REPUBLIC OF TÜRKİYE
MINISTRY OF INTERIOR
DISASTER AND EMERGENCY MANAGEMENT AUTHORITY

# RESEARCH REPORT

# ADAPTATION AND RISK REDUCTION STUDIES TO DISASTERS CAUSED BY CLIMATE CHANGE: A COMPARISON BETWEEN JAPAN AND TÜRKİYE


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## Disclaimer

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## ABBREVIATIONS

| | |
|---|---|
| **ADRC** | Asian Disaster Reduction Center |
| **AFAD** | Türkiye Disaster and Emergency Management Presidency |
| **AR5** | IPCC Fifth Assessment Report |
| **AR6** | IPCC Sixth Assessment Report |
| **FWI** | Fire Weather Index |
| **GHG** | Greenhouse Gas |
| **IPCC** | Intergovernmental Panel on Climate Change |
| **İRAP** | Provincial Risk Reduction Plan |
| **MGM** | Türkiye General Directorate of Meteorology |
| **OGM** | Türkiye General Directorate of Forestry |
| **RCP** | Representative Concentration Pathways |
| **SPI** | Standardized Precipitation Index |
| **SST** | Sea Surface Temperature |
| **TARAP** | Türkiye Disaster Risk Reduction Plan |
| **Ωarag** | Aragonite Saturation State |

## DISCLAIMER

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The views expressed in the report do not necessarily reflect the views of the ADRC. The boundaries and names shown and the designations used on the mapsin the report also do notimply official endorsement or acceptance by the ADRC.

## EXECUTIVE SUMMARY

Climate change, caused by human activities such as excessive use of fossil fuels, changes in land use, and deforestation since the Industrial Revolution, is one of the most significant global issues confronting humanity today.

According to the Sixth Assessment Report (AR6) of the Intergovernmental Panel on Climate Change (IPCC), global temperatures have risen by approximately 1.1°C since the pre-industrial period. If current trends persist, it is projected that global warming will reach 3°C by 2100.

Climate change has already led to various impacts of different magnitudes on ecosystems, economic sectors, and human health worldwide. The IPCC Report emphasizes that even if Greenhouse Gas (GHG) emissions were minimized today, the unavoidable effects of climate change would continue to be experienced for a long time.

Adaptation can be defined as the process of strengthening and implementing strategies to address and manage the impacts of climate change. It involves adjusting to changing climate conditions, mitigating adverse effects and turning challenges into opportunities wherever possible. Adaptation to climate change is a dynamic and integrated process, involving decision-making across numerous areas such as agriculture, food, water, public health, tourism, disaster management, insurance, infrastructure, biodiversity and ecosystems, energy, finance, urbanization, transport, industry, migration, and social development.

In Türkiye, studies on climate change and adaptation to climate change are carried out through plans and regulations. In addition, the Climate Law has been submitted to the parliament for approval.

In Japan, Mitigation measures (measures mainly to reduce greenhouse gas emissions) and adaptation measures are two complementary driving forces of climate change action. The government will steadily take climate change action in accordance with two laws paired with two plans: the Act on Promotion of Global Warming Countermeasures (Act No. 117 of 1998) and the Plan for Global Warming Countermeasures established under it; and the Adaptation Act and the Adaptation Plan.

In this report, disasters caused by climate change, climate change projections, national and regional climate change adaptation plans and adaptation measures were examined specifically for Türkiye and Japan.

# 1. GENERAL DESCRIPTION OF REPUBLIC OF TÜRKİYE AND JAPAN

General information about Türkiye and Japan is given in Table 1 under the following headings.

*Table 1. General Informations about Türkiye and Japan*

| | **REBUBLIC OF TÜRKİYE**[1] | **JAPAN**[2] |
|---|---|---|
| |   |   |
| **GEOGRAPHY** | Türkiye covers an area of 783,562 $km^2$. With Turkish straits and Sea of Marmara in between, Türkiye bridges Western Asia and Southeastern Europe. Türkiye's Asian side covers 97% of its surface, and is often called Anatolia. Another definition of Anatolia's eastern boundary is an imprecise line from the Black Sea to Gulf of Iskenderun. Eastern Thrace, Türkiye's European side, includes around 10% of the population and covers 3% of the surface area. The country is encircled by seas on three sides: the Aegean Sea to the west, the Black Sea to the north and the Mediterranean Sea to the south. Türkiye is bordered by Georgia, Armenia, Azerbaijan and Iran to the east. To the south, it's bordered by | Japan comprises 14,125 islands extending along the Pacific coast of Asia. It stretches over 3000 km northeast–southwest from the Sea of Okhotsk to the East China Sea. The country's five main islands, from north to south, are Hokkaido, Honshu, Shikoku, Kyushu and Okinawa. The Ryukyu Islands, which include Okinawa, are a chain to the south of Kyushu. The Nanpō Islands are south and east of the main islands of Japan. Together they are often known as the Japanese archipelago. As of 2019, Japan's territory is 377,975.24 $km^2$. Japan has the sixth-longest coastline in the world at 29,751 km . Because of its far-flung outlying islands, Japan's exclusive economic zone is the eighth-largest in the world, covering 4,470,000 $km^2$. |

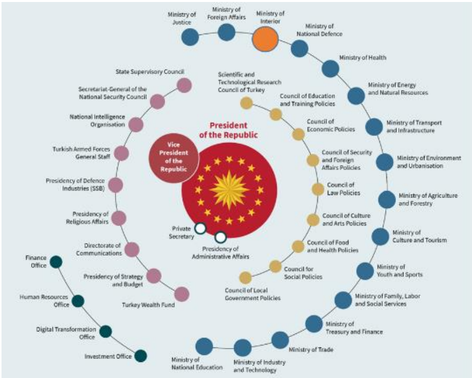
| | | |
|---|---|---|
| | Syria and Iraq. To the north, its Thracian area is bordered by Greece and Bulgaria. | |
| **CLIMATE** | The coastal areas of Türkiye bordering the Aegean and Mediterranean Seas have a temperate Mediterranean climate, with hot, dry summers and mild to cool, wet winters. The coastal areas bordering the Black Sea have a temperate oceanic climate with warm, wet summers and cool to cold, wet winters. The Turkish Black Sea coast receives the most precipitation and is the only region of Türkiye that receives high precipitation throughout the year. The eastern part of the Black Sea coast averages 2,200 millimetres (87 in) annually which is the highest precipitation in the country. The coastal areas bordering the Sea of Marmara, which connects the Aegean Sea and the Black Sea, have a transitional climate between a temperate Mediterranean climate and a temperate oceanic climate with warm to hot, moderately dry summers and cool to cold, wet winters.<br>Snow falls on the coastal areas of the Sea of Marmara and the Black Sea almost every winter but usually melts in no more than a few days.However, snow is rare in the coastal areas of the Aegean Sea and very rare in the coastal areas of the Mediterranean Sea. Winters on the Anatolian plateau are especially severe. Temperatures of −30 to −40 °C (−22 to −40 °F) do occur in northeastern Anatolia, and snow may lie on the ground for at least 120 days of the year, and during the entire year on the summits of the highest mountains. In central Anatolia the temperatures can drop below −20 °C (−4 °F) with the mountains being even colder. Mountains close to the coast prevent Mediterranean influences from extending inland, giving the central Anatolian Plateau a continental climate with sharply contrasting seasons. | The climate of Japan is predominantly temperate but varies greatly from north to south. The northernmost region, Hokkaido, has a humid continental climate with long, cold winters and very warm to cool summers. Precipitation is not heavy, but the islands usually develop deep snowbanks in the winter.<br>In the Sea of Japan region on Honshu's west coast, northwest winter winds bring heavy snowfall during winter. In the summer, the region sometimes experiences extremely hot temperatures because of the Foehn.The Central Highland has a typical inland humid continental climate, with large temperature differences between summer and winter. The mountains of the Chūgoku and Shikoku regions shelter the Seto Inland Sea from seasonal winds, bringing mild weather year-round.<br>The Pacific coast features a humid subtropical climate that experiences milder winters with occasional snowfall and hot, humid summers because of the southeast seasonal wind. The Ryukyu and Nanpō Islands have a subtropical climate, with warm winters and hot summers. Precipitation is very heavy, especially during the rainy season. The main rainy season begins in early May in Okinawa, and the rain front gradually moves north. In late summer and early autumn, typhoons often bring heavy rain.[99] According to the Environment Ministry, heavy rainfall and increasing temperatures have caused problems in the agricultural industry and elsewhere.[100] The highest temperature ever measured in Japan, 41.1 °C (106.0 °F), was recorded on July 23, 2018, and repeated on August 17, 2020. |
| **DEMOGRAPHY** | According to the Address-Based Population Recording System, the country's population was 85,372,377 in 2023, excluding Syrians under temporary protection. 93% lived in province and district centers. | Japan has a population of almost 125 million, of whom nearly 122 million are Japanese nationals (2022 estimates). A small population of foreign residents makes up the remainder. Japan is the world's fastest aging country and has |

People within the 15–64 and 0–14 age groups corresponded to 68.3% and 21.4% of the total population, respectively. Those aged 65 years or older made up 10.2%. Between 1950 and 2020, Türkiye's population more than quadrupled from 20.9 million to 83.6 million; however, the population growth rate was 0.1% in 2023. In 2023, the total fertility rate was 1.51 children per woman, below the replacement rate of 2.10 per woman. In a 2018 health survey, the ideal children number was 2.8 children per woman, rising to 3 per married woman.

the highest proportion of elderly citizens of any country, comprising one-third of its total population; this is the result of a post–World War II baby boom, which was followed by an increase in life expectancy and a decrease in birth rates. Japan has a total fertility rate of 1.4, which is below the replacement rate of 2.1, and is among the world's lowest; it has a median age of 48.4, the highest in the world. As of 2020, over 28.7 percent of the population is over 65, or more than one in four out of the Japanese population. As a growing number of younger Japanese are not marrying or remaining childless, Japan's population is expected to drop to around 88 million by 2065.

**GOVERNMENT**

There are 16 Ministries in the Organization of the Republic of Türkiye. AFAD currently carries out its duties under the Ministry of Internal Affairs.




Japan is a unitary state and constitutional monarchy in which the power of the Emperor is limited to a ceremonial role. Executive power is instead wielded by the Prime Minister of Japan and his Cabinet, whose sovereignty is vested in the Japanese people. Naruhito is the Emperor of Japan, having succeeded his father Akihito upon his accession to the Chrysanthemum Throne in 2019.

Japan's legislative organ is the National Diet, a bicameral parliament. It consists of a lower House of Representatives with 465 seats, elected by popular vote every four years or when dissolved, and an upper House of Councillors with 245 seats, whose popularly-elected members serve six-year terms. There is universal suffrage for adults over 18 years of age, with a secret ballot for all elected offices. The prime minister as the head of government has the power to appoint and dismiss Ministers of State, and is appointed by the emperor after being designated from among the members of the Diet. Shigeru Ishiba is Japan's prime minister; he took office after winning the 2024 Liberal Democratic Party leadership election. The broadly conservative Liberal Democratic Party has been the dominant party in the country since the 1950s, often called the 1955 System.

# 2. HAZARD CHARACTERISTIC OF THE TÜRKİYE AND JAPAN

## 2.1. TÜRKİYE

Türkiye is located in the Mediterranean, Alpine-Himalayan earthquake zone, one of the most active earthquake zones on earth, where approximately 20% of the world's earthquakes occur and where a devastating earthquake occurs in the country on average every five years. In terms of human and economic losses caused by disasters, our country ranks first among the countries of the Organization for Economic Co-operation and Development (OECD). [3]

There have been 141,794 recorded events in Türkiye between 1900 and 2025. The distribution of these events is given in Figure 1. Forest fires and landslides are in the first two places among these events. [4]

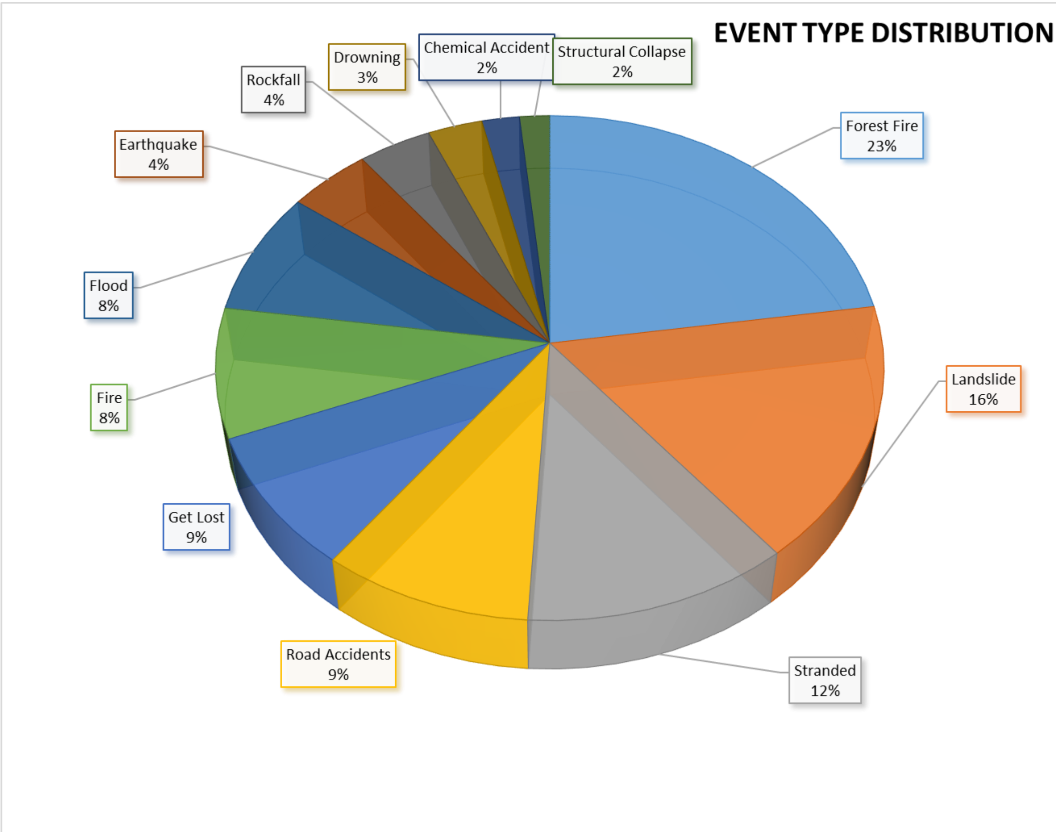



*Figure 1.Distribution of Event Types Between 1900 - 2025*

### 2.1.1. Flood

In Türkiye, floods are among the disaster types that cause human and economic losses after earthquakes. As a result of climate change, industrialization and unplanned urbanization, there have been significant increases in the number of floods and inundations and the damage they cause in our country. In our country, where extremely significant losses are experienced in almost every region and in addition to our big cities, many of our institutions have direct or indirect responsibilities regarding the issue, and important projects and management plans have been put into practice in recent years. [8]

An important step in developing resilience against disasters with a sustainable risk management approach is investments made in risk reduction activities. Structural or non-structural measures need to be taken in order to reduce the risks of flood-overflow disasters. In the studies to be carried out in every process within the framework of risk reduction management; it is of great importance to create and implement a coordinated and integrated program approach within a broader perspective, considering the current situation and practices. [5]

Being able to predict floods, which are a part of disaster management programs, and making early warnings based on this, provides significant reductions in loss of life and economic losses with planning and education.

The number of floods in 2023 is 565. There has been an increase in floods since the 2000s. In the last 10 years, approximately 100 or more floods have occurred each year. The year in which floods were most common since 1940 was 2023 (Figure 2). [6]

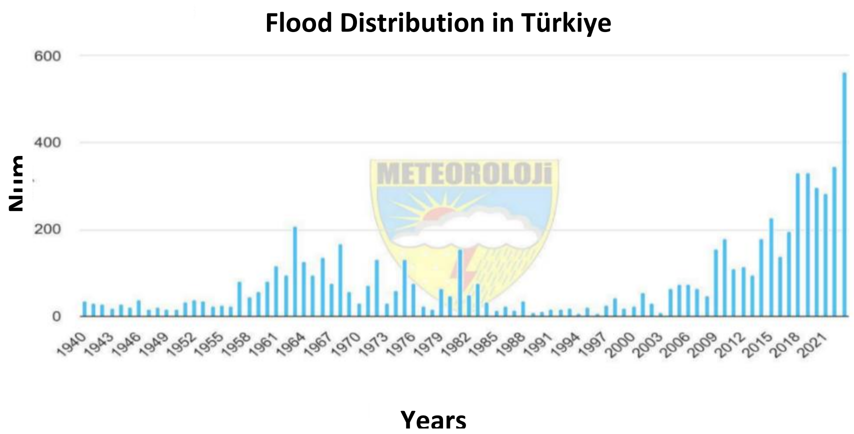



*Figure 2. Distribution of Floods Occurring in Türkiye Between 1940-2023 by Year*

### 2.1.2. Mass Movements

In the evaluation of the disasters that occur in our country based on the disaster event and the number of affected victims, the most damaging disaster types after earthquakes are landslides, rock falls and avalanches, which are grouped under the title of mass movements.

Mass movements, which have an extremely important place among natural disasters due to the negative effects they create both in the world and in our country, can cause loss of life and property in the settlement areas they affect, as well as damage and losses in areas with economic value.

Determining the hazards and risks related to mass movements, taking measures to reduce these hazards and risks in both newly planned areas and existing settlement areas, ensuring that individuals, institutions and organizations fully fulfill their duties in this regard, and allocating sufficient labor and financial resources for this purpose are important priorities and basic strategic goals in creating a society resilient to disasters. [5]

Between 2010 and 2025, 6491 landslides, rockfalls and avalanches occurred in Türkiye. The distribution of these events is given in Figure 3. [7]

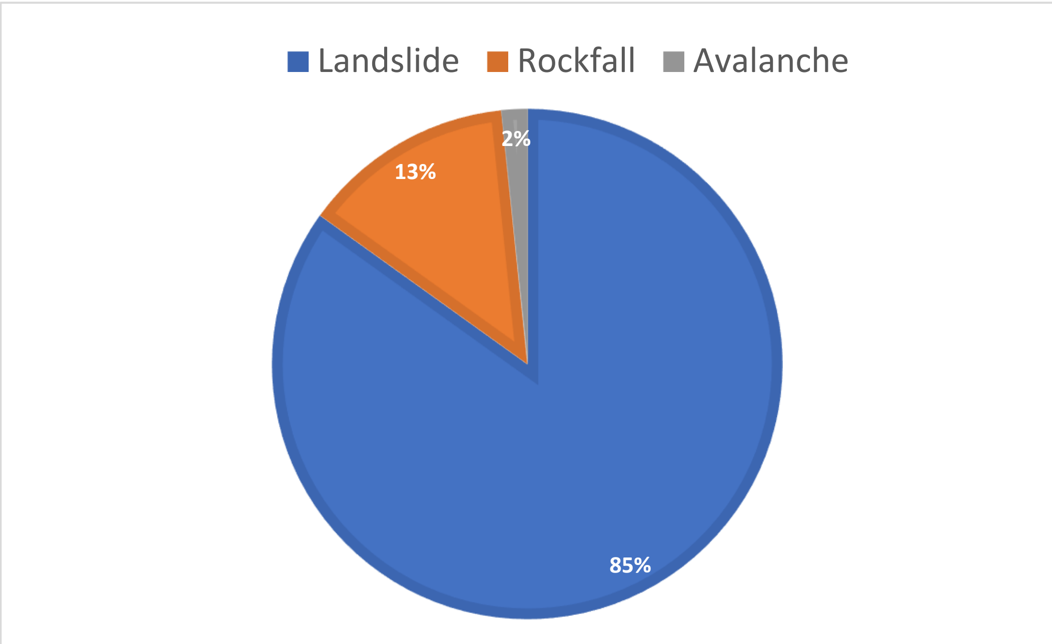
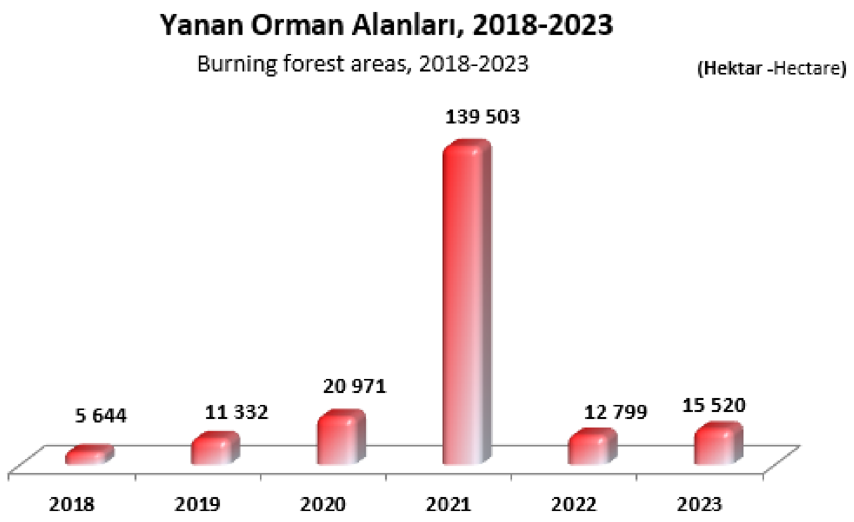



*Figure 3. Distribution of landslides, rockfalls and avalanches in Türkiye between 2010 and 2025*

### 2.1.3. Forest Fires

It has been determined that a large portion of the forest fires in our country occur as a result of negligence, carelessness and accidents. It has been determined that approximately 60 percent of our forested areas are likely to be exposed to fire. The destruction of forests and deforestation cause the loss of soil through erosion and climate change; and as a result of the disruption of the water system, it brings disasters such as desertification, floods, landslides, avalanches and drought. [5]

The number of forest areas and fires burned between 2018 and 2023 are given in Figure 4. In the forest fires that occurred in 2021, 139,503 hectares of land were burned and 2,793 fires broke out. [8]



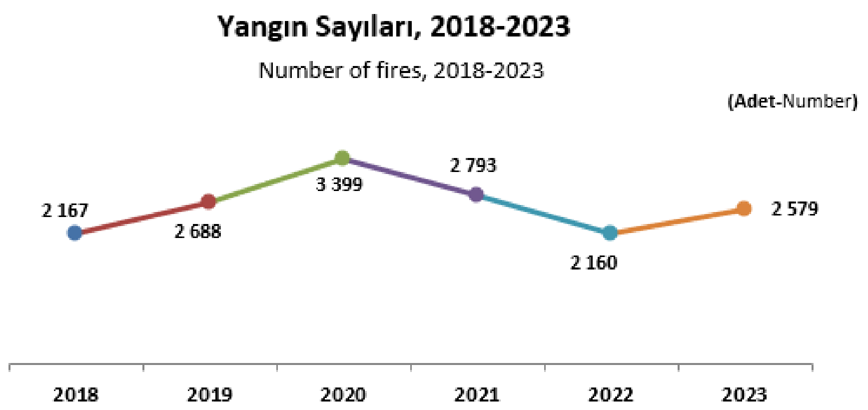




*Figure 4. Burned Forest Areas and Number of Fires Between 2018 and 2023*

### 2.1.4. Drought

Drought occurs when air temperatures exceed seasonal norms and annual precipitation averages fall below seasonal norms. Meteorologically, it is defined as temporary periods when precipitation falls below 80 percent of seasonal average values. [5]

Water stress resulting from drought is the situation where water demand exceeds the amount of water that can be supplied from water resources under sustainable conditions. Drought and water stress have very serious economic, environmental and social effects, and as a result, human health and food security can be negatively affected. [5]

The geography where Türkiye is located has been frequently exposed to the effects of drought throughout history. Drought occurs in our country at certain periods, but as a result of incorrect management and practices, the effect of drought, which exists in the natural cycle, can be large in economic and social dimensions. [5]

Our country's areal precipitation in 2024 was 537.2 mm. The annual average areal precipitation in Türkiye is 573.4 mm (1991-2020). There was a 6.3% decrease in precipitation compared to normal and a 16.3% decrease compared to last year's precipitation (Table 2). The decrease in precipitation directly affects meteorological drought (Figure 5). [9]

*Table 2. Areal precipitation distribution across Türkiye and comparison with past periods*

| Türkiye-Wide Area Rainfall Status (January 1, 2024 - December 31, 2024) | | | | | |
|---|---|---|---|---|---|
| | Rainfall (mm) | Normal (1991-2020) (mm) | 2023 Rainfall (mm) | Change Compared to Normal (%) | Change Compared to 2023 (%) |
| **Türkiye** | 537.2 | 573.4 | 641.5 | -6.3 | - 16.3 |

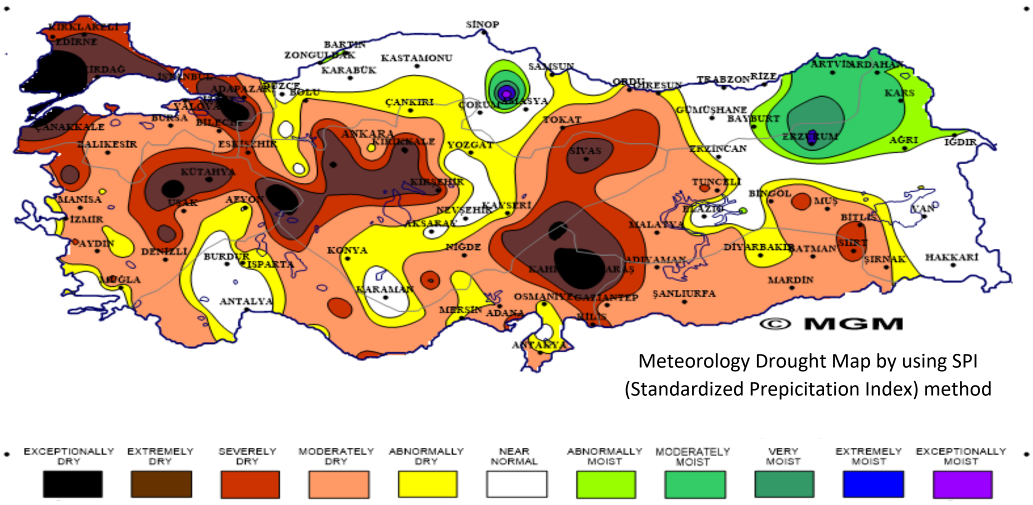



*Figure 5. Meteorology Drought Map by using SPI (Standardized Prepicitation Index) method February 2024 – January 2025*

### 2.1.5. Storm

Storms affect thousands of people directly or indirectly every year. Storm disasters, which cause many effects such as the disruption or halt of land, sea and air transportation in residential areas, harm to animals, falling trees, damage to agricultural areas and greenhouse activities; also cause serious financial losses every year. In addition to the damage that storm disasters leave on people and the environment, it is also an important detail that they trigger other disasters with their effects. For example, one of the most important causes of forest fires is the energy transmission and distribution lines damaged by the storm, which cause fires to start. In addition, the fact that forest fires grow, change direction suddenly, and occur during snow and rainfall makes the event more serious. [5]

According to the records of the General Directorate of Meteorology; when the number of storm disasters in long years is examined, it is seen that the number of storm disasters in the last 10 years is higher than in previous years. The 342 storm disasters that occurred in 2023 constitute 23.2% of all disasters. 2021 was the year with the highest number of storm disasters (Figure 6). [6]

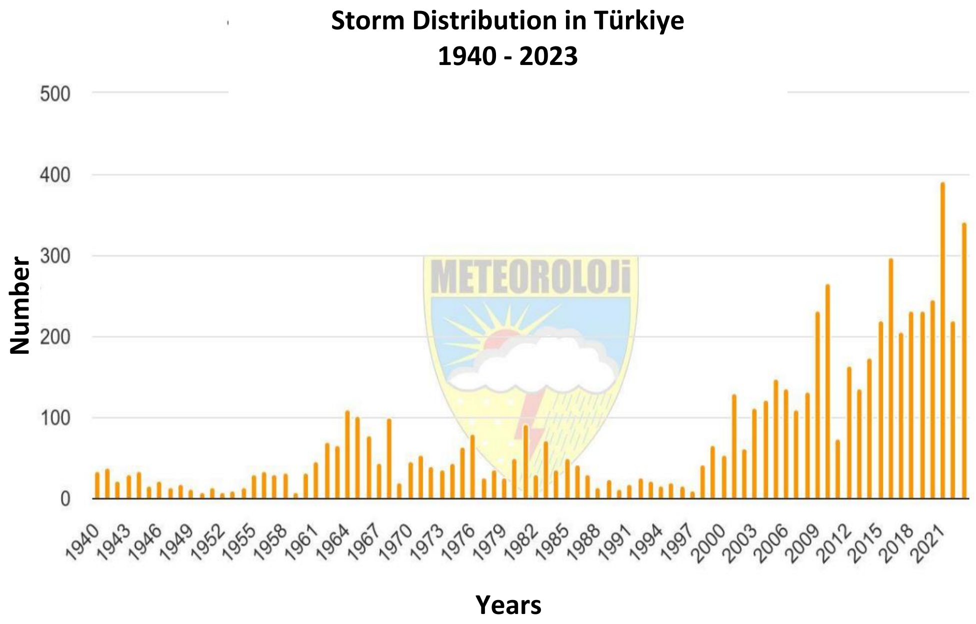



*Figure 6. Distribution of Storms Occurring in Türkiye Between 1940-2023 by Year*

When we look at the distribution of storm disasters by season in 2023, it is seen that they are mostly in the autumn season. 50% of the storm disasters recorded throughout the year occurred in the autumn, 24% in the spring, 15% in the winter and 10% in the summer (Figure 7). [6]

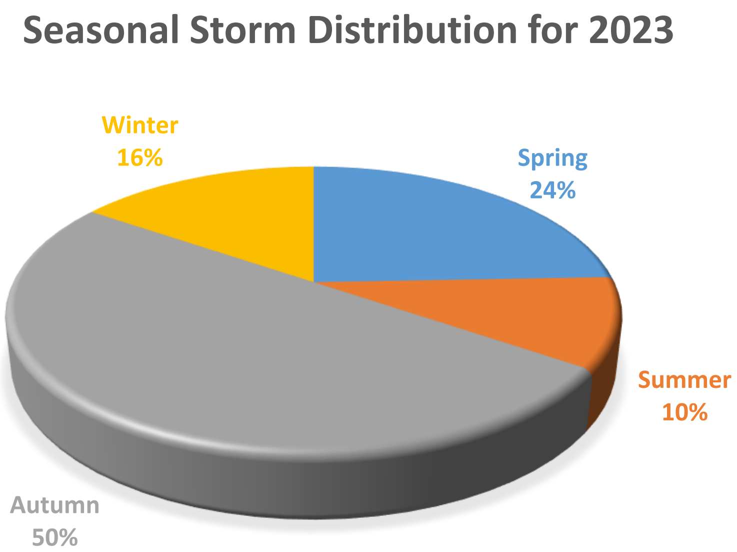



*Figure 7. Storm Occurrence Percentages in Türkiye in 2023 According to Seasons*

## 2.2. JAPAN

Climate change and other factors are increasing the risk of natural disasters. Temperatures and the frequency of heavy rains have changed over the past 100 years. In Japan, damage caused by meteorological disasters typhoon, windstorms, heavy rains, floods, sediment disasters, and storm surges have been occurring almost every year. [10] The distribution of disaster types is shown in Figure 8. [11]

Meteorological disasters have intensified and become more frequent over the past 100 years in visible ways and this trend is expected to continue as global warming progresses. [10]

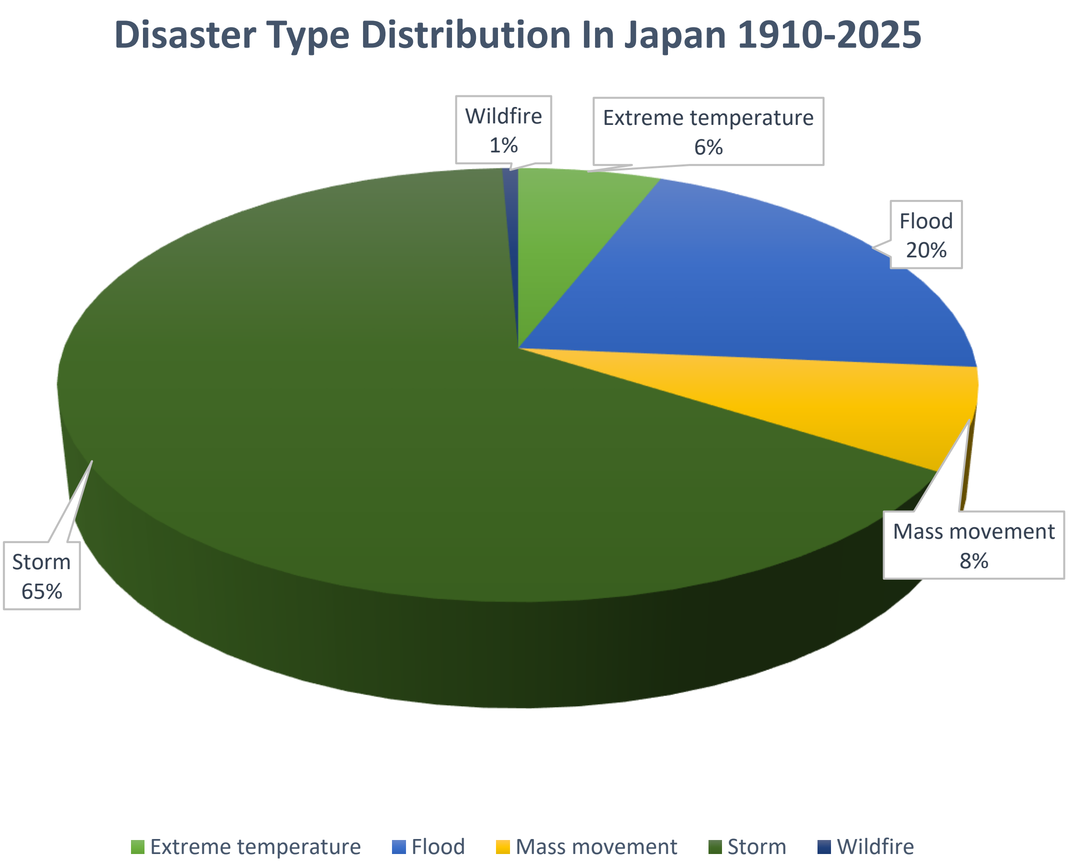



*Figure 8. Disaster Type Distribution in Japan 1910 – 2025*

### 2.2.1. Flood and Tsunami

Floods and tsunamis are imbedded in Japanese culture and history. Southern parts of some regions are under sea level like Kyushu, Shikoku and Okinawa. Rising oceans are also making the Tokyo metropolitan area, home to 38 million people, vulnerable to storm surges. Years of pumping up groundwater have caused some parts of the city to sink nearly 5 meters over the past century. This means that large parts of Tokyo are now below sea level and are only protected by outdated dikes.

With a population of 127 million, the population density is very high. Most residential and industrial areas are located in low-lying areas, along rivers; these areas are very vulnerable to river flooding and flash floods. According to a 1985 study, 49 percent of the population and 75 percent of businesses are located in flood-prone areas. Given population growth in the Kanto Plain, where Japan's second-longest river, the Tone, is located, these shares are likely higher today. Water pushed to shore by strong winds or typhoons and coinciding with tide can cause significant sea level rise. These kinds of situations are then called a storm surge. In addition, precipitation is an increasing cause of flooding in Japan. [2]

### 2.2.2. Heavy Rain

Heavy rain comes in various forms, including prolonged rainfall, and torrential rain.

- Prolonged rainfall – rain that continues for several days – is common from spring to the beginning of summer, and from the end of summer into autumn.
- Torrential rains, where heavy rains suddenly fall in one place, generally last for a short period of time.They are common from late spring to summer.[12]

### 2.2.3. Forest Fire

In 2022, 1,239 forest fires occurred, burning down 605 ha of forest. Forest fires intensively occur in winter and spring, with most of the cases caused by people carelessly using fire. [13]

## 3. CLIMATE CHANGE PROJECTIONS AND DISASTER-BASED SCENARIOS

Social scientists have designed four main scenarios to estimate how much greenhouse gas emissions will increase the world's average temperature in the future. We can describe these scenarios as very optimistic (RCP 2.6), optimistic (RCP 4.5), pessimistic (RCP 6.0) and very pessimistic (RCP 8.5).

Global annual mean surface temperature has increased at a rate of 0.72°C/100 years since the second half of the 19th century. Global annual mean surface temperature for the end of the 21st century (2081-2100), compared to that for the end of the 20th century (1986-2005), is projected to rise by 0.3 to 1.7°C under the RCP2.6 scenario and 2.6 to 4.8°C under the RCP8.5 scenario (Figure 9). [14]

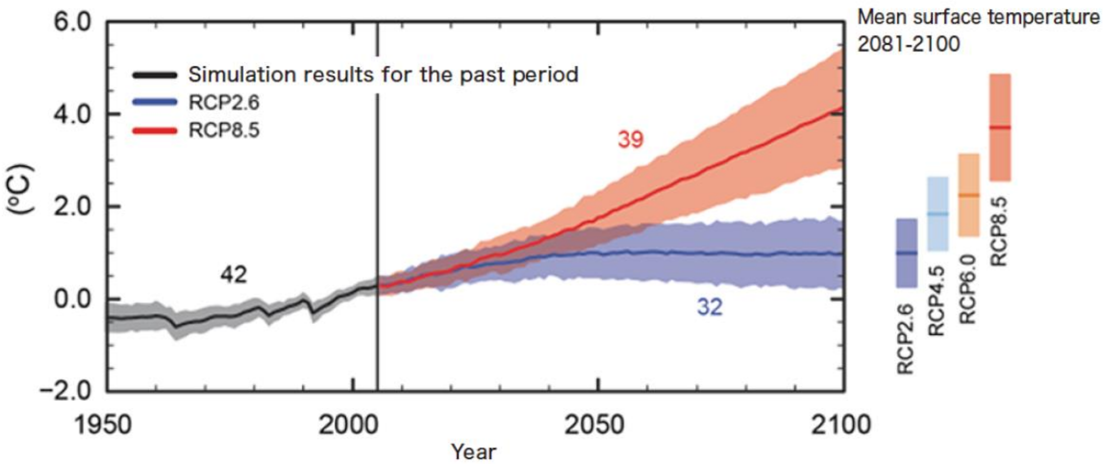



*Figure 9. Projected changes in global annual mean surface temperature*

Based on multi-climate-model simulations under the RCP2.6 scenario (purple) and the RCP8.5 scenario (red). The shading shows a measure of uncertainty.

Ocean warming dominates the increase in energy stored in the climate system, accounting for more than 90% of the energy accumulated between 1971 and 2010. Global annual mean sea surface temperature has increased at a rate of 0.53°C/100 years between 1891 and 2016. Global ocean temperature is projected to keep increasing during the 21st century. Ocean warming in the top one hundred meters for the end of the 21st century is projected to increase by 0.6°C under the RCP2.6 scenario and 2.0°C under the RCP8.5 scenario. (Figure 10). [14]

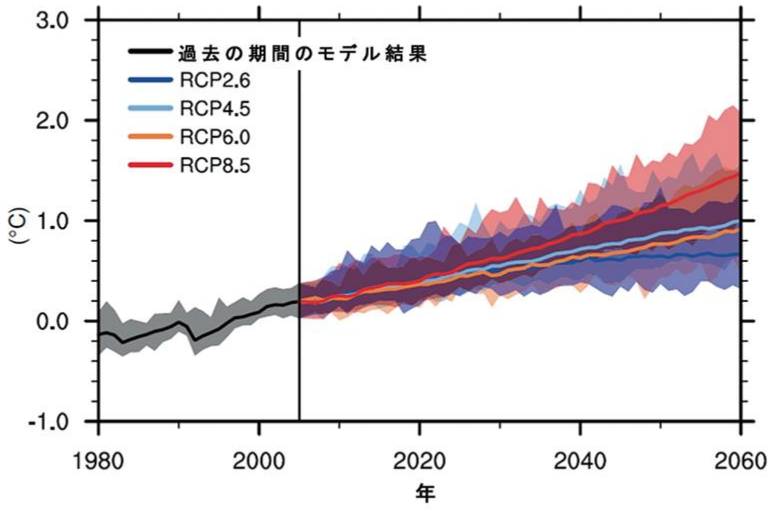



*Figure10.Projected changes in global annual mean sea surface temperature*

Based on multi-climate-model simulations under the RCP2.6 scenario (blue), RCP4.5 scenario (light blue), RCP6.0 scenario (orange) and RCP8.5 scenario (red). The shading shows the 90% range of projected global annual mean sea surface temperature anomalies.

Arctic sea-ice extent has statistically significantly decreased since 1979. The decrease in the annual minimum sea-ice extent is particularly notable, and the decreasing rate per year is comparable with the area of Hokkaido Island. It is very likely that the Arctic sea-ice cover will continue shrinking and thinning during the 21st century due to global warming. The reduction of Arctic sea-ice extent in September for the end of the 21st century (2081-2100) is projected to decrease by 43% under the RCP2.6 scenario or 94% under the RCP8.5 scenario compared to the end of the 20th century (1986-2005). A nearly ice-free Arctic Ocean in September before mid-century is likely under the RCP8.5 scenario. (Figure 11). [14]

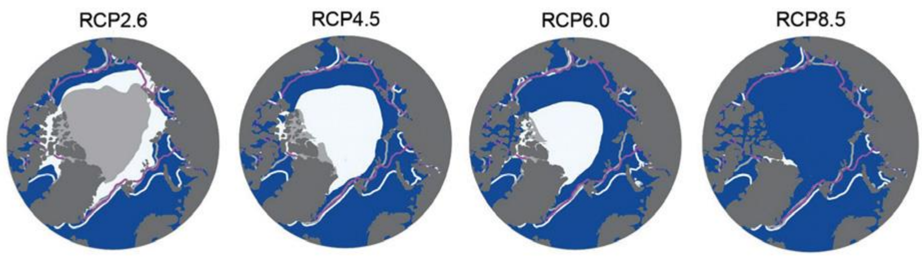



*Figure 11. Projected changes in the Northern Hemisphere sea-ice extent in September*

The white areas show the projected mean sea-ice extent for the end of the 21st century and the pink lines show the observed sea-ice extent at the end of the 20th century.

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) projects that the global frequency of tropical cyclones will likely either decrease or remain essentially unchanged. The report also states that it is likely that both global mean maximum wind speed and amount of rainfall of tropical cyclones will increase, but there is low confidence in region-specific projections. One of recent studies projects that very intense tropical cyclones (maximum wind speed of 59 m/s or higher) are likely to pass more frequently over the area from the seas to the south of Japan to Hawaii, as well as to the west of Mexico. (Figure 12). [14]

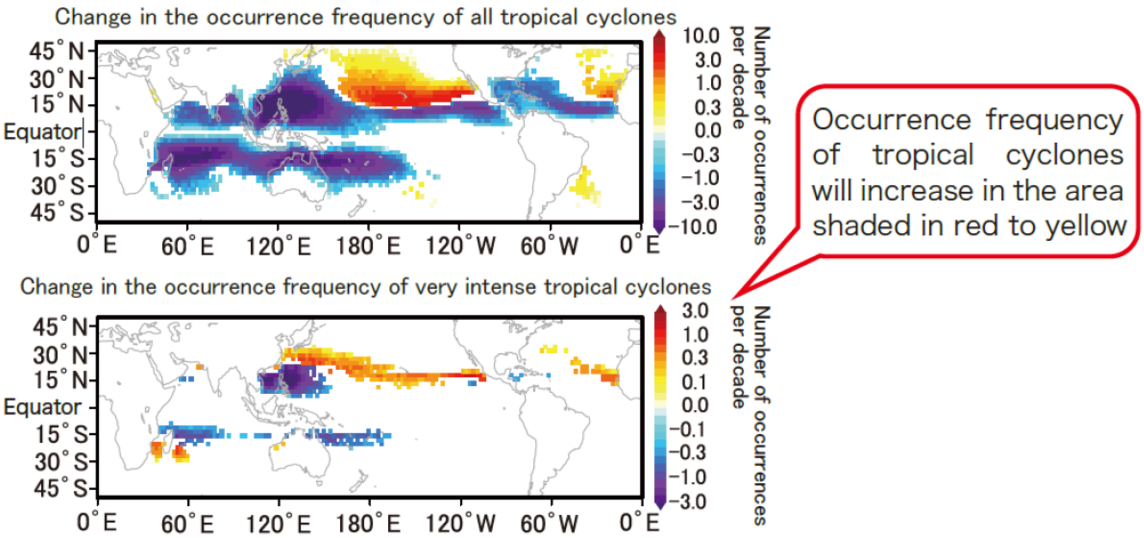



*Figure 12. Examples of future projections for tropical cyclones*

The unit on the right is the number of occurrences of tropical cyclones per decade. Future changes are shaded in color only for regions that are statistically significant.

In this section, the projections of the two countries are examined. Summary information is given in Table 3.

*Table 3. Summary information*

| PROJECTIONS | TÜRKİYE | | JAPAN | |
|---|---|---|---|---|
| **Temperature** | RCP4.5 scenario | RCP8.5 scenario | 2°C Warming Scenario Scenario | 4°C Warming Scenario |
| | average increase of 2.2°C. | average increase of 3.8 °C | Approx. 1.4°C increase | Approx. 4.5°C increase |
| **Precipitation** | decrease approximately 60% at most in the Mediterranean Region | decrease approximately 80% over the Aegean and the Mediterranean Regions<br><br>increase approximately 90% in the East Black Sea and the north of the East Anatolia Region | Approx. x 1.6 increase | Approx. x 2.3 increase |
| **Drought** | increase 20% | in the East Anatolia and Southeast Anatolia Regions will increase 60% | \ | \ |
| **Heatwave** | in the future period of the first 20-years will increase up to 60 days per year at the end of the century | increase from 20 days per year to a maximum 100 days in the last period of the century | \ | \ |
| **Cold Wave** | 3 days decrease | 3 days decrease | \ | \ |
| **Forest Fire** | Increase and decrease depend on the region | Increase and decrease depend on the region | \ | \ |
| **Extreme Wind** | Increase and decrease depend on the region | Increase and decrease depend on the region | \ | \ |
| **Snowing** | \ | \ | Approx. 30% decrease | Approx. 70% decrease |
| **sea level** | \ | \ | Approx. 0.39 m increase | Approx. 0.71 m increase |
| **Ocean Surface Temperatures** | \ | \ | Approx. 1.14°C increase | Approx. 3.58°C increase |
| **Sea Ice** | \ | \ | Sea of Okhotsk ice extent for March Approx. 28% decrease | Sea of Okhotsk ice extent for March Approx. 70% decrease |

| PROJECTIONS | TÜRKİYE | | JAPAN | |
|---|---|---|---|---|
| **Ocean Acidification** | \ | \ | Approx. 0.04 decrease | Approx. 0.3 decrease |
| **Typhoon** | \ | \ | \ | increased occurrence frequency* |

## 3.1. TÜRKİYE

The changes in the extreme climate indexes calculated for the projection period of 2021-2100 for the RCP4.5 and RCP8.5 emission scenarios -known as the optimistic and pessimistic scenarios- were analysed according to the reference period of 1971-2000, and the results were examined on a national scale. Extreme climate indexes were examined according to the following: whether they were above or below various physically identified threshold values for daily precipitation, temperature, and wind variables.

### 3.1.1. Temperature Projections

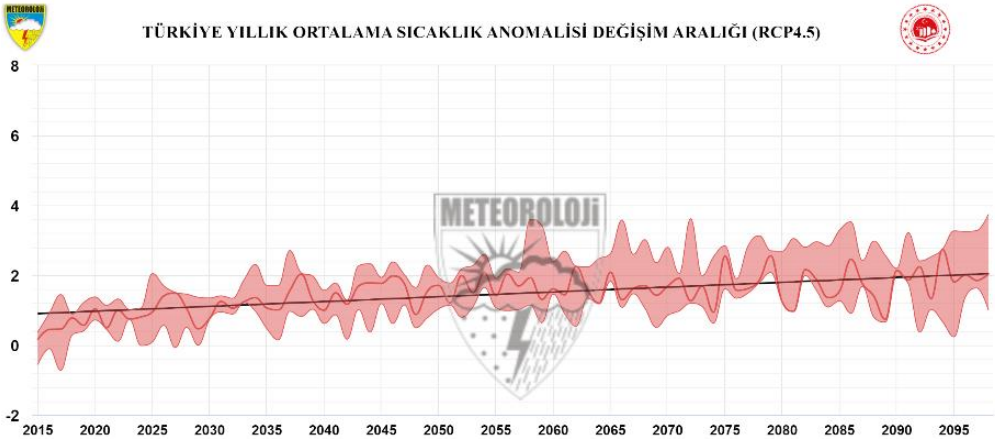
Using HadGEM2-ES, MPI-ESM-MR, GFDL-ESM2M global model datasets, dynamic downscaling method with RegCM4.3.4 Regional Model, RCP4.5 and RCP8.5 scenarios, 1971-2000 reference period 2016-2040, 2041-2070, 2071-2099 future period 20 km resolution projection results were obtained for Türkiye and the region.

According to the results we obtained from the projections of 3 global models, the average temperature increase throughout the country for the period 2016-2099;

According to the RCP4.5 scenario, annual average temperatures in Türkiye are expected to increase by 1.5 - 2.6 °C on average in the period 2016-2099. The average temperature anomaly is expected to be between -0.9 and 4.1°C in the first half of the century, with annual average temperatures increasing by 1.4°C on average, and an increase of between 0.6 and 4.1°C in the second half of the century, with an average increase of 2.2°C. [15]

According to the RCP8.5 scenario, annual average temperatures in Türkiye are expected to increase by an average of 2.5 - 3.7 °C during the period 2016-2099. The average temperature anomaly is expected to be between -0.4 and 3.8 °C in the first half of the century, with an average annual increase of 1.7 °C, and in the second half of the century, an increase between 1.4 and 6.6 °C and an average increase of 3.8 °C is expected (Figure 13).

a)




b)

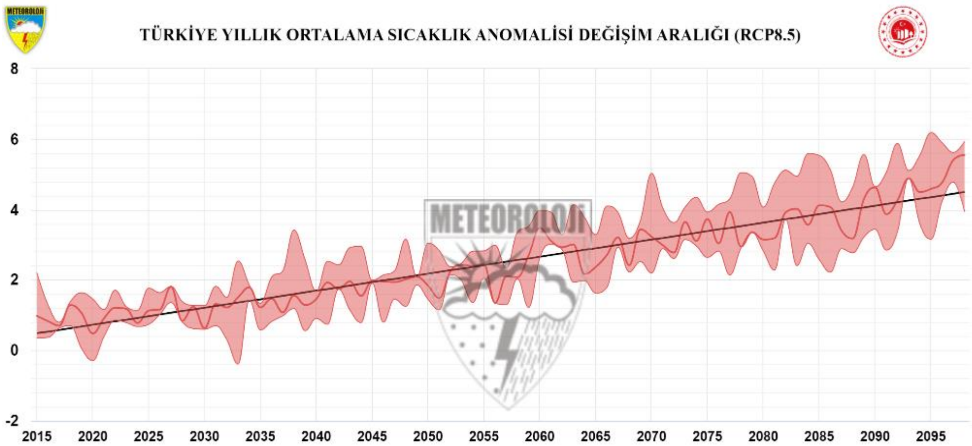


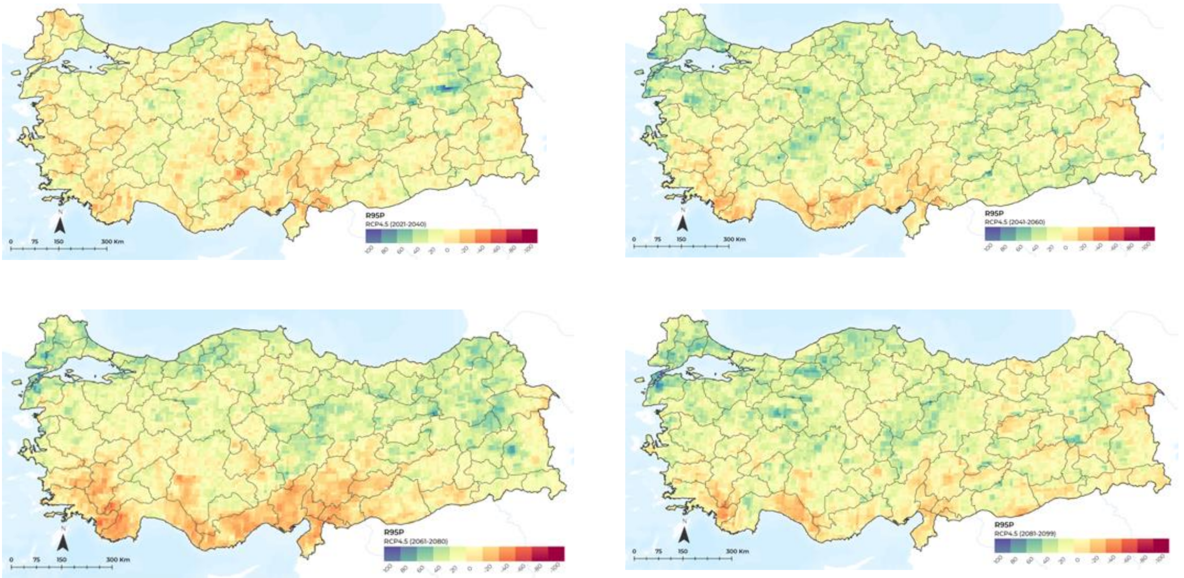

*Figure 13.a) Türkiye Annual Average Temperature Anomaly Change Range (RCP 4.5)*

*b) Türkiye Annual Average Temperature Anomaly Change Range (RCP 8.5)*

### 3.1.2. Precipitation Projections

When the changes in heavy precipitation in the future period are considered, a country-wide increase up to 20% and a decrease approximately 20% is expected for both scenarios, especially in the south, southwest, and inner parts of the country, until the 2040s. A decreasing trend is seen in the total amount of heavy precipitation in the southern parts and an increasing trend is seen, especially in the northeast, as of the 2060s. It is estimated according to the RCP4.5 scenario that there will be a decrease approximately 60% at most in the Mediterranean Region in the period of 2061-2080. The most significant changes are expected to be experienced in the last period according to the RCP8.5 scenario. Accordingly, the total amount of heavy precipitation will decrease approximately 80% over the Aegean and the Mediterranean Regions. It is estimated that it will increase approximately 90% in the East Black Sea and the north of the East Anatolia Region (Figure 14). [16]

a)




b)

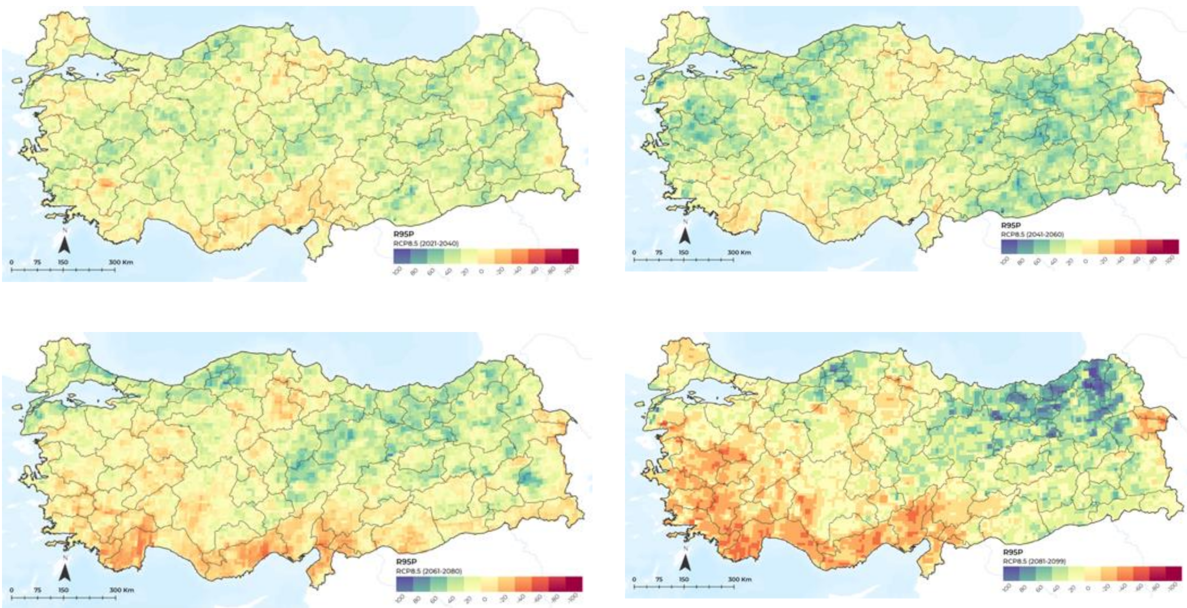


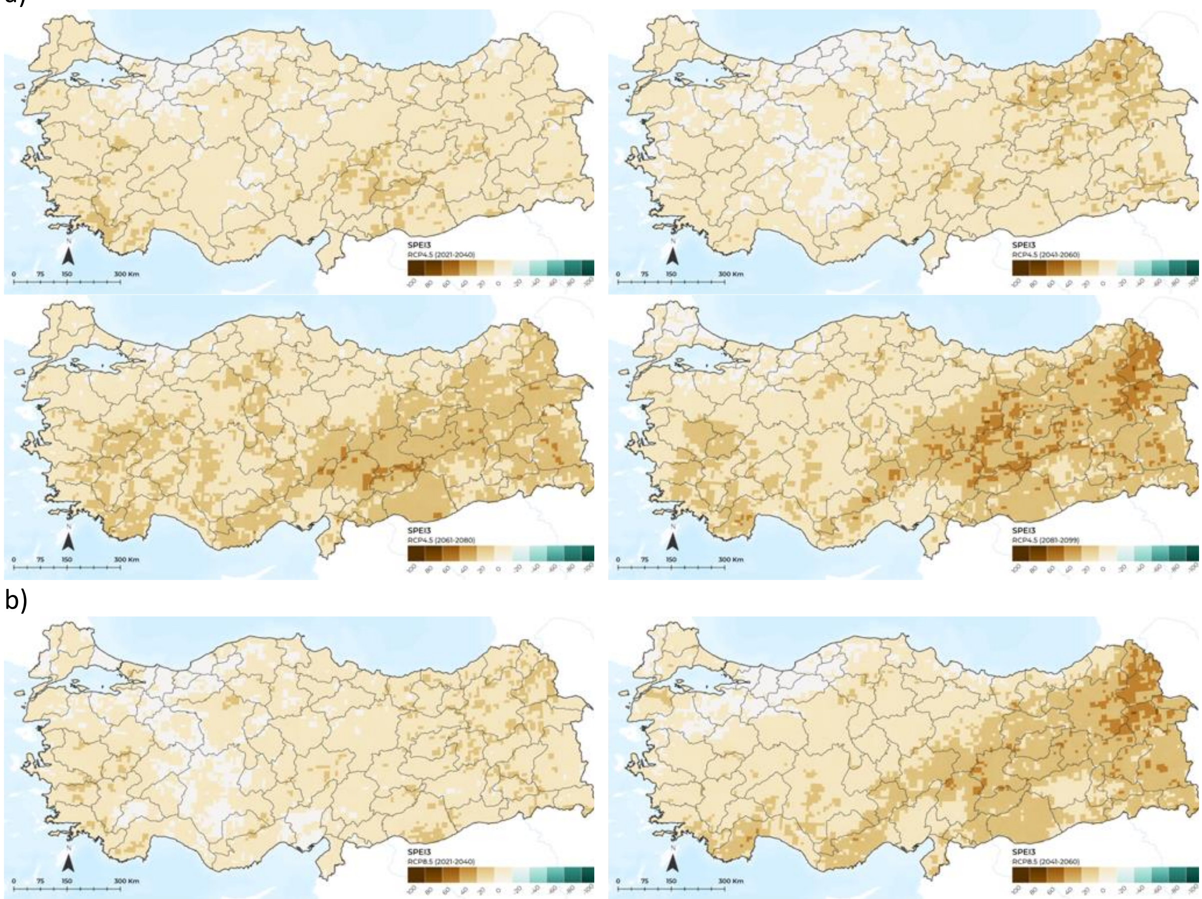

*Figure 14 Annual Total Heavy Precipitation Amount a) RCP4.5 and b) RCP8.5 Scenarios Future Period Changes*

### 3.1.3. Drought Projections

When the change in meteorological drought intensity in the future period is considered, it is predicted that there will be an increase towards the end of the century for both emission scenarios. 20% decrease is expected in meteorological drought intensity due to the expected increase in total precipitation in the east of the Marmara Region and in the West Black Sea Region according to the RCP4.5 scenario. It is estimated that the drought intensity will increase 20% approximately with a further rise in temperatures as of the 2060s. It is predicted that the meteorological drought intensity will tend to increase in the future periods in the rest of the country and it will intensify especially in the East and Southeast Anatolia Regions.

According to the RCP8.5 scenario, it is estimated that similar change will become more intense especially after the 2060s. It is expected that the meteorological drought intensity in the East Anatolia and Southeast Anatolia Regions will increase 60% and above approximately when compared to the reference period (Figure 15). [16]

a)



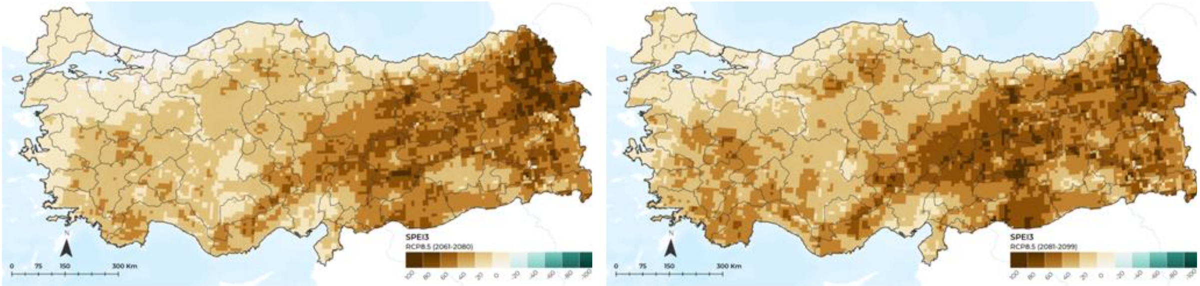


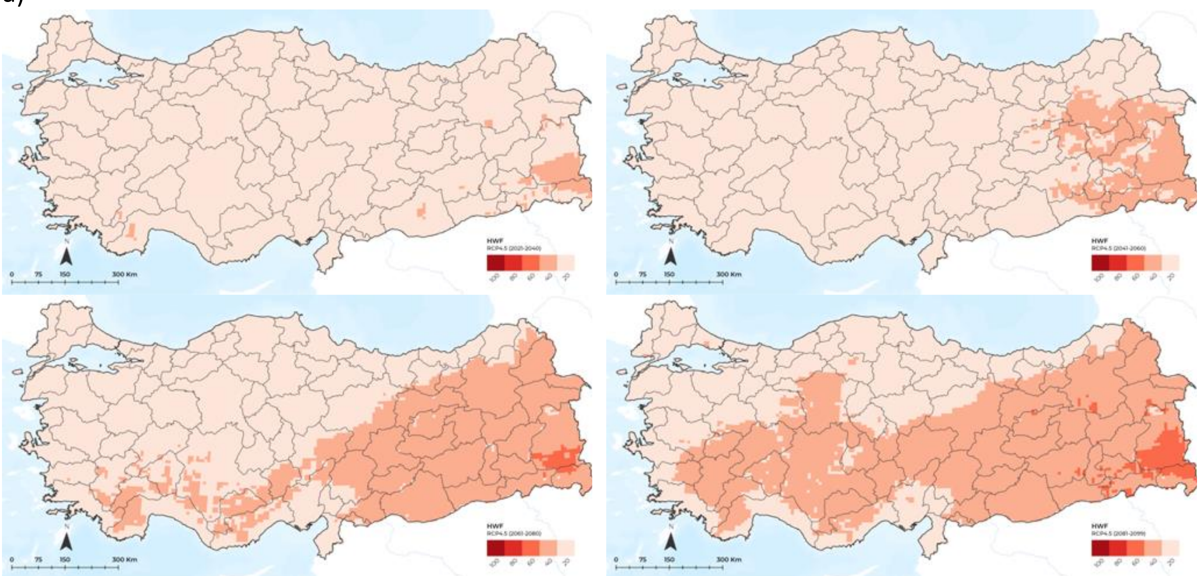
*Figure 15. Meteorological Drought Intensity a) RCP4.5 and b) RCP8.5 Scenarios Future Period Changes*

### 3.1.4. Heatwave Projections

According to both emission scenarios, it is estimated that the frequency of heatwave hazard will gradually increase in the next century, especially in the southeast of Türkiye. It is expected that the average 20-day frequency increase of Türkiye in the future period of the first 20-years will increase up to 60 days per year at the end of the century according to the RCP4.5 scenario. It is estimated that the highest heat wave frequency will be seen in the Southeast Anatolia Region.

According to the RCP8.5 scenario, the change in heatwave frequency indicates an increase from 20 days per year to a maximum 100 days in the last period of the century. It is predicted that this increase will be seen between the period of 2081-2100 and the estimated heatwaves will continue for 80 days or more on average, especially in the Southeast and East Anatolian Regions. It is expected that the change in the frequency of the heatwave in the future period will be at least over the Black Sea Region for both scenarios (Figure 16). [16]

a)



b)

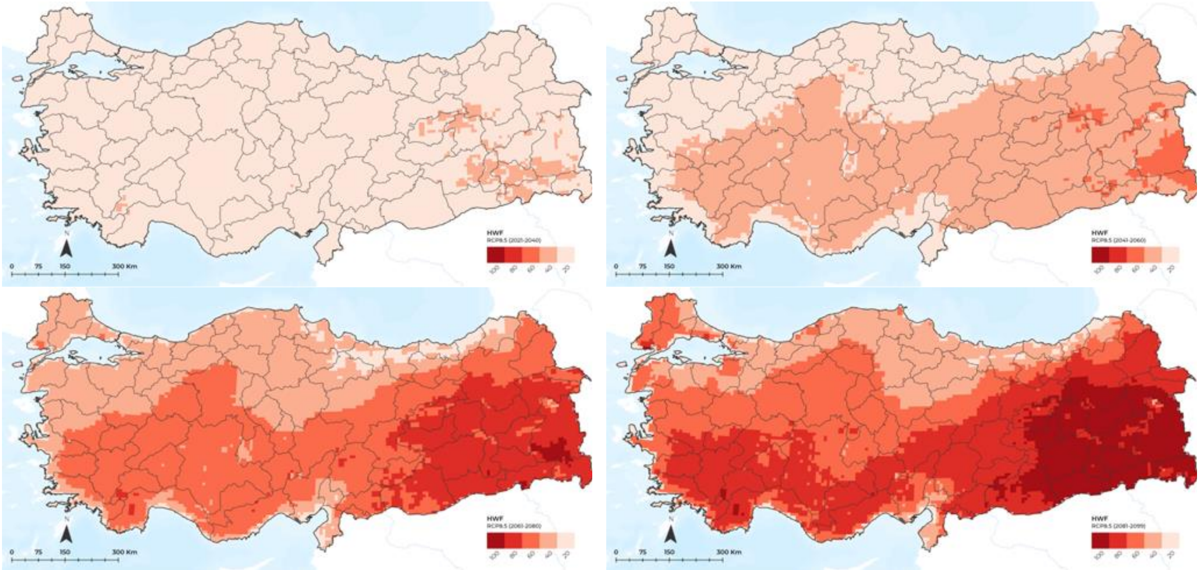
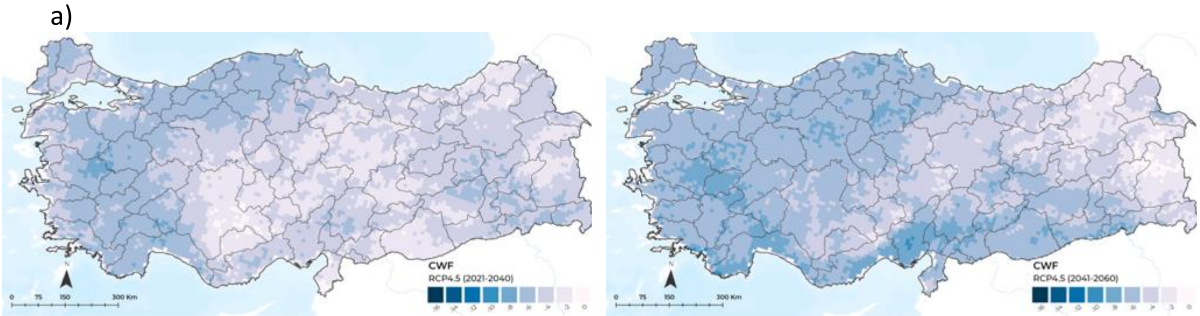


*Figure 16.Heatwave Frequency a) RCP4.5 and b) RCP8.5 Scenarios Future Period Changes*

### 3.1.5. Cold Wave Projections

It is estimated according to both scenarios that cold wave frequency will decrease in the future periods. It is predicted that the cold wave frequency, which gradually decreases towards the end of the century, will gradually reduce its impact, especially in the Marmara and Aegean Regions in the west of the country according to the results of the RCP4.5 scenario. In addition, it is estimated for the Southeast Anatolia Region that the frequency of cold waves in and around the province of Şırnak will decrease to 8 days in the future last period. An average of 3 days decrease in cold wave frequency is expected country-wise in the first period, while a gradually intensified decreasing trend is expected towards the end of the century according to the RCP8.5 scenario. In the future period of 2081-2100, it is predicted according to the RCP8.5 scenario that the frequency of cold waves will decrease to 2 days in the province of Şırnak in the Southeast Anatolia Region and the province of Antalya in the Mediterranean Region (Figure 17). [16]

a)



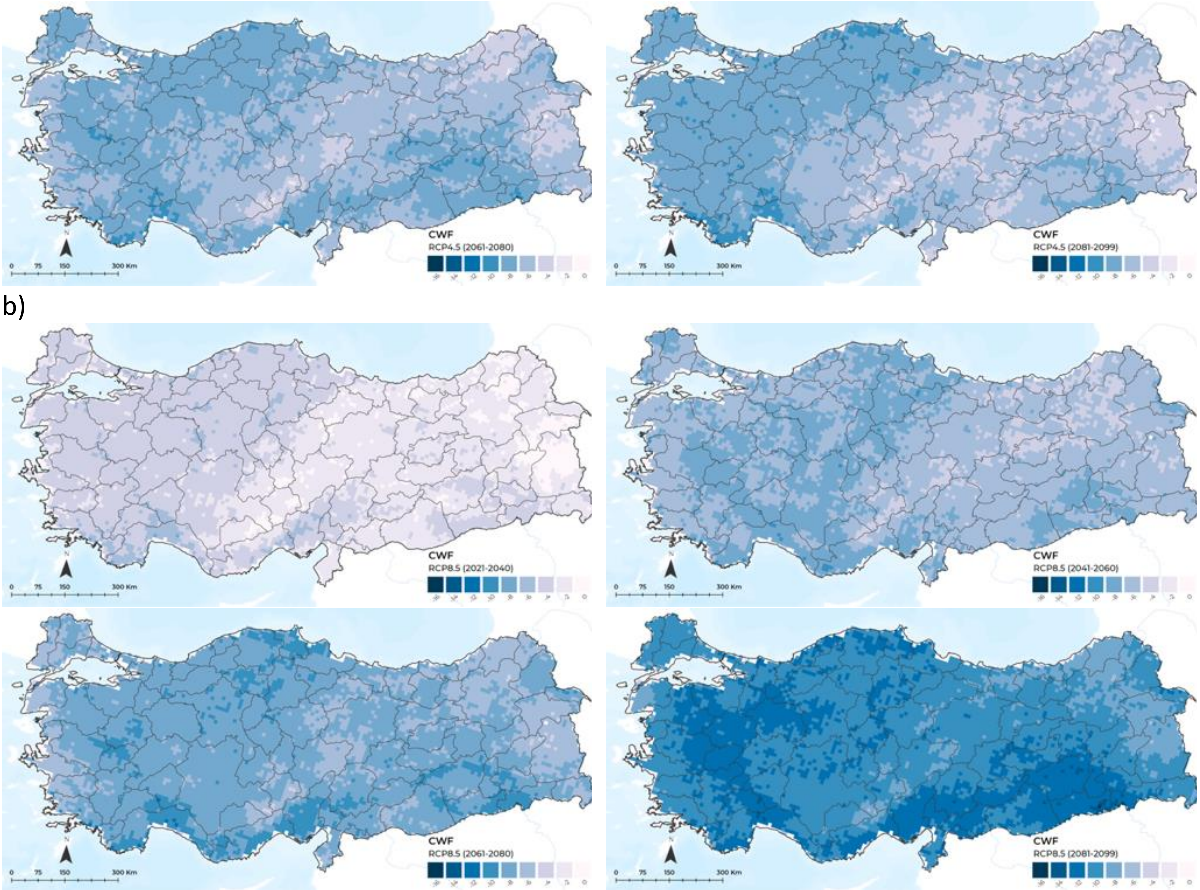



*Figure 17.Cold Wave Frequency a) RCP4.5 and b) RCP8.5 Scenarios Future Period Changes*

### 3.1.6. Forest Fire Projections

The percentiles of change for the future period show spatial differences according to both scenarios. A decrease in the fire weather risk in the western and eastern coasts of the Black Sea Region and the high parts of the East Anatolia and an increase up to 10% in the rest of the regions is predicted according to the RCP4.5 scenario for the period of 2021-2040. It is estimated that the fire weather risk will increase in the period of 2041-2060, except for the Marmara and Black Sea Regions, and will reach the highest values towards the end of the century, especially around the provinces of Ardahan and Kars in the East Anatolia Region.

A decrease in fire weather risk is expected in almost all parts of the country, except for the western and eastern parts of the country, for the period of 2021-2040 according to the RCP8.5 scenario. It is estimated that the Fire Weather Index (FWI) index, which is expected to decrease only in the Marmara Region in the 2050s, will increase at least 5% in the rest of the country and reach a 40% increase especially in East Anatolia Region. It is predicted that the FWI index, which represents the fire-prone weather, will increase country-wide as of the mid-century and will increase 30% or more in the Aegean, the Marmara, and the East Anatolian Regions by the end of the century. On the other hand, it is estimated that the FWI will tend to decrease continuously in almost all periods in the coastal areas of the provinces of Trabzon and Rize. Like RCP4.5, the regions where the increase in fire weather will be the highest were identified as the provinces of Ardahan, Kars, and Iğdır in the East Anatolia Region (Figure 18). [16]

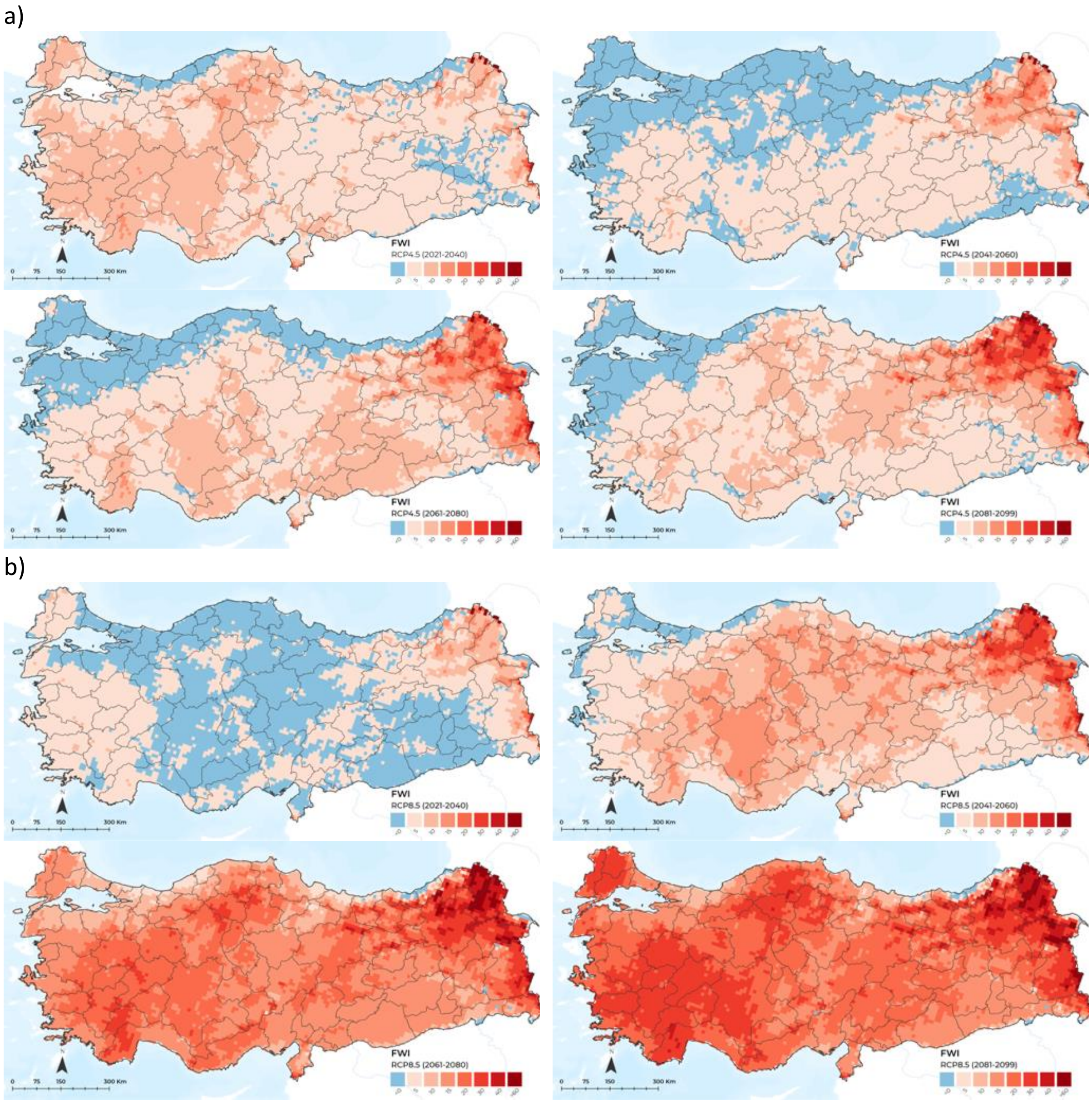



*Figure 18. FWI Annual Mean Values a) RCP4.5 and b) RCP8.5 Scenarios Future Period Changes*

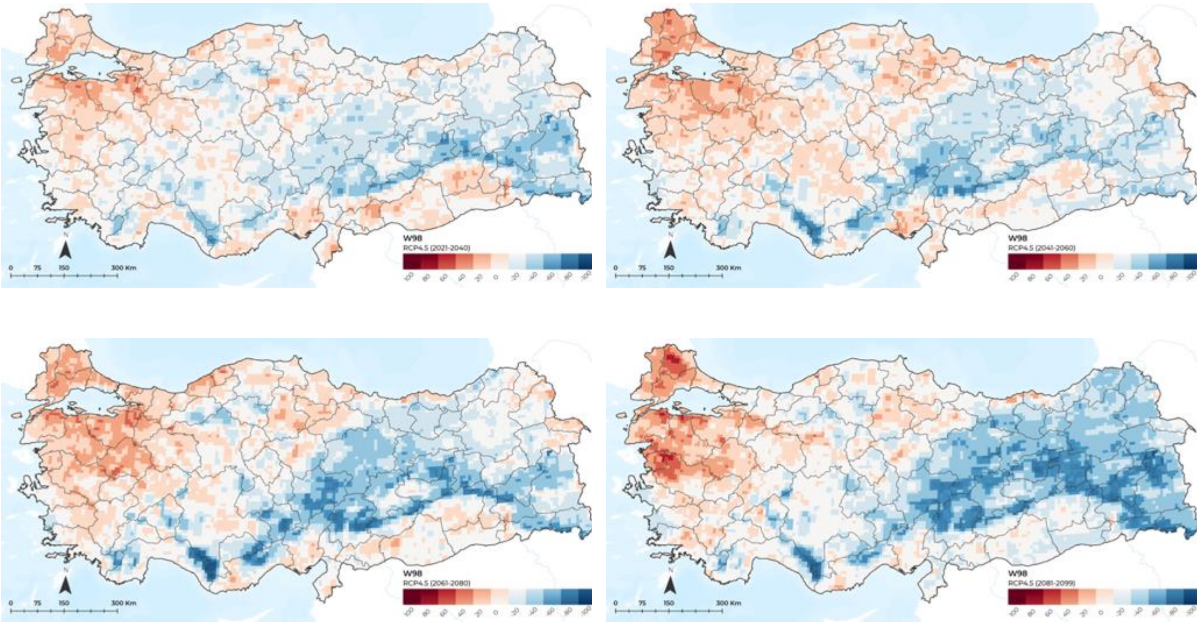
### 3.1.7. Extreme Wind Projections

Although the change in the W98 index identified for extreme wind hazard in Türkiye for the future period, when compared to the reference period, shows a similar pattern for the RCP4.5 and RC8.5 scenarios, the amount of change differs. The pattern of the calculated change values in Türkiye in the future period is generally indicates a direction of increase in the Marmara and Aegean Regions and decrease in the East Anatolia and Taurus Mountains. In addition, extreme winds are expected to increase significantly from 40% to 80% in the Marmara Region in the future period according to the RCP4.5 scenario.

This increase is expected to be seen in the north of the Marmara Region and the Aegean Region, especially around Kırklareli and Bergama district of Çanakkale. On the East Anatolia and Central Taurus Mountains, extreme winds will gradually decrease. It is estimated that there will be a decrease from 40% to 80% towards the end of the century.

It is estimated that the change in extreme winds will generally tend to decrease country-wide in the RCP8.5 scenario, but the change will be more severe than in the RCP4.5 scenario. While an increase of 60% is expected for extreme winds as of the 2060s in the Thrace part of the Marmara Region and the North Aegean Region, this value is foreseen to reach 90% as of the 2080s. It is estimated that the expected change in the direction of decrease on the Central Taurus and Southeast Taurus will increase to 80% and above as of the 2060s. It is predicted that the change in the direction of decrease in extreme winds identified according to the future projections will be more than the other regions, especially in the East Anatolia Region, where the country has a high altitude (Figure 19). [16]

a)




b)

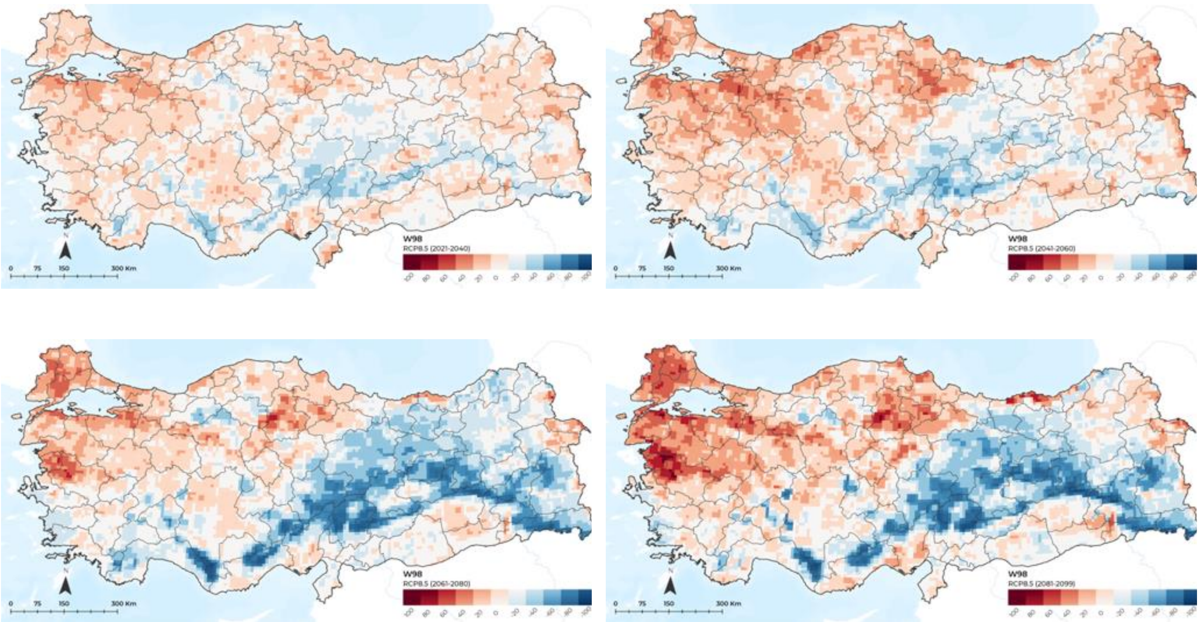



*Figure 19.Extreme Wind a) RCP4.5 and RCP8.5 Scenarios Future Period Changes*

## 3.2. JAPAN

### 3.2.1. Temperature Projections

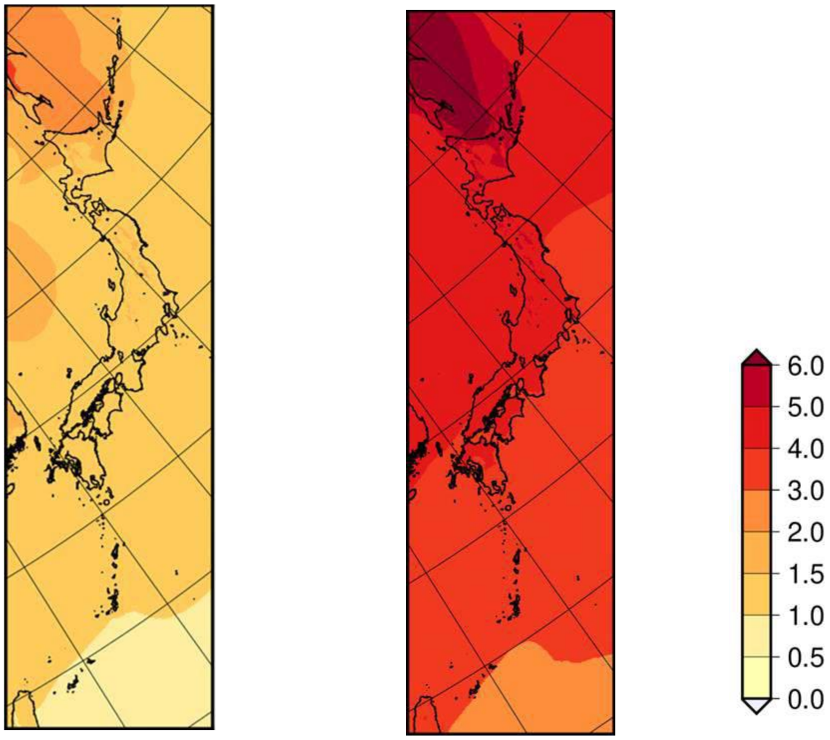
Between 1910 and 2019, the annual numbers of days with maximum temperatures of ≥ 30 and ≥ 35°C and minimum temperatures of ≥ 25°C (referred to here as Tmax ≥ 30°C, Tmax ≥ 35°C and Tmin ≥ 25°C days, respectively) have increased, while those of days with minimum temperatures of < 0°C (referred to here as Tmin < 0°C days) have decreased. In particular, the number of Tmax ≥ 35°C days has increased significantly since the mid-1990s (Table 4). [14]

Expected changes according to 2°C and 4°C Warming Scenarios are given below.

- Under both scenarios, the annual surface temperature over Japan for the end of the 21st century is expected to increase, with more Tmax ≥ 35°C / Tmin ≥ 25°C days and fewer Tmin < 0°C days in many regions.
- The temperature increase over Japan is greater under the 4°C Warming Scenario than under the 2°C Warming Scenario.
- Under the same scenario, higher latitudes correspond to greater increases in temperature. Values are also higher in winter than in summer (Figure 20).

*Table 4.Temperature change*

| | **2°C Warming Scenario Scenario**<br>**Potential conditions with achievement of the Paris Agreement's 2°C target** | **4°C Warming Scenario**<br>**Potential conditions with no future additional mitigation measures** |
|---|---|---|
| **Annual surface temperature over Japan** | Approx. 1.4°C increase | Approx. 4.5°C increase |
| **Annual global average surface temperature** | Approx. 1.0°C increase | Approx. 3.7°C increase |
| **Tmax ≥ 35°C days per year** | Approx. 2.8-day increase | Approx. 19.1-day increase |
| **Tmin ≥ 25°C days per year** | Approx. 9.0-day increase | Approx. 40.6-day increase |
| **Tmin < 0°C days per year** | Approx. 16.7-day decrease | Approx. 46.8-day decrease |




Projection under the 2°C Warming Scenario

Projection under the 4°C Warming 2°C Warming Scenario Scenario

*Figure 20 Changes in annual surface temperature for the end of the 21st century (2076 – 2095 average) relative to the end of the 20th century (1980 – 1999 average)*

### 3.2.2. Precipitation Projections

While the frequency of daily and hourly extreme precipitation has increased in Japan, that of wet days has decreased (both statistically significant). No statistically significant long-term trend is observed in annual or seasonal precipitation over Japan. [14]

Expected changes according to 2°C and 4°C Warming Scenarios are given below.

- The frequency and intensity of daily and hourly extreme precipitation over Japan are expected to increase, while those of wet days are expected to decrease.
- No statistically significant change in annual precipitation over Japan is projected. There is significant uncertainty in projections on regional and prefectural scales.
- The precipitation system associated with the Baiu (seasonal rain) front in June is expected to intensify and be south of its normal location. The projection for July is characterized by significant uncertainty (Table 5).

*Table 5. Precipitation Change*

| | 2°C Warming Scenario Scenario<br>Potential conditions with achievement of the Paris Agreement's 2°C target | 4°C Warming Scenario<br>Potential conditions with no future additional mitigation measures |
|---|---|---|
| **Annual number of days with precipitation ≥ 200 mm** | Approx. x 1.5 increase | Approx. x 2.3 increase |
| **Annual number of events with precipitation ≥ 50 mm/h** | Approx. x 1.6 increase | Approx. x 2.3 increase |
| **Annual maximum daily precipitation** | Approx. 12% (15 mm) increase | Approx. 27% (33 mm) increase |
| **Annual number of days with precipitation < 1.0 mm** | No statistically significant change | Approx. 8.2-day increase |

Precipitation ≥ 50 mm/h is torrential rainfall rendering umbrellas useless and creating spray that impairs visibility.

### 3.2.3. Snowing Projections

Data collected at observation stations on the Sea of Japan side of the country indicate that:

- the annual maximum snow depth in winter has decreased; and
- the annual number of days with snowfall ≥ 20 cm has decreased.

Expected changes according to 2°C and 4°C Warming Scenarios are given below.

- Outside inland Hokkaido, snowfall and snow depth are expected to decrease as global warming progresses, with a higher likelihood of rain.
- Reduced snowfall amounts do not necessarily correspond to reduced risk of exceedingly rare incidences of extremely heavy snowfall. It should be noted that the confidence level of this projection is low (Table 6). [14]

*Table 6. Snowing Change*

| | 2°C Warming Scenario Scenario<br>Potential conditions with achievement of the Paris Agreement's 2°C target | 4°C Warming Scenario<br>Potential conditions with no future additional mitigation measures |
|---|---|---|
| **Annual maximum snow depth and snowfall** | Approx. 30% decrease (except Hokkaido and certain other areas) | Approx. 70% decrease (except some areas of Hokkaido) |
| **Snowfall period** | \ | Shorter<br>(delayed start, early end) |
| **Heavy snowfall (decadal max. in the present climate)** | \ | Potential increase in Honshu mountainous areas and Hokkaido inland areas |

### 3.2.4. Sea Level, Storm Surges and Extreme Waves Projections

The global mean sea level (GMSL) increased by 0.16 m between 1902 and 2010 due to melting ice sheets/glaciers and seawater expansion caused by ocean temperature increase. The average rate of sea level rise was 3.6 mm per year between 2006 and 2015, which is approximately 2.5 times that observed between 1901 and 1990.

A clear trend of sea level rise has been observed since 1980 along the Japanese coast, although some long-period variability (assumed to be natural) is predominant over the whole period. No statistically significant long-term trend is observed in the frequency/intensity of storm surges along the Japanese coast. The heights of extreme waves along the Japanese coast show an increasing tendency, which is larger on the Pacific side. [14]

Expected changes according to 2°C and 4°C Warming Scenarios are given below.

- Under both scenarios, mean sea level rise along the Japanese coast by the end of the 21st century is expected to match the global mean.
- No remarkable difference is observed among projected regional rises except for coastal areas influenced directly by the warm Kuroshio current, where levels are expected to rise slightly.
- The projected sea level rise suggests an enhanced risk of flooding.
- The scale of maximum storm surges in the bays of Tokyo, Osaka and Ise are expected to increase (dependent on typhoon projection).
- Wave heights in decadal-scale events are expected to increase along the Japanese coast (with low confidence due to high uncertainty in the projection of typhoon path changes).

*Table 7. Sea Level, Storm Surges and extreme Waves Changes.*

| | **2°C Warming Scenario Scenario**<br>**Potential conditions with achievement of the Paris Agreement's 2°C target** | **4°C Warming Scenario**<br>**Potential conditions with no future additional mitigation measures** |
|---|---|---|
| **Mean sea level along the Japanese coast** | Approx. 0.39 m increase | Approx. 0.71 m increase |
| **Global mean sea level** | Approx. 0.39 m increase | Approx. 0.71 m increase |

### 3.2.5. Ocean Surface Temperatures Projections

Averaged sea surface temperatures (SSTs) around Japan increased at a rate of 1.14°C per century between 1900 and 2019. [14]

- This exceeds the global average of 0.55°C per century. Rates of increase appear relatively high in continental sea areas due to the warming tendency of land and the influence of warm currents.

Expected changes according to 2°C and 4°C Warming Scenarios are given below.

- The degree of temperature increase depends on seasonal factors and sea areas .

Expected changes according to 2°C and 4°C Warming Scenarios are given below.

- Under both scenarios, the average SST around Japan for the end of the 21st century is expected to increase.
- SST increase displays non-uniform characteristics, with significant changes in the central part of the Sea of Japan under the 2°C Warming Scenario and in the Kushiro/Sanriku area under the 4°C Warming Scenario.
- Northward displacement of subtropical circulation due to northward shifting of westerly winds may cause SST increase around Japan to exceed the global average. This may lead to high regional SST variability.

*Table 8. Ocean Surface Temperatures Changes*

| | **2°C Warming Scenario Scenario** Potential conditions with achievement of the Paris Agreement's 2°C target | **4°C Warming Scenario** Potential conditions with no future additional mitigation measures |
|---|---|---|
| **Average SST around Japan** | Approx. 1.14°C increase | Approx. 3.58°C increase |
| **Average global SST** | Approx. 0.73°C increase | Approx. 2.58°C increase |
| **Average global ocean temperature (depth 0 – 2,000 m)** | Approx. 0.35°C increase | Approx. 0.82°Cincrease |

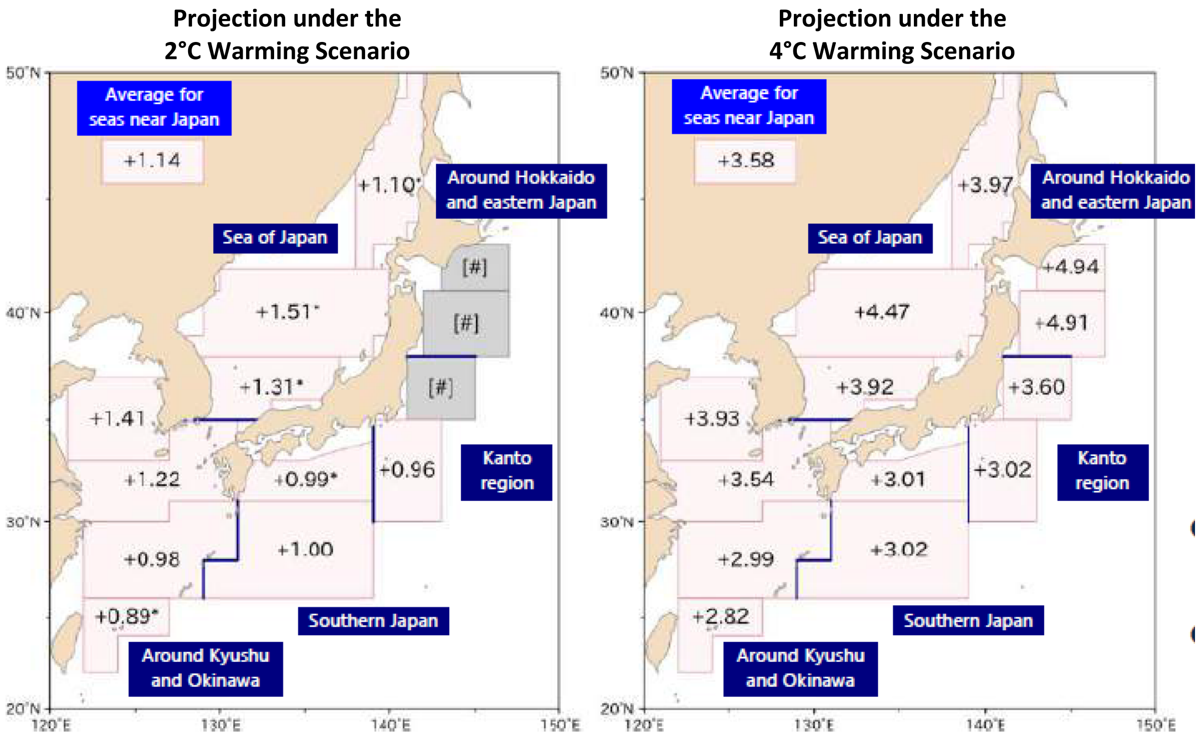



*Figure 21. Expected changes in SST for the 2081 – 2100 average relative to the 1986 – 2005 average Asterisks denote statistical significance at 95% or more. No tendency of statistical significance is observed for hash-marked areas.*

### 3.2.6. Sea Ice Projections

The annual maximum Sea of Okhotsk ice extent decreased at a rate of 61,000 km2 (equivalent to 5.3% of the normal annual maximum) per decade between 1971 and 2020.

Observation data for the Japanese coast of the Sea of Okhotsk since 1956 indicate a remarkable reduction in drift ice amounts since the second half of the 1980s.

The annual minimum Arctic Sea ice extent decreased at a rate of 890,000 km2 (equivalent to 14% of the normal annual minimum) per decade between 1979 and 2019.

No statistically significant change is observed in the Antarctic Sea ice extent.

Expected changes according to 2°C and 4°C Warming Scenarios are given below (Table 9). The Sea of Okhotsk ice extent in March for the end of the 21st century is expected to decrease under both scenarios, although the reduction under the 2°C Warming Scenario would be within the range of variability in the present climate. [14]

- The amount of sea ice drifting toward the Hokkaido coast is expected to decrease along with reduced sea ice formation along he Siberian coast.
- Arctic Sea ice extent/thickness is highly likely to decrease during the 21st century, falling to practically zero by the mid-21st century under the 4°C Warming Scenario (Figure 22).

*Table 9. Sea Ice Changes*

| | **2°C Warming Scenario Scenario**<br>**Potential conditions with achievement of the Paris Agreement's 2°C target** | **4°C Warming Scenario**<br>**Potential conditions with no future additional mitigation measures** |
|---|---|---|
| **Sea of Okhotsk ice extent for March** | Approx. 28% decrease | Approx. 70% decrease |
| **Arctic Sea ice extent for February** | Approx. 8% decrease | Approx. 34% decrease |
| **Arctic Sea ice extent for September** | Approx. 43% decrease | Approx. 94% decrease |

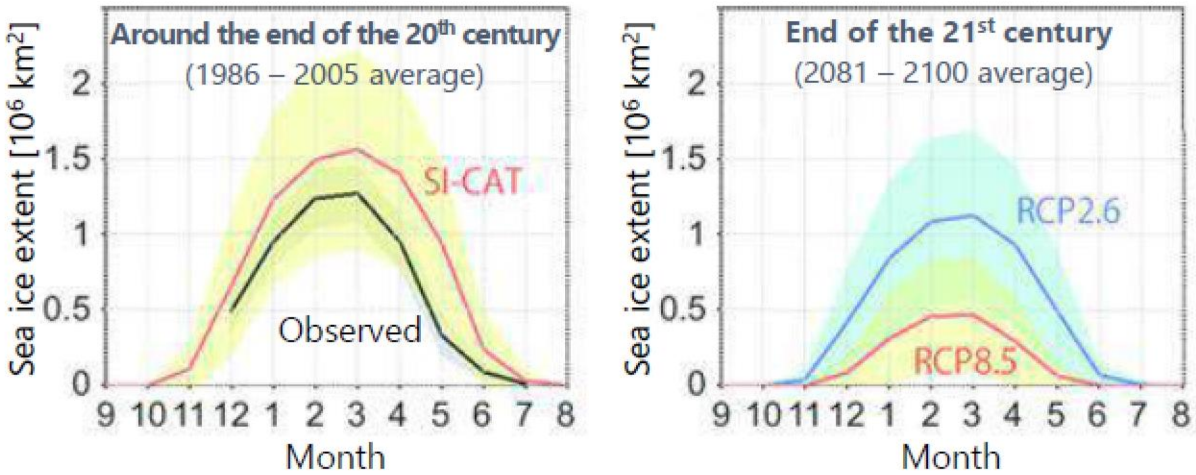



*Figure 22. Figure Seasonal changes in Sea of Okhotsk ice extent*

### 3.2.7. Ocean Acidification Projections

Around 30% of anthropogenic CO2 emitted into the atmosphere is absorbed by oceans, which causes the hydrogen ion exponent (pH) of global surface seawater to decrease at a rate of approx. 0.02 per decade. The global average surface seawater pH is estimated to have decreased by 0.1 since the onset of industrialization.

Observation data collected from 137°E since 1983 indicate ongoing acidification at a rate similar to the global average (pH values are generally reduced at lower latitudes, where the sea surface temperature is higher).

A tendency of acidification is also seen along the Japanese coast, with pH values between 1978 and 2009 decreasing by 0.014 and 0.024 per decade in summer and winter (the annual lowest and highest, respectively). These rates are similar to those seen in open seas. [14]

Expected changes according to 2°C and 4°C Warming Scenarios are given below.

- Globally, pH values are expected to fall rapidly in polar and high-latitude regions.
- Aragonite saturation (Ωarag) indicates acidification in the marine ecosystem. Ωarag in high-latitude regions is expected to fall below 3 (a guidance value for significant effects on coral reefs) earlier than in the subtropical zone, even though the rate of decrease is higher in the latter.
- Increasing ocean acidification around Okinawa and southern Japan is expected at a rate similar to that of the global average.

*Table 10. Ocean Acidification Changes*

| | **2°C Warming Scenario Scenario Potential conditions with achievement of the Paris Agreement's 2°C target** | **4°C Warming Scenario Potential conditions with no future additional mitigation measures** |
|---|---|---|
| **Surface seawater pH south of Japan** | Approx. 0.04 decrease | Approx. 0.3 decrease |
| **Surface seawater pH (global average)** | Approx. 0.065 decrease by the mid-21st century and stable thereafter | Approx. 0.31 decrease |
| **Annual average Ωarag around Okinawa** | Ongoing decrease until the mid-21st century 3 or more | Below 3 seasonally in the 2020s – 2030s<br>Below 3 throughout the year after around 2050 |
| **Annual average Ωarag south of Japan** | Approx. 0.2 decrease | Approx. 1.4 decrease |
| **Annual average Ωarag (global average)** | \ | Below 3 by 2060 except in low latitudes |

### 3.2.8. Typhoon Projections

No long-term trend is observed in the number of typhoons approaching or making landfall on Japan. No long-term trend is observed in the number of strong typhoons or in their percentage among all typhoons. In and around Japan, the latitude of maximum typhoon intensity exhibited a northward shift.

Expected changes according to 2°C and 4°C Warming Scenarios are given below.

- Numerous researchers have projected increased typhoon intensity in the Japan area due to greater amounts of atmospheric water vapor, which is the driving force behind typhoons.
- The results of 4°C warming simulations and other studies indicate high potential for increased occurrence frequency* of intense category 4 – 5 tropical cyclones over waters south of Japan.

* The number of typhoons expected within a specific area/period

# 4. NATIONAL AND LOCAL CLIMATE ADAPTATION PLANS

## 4.1. TÜRKİYE

Studies on adaptation to climate change began in Türkiye in the early 2000s. In order to determine strategies and actions related to adaptation to climate change in Türkiye, Türkiye's Climate Change Adaptation Strategy and Action Plan was prepared for the period 2011-2023. The Action Plan included water resources management, agricultural sector and food security, ecosystem services, biodiversity and forestry, natural disaster risk management and human health sectors. Since the said plan period is due to be completed in 2023, the Climate Change Adaptation Strategy and Action Plan was published to cover the years 2024-2030.

The relationship between disasters and climate change was also studied in detail within AFAD in 2012 and the Climate Change Roadmap document prepared for this purpose was published in 2014. As the frequency and severity of disasters increased, the studies gained momentum and it was decided that disaster risk reduction studies would be carried out in detail at the provincial level. For this purpose, Provincial Risk Reduction Plans were prepared as a result of long-term studies in each province. The disasters studied were determined according to the hazards of each province. Both disasters caused by climate change such as landslides, floods, avalanches, and sinkholes, as well as the impact of climate change on disasters, were studied in detail in some provinces and actions were prepared (Figure 23).

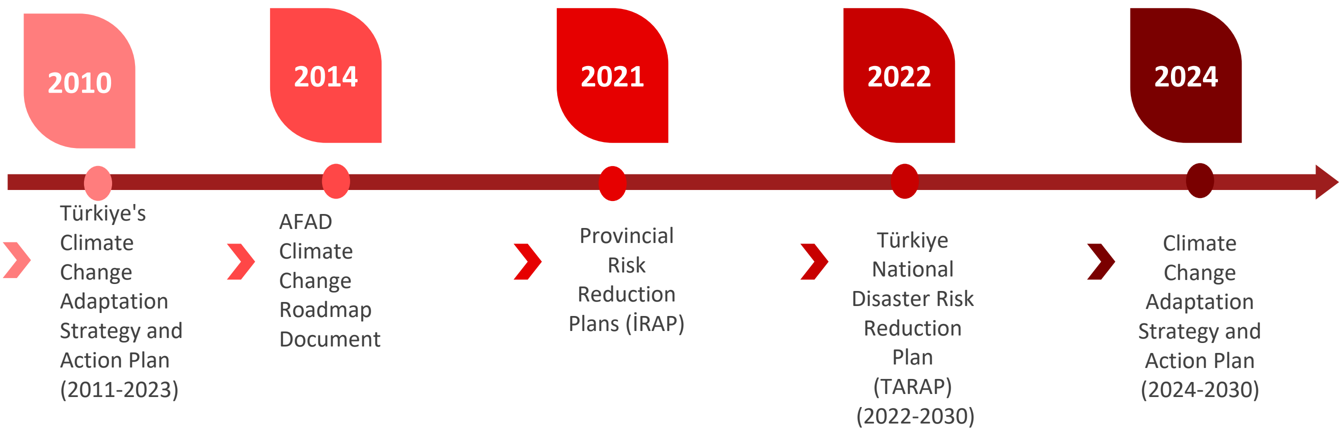



*Figure 23. Climate change adaptation legal processl*

## 4.2. JAPAN

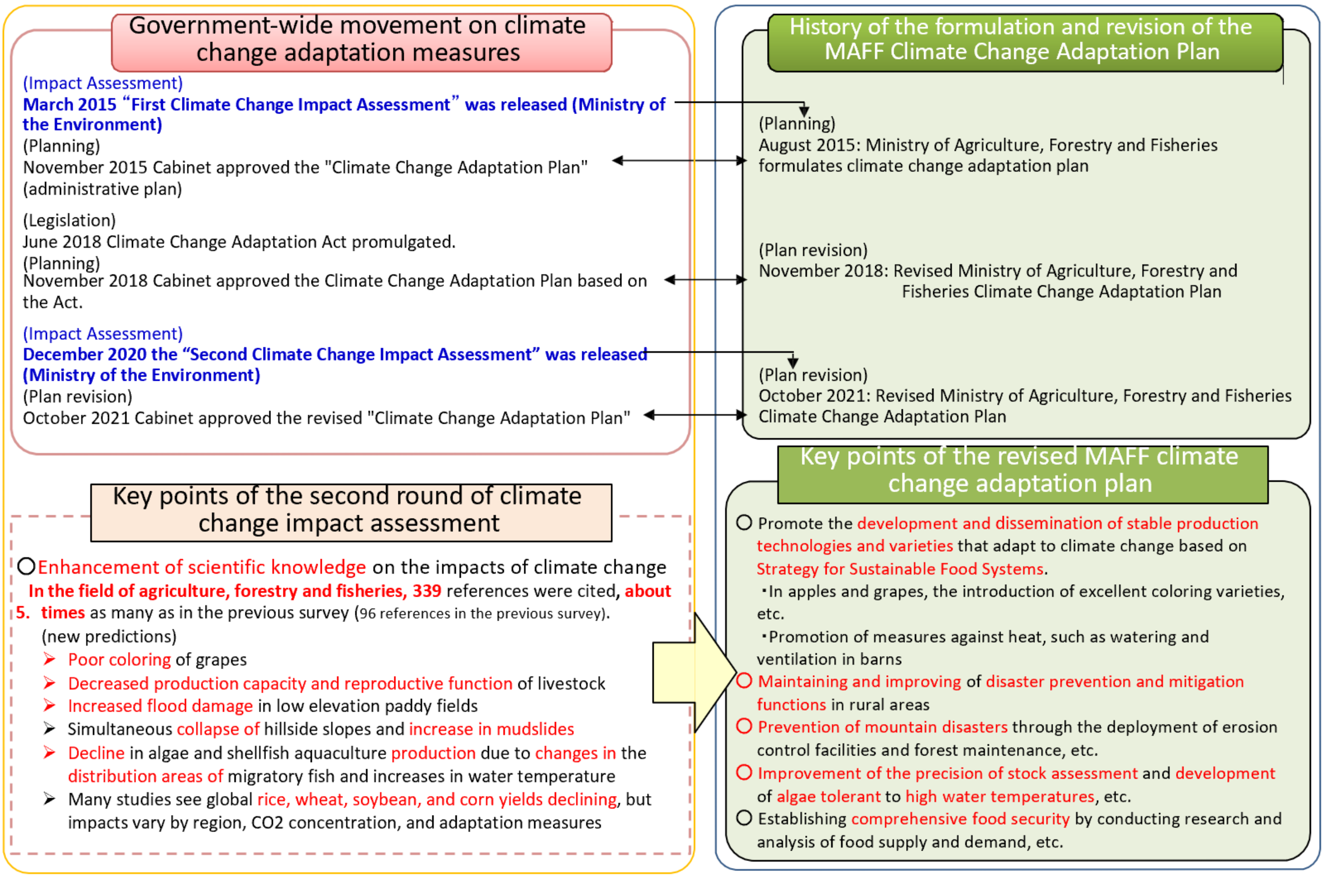



*Figure 24. Climate change adaptation legal process [17]*

## 5. IMPACT OF CLIMATE CHANGE AND ADAPTATION COUNTERMEASURES BASED ON THE SECTORS

With the Türkiye National Climate Change Adaptation Strategy and Action Plan, adaptation strategies and action plans have been prepared in 12 sectors, including agriculture and food security, ecosystem services and biodiversity, water resources management, tourism and cultural heritage, industry, city, social development, public health, transportation and communication, energy, disaster risk reduction and cross-cutting issues.

Japan Climate Change Adaptation Plan has been prepared in the 7 sectors (agriculture, forestry and fisheries; water environment and water resources; natural disasters and coastal areas; ecosystems; human health; industrial and economic activities.

In both plans, disasters that could affect the sectors were analyzed and adaptation measures were developed to adapt to the changes that may occur as a result of these disasters. A comparison of the disasters that may affect the sectors across countries is given in Table 11.

*Table 11. Summary of sectors affectedd by disaster types*

| | **TÜRKİYE** | **JAPAN** |
|---|---|---|
| **Agriculture** | • Drought<br>• Floods<br>• Storms and strong winds<br>• Hail | • More rainless days<br>• Less winter snowfall<br>• Heat Stroke |
| **Biodiversity** | • Drought<br>• Floods<br>• Heat | • High temperature |
| **Industry** | • Heavy rain<br>• Drought | • Tropical cyclones<br>• Tornadoes<br>• Heavy snow |
| **Marine, Coastal areas and fisheries** | • Heat waves | • high water temperature |
| **Turishm and Cultural Heritage** | • Heat wave | • Sea level rise<br>• Less snowfall<br>• High temperature |
| **Forestry** | • Fires<br>• Drought<br>• Strong winds | • Water stress |

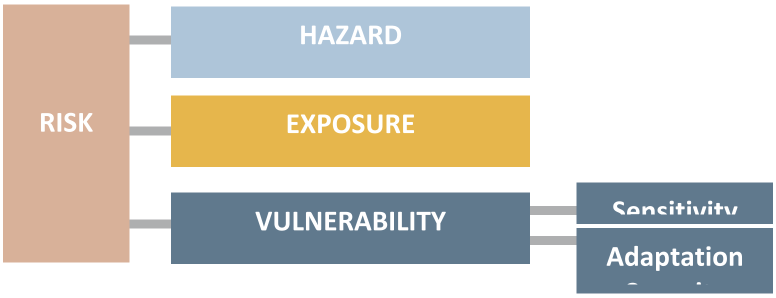
| | | |
|---|---|---|
| **Energy, Transport and Communication** | • Heavy rain<br>• Floods<br>• Drought<br>• Storms and strong winds<br>• Heat waves | • |
| **Urban** | • Heavy rain<br>• Heat wave | • Rainfall<br>• Droughts<br>• Tropical cyclones |
| **Water management** | • Drought<br>• Heavy rain | • More rainless<br>• Droughts |
| **Livestock** | • Drought<br>• Heat wave | • Heat wave |
| **Public health** | • Extreme Weather Events<br>• Heat and Cold Waves | • Extreme Weather Events |

## 5.1. TÜRKİYE

With the National Climate Change Adaptation Strategy and Action Plan, adaptation strategies and action plans have been prepared in 12 sectors for the years 2024-2030, including agriculture and food security, ecosystem services and biodiversity, water resources management, tourism and cultural heritage, industry, city, social development, public health, transportation and communication, energy, disaster risk reduction and cross-cutting issues. Disaster has been addressed as a cross cutting sector in every sector, and has also been studied as a sector to increase our resilience to disasters (Table 12). [18]

Risk analyses have been conducted for each sector regarding their vulnerability to disasters. Vulnerability and risk are influenced by a wide range of factors, including anthropogenic climate change, natural climate variability, and socio-economic development (IPCC, 2012). Consequently, climate change impacts can disrupt the normal functioning of societies and cause significant damage or loss of function in sectors, depending on the severity of these changes.

Risk is defined as the potential for negative consequences when elements of value, such as human lives, ecosystems, cultural assets, and physical infrastructure, are exposed to harm. According to the IPCC Fifth Assessment Report (AR5), risk is conceptualized as a combination of vulnerability, exposure, and hazard (Figure 25). Climate risk, specifically, refers to the potential for adverse outcomes resulting from the exposure of these valued elements to climate hazards. Systems may be exposed to individual or multiple climate hazards simultaneously. [18]




*CapacityFigure 25. Risk components according to IPCC AR5 approach*

*Table 12. Disaster Risk Reduction Impact And Countermeasure*

| | **Current Status** | **Future prediction** |
|---|---|---|
| **IMPACT** | • According to the Climate Change 2022: Impacts, Adaptation and Vulnerability Report of the United Nations (UN) Intergovernmental Panel on Climate Change (IPCC), Türkiye is one of the most vulnerable countries in Europe in the context of extreme weather events. | • Türkiye is located in the Mediterranean Basin, which, according to IPCC reports, is one of the regions most vulnerable to climate change. Due to its geographical position, Türkiye is already impacted by climate-related disasters such as droughts, floods, and extreme weather events, and projections indicate that the country's vulnerability to such disasters will increase in the future. |
| **COUNTERMEASURE** | **Implementation of countermeasures, research and development, etc** | |
| | To strengthen the understanding of and information infrastructure for climate change and disaster risks for sustainable and resilient development.<br>• Conducting comprehensive risk assessment and planning studies to establish climate change risks more clearly.<br>• Developing a Multiple Hazard Early Warning System, including warning systems for fast- and slow-growing events, that aims to reach all segments of society and involves foresight and response actions.<br>To ensure transformative risk governance to strengthen climate and disaster resilience.<br>• Ensuring the systematic integration of climate change adaptation and disaster risk reduction in national and local sustainable and resilient development planning.<br>• Revising the legislation, including policies and sectors, by taking climate change into consideration to enhance the disaster resilience of critical infrastructure, and formulating practical guidelines in this regard.<br>• As part of compensating for losses and damages caused by climate-related disasters, enhancing the insurance mechanism, improving the loss and damage identification process, and creating the Turkish Losses and Damages Platform. | To build institutional capacity and raise awareness to achieve inclusive and sensitive climate and disaster resilience.<br>• Building institutional and technical capacity to enhance disaster resilience.<br>• Taking into account the potential displacements caused by climate-related risks in the National Migration Policy and action plans and including climate change adaptation in the migration management process.<br>To make consistent and sustainable investments in the context of climate and disaster resilience.<br>• Carrying out the post-disaster restructuring and reconstruction process by taking into account the issues of climate change impacts and ecosystem-based disaster risk reduction. |

## 5.2. JAPAN

To pursue climate change adaptation effectively, the emphasis should be placed on flexible actions based on an adaptive approach that involves the assessment of climate change impacts, progress management of the Climate Change Adaptation Plan, and review of that plan according to the progress.

When developing adaptation measures, the government should focus on collecting basic information on the subject regions/areas, determine assessment indicators for existing visible impacts or expected impacts, projecting future impacts using these indicators, and then establishing measures based on the obtained projections; and establishing a plan related to use and conservation based on local circumstances through discussions with local stakeholders, building consensus, and taking comprehensive actions through collaboration and the sharing of roles with these stakeholders. When establishing measures, it is necessary to examine options according to the situation, such as whether climate change is projected to impact the distribution of species to be conserved in the subject areas and on other living things that have an adverse impact on the species to be conserved and whether there is a refugium for them. In addition, when implementing measures, it is essential to engage in adaptive management, which involves monitoring changes in the subjects of assessments and reviewing the plan regularly. It is also necessary to develop human resources for the management and investigation/research of the natural environment from the long-term perspective to ensure appropriate and effective implementation of adaptation measures. [10]

Based on scientific findings, the adaptation plan assessed the impacts of climate change on 71 categories in the 7 sectors (agriculture, forestry and fisheries; water environment and water resources; natural disasters and coastal areas; ecosystems; human health; industrial and economic activities; and life of the citizenry and urban life) from three perspectives: significance, urgency, and confidence. An example evaluation is given in Table 13.

*Table 13. Mountainous Disaster and Forest Conservation Works and Forest Road Facilities [17]*

| | Current Status | Future prediction |
|---|---|---|
| **IMPACT** | • Concentrated torrential rainfall caused by the formation of linear precipitation zones triggers multiple surface collapses and mudslides.<br>• Driftwood disasters occur frequently when collapsed sediment flows downstream, engulfing standing trees and sediment in the vicinity of the stream, causing a large amount of driftwood. | • Increase in the frequency of heavy rainfall due to climate change, and increase in the number of simultaneous collapses of hillside slopes and mudslides due to increased localized heavy rainfall<br>• Increased risk of damage from storm surges, tidal waves and tsunamis, and increased coastal erosion trends. |
| **COUNTERMEASURE** | **Implementation of countermeasures, research and development, etc** | |
| | Increased risk of occurrence of mountain disasters<br>• Promotion of mountain control measures and forest improvement based on the "Five-Year Acceleration Plan for Disaster Prevention, Disaster Mitigation, and Building National Resilience" and other measures<br>• Development of forest road facilities in consideration of the increased frequency of torrential rains.<br>Response to changes in the form of disasters such as river flooding<br>• Promote efforts to improve and conserve forests in the upper reaches of rivers, etc., in cooperation with efforts for watershed flood control.<br>• Reduce the risk of driftwood disasters by installing driftwood-catching dams, conducting forest maintenance such as thinning to promote the development of root systems, cutting down dangerous trees in mountain streams, and changing forest types with consideration for the stream ecosystem.<br>• Control of sediment runoff through the careful placement of erosion control dams. | Increased risk from storm surges, tidal waves and tsunami<br>• Strengthen development of coastal disaster prevention forests to protect against tsunami and wind damage.<br><br>Research and development, etc.<br>• Study to improve the accuracy of identifying high-risk areas for mountain disasters by using laser surveying, etc.<br>• Study on the development of facilities to cope with disaster risks and forest management utilizing the disaster prevention and mitigation functions of forests. |

## 6. CONCLUSION

Climate and disaster risks are increasing across the world, with climate-related disasters becoming more frequent in the last 50 years (World Meteorological Organization, 2021). In the last 5 years, the number of those who suffered from or lost their lives due to climate-related disasters have increased compared to the previous 5 years. While climate and disaster risks are increasing at an unprecedented pace, Türkiye is being addressed in the latest studies as one of the most disaster-prone countries in the European region and the Mediterranean Basin which have the severest experience of extreme climate events and climate change. In 2019, in addition to the earthquake which affected the population and infrastructure, 936 extreme events including heavy precipitation/floods (%36), storms (27%) and hail (18%) resulted in an annual average loss of 0.20% of the GDP (TSMS, 2020). The average loss for the Organization for Economic Cooperation and Development (OECD) was on the other hand 0.09% (International Finance Corporation, 2022).

According to climate projections, this trend is expected to increase further in the future, given the expected impacts of climate change, unfavourable environmental conditions and increased pollution, continuously increasing urbanization, increasing migration patterns and other risk factors. Eventually, it is projected that the frequency, intensity and impact of climate-related disasters will increase, exacerbating current situations of vulnerability and social inequality in addition to creating new ones and significantly affecting the resilience of national and local communities, and particularly women, youth, elderly and other vulnerable groups.

In order to understand the effects of climate change, projections were made in both Türkiye and Japan using IPCC reports. When the geographical features of Türkiye and Japan are taken into consideration, it was observed that temperature and precipitation projections are common. In Türkiye, unlike Japan, drought, heatwave, coldwave, extreme wind and forest fire projections were made; in Japan, unlike Türkiye, snowing, sea level, ocean surface temperature, sea ice and ocean acidification projections were made.

When the joint analysis results of both countries were examined, it was seen that temperatures would increase, precipitation regime would decrease in Turkey and increase in Japan. It was seen that studies on ocean level were more important due to Japan's geographical location. In Turkey, it was seen that studies on increasing temperatures and decreasing precipitation would increase the risk of drought even more.

Different methodologies were used in the climate change adaptation action plan preparation studies in both countries. The IPCC 5 AR5 approach was used in Türkiye. According to the IPCC Fifth Assessment Report (AR5), risk is conceptualized as a combination of vulnerability, exposure, and hazard. In the analysis, disaster-based hazard, exposure, vulnerability and risk were determined in each sector. Climate signal and climate impact were included in the hazard category; sensitivity and adaptation capacity were included in the vulnerability category. This analysis was conducted for each sector, and strategic targets and actions were determined according to the results. The effects of climate change in Japan were prepared in two parts as current status and future estimates, and then the precautions that can be taken against these changes were determined. These analyses were made from three perspectives: significance, urgency, and confidence.

National Climate Change Adaptation Strategy and Action Plan, adaptation strategies and action plans have been prepared in 12 sectors for the years 2024-2030 in Türkiye. Japan Climate Change Adaptation Plan has been prepared in the 7 sectors. Although the number of sectors is different, when looking at the sub-divisions, it is seen that all sectors have something in common.

It is seen that agriculture and animal husbandry, biodiversity, public health sectors will be affected in both countries due to heat; agriculture and animal husbandry, forestry, urban sectors will be affected by decreasing or increasing precipitation. It was seen that heat wave will be effective for Turkey, sea level rise, less snowfall and high temperature will be effective for the Tourism sector in Japan. While drought and heavy rain are effective for the Industry sector in Turkey, tropical cyclones and heavy snow are considered as risks in Japan.

Although Turkey and Japan are located in different geographical regions, it is seen that many sectors can be affected in a similar way due to disasters that may occur due to the effects of climate change. When the current situation in the world and climate change projections are examined within the scope of this report, it is concluded that instead of resisting change and fighting nature, we need to keep up with change and work in coordination with public institutions, the private sector, NGOs and especially the public on adaptation to climate change.

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