# G20 CLIMATE RISK ATLAS

## Impacts, policy, economics

cmcc

# TURKEY

With the scientific
contribution of
Enel Foundation

### How to read the Atlas: graphs, colours and scenarios.

The maps used in this Atlas are taken from **The World Bank Official Boundaries** - ***https://datacatalog.worldbank.org/search/dataset/0038272*** (accessed on May 28, 2021). For the section Energy, the maps are based on Panoply Data Viewer ***https://www.giss.nasa.gov/tools/panoply/credits.html***

Each sector of this Atlas contains data and information on various climate scenarios.

When reported in graphs, the **colour black** indicates data and information referring to the current state, the past or the baseline.

When the authors refer to **RCP (Representative Concentration Pathways)**, the 3 colours used across the factsheet refer to 3 scenarios, which are 3 different development options with different levels of greenhouse gas emissions, **respectively low emissions (green), medium emissions (orange), and high emissions (red)**. The same colour code is used when RCPs are associated with Shared Socioeconomic Pathways (SSP).

In some cases, the authors refer to global warming scenarios. In these cases, the 3 colours used refer to a temperature rise of **1.5°C (green), 2°C (dark green), and 4°C (red)**.

When the authors refer exclusively to **Shared Socioeconomic Pathways - SSPs** (Population affected by river floods in the section: "Water"), data related to **SSP3** - that encompasses, among other things, slow economic growth, material-intensive consumption, and persisting or worsening inequalities – **are reported in a lighter shade**; **SSP5** – which refers to social and economic development that is coupled with an energy-intensive lifestyle and the abundant exploitation of fossil fuel resources – is shown using a **middle shade of the colour**, whereas data related to **the present** conditions **are represented in a dark shade**.

Further details on scenarios, methodologies, and the full list of references are available at: **www.g20climaterisks.org**

Concept and graphic design by element6.eu

# TURKEY CLIMATE

## OVERVIEW

Turkey presents a complex climate: the southern and western coastal areas have a Mediterranean climate whereas the eastern part adjoining Syria and the Middle East are very hot during the summer. Such complexity depends on different factors among which a variable topography, the presence of the Black Sea to the north and, beyond that, the vast Russian plain which in winter acts as a source of very cold air.

## TEMPERATURE

The temperature regime in Tukey varies in space and time according to orography and proximity to the sea. Temperatures are lowest in inland areas, with a marked difference between day and night. The warmest areas are the western and southern coasts.

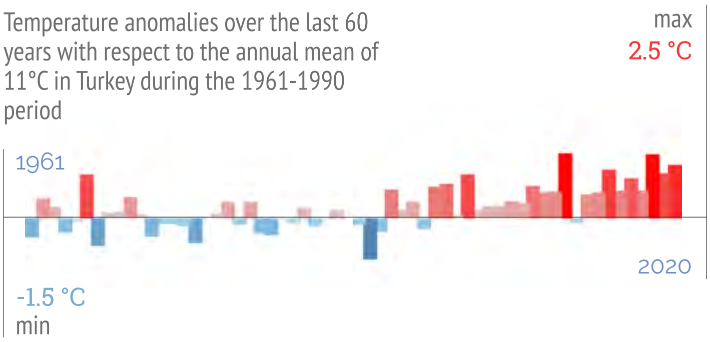
### MEAN TEMPERATURE

+3 20

Celsius degrees / Over 1991-2020

### TEMPERATURE TREND

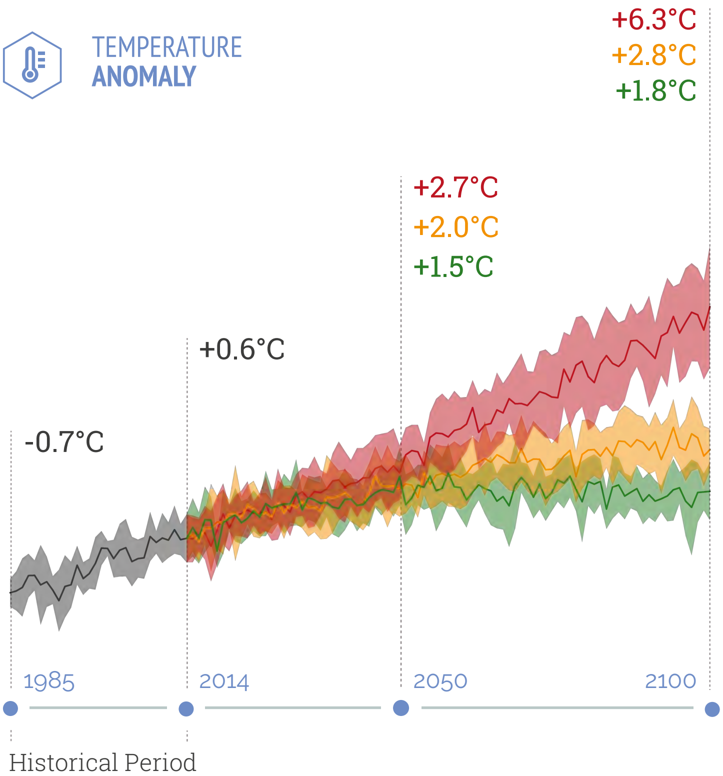
Temperature anomalies over the last 60 years with respect to the annual mean of 11°C in Turkey during the 1961-1990 period




## TEMPERATURE PROJECTIONS

Under a low emissions scenario projected temperature variations will remain contained at around +1.5°C, both by 2050 and 2100.
Under a high emissions scenario, with no reduction in GHG emissions, much greater temperature anomalies are expected by both 2050 and 2100.

TEMPERATURE ANOMALY




## EXPECTED VARIATION FOR TEMPERATURE AT 2050

The indicators show variations in selected temperature characteristics for a thirty-year period centred on 2050 (2036-2065) with respect to the reference period 1985-2014.

| Annual Mean Temperature | Max Temperature of warmest month | Min Temperature of coldest month |
|---|---|---|
| +2.7°C | +3.7°C | +2.4°C |
| +2.0°C | +2.8°C | +1.8°C |
| +1.7°C | +2.3°C | +1.7°C |

# PRECIPITATION

The precipitation regime in Turkey changes depending on the time of year and location. In the inner areas overall precipitation is small, whereas towards the Black Sea it is more significant.
Some years, rainfall causes severe floods and landslides, whereas in others increasing temperatures coupled with decreasing precipitation lead to significant water stress, particularly in the southern and western parts of the country.

## MEAN PRECIPITATION

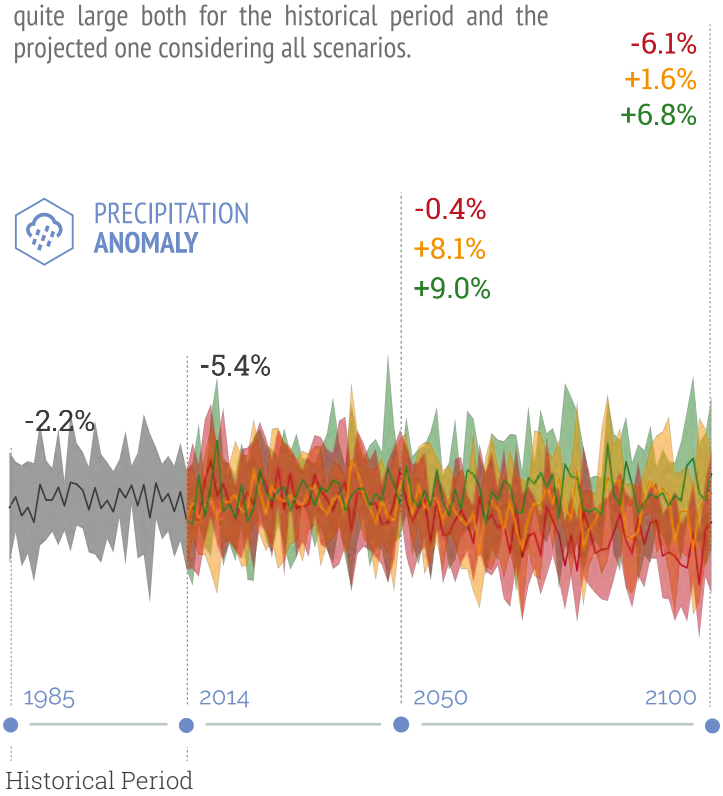
262 2,453

mm/year / Over 1991-2020

# PRECIPITATION PROJECTIONS

Precipitation is projected to decrease, especially under a high emissions scenario. The variability is quite large both for the historical period and the projected one considering all scenarios.

PRECIPITATION ANOMALY



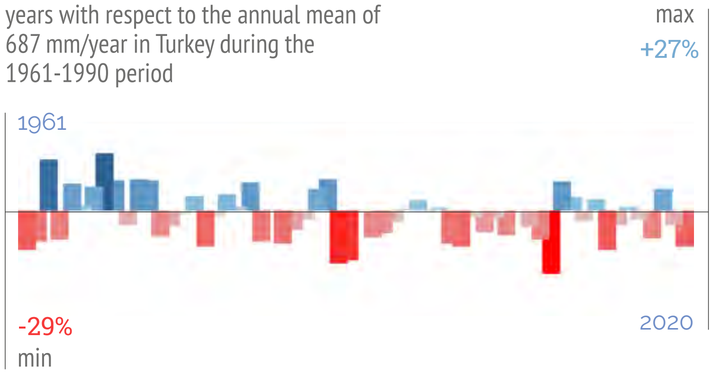

# EXPECTED VARIATION FOR PRECIPITATION AT 2050

The indicators show variations in selected precipitation characteristics for a thirty-year period centred on 2050 (2036-2065) with respect to the reference period 1985-2014.

| | | | |
|---|---|---|---|
| Annual total precipitation | -3.0% | -1.5% | +1.7% |
| Precipitation of wettest month | +1.0% | -1.1% | +2.0% |
| Precipitation of warmest quarter | -27.6% | -16.9% | -14.0% |

## PRECIPITATION TREND

Precipiation anomalies over the last 60 years with respect to the annual mean of 687 mm/year in Turkey during the 1961-1990 period




# VARIATION OF SPECIFIC CLIMATE INDICATORS

Climate indicators variation showing impacts of climate change on sectors such as agriculture, health and water. Analysis considers 3 threshold average temperature increase: **+1.5°C**, **+2°C**, **+4°C**.

| | | | | |
|---|---|---|---|---|
| Agricultural drought proportion of time | % of time | +37% | +23% | +18% |
| Hydrological drought proportion of time | % of time | +20% | +14% | +11% |
| Heatwave duration | % of time | +4,242% | +774% | +284% |
| Runoff increase | % of area | +27% | +13% | +5% |
| Agricultural drought frequency | % of change | +88% | +58% | +33% |
| Hydrological drought frequency | % of change | +11% | +9% | +18% |
| Heatwave frequency | % of change | +100% | +69% | +41% |
| Runoff decrease | % of area | +9% | +2% | +1% |

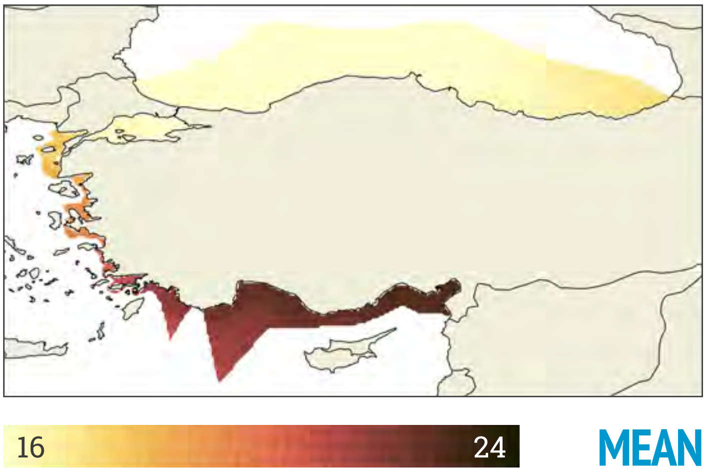
# TURKEY OCEAN

## OCEAN IN TURKEY

Turkey's marine exclusive economic zone (EEZ) is mainly temperate with a nearly subtropical regime in the Mediterranean basins, hosting a wide ensemble of ecosystems such as seagrass beds and coral reefs. The country's coastal systems can be divided into three areas: the Aegean Sea, Black Sea, and the levantine part of the Mediterranean Sea.

## CURRENT CLIMATE CONDITIONS

Mean sea surface temperature reflects the rather homogeneous temperate climate of the region, with colder waters along the Black Sea coasts.

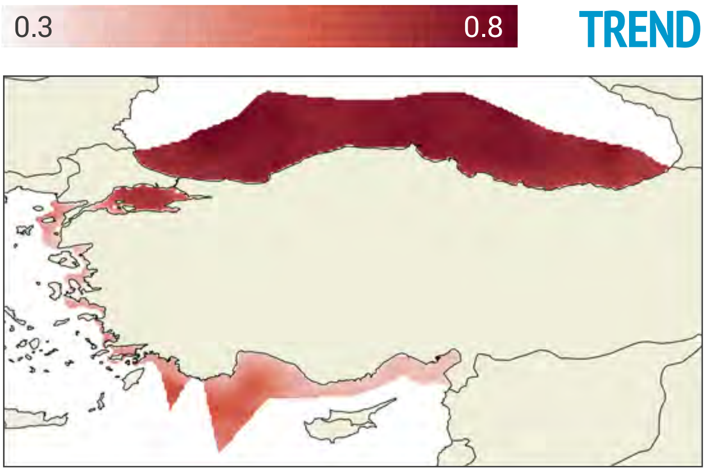



**MEAN**

**SEA SURFACE TEMPERATURE**

Celsius degrees / Over 1991-2020

**TREND**




Surface temperature trends indicate a general warming of 0.4°C per decade on the Mediterranean coasts, with increased gains up to 0.7°C per decade along the Black Sea.

## FUTURE PROJECTIONS

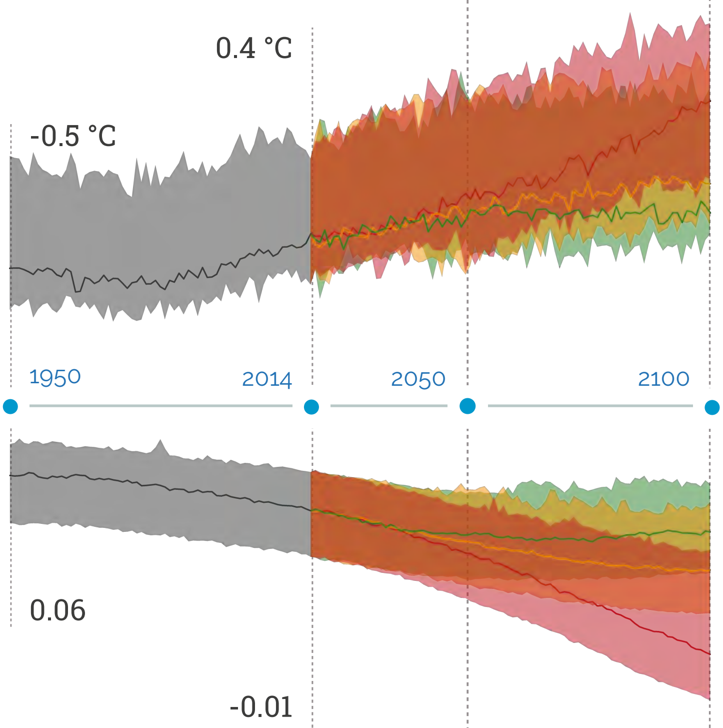
Projected annual changes within the marine EEZ for the two most significant marine indicators of climate change: sea surface water temperatures and pH.

Seawater temperature changes are in line with the definitions of each scenario, with maximum values close to +5°C under a high emissions scenario in 2100.

+5.1 °C
+2.7 °C
+1.7 °C

SEA SURFACE TEMPERATURE **ANOMALY**

+2.3 °C
+1.8 °C
+1.6 °C




SEA SURFACE pH **ANOMALY**

-0.1
-0.12
-0.16

Seawater surface pH becomes more acidic in all scenarios, closely reflecting rising atmospheric $CO_2$ concentrations, and only a low emissions scenario leads to a stable condition by 2100.

-0.09
-0.19
-0.38

# ECOSYSTEM INDICATORS AT 2050

Regional changes in key marine ecosystem indicators under projected future scenarios by mid-century (2036-2065) with respect to present climate conditions (1985-2014).



| | Aegean Sea | Black Sea | Levantine |
|---|---|---|---|
| **Temperature** regulates the metabolism of marine organisms determining which habitats remain suitable. Excessive warming will likely push ecosystems beyond tolerance thresholds. | 17.43°C | 15.84°C | 20.71°C |
| | +2.61 °C | +2.55 °C | +2.06 °C |
| | +2.29 °C | +2 °C | +1.57 °C |
| | +2.19 °C | +1.81 °C | +1.34 °C |
| **pH** represents the acid/base status of marine waters, where a decreasing pH reflects the acidification of the ocean due to increased absorption of atmospheric $CO_2$. | 8.12 | 8.12 | 8.1 |
| | -0.16 | -0.17 | -0.15 |
| | -0.12 | -0.13 | -0.11 |
| | -0.09 | -0.11 | -0.09 |
| **Oxygen** is fundamental to sustain marine life and its reduction can have a large impact on coastal ecosystem services including fisheries and aquaculture. | 243.56 mmol/m³ | 266.4 mmol/m³ | 227.42 mmol/m³ |
| | -4.71 % | -3.59 % | -3.52 % |
| | -3.79 % | -2.94 % | -2.93 % |
| | -3.53 % | -3.91 % | -2.56 % |
| **Chlorophyll** is an indicator of the biomass available at the base of the marine food web supporting all ecosystem productivity. | 0.2 mg/m³ | 0.18 mg/m³ | 0.11 mg/m³ |
| | -4.06 % | -15.85 % | +15.45 % |
| | +6.6 % | -15.85 % | -2.73 % |
| | -11.68 % | -20.22 % | +11.82 % |

## FISH CATCH POTENTIAL

Fish catch potential is an estimate of the maximum fish catch achievable given the marine resources available over a sustained period. It is linked to the concept of maximum sustainable yield, meaning the maximum amount of fish that can be extracted from a system without causing a collapse in fish populations.

It is a characteristic of the natural system, which is substantially different from realized catch, and a direct result of the fishery policy in place.

While no specific data is available the Turkish EEZ, a decrease in potential catch between 0 and 5% have been projected at mid century under high emissions scenarios for the Mediterranean Sea.

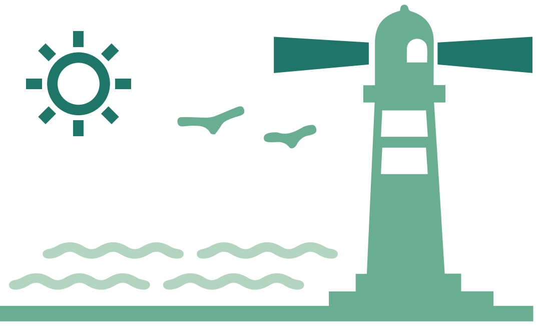
## ANALYSIS DETAILS

All datasets were analysed using only data from within the marine EEZ and therefore excluding overseas territories, detached islands and any disputed or joint territories with other nations. In the assessment of current climate conditions, seawater surface tempereature data was obtained using satellite observations distributed in the framework of ESA Climate Change Initiative.

Future projections of marine indicators are represented by the combined analysis of results from 15 different Earth System models participating in the Coupled Model Intercomparison Project Phase 6 (CMIP6). These models include new and better representations of physical and biogeochemical processes, compared to previous IPCC assessment reports.

Fish catch potential data was obtained using the FAO's technical report and refers to the best and worst case climate scenarios from the Fifth IPCC Assessment Report. These mean estimates are subject to substantial uncertainties as discussed in the original work.

# TURKEY
# COASTS



## OVERVIEW

Turkish shorelines face the Black Sea to the north, the small Sea of Marmara to the north-west, the Aegean Sea to the west, and the Mediterranean and Black seas to the south, which are connected by the Bosphorus Strait, a natural channel surrounded by the city of Istanbul. With approximately 500 islands and more than 8,000 kilometres of coastline, Turkish coasts combine rocky shores, sandy beaches and a limited number of fertile coastal floodplains. The most important coastal ecosystems are seagrass beds, coastal wetlands and dunes. Most of the coastal population is concentrated in the cities of Istanbul, with over 7 million inhabitants, and the smaller towns of Izmir, Antalya and Mersin on the Mediterranean coast. Numerous coastal settlements are found along the Black Sea and Mediterranean coasts.

Shoreline Length — 8,140 km

Sandy Coast Retreat at 2050 — -22.7 m

## CLIMATE CHANGE HAZARDS

Coastal hazards such as erosion, storm tide inundation and permanent flooding, can have strong adverse impacts on coastal regions, with loss of sandy shores, damage to settlements, infrastructure and ecosystems. Climate change can exacerbate these impacts due to rising sea levels and increasing impacts of waves and storms. Climate change impacts on the coastal zone of Turkey are mainly driven by rising sea levels and possible changes in storms intensity and direction affecting the Eastern Mediterranean and the Black Sea. Possible impacts of sea level rise may include salt water intrusion into low lying areas and aquifers, recession of pocket sandy beaches and adjacent dunes, and shoreline recession in low lying coastal floodplains. These are concentrated on the Southern coast on the Mediterranean, with the delta of the Ceyhan (Pyramus) River being the largest, and less comillimetreson on the Turkish Black coast, where the KiKızılırmak Delta river is the largest.

### SEA LEVEL RISE

Relative sea level rise has been observed over the past century, with significant localised increases, mainly driven by eustatic adjustments, of up to 6 millimetres per year, and an average increase of 2 millimetres per year. The latest IPCC projections indicate that, by 2050, global sea levels may rise between 0.18 metres, under a low emissions scenario, and 0.23 metres, under a high emissions scenario.

Observed and projected sea level rise at 2050 — 2 mm/year — 0.23 m — 0.18 m

### EXTREME SEA LEVEL

On average, one in 100 extreme sea level events are expected to rise from 0.91 metres at present day to 1.08 metres by 2050 under a medium emissions scenario.

Current and projected extreme sea level at 2050 — 0.91 m — 1.17 m — 1.08 m

### OBSERVED STORMS

The Turkish coast is influenced by storms developing in the Aegean, eastern Mediterranean and Black Sea. Although most parts of the Turkish coast are protected, the most exposed one is the Mediterranean. Trends in the Aegean for the past decades show a possible decrease in wave heights. The Eastern Mediterranean also shows a possible decrease in the wave height. Black Sea trends are uncertain.

### FUTURE STORMS

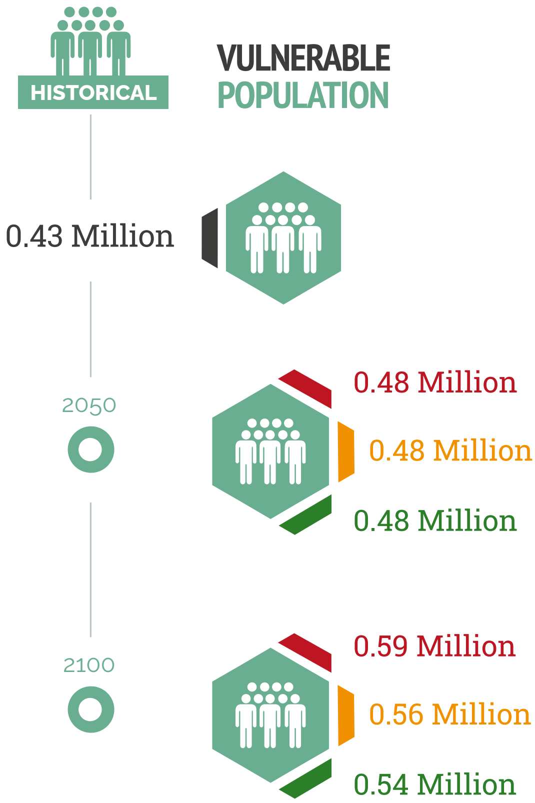
In the Mediterranean and Aegean, mean and maximum wave height under a high emissions scenario appear to be decreasing, with a slight eastward rotation in wave direction. The impact of climate change on the Black Sea region is quite uncertain, with both potential decreases or increases in the wave energy distribution.

# VULNERABILITY AND RISK

Parts of the Turkish coast are vulnerable to the impacts of sea level rise, in particular the low lying coastal plains and the beaches along the Black, Aegean and Mediterranean seas. The high level of human activities in coastal areas puts a significant amount of stress on Turkish coastal zones, especially on coastal lowland plains.

The Marmara region around Istanbul has the highest population density of all. Some of the most vulnerable areas include the delta of the Kizilirmak river, mostly attributed to decreasing sediment supply to the coast, and the Ceyhan River delta, at risk from erosion, subsidence and saline intrusion.

Shoreline erosion is impacting numerous coastal tourism destinations on the Turkish coast. Recent analysis shows that approximately 4.8% of the Turkish coast is at high risk from climate change. Under a medium emissions scenario, the total population exposed to the annual coastal flood level is expected to increase from 430,000 to 480,0000 people by 2050.




## INFLUENCE OF SEA LEVEL RISE ON EXTREME SEA LEVEL

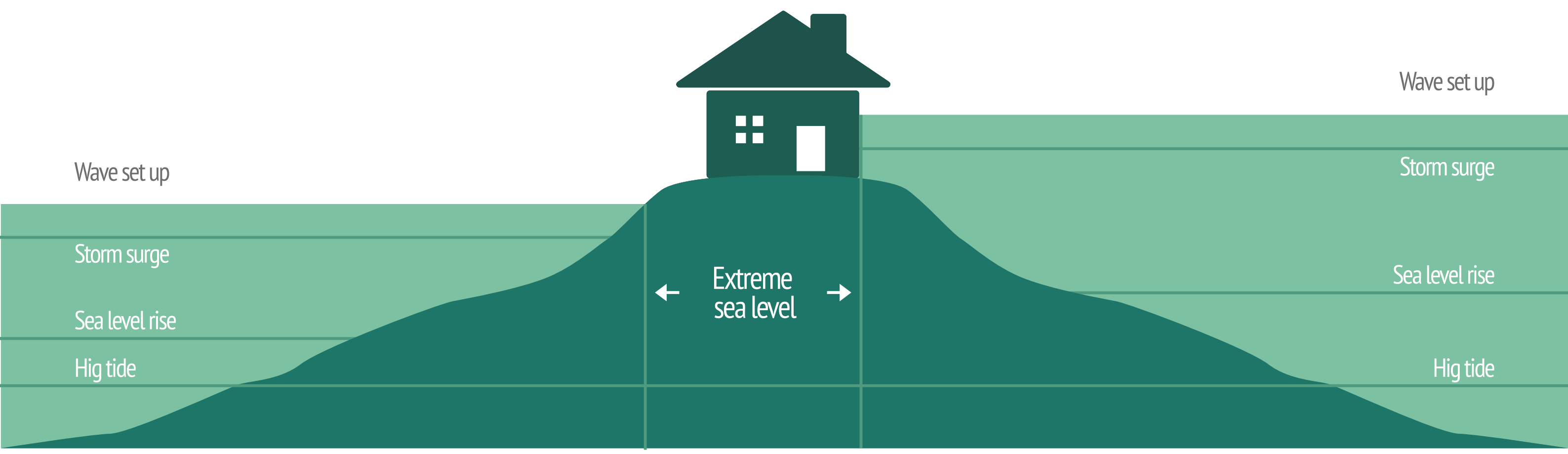
Present and future sea level rise are a consequence of carbon induced global warming causing melting ice and ocean expansion due to heat accumulation.

The extreme sea levels reported here are based on the 100-year storm surge + wave set up + sea level rise + high tide indicators. The first two parameters (storm surge + wave set up) are based on the 100-year value for the event; sea level rise is its projected value at 2050; and high tide is the absolute value of the highest tide calculated for a given locality, which won't be influenced by climate change.

+ **Wave set up** refers to the accumulation of water near the shore due to the presence of breaking waves.

+ **Storm surge** is an occasional increase in sea level driven by shoreward wind-driven water circulation and atmospheric pressure.

+ **High tide** is usually the highest tide reached in a given location based on tide records.




**Present sea levels** have risen globally by approximately 20 centimetres over the past century.

**Future sea level rise** is a projection based on different global warming scenarios, at approximately 100 centimetres by the end of 2100, with consequent inundation during extreme sea level events.

# TURKEY WATER

## OVERVIEW

Water resources in Turkey are unevenly distributed across 25 hydrological river basins. The rivers often have irregular flows due to changing climate conditions and variations in topography. Rainfall is concentrated in the south and north of the country, with some of the largest rivers being the Kizilirmak River, flowing into the Black Sea, and the Ceyhan River, flowing into the Mediterranean.

Surface and groundwater resources are fairly limited in the highly urbanized and industrialized western part of the country. Annual freshwater consumption is about 44 billion cubic metres, of which 74% is used for agriculture, 15% for domestic uses, and 11% towards industrial uses. Turkey is located in a semi-arid region of the world, and precipitation varies greatly in different seasons and areas.

Renewable internal freshwater resources — 227 billion m$^3$

Renewable internal freshwater resources per capita — 2,798 m$^3$

Turkey's mean annual precipitation is 643 millimetres, which amounts to 501 billion cubic metres of water. Of this, 274 billion cubic metres evaporate and 69 billion cubic metres leak into aquifers and thus are lost from the water budget. Of the total amount, 158 billion cubic metres are mixed with rivers and lakes as surface water. Whereas 7 billion cubic metres come from neighbouring countries and 41 billion cubic metres are retrieved from groundwater.

## CLIMATE CHANGE HAZARDS

Climate change can affect water resources through increasing temperatures, higher rates of evapotranspiration and altered rainfall patterns. This leads to changes in the water cycle, including decrease of snow and ice coverage, alterations of surface runoff and groundwater storage, as well as drought and flood occurrence. Reduced winter precipitation (especially in the western provinces), loss of surface waters, more frequent arid seasons, and degradation of soil are expected in Turkey, all of which are direct threats to water resources. Projections show an increase in the frequency, intensity and duration of extreme weather events such as drought in the south, southeast and west, as well as flooding, particularly in the western Black Sea region.

### KEY POINT RUNOFF

With surface water concentrating 80% of the country's water resources, runoff management and variability is a critical challenge for Turkey's water management. Precipitation and runoff exhibit decreasing trends over many regions in Turkey over the past four decades, however, runoff has increased in the mountainous regions in response to higher temperatures and melting snow.

Regional climate change simulations suggest a 10-30% decline in the annual surface runoff of the Aras, Euphrates, and Tigris basins and a slight increase of about 4% in the annual surface runoff of Coruh basin by the end of the present century. At the country level an average increase in surface runoff by approximately 10% and -2% is expected respectively under low and high emissions scenarios for the 2045-2055 period compared to 2015-2025. If temperatures rise by 1.5°C, 2°C or 4°C, 1%, 2.1% or 9% of the area of the country will likely experience an increase in runoff, while 5%, 12.7% or 27% of the surface of the country will likely experience a decrease in runoff, respectively.

2050

Changes in annual runoff
% of change

-2.4%

+9.8%

2050

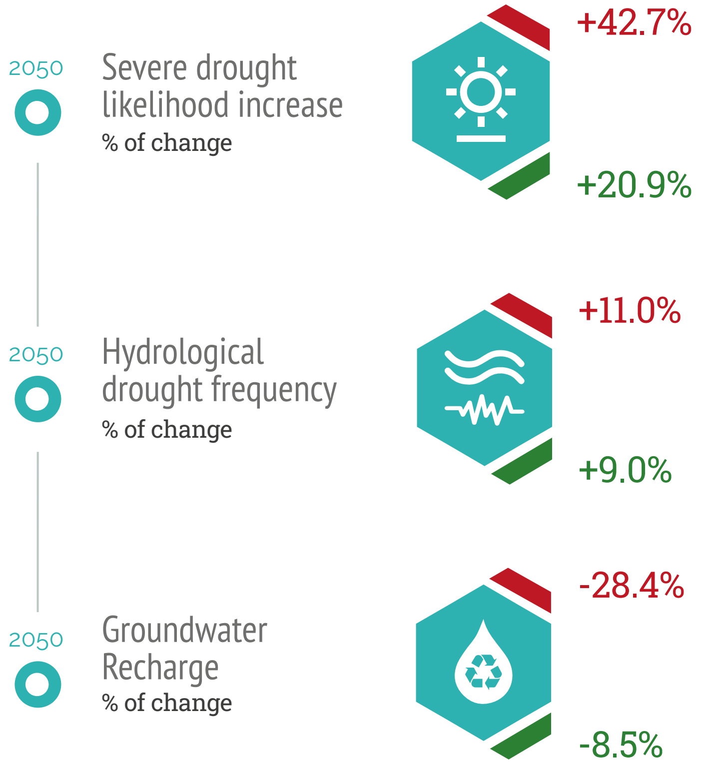
Runoff increase
% of area

+9.0%

+1.0%

## KEY POINT DROUGHTS

Drought is a major concern in parts of Turkey where rainfall is highly variable and low. The combination of rainfall deficiency with other climatic factors and in particular high temperature creates serious risk of drought in the central and south-eastern parts of the country where agriculture is the main economic sector. Impact of drought in the low and variable rainfall regions of the country can be widespread, affecting water supply for agriculture, industry and the population. Drought risk is distributed unevenly in Turkey, with some areas experiencing higher risk, such as the coastal and central regions. Major droughts in the country have been recorded in 2007-2008 and 2013-2014. Particularly severe drought conditions are expected in the Western Mediterranean and Aegean Regions, although other regions of the country will also face more frequent, intense and long lasting droughts.



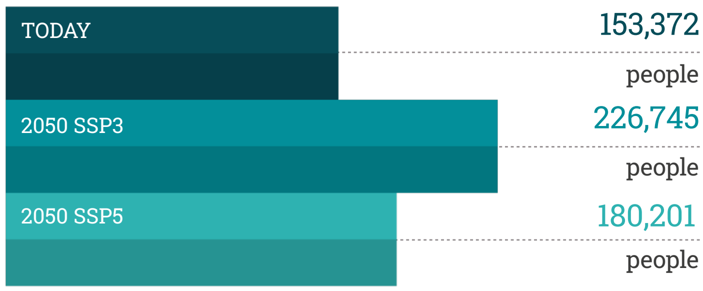

## KEY POINT GROUNDWATER

About 18% of the total water resource potential of Turkey is made up of groundwater resources, mainly occurring in alluvial and karstic aquifers: a significant portion of the streamflow of major rivers is supplied by groundwater through springs and baseflow. Large coastal plains and deltas, grabens and pull-apart basins constitute the major alluvial aquifers. Turkey has faced some water mismanagement problems whose consequences are observable in terms of the decline of groundwater levels, reduced spring and streamflows, desiccation of lakes and wetlands, and loss of ecosystems. While a reduction in rainfall in western Turkey and changes in the distribution of rainfall in other parts of the country will affect groundwater availability and recharge, there is uncertainty about the geographical distribution of these changes. At the country level, a -15.9%, -17.6% and -20.3% decrease of the annual groundwater recharge for the period 2045-2055 compared to the timeframe 2015-2025 is expected respectively under low, medium and high emissions scenarios.

## KEY POINT FLOODS

Nearly 30% of all the natural disasters in Turkey consist of flood events. Due to the diverse topography and geographic location of Turkey, flood hazards are observed both upstream of catchments as flash floods, and downstream of catchments as over-bank floods. More than 2,000 floods were recorded in the period between 1930 and 2020, causing 1,026 deaths, with about 1.5 million people affected. The number of damaging floods has also increased with the growing population. Floods concentrate in the summer season with a peak in July. Most of the floods and deaths occurred in the Black Sea region. Different regions may be affected differently by climate change. The Black Sea region is expected to experience an increase in flood risk under medium and high emissions scenarios of 100% to 300% by approximately 2050. On the country scale, changes in the amount of people exposed to floods are expected, with an increase from about 153,000 in the present day to 226,000 under SSP3 and 180,000 under SSP5 by 2050.

## POPULATION AFFECTED BY RIVER FLOODS

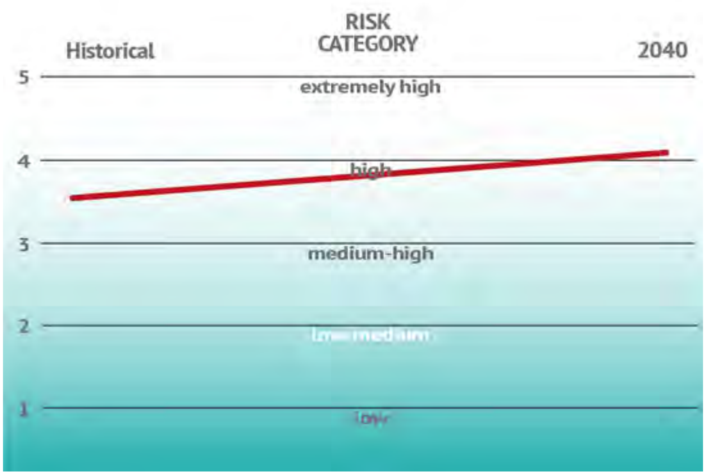



# RISK INDICATORS

The water stress index summarises current and future water related vulnerabilities and risks at the global level. Scores are based on the ratio of total water withdrawals, including agriculture, industrial and human consumption, to available renewable surface and groundwater supplies.

## WATER STRESS

Turkey's water stress level is considered high for the recent past (1960-2014 average), and it is expected to increase in the near future (2030-2050) based on climate change projections.



# TURKEY AGRICULTURE

## OVERVIEW

Turkey's climate varies widely with a combination of maritime and continental patterns shaping several agroclimatic regions: the Black Sea, the southern coastal Mediterranean, and the Aegean and Central Anatolia plateau.

Agricultural fields cover 35% of Turkish land. Wheat is the major staple food crop and is mostly grown in Central Anatolia, but also in Eastern Anatolia and Mediterranean regions. Other relevant cereals include oats and barley in central Anatolia, while maize an d rice are mostly cultivated in the Black Sea and Maramara regions.

Major cultivated industrial crops are sugarbeet, cotton and tobacco. Fruits and vegetables are also important to the Turkish economy with cultivation of grapes, olives, citrus, apricots, figs, hazelnuts, pistachios, melons, potatoes, etc. Agriculture adsorbs 84% of total water withdrawal, and only 20% of agricultural land is irrigated.

20 Mt
Wheat

17.4 Mt
Sugarbeet

7 Mt
Barley

5.7 Mt
Maize

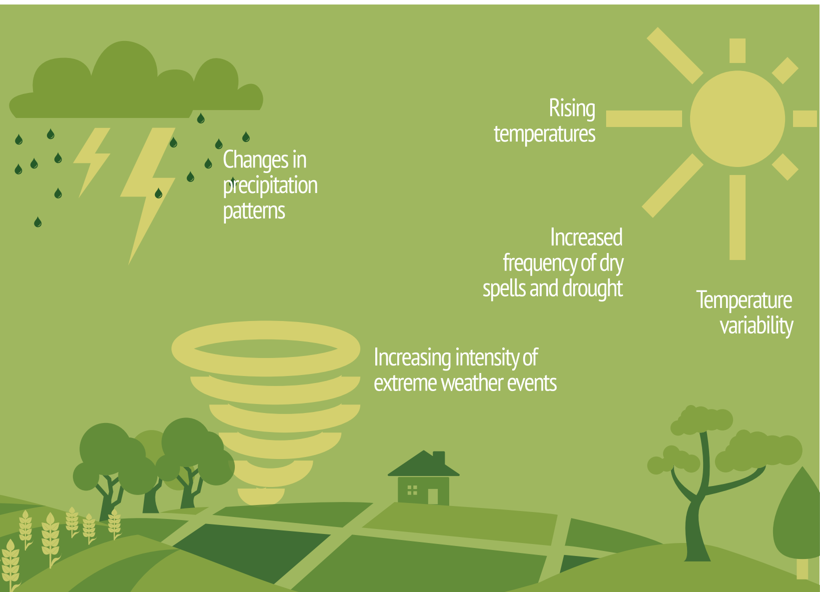
3.9 Mt
Grapes

1.5 Mt
Olives

| | Added Value of Agricultu-re, Forestry and Fishing | Share of Agriculture Value added in Total GDP | Agricultural land | Area Equipped for Irrigation |
|---|---|---|---|---|
| 2000 | 40,851 USD Million | 9.9 % | 26,379 Thousand HA | 4,745 Thousand HA |
| 2018 | 61,822 USD Million | 6.3 % | 23,185 Thousand HA | 5,215 Thousand HA |

## EXPECTED IMPACTS ON AGRICULTURE PRODUCTIVITY

Rising temperatures, reduction in average annual precipitation, and intensification of extreme events such as heat waves and drought, affect production variability with a tendency towards yield reduction for many cultivated species, accompanied by a probable decrease in food quality. Crops respond to increases in temperatures with changes in duration of the growing season, early appearance of phenological phases and potential shifts of cultivation areas toward higher latitudes and altitudes for better growing conditions. However, impacts vary significantly depending on the geographical area and specific crops in question.

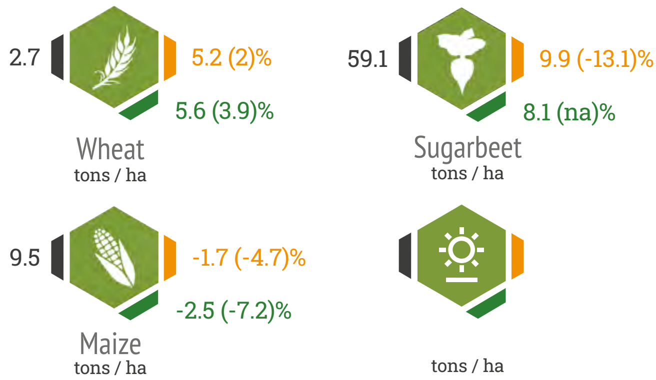


# CROP PRODUCTIVITY

Crop productivity refers to the harvested yield of a crop per unit of land area. It is strongly influenced by climate and other environmental and management factors.

Climate change is expected to have an impact on the productivity of several major crops, although this may in part be offset by the fertilizing effect of higher $CO_2$.

Impacts are estimated using a range of model projections based on low to high emission scenarios and reported as percentage changes between the 30-year average around the historical period and the 30-year average around 2050.




2050

**Productivity change with (without) the $CO_2$ fertilization effect. Estimates assume sufficient water and nutrient supplies, and do not include impacts of pests, diseases, or extreme events.**

## CHANGE IN WHEAT

− = +

## CHANGE IN MAIZE

− = +

It is estimated that Turkey will experience overall decreases of up to 25% in maize yield, although a localised increase may be seen in the Black Sea and Maramara regions. Under the combined effect of $CO_2$ fertilization and increasing temperatures, wheat yields are expected to increase overall, with some losses expected in the Mediterranean southern coastal region. Prolonged drought events may alter the stability of wheat production, particularly in the Central Anatolian provinces. Increasing temperatures will accelerate and shorten cereal phenological stages, reducing time for biomass accumulation and final yield. Hazelnut yield may decrease by up to 13% in the eastern Black Sea sub-region, while some increase can be expected in the Black Sea and Eastern Marmara regions. Hazelnut yield stability will be affected by frost risks associated with earlier blooming of hazelnut flowers.

# ADAPTATION IN AGRICULTURE AND WATER RESOURCES

Agriculture is the biggest water user in Turkey and is expected to be severely affected by climate change. Climate change may benefit some widely used crops. However, higher temperatures will generally require an increase in irrigation demand due to higher plant evapotranspiration. Currently, there is a widespread use of inefficient irrigation methods, which may considerably enhance water shortages in the future. Water use efficiency gains of up to 50% are possible by switching from gravity to drip irrigation or sprinkler feed systems.

## CHANGE IN WATER DEMAND

− = +

Agriculture
Water Demand
% of change


2050

Adaptation practices should aim to reduce cultivation of water-intensive crops in drought-prone areas, and management should focus on working under climate conditions of water scarcity.

# TURKEY FORESTS

## FORESTS IN TURKEY

Turkish forests are generally located in mountainous areas with high biodiversity values. In the north, deciduous forests prevail at moderate elevation, while conifers dominate at higher ones.

Being characterized by a diversified climate, the specific composition of forests varies according to the biogeographical zone, with typical forest formations of different regions.

### FORESTED AREA AND CARBON STORAGE

About 30% of Turkey is covered in forests, with a steadily growing trend over the last few decades. Recent estimates confirm that forests remove 90.19 million tons of $CO_2$ equivalent from the atmosphere, representing a crucial sink for Turkey's emissions reduction policies.

1990

20 Mln ha
Million hectares
Forested area

21 Tons/ha
Tons of Carbon per hectare
Carbon stock

2020

22 Mln ha
Million hectares
Forested area

87 Tons/ha
Tons of Carbon per hectare
Carbon stock

## FOREST PRODUCTIVITY

Forest productivity or Net Primary Production is the net carbon captured by plants. It is the difference between the carbon gained by Gross Primary Production - net photosynthesis measured at the ecosystem scale - and carbon released by plants' respiration. It is expressed per unit land area.

2050

Productivity anomaly
Tons of Carbon per hectare per year

+0.28

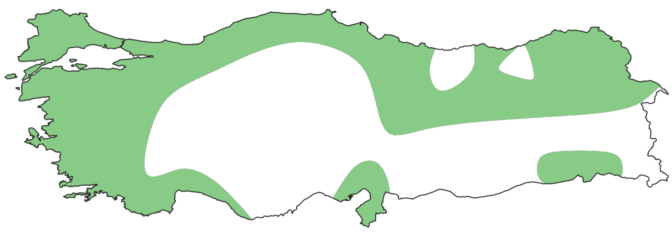
+0.31

Weak increase in western and northern Turkey

+ Fertilizing effect of increasing atmospheric $CO_2$, rising temperatures, and prolonged growing season promote production

No areas with an expected decrease in forest primary production

+ Increasing risk of drought stress due to modifications in the water regime reduce productivity



## KEY SPECIES UNDER CLIMATE CHANGE

REDUCTION
BEECH
Strong reduction of suitability range of Oriental beech (Northern Turkey)

LOW VULNERABILITY
CONIFERS
Southern conifers show less vulnerability

EXPANSION
MEDITERRANEAN
Mediterranean needleleaved evergreen types to expand northwards

VULNERABILITY
PINE
High vulnerability for Turkish pine in drier areas (South)

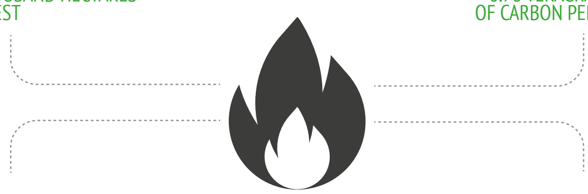
# FIRES IN TURKEY

Fire is a structural ecological process that provides several types of ecosystem services and impacts on socio-ecological systems, including human health, carbon budgets, and climate change. Changes in global fire activity are influenced by multiple factors such as land-cover change, policies, and climatic conditions. Fire also releases large quantities of greenhouse gases into the atmosphere, contributing to a vicious cycle.

During the last three decades, the total forest area affected by fire amounted to approximately 300 thousand hectares with 65.5 thousand fires occurring.

BURNING
300 THOUSAND HECTARES OF FOREST

EMITTING
0.78 TERAGRAMMES OF CARBON PER YEAR

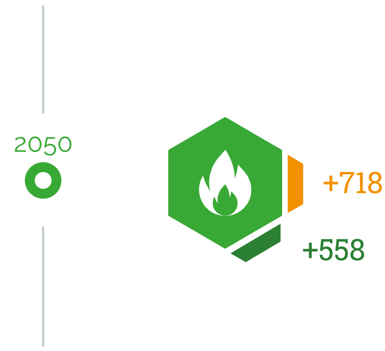


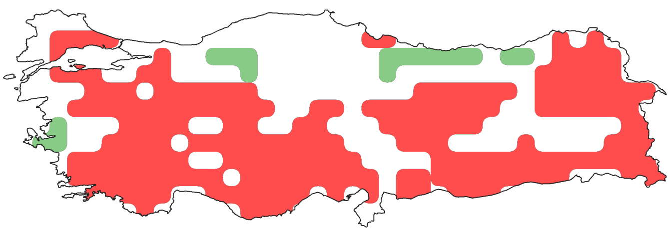
AGRICULTURE RELATED FIRE EMISSIONS CONTRIBUTED TO 73% OF TOTAL FIRE RELATED CARBON EMISSIONS

COSTING
8.6 MILLION USD IN FIRE DAMAGES TO FOREST RESOURCES

# FUTURE BURNED AREA

Under a low emissions scenario, the entire country might experience a generalized increase in fires in areas that are dominated by mediterranean shrublands and temperate forests. This trend is further emphasized under a medium emissions scenario.



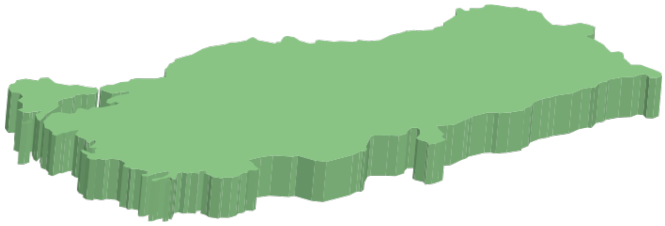



Decrease in burned areas for a low emissions scenario

Increase in burned areas for a low emissions scenario
+ Prolonged fire season across all of Turkey due to rising temperatures

# WHERE DO FIRES OCCUR?

Wildfires mostly affect mediterranean and temperate broadleaf forests.



Fire prone areas are located across the Mediterranean and Aegean shores.

## CASE STUDY: WILDFIRES

In Turkey, the year with most fires was 2013, while the worst fires since 1990 occurred in 1994, 2000, 2008, and 2021. Large wildfires are a challenging threat to the Wildland urban interface (WUI), the transition zone between houses and wild vegetation, as well as for tourism.

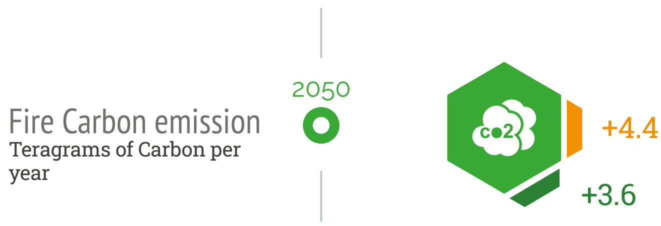
In 2008, a large forest fire occurred in Antalya, Turkey's most touristic province, burning for 5 consecutive days and affecting approximately 15,800 hectares of forest.

During the summer of 2021, Turkey had to deal with one of its most pronounced fire seasons. Over the course of a week more than 130 fires were reported mainly across the Mediterranean and Aegean coasts. The number of fires and the burned areas recorded during 2021 were around 104% and 450% greater than the respective averages for 2008 and 2020.

Strong relationships exist between fire activity, drought, high temperatures, low humidity and wind.

# FUTURE FIRE EMISSIONS

Fire emissions follow a similar spatial pattern to burned areas with a marked increase in mediterranean areas under a medium emissions scenario.



# TURKEY
# URBAN

## OVERVIEW

The rate of urbanization in Turkey in 2020 was 76.15% and is expected to reach 86% in 2050.

One quarter of the urban population lives in the agglomeration of Istanbul, and another 33% in urban areas with less than 300,000 inhabitants. Migration from rural areas is on-going and population growth is concentrated in urbanized areas.

Built up areas cover 1.55% of Turkey (12,098.87 square kilometers).

**Population in Urban Areas**

2020: 63,803,445

2050: 82,192,061

Graphs refer to data provided by United Nations, Department of Economic and Social Affairs, Population Division (2018). World Urbanization

**Urbanization Rate**

2020: 76.1%

2050: 86.0%

## OVERVIEW OF KEY CLIMATE IMPACTS IN URBAN AREAS

Major impacts from climate change for Turkish urban areas regard heat stress, flooding and droughts as well as flooding from heavy precipitation events and storm surges.

### HEATWAVES AND HEAT STRESS

Mean temperatures in Turkey are increasing, from 13.2°C for the period between 1971 and 2000, to 13.5°C for the period between 1981 and 2010. Heatwave related mortality has increased.

During three heatwaves in Istanbul in 2015, 2016, and 2017, heatwave related mortality increased by 11%, 6%, and 21%, respectively. Frequency and intensity of heatwaves is expected to increase under future climate change, with heatwave frequency to double under a high emissions scenario, by 2050.

**2050 – Cooling Degree Days** (% of change)

+51.0%

+22.0%

+16.0%

**2050 – Heatwave frequency** (% of change)

+99.6%

+68.7%

+40.8%

**2050 – Heatwave duration** (% of time)

+4,242%

+774%

+284%

## RAPID URBANIZATION

In Turkey, rapid urbanization is transforming agricultural areas with impervious surfaces and increases population densities at the urban peripheries. The results are decreasing shares of permeable and vegetated surfaces in the urban areas and fringes.

Under heatwaves, differences between urban impermeabilized areas and the surrounding areas are up to 6°C. High temperatures in urban areas worsen impacts from high levels of air pollution. In 2017, the entire Turkish population was exposed to pollution levels exceeding WHO guideline values for PM2.5.

2017

Population exposed to air pollution

100.0%

## COASTAL FLOODING

Population densities in Turkish coastal cities are increasing, due to intense migration, thus enhancing the exposure of assets and people in areas vulnerable to increasingly frequent flooding and erosion. Sea level rise will put growing cities on the Mediterranean coast, as well as tourist attractions in Istanbul, at risk.

Projected sea level rise

2050

0.23 m

0.18 m

2100

0.77 m

0.38 m

## FLOODING

Changing precipitation patterns are already causing both water scarcity and flash floods in Turkish cities. Due to an increasing rate of soil sealing both in cities and throughout the country, water is prevented from infiltrating into the ground and causes increasing run-off and accumulation of water masses in the lower parts of cities.

Flooding following intense precipitation events lead to loss of life and property in metropolitan cities such as Istanbul, Ankara, Izmir, as well as in smaller cities and rural centres. Precipitation is expected to decrease and become more variable with a potential increase in extreme events both under the form of intense precipitation and drought periods. Consequently, water scarcity will represent a major challenge for urban areas.

2050

Runoff increase
% of area

+9%

+2%

+1%

## SURFACE SEALING AND FLOODS

Heavy precipitation in cities is problematic due to the high level of sealed surfaces. Soil sealing increases run off and reduces the amount of water absorbed by soil. Where there are large amounts of impervious ground cover, short duration extreme rainfall events can lead to increased flooding, even resulting in flash floods.

## URBAN GROWTH AND LAND USE CHANGE

Urban growth will further increase flood risk, as soil sealing reduces natural drainage capacities of urban soils, accelerating and increasing run off.

Due to future intense urbanization in the urban area of Istanbul, the extent of potentially flooded surfaces may almost double: from 2.4 square kilometers to as much as 4.3 square kilometers for the same event, under intense future urbanization.

2010

% of urban population
Population living in slums

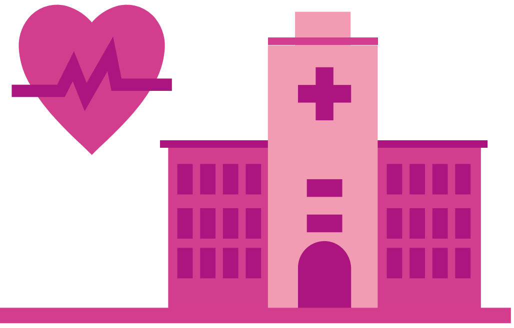
8.6%

2018

% of total population
Urban population living in areas where elevation is below 5 meters

1.2%

# TURKEY
# HEALTH

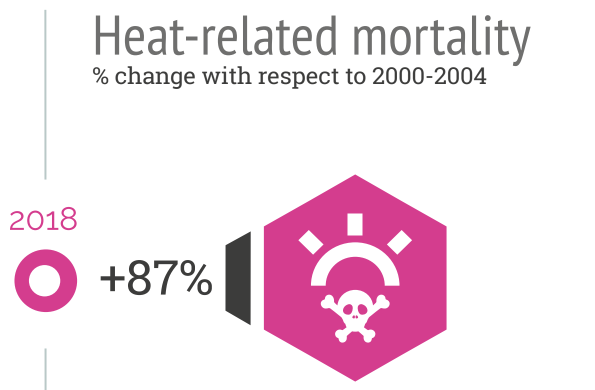


## OVERVIEW

Turkey is highly sensitive to the health impacts of climate change, including extreme weather-related deaths, increased morbidity from cardiovascular diseases, and dengue and malaria mortality. It is estimated that the intensity, frequency, duration, and geographical extent of heatwaves will increase due to climate change which will likely increase the frequency and intensity of heatwaves, leading to increased mortality among the elderly and children. Warming, changing rainfall patterns, and increase in frequency and intensity of extreme events, such as heatwaves and floods, will also likely increase the spread of vector-borne diseases, including malaria, Crimean-Congo Haemorrhagic Fever (CCHF), sandfly fever, leishmaniasis, and dengue.

### HEAT RELATED MORTALITY

In 2018, there was an 87% increase in heat-related deaths in Turkey, compared to the 2000-2004 baseline.

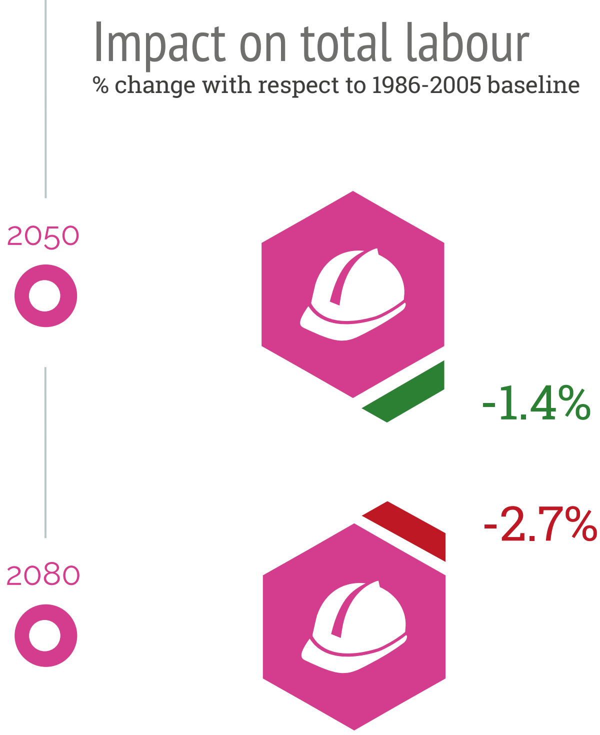



### IMPACTS ON LABOUR

Labour is directly affected by changes in environmental conditions. Warming affects both the number of hours worked (labour supply) and on the productivity of workers during their working hours (labour productivity). Both labour supply and productivity are projected to decrease under future climate change in most parts of the world, and particularly in tropical regions.

Parts of sub-Saharan Africa, south Asia, and southeast Asia are at highest risk under future warming scenarios. Future climate change will reduce global total labour in the low-exposure sectors by 18 percentage points and by24.8 percentage points in the high-exposure sectors under a 3.0°C warming scenario

Total labour in Turkey is expected to decline by 1.4% under a low emissions scenario, and by 2.7% under a medium emissions scenario.



## CLIMATE CHANGE AND DENGUE

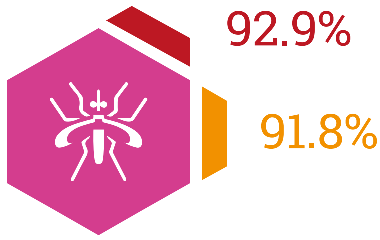
Dengue has spread throughout the tropical world over the past 60 years and now affects over half the world's population. Globally, vectorial capacity for both dengue vectors (A. aegypti and A. albopictus) has been rising steadily since the 1980s, with nine of the ten highest years occurring since 2000.

Climatic stressors are one important driver of the current distribution and incidence of dengue. Climate change is likely to expand the geographical distribution and suitability of several vector-borne human infectious diseases including dengue. The risk of dengue transmission is increased by warming climates, as the growth and development of mosquitoes are significantly influenced by temperature, precipitation, and humidity.

2050

### Dengue suitability

% of population at risk




## CLIMATE CHANGE AND ZIKA

Zika virus has spread to at least 49 countries and territories since 2013. Climate change impacts on transmission suitability risk have increased over the years and future warming over 1.3 billion additional people could face suitable transmission temperatures for Zika by 2050.

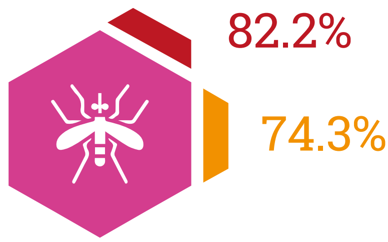
## DENGUE AND ZIKA: POPULATION AT RISK

Under a medium emissions scenario, 91.8% of the population will be at risk of transmission-suitable mean temperature for dengue by 2050, whereas 92.9% will be at risk under a high emissions scenario. In the case of Zika, 74.3% of the population will be at risk by 2050 with medium emissions, whereas 82.2% will be at risk with high emissions.

2050

### Zika suitability

% of population at risk



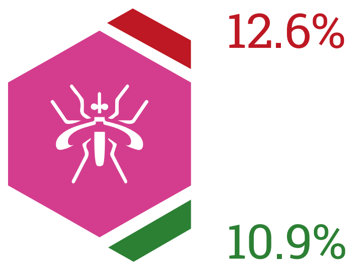

## CLIMATE CHANGE AND MALARIA

10.9% of the Turkish population will be at risk of malaria under a low emissions scenario in 2050, whereas 12.6% will be at risk under a high emissions scenario.

2050

### Malaria suitability

% of population at risk




## POLLUTION AND PREMATURE MORTALITY

57,779 people died prematurely due to exposure to PM2.5 in Turkey in 2018, compared to 28,924 in 2010.

# TURKEY
# ENERGY

## ENERGY SYSTEM IN A NUTSHELL

Turkey's strong and sustained economic growth over the past decades led to a strong increase in energy demand, resulting in heavy import dependency for oil and gas.

Turkey reacted by diversifying its oil and gas providers, and its overall energy mix. This led to a strong expansion of renewables, the commissioning of its first nuclear plant by 2023, and strong improvements in energy efficiency. Turkey has one of the lowest energy intensities of GDP in the world.

0.06
ktoe/US$
Energy intensity

2.2%
AC Share in electricity consumption

72%
Import dependence ratio

## CLIMATE CHANGE TODAY

### INCREASING TEMPERATURES

Temperatures in Turkey have been increasing at a yearly rate of 0.0665°C since 1994, which is double the world average, and has resulted in a sharp increase in cooling needs.

### EXTREME EVENTS

Extreme weather conditions have already resulted in increased droughts, floods, forest fires and heatwaves, threatening the energy sector's operations and infrastructure.

## ENERGY SUPPLY

Fossil fuels dominate the energy mix: 29.3% oil, 28.6% coal, 25.2% natural gas in 2019. There is no nuclear generation yet, but a plant has been commissioned for 2023. While biofuels halved since the 90's, to a 2.2% share, wind and solar underwent a 30-fold expansion, and now cover 9.4% of total primary energy supply, whereas hydropower (5.2%) also saw an almost five-fold increase.


## ENERGY DEMAND

In Turkey, energy is used mainly by the industrial sector (about 36% of final demand in 2018, including 4.5% for non-energy use), transport (27%) and residential (20%), followed by commercial use (12%) and agriculture and fishing (4.4%). Air conditioning's contribution to residential electricity demand is still very low (2.2% in 2017).

# FUTURE ENERGY DEMAND

Turkey has a variety of climates, ranging from Mediterranean on the west and southern coast, to alpine in the central-east mountains making both heating and cooling needs relevant. Overall, the increase in cooling needs will prevail, resulting in an increase in electricity demand of 477.7 PJ (or 119 million KWh) by 2050 under a medium emissions scenario. Summer demand peak may arise in the presence of heatwaves.

Net change in energy demand due to changes in DD/CDD
Billion KWh

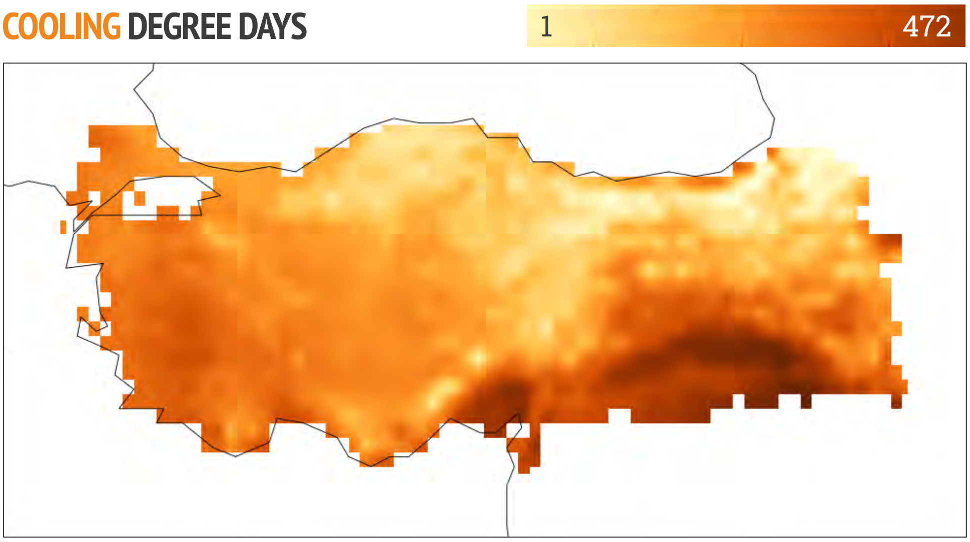
2050

+ 118.8

## COOLING NEEDS

Highest increase in cooling needs in the southern regions, including the highly touristic Mediterranean coast. Significant increases in the west, with Istanbul showing higher increases than Ankara.

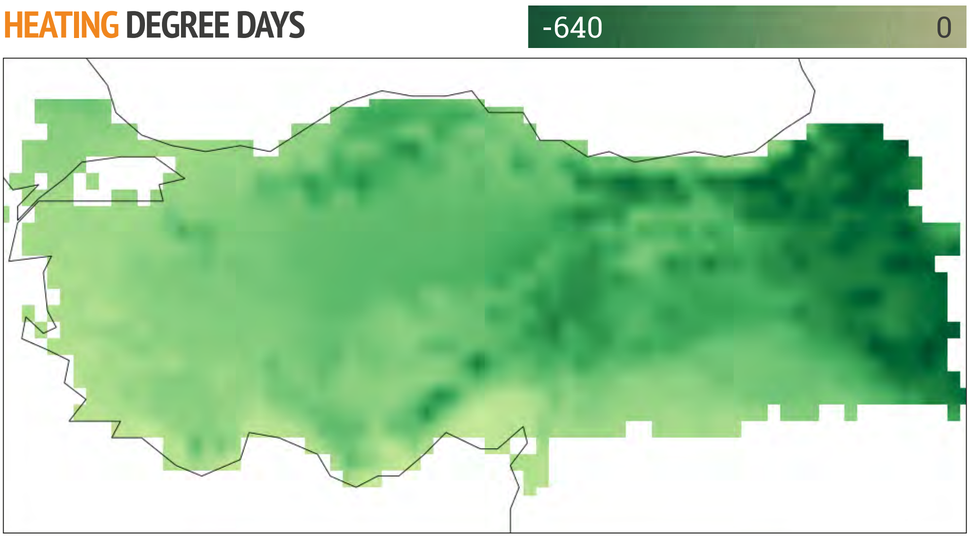
### COOLING DEGREE DAYS




## HEATING NEEDS

Largest drops in heating needs are expected in the traditionally coldest parts of the country (mountain areas on the eastern border and Black Sea region). Significant decrease in heating degree days are expected all over Turkey.

### HEATING DEGREE DAYS




# FUTURE ENERGY SUPPLY

The future configuration of the Turkish energy mix is likely to be determined by the evolution of energy policies and hence is outside the scope of this report. Turkey's push to diversify energy sources, beside spurring the current expansion of renewables and opening to nuclear generation, has kept a neutral and pragmatic stance towards all energy sources, and has not yet resulted into a long-term decarbonization commitment; hence there is no evidence to support a substantial shift in the current relative relevance of the various components of the energy mix and their related vulnerabilities.

Change in Hydropower generation
% of change

2050

-4.62%

-3.53%

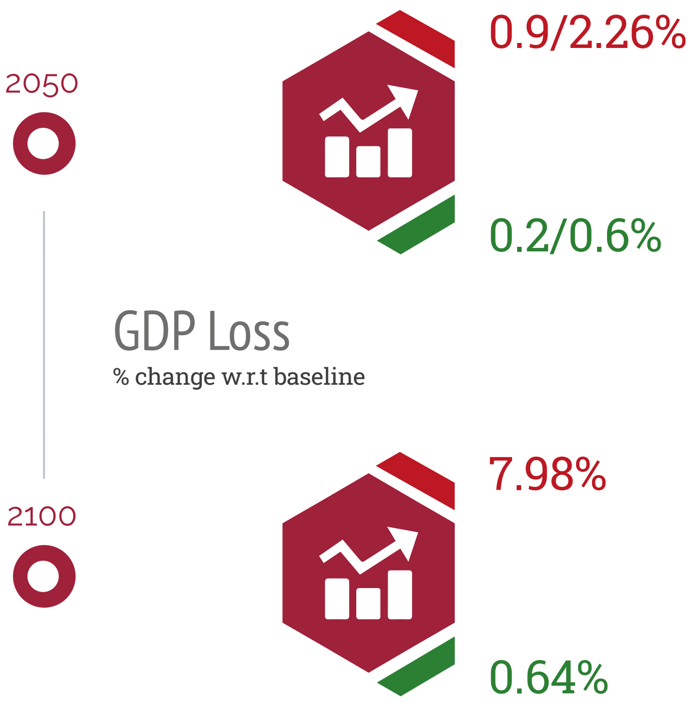
# EXPECTED IMPACTS OF CLIMATE CHANGE

There are no quantitative projections of the impacts of climate change on Turkey's energy sector. Qualitatively, the main concerns are for the decreasing output of hydropower, for the impact of droughts on the thermal efficiency of thermal power plants, for the impacts of heatwaves on the electricity transmission systems, and the impact of increased frequency of extreme events.

# TURKEY ECONOMY

## OVERVIEW

Turkey ranks 18th in terms of GDP in the G20 group. The COVID 19 crisis had a small impact when compared to other G20 countries. In 2020 real GDP grew by 1.8%. In 2021 growth continued and real GDP grew by 6%.




## IMPACTS ON GDP

The projected macroeconomic impact of climate change on Turkey's economy varies according to the emission scenarios considered, the time horizon, the direct impacts covered, and the specificities of the estimation method used.

It ranges from a virtually unchanged situation (0.07% loss) under a low emissions scenario in 2030, to almost an 8% GDP loss under a high emissions scenario by the end of the century.

## SECTORAL ECONOMIC IMPACTS

### IMPACTS ON AGRICULTURE

Until a few decades ago, agriculture was traditionally a major contributor to Turkish GDP. It ha declined steadily from 65% of GDP in 1960 to 6.9% in 2019. An important source of vulnerability for Turkish agriculture is its dependence on precipitation to satisfy its water needs. About three fourths of water consumption in Turkey is used for irrigation (making agriculture the primary water user); however, in 2016, only 31.4% of the cultivated land could be irrigated.

The direct impact of climate change (medium emissions scenario) on agriculture will result in a virtually constant sector's added value (+0.36%) up to 2035, a slight decline between 2035 and 2060 (-1.69%) and a more sustained decline in the last four decades of the century (-5.12%).

The expected decline in precipitations will lower the income of farmers working on rain-fed land by 0.71% by 2060 and by 1.23% by the end of the century, while slightly raising those of the farmers working on irrigated land. The Turkish agri-food industry would undergo similar if smaller impacts, with a virtually constant added value (+0.1%) up to 2035, a slight decline between 2035 and 2060 (-1.14%) and a more sustained decline in the last four decades of the century (-3.32%).

There will be noticeable differences across provinces, with the southern and west-central ones suffering the most in terms of agricultural impacts and the Bosphorus area and north-central provinces taking the hardest hit in terms of agri-food production.

Impacts on livestock have not been assessed yet in economic terms but significant adverse effects are expected from heatwaves as well as from increased occurrence of droughts, floods, and landslides.

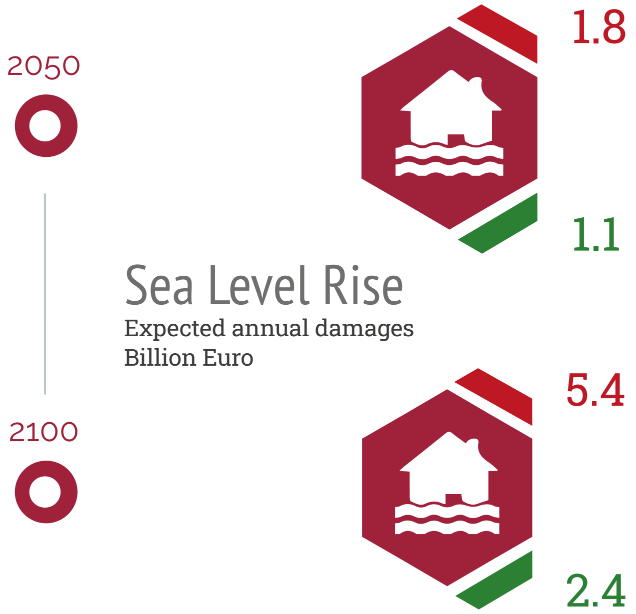
### IMPACTS ON ENERGY

As with all other economic sectors, energy supply and energy networks in Turkey will undergo more intense stress from extreme weather events, in particular those related to the water-energy nexus due to floods and droughts.

Economic impacts of shifts in household and firm energy demand (see chapter on energy) are difficult to predict and will mostly lead to redistribution effects. In the case of Turkey, the magnitude of the increase in demand for cooling is expected to exceed by far the one of the decrease in heating demand, hence a significant increase in energy bills is expected.

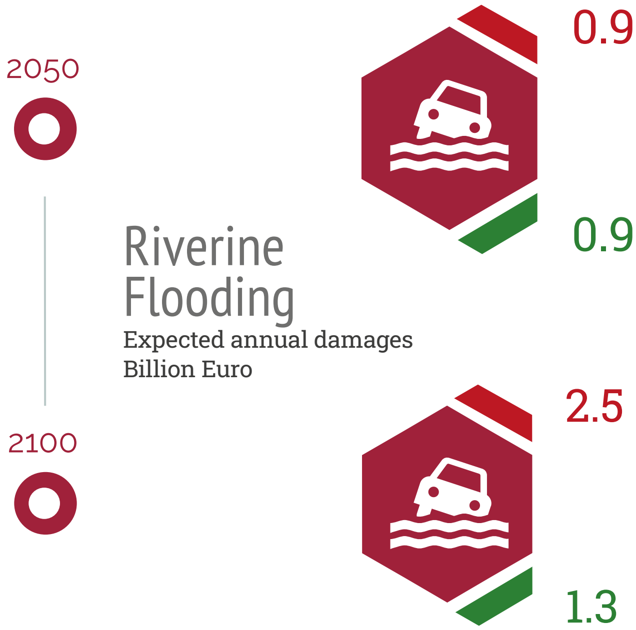
## SEA LEVEL RISE DAMAGES

Sea level rise can pose non-marginal threats to Turkish coastal infrastructure. Without improvements in the current level of coastal protection the country may experience physical asset losses amounting to 1.1 and 1.8 billion EUR by mid century and to 2.4 and 5.4 billion EUR by the end of the century in low and high emission scenarios, respectively.




## RIVER FLOODING DAMAGES

Riverine floods are only slightly less concerning. Inland infrastructure may be subject to direct annual losses of 0.9 billion EUR by 2050 and ranging between the 1.3 billion EUR for a low emissions scenario and 2.5 billion EUR for a high emissions scenario in the second half of the century.




## IMPACTS ON FORESTRY AND FISHERY

Fisheries are expected to suffer negative impacts as well, mainly due to the transition of marine ecosystems along Turkey's coasts towards patterns typical of warmer waters. This transition is already observed and expected to intensify in the future, with tropical species moving into the Mediterranean Sea from the Red Sea and Mediterranean species, in turn, moving into the Black Sea. Such a transition has already resulted in anchovies becoming rare along the Turkish coast on the Black Sea, causing their price to soar by up to 300%.

## IMPACTS ON TOURISM

Before the COVID 19 crisis, tourism used to be a very dynamic and fast-growing economic sector in Turkey, accounting for almost 4% of GDP and directly employing 2.2 million people, or 7% of the workforce, in 2018. Almost 52% of total service exports in 2018 came from travel, and 45.8 million international tourists arrived in Turkey in the same year, generating 142.4 TRY (25.6 EUR) billion in revenues.

As with other Mediterranean destinations, Turkey is vulnerable in terms of suitability of climate conditions for tourist activities, particularly for beach-and-sand tourism and urban tourism.

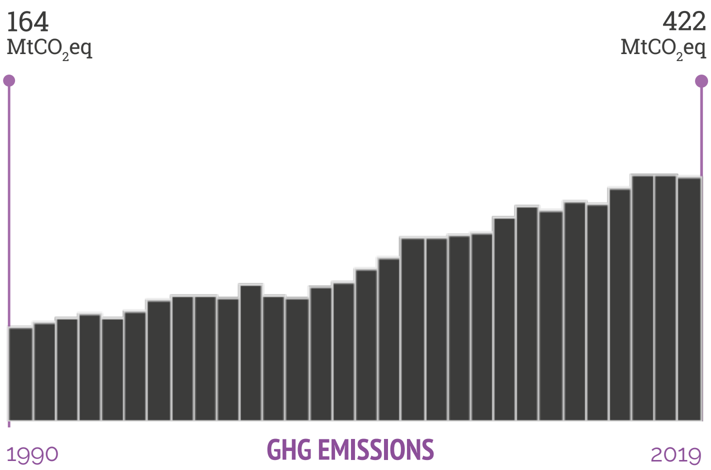
Changing climatic conditions adversely affecting tourism activity might lead, by the end of the century, to overall Turkish GDP losses of 0.89% in case of a 1°C increase in average global temperatures, 2.82% in case of a 2°C increase, and 5.37% in case of a 3°C increase.

Southern beach destinations such as Antalya will be hit the worst, while Istanbul, which can count on a wider range of cultural and historical attractions and whose climatic comfort conditions will not be so severely worsened by climate change, will face only a moderate loss in visitors in percentage terms compared to a no climate change counterfactual scenario.

# TURKEY
# POLICY

## OVERVIEW

Turkey is the world's 20th economy in terms of nominal GDP. It is 16th for GHG emissions among G20 countries. The emissions trend is steadily increasing.




## INTERNATIONAL COMMITMENTS

Turkey officially ratified the Paris Agreement in 2021. The Turkish NDC commits to reduce GHG emissions by 21% with reference to a specific business-as-usual scenario by 2030.

### CLIMATE POLICY COMMITMENTS CHRONOLOGY

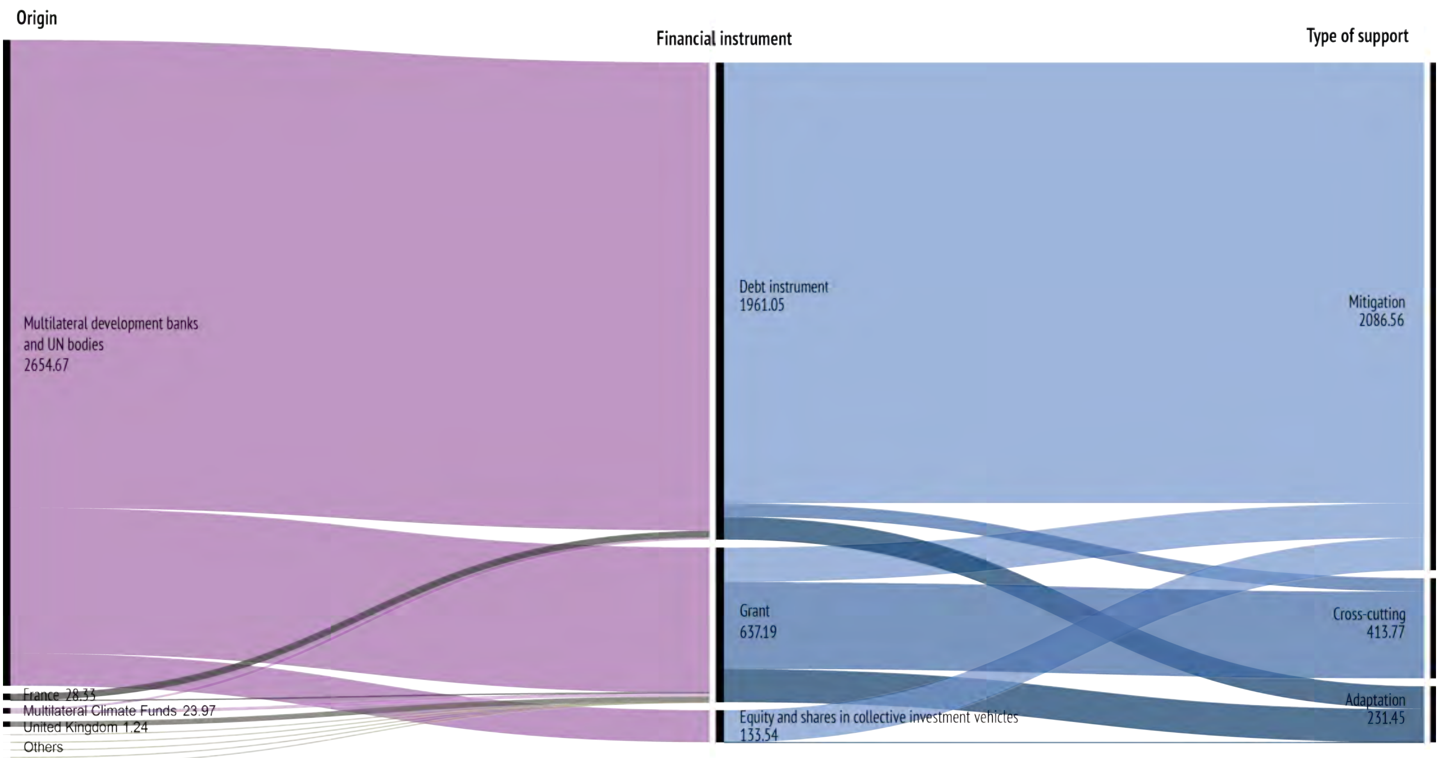
2009 — **KYOTO PROTOCOL - 1ST PERIOD**
No target

2021 — **PARIS AGREEMENT - 1ST NDC**
21% GHG reduction by 2030, with reference to a specific business-as-usual scenario

**PARIS AGREEMENT - NDC UPDATE**
No further update

## INTERNATIONAL CLIMATE FINANCE ASSISTANCE

The diagram is based on OECD DAC data on climate-related development finance and it shows that Turkey ireceived 2.7 billion USD in 2017-2018, mainly from multilateral financial institutions and in the form of debt instruments.



## SUSTAINABLE RECOVERY POLICY

In 2020, Turkey spent 2.63 billion USD to recover from the crisis generated by the Covid-19 pandemic. According to the Global Recovery Observatory, the full amount can be considered sustainable, because it targets clean transports

| Total Spending | Recovery Spending | Green Spending |
|---|---|---|
| 74.55 billion $ | 2.63 billion $ | 2.63 billion $ |

## DOMESTIC ADAPTATION POLICY

Turkey developed a framework for adaptation consisting in an Adaptation Strategy with an integrated Adaptation Action Plan (2011). In this framework, sub-national entities are designated to develop their own adaptation plans.

- Domestic Adaptation Policy
  - ○ Inclusion of Adaptation in NDCs
  - ○ Integrated Adaptation & Mitigation Policy
  - ● Dedicated Adaptation Strategy
  - ● Dedicated Adaptation Plan
- Subordinate Adaptation Policies
  - ○ Sectoral Adaptation Plans
  - ● Subnational Adaptation Plans

○ Policy not in place ● Active policy

## ADAPTATION POLICY HIGHLIGHTS

### TRANSNATIONAL INITIATIVES

#### Strengthening Multi-Hazard Early Warning Systems and Risk Assessment in the Western Balkans and Turkey

The project aims to reduce the vulnerability of Albania, Bosnia and Herzegovina, Croatia, the Northern Macedonia, Montenegro, Serbia, Kosovo, and Turkey to natural hazards such as drought, flood and forest fires

### NATIONAL INITIATIVES

#### Enhancing Required Joint Efforts on Climate Action Project

Technical assistance is provided on capacity building through an extensive training programme. Effective communication with climate-related stakeholders, and awareness raising activities are conducted and local climate change actions are realised through a grant scheme of 38 projects.

#### Strategic plan for climate change adaptation of forestry

The Plan aims at enhancing climate adaptation actions to assist the forestry sector to become more resilient by suggesting 9 strategies and 51 respective actions

### SUBNATIONAL INITIATIVES

#### Istanbul Climate Change Action Plan

The plan aims at enhancing resilience of the city's ecosystem, social structure and economy against climate change and reduce greenhouse gas emissions.

#### Bursa Sustainable Energy and Climate Change Adaptation Plan

The plan outlines the measures to reduce direct urban greenhouse gas emissions and actions to address urban heat island effect, water management, public health, green areas, biodiversity, and corridors.

## ENERGY TRANSITION

Turkey ranks in the middle of the ranking for what regards the Energy Transition indicator. Of significance is the positive performance in the Renewables sector, thanks in particular to the role of hydropower and geothermal in the electricity mix, while on the contrary high levels of Emissions are determined by the still relevant role of coal in the electricity mix, by an energy-intensive industrial sector and by high levels of air pollution in the country.

Fossil fuels are still a relevant component of Turkey's energy mix. When it comes to Electrification, Turkey ranks immediately below the group of best performers, thanks in particular to good quality services in this domain.

| | G20 Average | Country |
|---|---|---|
| Energy Transition | 58.7 | 58.7 |
| Fossil Fuels | 45.3 | 45.7 |
| Renewables | 19.7 | 23.4 |
| Efficiency | 84.9 | 85.1 |
| Electrification | 70.8 | 70.7 |
| Emissions | 72.9 | 68.7 |

G20 AVERAGE
COUNTRY

Only actively pursuing an energy transition based on decarbonization and electrification – from policy and regulation, to health and education – will enable countries to benefit the most from future opportunities and fight climate change whilst ensuring an equitable distribution of wealth.

The Energy Transition indicators were developed by Enel Foundation in cooperation with SACE, and provide a retrospective analysis based on historical data.