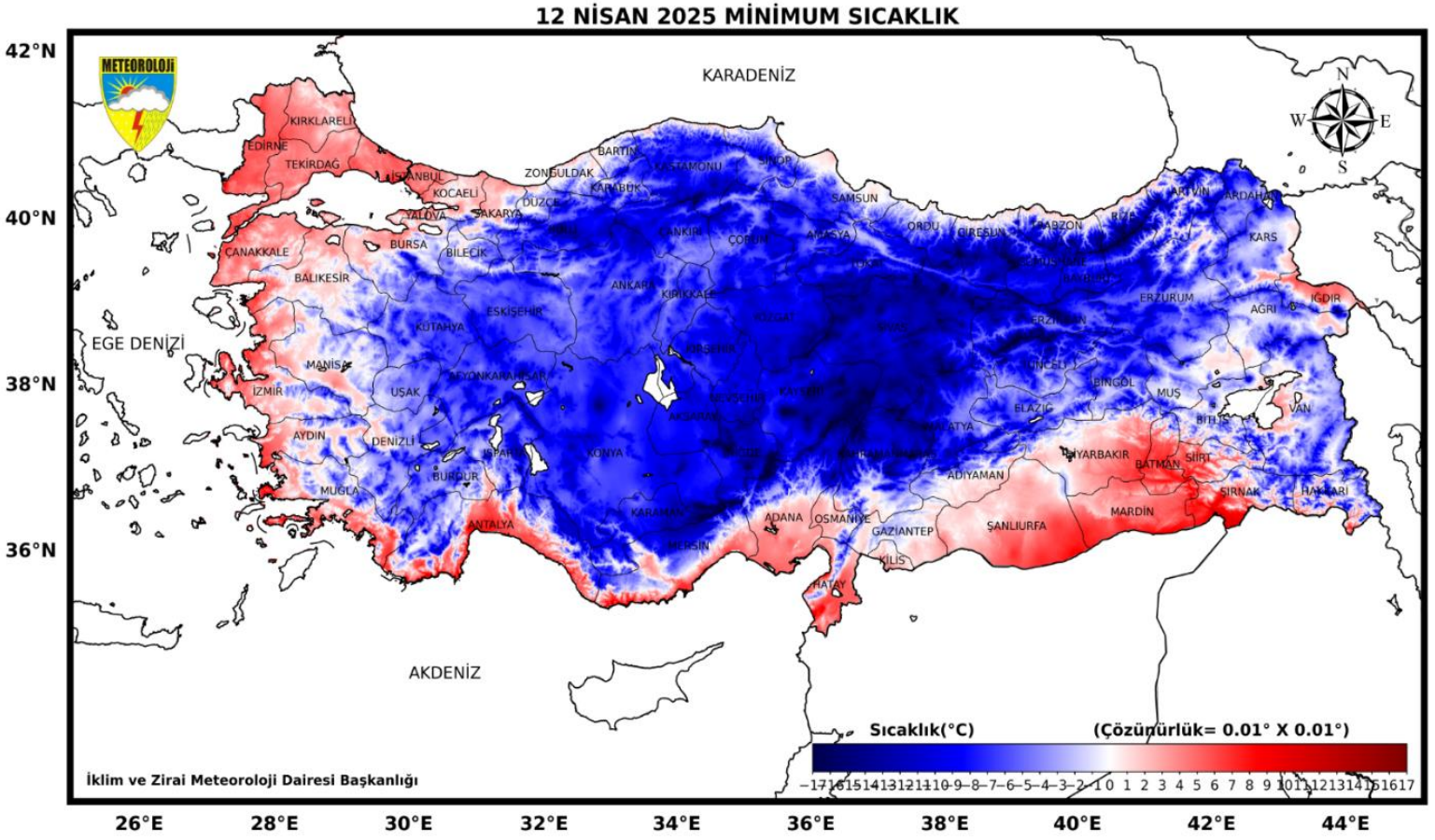
- "Take precautions"
- Check for structural damage to buildings.
- If in the dark, use a flashlight, not a candle.
- Throw away all food that has come into contact with flood water, including canned goods.



After the flood

3. Agricultural Frost and Protection Methods

Figure 3.1. April 12, 2025 Agricultural Frost Map



1. Stopping radiation from reaching the atmosphere

Artificial cloud formation (fog) by spraying water vapor into the air

2. Thermal insulation

This method covers crops with non-toxic protein foam.

3. Direct air and plant heating

To prevent heat loss from the ground to the atmosphere through radiation.

4. Water application

Can be applied to plants that can withstand the ice load of overhead irrigation or sprinkler systems.

4. Hail and Protection Methods

Figure.4.1. Hail in Ankara, Gaziantep and Kahramanmaraş on 07.05.2025.

Ways to protect vehicles from hail

1. Take the weather into consideration

2. Prefer closed parking areas for your vehicle

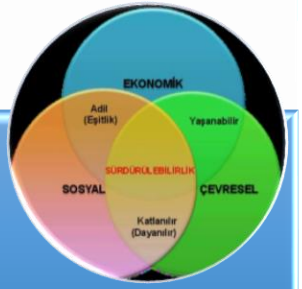
3. If there is no closed parking area, use a car tarpaulin

5. If there is no tarpaulin, use floor mats

6. Get insurance for your vehicle to transfer risk

Hail net

Hail ball



RESULTS

Climate change is one of the biggest problems facing humanity in the 21st century.

There have been significant climate changes in the world since its 4.6 billion years of existence, and cold and hot periods have been experienced. However, in the last 1000 years, human-induced greenhouse gas increases have never reached 420 ppm.

According to global climate assessments made by the World Meteorological Organization (WMO); The year 2024 was recorded as the hottest year of the last 175 years with a temperature anomaly of 1.55°C.

Turkey closed 2024 with a temperature anomaly of 1.7°C, a precipitation deficiency of 6.3% and 1257 extreme meteorological events. The most extreme events in 2024 were 35% heavy rain and floods, 20% storm, 18% hail, 9% heavy snow, 8% lightning, 3% landslide, 2% hurricane and frost.

According to the Aydeniz and Trawertha climate classification methods, our province of Ankara has a climate that is semi-humid-semi-arid in the north, semi-arid in the south, cold in winters, hot in summers, and influenced by land. There is an increasing trend in Ankara temperatures of 5.3°C/100 years and precipitation of 61 mm/100 years.

As the climate changes, the frequency and magnitude of severe weather and climate events are expected to increase (IPCC, AR5, WG1, 2014). Ankara is more frequently faced with extreme events such as heavy rain, hail, drought and late spring frosts, the frequency and severity of which have increased as a result of climate change.

The results obtained from Ankara's sectoral climate indices are as follows: The number of consecutive dry days in Ankara shows an increasing trend of 14.4 days/100 years. It is estimated that the rainless period, which sometimes reaches 90 days in Ankara, will exceed 100 days. For this reason, products that consume less water and are resistant to drought should be preferred in agriculture, water should be used economically and methods such as water recovery and water harvesting should be considered. Plant selections should be made accordingly, knowing that although the number of frost days in Ankara has decreased, it has not disappeared.

In Ankara, Tropical nights (TR20), Tropical days (SU30), Very hot days SU35), Hot days (TX90p), Heat wave duration CTX-90-HWD tend to increase. This situation will affect the water, health, agriculture and energy sectors in Ankara in different ways. Due to high temperatures, there will be a decrease in water resources due to evaporation, and heat waves will cause health problems such as muscle cramps and heart attacks in the elderly, children and those with chronic diseases. Therefore, it is recommended not to go out at noon, to wear light-colored and light clothes, and to drink plenty of water. Since high temperatures will negatively affect those working in the agricultural sector, caution should be taken. Harvested products should be taken to cold storage to prevent rapid deterioration. Since cooling requirements will increase at high temperatures, energy infrastructures will need to be strengthened.

There are increasing trends in growth day-degrees (GDD-grow) and season length (GSL) indices in Ankara. This situation is positive for agriculture as it provides the opportunity to grow more than one product, but it also has negative effects such as early flowering in spring and frost damage and not being able to meet the wintering requirement.

In arid areas, species with the least water needs should be selected, plants that can collect water from fog and dew should be tried. Afforestation and greening works should be carried out to prevent desertification and erosion, and at the same time balance city temperatures. Corn and sugar beet production, which consume a lot of water in Ankara, should be abandoned. The flood irrigation method should be abandoned in irrigation, and closed system irrigation, sprinkler and drip irrigation methods should be switched to. It should not be forgotten that there will be a decrease in yield and significant increases in irrigation water needs, especially after 2050.

ACKNOWLEDGEMENTS

I would like to thank my colleagues who have always supported my work.

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SUGGESTIONS or QUESTIONS