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


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
**OVERVIEW**

The USA has several climates due to its large size and geographical complexity, including mountains and deserts. The predominant climate is continental, with cold winters and hot summers, the duration of which varies according to latitude and distance from the sea. Other climates exist throughout the country, such as alpine in mountainous areas, subarctic in Alaska, tropical in Florida, Mediterranean along the west coast, and desert in the southwest.

**TEMPERATURE**

The temperature regime in the USA varies from region to region. In general, temperatures drop from the East Coast to the West Coast depending on latitude and other climatic factors which define climate types.

**MEAN TEMPERATURE**

Celsius degrees / Over 1991-2020

**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.

**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.
The precipitation regime in the USA varies from region to region due to the country’s size and geographical complexity. The eastern part of the contiguous USA, east of the 98th meridian, the Pacific Northwest Mountains, the Willamette Valley, and the Sierra Nevada are the wettest parts of the country. The driest areas are the desert Southwest, the Great Basin, the valleys of north-eastern Arizona, eastern Utah and central Wyoming. Increased warming in urban heat islands leads to increased precipitation downwind of cities.

**Mean Precipitation**

<table>
<thead>
<tr>
<th>Precipitation (mm/year)</th>
<th>73</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over 1991-2020</td>
<td>7,209</td>
</tr>
</tbody>
</table>

**Precipitation Trend**

Precipitation anomalies over the last 60 years with respect to the annual mean of 711 mm/year in the United States during the 1961-1990 period.

**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.

**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.
OCEAN IN UNITED STATES
The US marine exclusive economic zone (EEZ) comprises a wide range of environmental conditions, from the cold waters surrounding Alaska to the subtropical ecosystem of the southern coasts. Coastal systems can be divided into three main areas: Alaskan, Atlantic and Pacific marine regions.

CURRENT CLIMATE CONDITIONS
Mean sea surface temperatures reflects the different climate regimes over the wide EEZ domain.

Surf temperature trend indicates high warming rates in the colder marine regions, with values up to 0.8°C/decade.

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 in 2100 close to +5°C under a high emissions scenario.

Seawater surface pH becomes more acidic in all scenarios, closely reflecting rising atmospheric CO₂ concentrations, and only a low emissions scenario leads to a stable condition by 2100.
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 temperature 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.
Global warming will likely exacerbate the issue of storm surges and high waves, both through sea level rise and an intensification in the frequency and severity of tropical storms. The balance of these two factors will depend largely on location. For example, in New York the impact of future sea level rise on the frequency of extreme water level events will have a much larger effect than any changes in the intensity of tropical storms.

Waves and storms present a particularly strong threat to the Atlantic coast of the USA, with large hurricanes capable of causing significant damage (such as hurricane Harvey in 2017 and Katrina in 2005). However, the potential for high energy waves to cause continuous erosion and environmental damage exists throughout the coastal regions of the country, particularly in low-lying areas such as in Florida.

Global warming will likely exacerbate the issue of storm surges and high waves, both through sea level rise and an intensification in the frequency and severity of tropical storms. The balance of these two factors will depend largely on location. For example, in New York the impact of future sea level rise on the frequency of extreme water level events will have a much larger effect than any changes in the intensity of tropical storms.
**VULNERABILITY AND RISK**

By 2010, 39% of the USAs population was living in coastal areas, and that number is projected to continue to increase. This represents a large number of people at risk from the coastal impacts of climate change. Over 13 million people live on land that is projected to be flooded by 2100 under a high emissions scenario. Beyond the direct impacts that this would have on urbanized areas and the local population, this could also have knock-on effects by driving migration inland. Coastal biodiversity and species distribution are also prone to the negative impacts of climate change, with sea level-driven habitat loss posing a major threat.

Significant changes would be experienced with sea level rise alone, not to mention the more frequent extreme flooding events and their impacts on infrastructure and the natural environment, particularly on the East Coast where the low lying land is more vulnerable to coastal inundation and erosion. The economic impacts could be severe, for example in the Houston-Galveston area which is a major economic and productive centre on the Gulf Coast and which is particularly vulnerable to storm surges and flooding events. Under a medium emissions scenario, the total population exposed to the annual coastal flood level is expected to increase from 760,000 to 1.1 million by 2050.

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**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.

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**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.
Increasing temperatures, which are likely to impact the entire USA, may result in lower surface runoff as a consequence of increasing evapotranspiration in large areas, possibly counterbalancing the effects of increasing rainfall. This is likely in areas such as parts of the Colorado River basin.

On a country scale, an increase in surface runoff by an average of 7.91% under a low emissions scenario, and 8.21% under a high emissions scenario, is expected for the 2045-2055 period compared to 2015-2025.

If temperatures rise by 1.5°C, 2°C and 4°C, then 2%, 5.4% and 16% of the country will likely experience an increase in runoff, whereas 4%, 12.3% and 39% of the country will likely experience a decrease in runoff for the same temperature changes.

Climate change can affect water resources due to 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 in surface runoff and groundwater storage, as well as drought and flood occurrence. Projected rainfall patterns show a possible decrease in water availability mainly in the west and southwest of the country, including the Colorado River basin, and changes in snowfall and melting patterns which may affect water availability and cycles. The Great Plains and the Mississippi River, may also experience changes in water availability from snow melt and increasing intensities of rainfall events.

The USA is a water-rich country in terms of water resources per capita. However, it also faces problems of uneven distribution. The industrial sector uses the largest share of water, with 46% of the total, followed by agriculture with 41%, and domestic use with 13%.

Many areas of the USA, and the western states in particular, face periodic water shortages. The amount of water available in these areas is limited and demand will continue to rise as population grows. Many areas in the west have experienced less rain over the past 50 years, as well as increases in the severity and length of droughts. This is causing particular concern in the south-west of the USA.

Climate change affects water resources, leading to changes in the water cycle that include decreased snow and ice coverage, alterations in surface runoff and groundwater storage, as well as changes in drought and flood occurrence. Projected rainfall patterns show a possible decrease in water availability mainly in the west and southwest of the country, including the Colorado River basin, and changes in snowfall and melting patterns which may affect water availability and cycles. The Great Plains and the Mississippi River may also experience changes in water availability from snow melt and increasing intensities of rainfall events.

Changes in annual runoff
% of change

Runoff increase
% of area

<table>
<thead>
<tr>
<th>Year</th>
<th>Changes in annual runoff</th>
<th>Runoff increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>2050</td>
<td>+8.3%</td>
<td>+16.0%</td>
</tr>
<tr>
<td></td>
<td>+7.9%</td>
<td>+2.0%</td>
</tr>
</tbody>
</table>

This trend has been most pronounced in the north-east, Midwest, and upper Great Plains, where the amount of rain falling during the most intense 1% of storms has increased by more than 30%.

The USA is a water-rich country in terms of water resources per capita. However, it also faces problems of uneven distribution. The industrial sector uses the largest share of water, with 46% of the total, followed by agriculture with 41%, and domestic use with 13%. Shifts in rainfall quantities during storms provide evidence that the water cycle is already changing. Over the past 50 years, the amount of rain falling during very heavy precipitation events has increased for most of the USA.

This trend has been most pronounced in the north-east, Midwest, and upper Great Plains, where the amount of rain falling during the most intense 1% of storms has increased by more than 30%.

Climate change affects water resources, leading to changes in the water cycle that include decreased snow and ice coverage, alterations in surface runoff and groundwater storage, as well as changes in drought and flood occurrence. Projected rainfall patterns show a possible decrease in water availability mainly in the west and southwest of the country, including the Colorado River basin, and changes in snowfall and melting patterns which may affect water availability and cycles. The Great Plains and the Mississippi River may also experience changes in water availability from snow melt and increasing intensities of rainfall events.
**KEY POINT DROUGHTS**

Evidence shows that climate change has already led to more intense and longer meteorological droughts in some regions of the world, including the US. For example, the Southwest of the US has been identified as global drought hotspot, with very significant droughts in the 2010s. In part, the severity of these droughts has been attributed to human-induced climate change.

The recent National Climate Assessment shows that seasonal drought is expected to intensify in most US regions, and long-term drought will occur in large areas of the southwest, southern Great Plains, and southeast. This drying trend may pose a substantial threat to US food security as nearly two-thirds of the country’s freshwater diversions are used for agricultural irrigation.

**KEY POINT GROUNDWATER**

Half of the US population relies on groundwater for domestic uses. Water use trend analysis shows that irrigated areas and groundwater withdrawals have increased over the last 30 years in humid and temperate regions, whereas the overall irrigated area has decreased in semi-arid regions. At the same time, the irrigation rate and share of irrigation from groundwater have increased everywhere, suggesting a potential shift in the preferred water source for irrigation.

Parts of the south-west are likely to experience declines in groundwater recharge, whereas the north-west may experience slight increases to modest declines. The available estimates indicate average declines of 10-20% in total recharge across the aquifers of the southern states.

On a country level, a +3.5%, +6.4% and -11.4% change in annual groundwater recharge for the period 2045-2055 compared to 2015-2025 is expected under low, medium and high emissions scenarios respectively.

**KEY POINT FLOODS**

Flooding is the second deadliest climatic hazard in the US, second only to heat. Floods are caused by heavy rain, snowmelt, structural failure of protective structures, or a combination of these factors. In general, flood-related fatalities have increased over the last 25 years compared with the early-to-middle part of the twentieth century. Changing rain patterns may affect the frequency and intensity of floods and the total population exposed to floods is expected to increase from about 30,000 today to about 94,000 under SSP3 and 134,000 under SSP5 by 2050, with higher impact flood events.

**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**

The USA’s water stress level is considered low to medium for the recent past (1960 to 2014 average), although it is expected to increase for the 2030 to 2050 period based on climate change projections.
Agriculture is a major, and highly mechanized, industry in the USA, which is a net exporter of food and currently the largest producer of maize, second for soy production and fourth for wheat.

Agricultural activity is particularly concentrated in the Great Plains, a vast expanse of flat, arable land in the center of the nation in the region west of the Great Lakes and east of the Rocky Mountains. The eastern, wetter half, is a major corn and soybean producing region known as the Corn Belt, whereas the western, drier half, is known as the Wheat Belt for its high rate of wheat production.

The Central Valley of California produces fruits, vegetables and nuts. The South has historically been a large producer of cotton, tobacco, and rice, although agricultural production has declined over the past century.

**Expects 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 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 CO₂.

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.

Maize and sugarcane are predicted to suffer a considerable decline in productivity, particularly in semi-arid regions where higher temperatures exceed the optimum temperature for crops. The greatest maize productivity losses are expected in the western and southern regions of the United States, where large increases of consecutive dry days and number of hot nights during the grain production period lead to lower productivity and reduced quality. Wheat and soybean may on average increase their productivity. However, productivity changes can have disparities across regions following climate change patterns. Citrus productivity may increase over growing areas in Florida, Arizona, Texas, and California, also because of reduced frost risks. Increases in temperatures will shift grape production to cooler climate regions, and actual production areas will require warmer climate varieties and lower quality wines. Nut trees may experience a productivity decline, where milder winters will not be able to fully satisfy chilling requirements, limiting flower emergence and viability.

Agriculture in the United States is a major user of both ground and surface water, with much of the irrigated land concentrated in the west and southeast. Water resources are expected to decline in the west and southwest in spring and summer, also due to earlier snowmelt and reduced snowpack. In the last decade, the United States experienced a pronounced drought with more than two-thirds of its counties declared as disaster areas and large declines in aquifer levels. Higher temperatures will generally require an increase in irrigation demand due to higher plant evapotranspiration. Water withdrawals in the Great Plains are expected to exceed renewable freshwater resources by 40%, making them particularly prone to water stress.

Climate risks imply substantial increases in water demand (up to 30-35% in some areas) to maintain agriculture production, which will require adaptation practices and crop varieties enhancing water-use efficiency to limit increasing stress on water resources.
**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.

Increase particularly pronounced for more forested areas such as on the Eastern and Western coasts
+ Fertilizing effect of CO₂, and increasing length of the growing season due to rising temperatures promote productivity, particularly in the north

Decrease in a few areas, particularly in Midwest and northeastern forests
+ Increasing risk of drought stress due to modifications in the water regime reduce productivity

**KEY SPECIES UNDER CLIMATE CHANGE**

**LOW VULNERABILITY**
- **OAKS**
  Systems dominated by oaks show low vulnerability

**COMPETITIVENESS**
- **HICKORY**
  Species such as hickory and pine are expected to become more competitive

**HIGH VULNERABILITY**
- **BOREAL**
  Northern and boreal forests will experience high vulnerability and a pronounced decline

**FORESTS IN UNITED STATES**

USA forests play a key role in tackling the climate emergency and can be seen as the country’s most important nature-based solution. Given its vastness, the US territory hosts all the main types of existing forests, from boreal to temperate and finally tropical ones.

Of these, nearly 25% are primary forests. In large areas of Florida, a wide distribution of the very important coastal mangrove forest biome is found.

**FORESTED AREA AND CARBON STORAGE**

Forests cover almost 35% of the country. The United States Forest Service reports that they capture between 15 and 20% of domestic carbon dioxide emissions by storing approximately 800 million metric tons of carbon dioxide per year. The total amount of carbon stored in forest ecosystems to date is almost 58 gigatonnes.

![Map of United States showing forested areas and productivity anomaly](image)

<table>
<thead>
<tr>
<th>Year</th>
<th>Forested Area (Million hectares)</th>
<th>Carbon Stock (Tons/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>303 Mln ha</td>
<td>192 Tons/ha</td>
</tr>
<tr>
<td>2020</td>
<td>310 Mln ha</td>
<td>201 Tons/ha</td>
</tr>
<tr>
<td>2050</td>
<td></td>
<td>+0.46</td>
</tr>
</tbody>
</table>

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![Map of United States showing forested areas and productivity anomaly](image)
**Fires in United States**

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 two decades, a total of 1,300 million wildland fires occurred.

**Burned Area**
- 52 million hectares

**Emitting**
- 28.8 teragrammes of carbon per year

**Costing**
- 2.9 and 3.1 billion USD in suppression costs between 2017 and 2018

**Forest Fire Emissions**
- Contributed to 62% of total fire related carbon emissions

**Where Do Fires Occur?**

In California, shrublands experience high-intensity fires, whereas montane mixed forests are characterized by surface fires.

Southern and western regions of the US are the most affected by fires.

In low-elevation and mid-montane forests, low severity fires are more frequent.

**Variation of Specific Fire Indicators**

- **% of change**
  - Number of weeks with large wildland fires
  - 2050: 26
  - 2060: 23
  - Increase: +53%

- **Billion US$ per year**
  - Health economic damages attributable to wildfires
  - 2050: 23
  - 2060: 26
  - Increase: +1600

- **Cases/year**
  - PM2.5 mortality attributable to wildfires
  - 2050: 23
  - 2060: 26
  - Increase: +1300

**Future Burned Area**

Under a low emissions scenario, models project a generalized increase in burned areas across the south-west basins and plateaus, as well as in northern California and throughout the Great Plains and northern Florida. This trend might be emphasized under a medium emissions scenario, and more pronounced in California and in the Gulf Coastal Plains.

**Future Fire Emissions**

Fire emissions follow a similar spatial pattern to burned area. The largest projected changes are expected in the Pacific Northwest (and northern California) and from the Northern Rockies down to the Southwest - with more pronounced changes under a medium emissions scenario.
OVERVIEW
The USA’s population is projected to increase by 14% by 2050, becoming increasingly urbanized.

More than 10% of the urban population resides in the 2 largest cities - New York City and Los Angeles, while the majority of urban residents live in cities with 1 to 5 million people.

Built up areas cover 1.54% of the USA (143,238.63 square kilometers).

OVERVIEW OF KEY CLIMATE IMPACTS IN URBAN AREAS
Impacts on cities and their inhabitants are constantly evolving as climate change increases their exposure and vulnerability to extreme weather events and sea level rise, with significant variations across the country.

Acute and chronic climate stressors and how they interact with local geographic characteristics differ regionally. Most cities are subject to multiple climate impacts that affect multiple urban sectors.

HEATWAVES AND HEAT STRESS
Cities experience higher temperatures than surrounding rural areas because of the Urban Heat Island (UHI) effect, whereby built up areas absorb solar radiation during the day and release heat at night, warming the surrounding air.

UHI is caused by factors such as less natural landscapes, the materials used for buildings, urban layouts and waste heat. Heatwaves are occurring more often than they used to in major cities, increasing from an average of two heatwaves per year during the 1960s, to six per year during the 2010s.

The duration of individual heatwaves and the heatwave season have also been increasing, along with heatwave intensity. Future scenarios of 1.5°C, 2°C and 4°C mean temperature increases indicate that heatwaves will last longer throughout the entire country.

Graphs refer to data provided by United Nations, Department of Economic and Social Affairs, Population Division (2018). World Urbanization.
Annual precipitation has decreased in much of the west, southwest, and southeast; and increased in most of the northern and southern plains, Midwest, and Northeast. Across most of the country, heavy precipitation events have increased in both intensity and frequency, however there are important regional differences in trends, with the largest increases occurring in the Northeast.

Seasonal average precipitation projections include a mix of increases, decreases, or little change, depending on location and season. Generally, high-latitude regions are expected to become wetter while the subtropical zone becomes drier. Precipitation extremes will increase in frequency and intensity in the future throughout the contiguous United States.

Heat related health impacts from increasing air temperatures in urban areas are furthermore accentuated by air pollution. Wildfires, on the rise in the West, contribute to lower air quality in cities near the wildland–urban interface.

PM2.5 from wildfire smoke is the air pollutant of greatest concern to public health. In 2017, 3.3% of the population was exposed to levels exceeding WHO guideline values for PM2.5.

The cities most vulnerable to flooding in the USA are low-lying coastal areas, where the built environment is subject to storm surge, high tide flooding, and saltwater intrusion. There has been an increase in coastal flooding since the 1950s, with the rate of increase accelerating at most locations along the East and Gulf coasts; the East Coast endures the most frequent coastal flooding and has experienced the largest increases in the number of flood days.

The ongoing increase in the frequency, depth, and extent of tidal flooding due to sea level rise will cause cascading impacts on the larger economy. The increased probability of heavy precipitation events will further heighten the risk of coastal flooding in the future.

Annual precipitation has decreased in much of the west, southwest, and southeast; and increased in most of the northern and southern plains, Midwest, and Northeast. Across most of the country, heavy precipitation events have increased in both intensity and frequency, however there are important regional differences in trends, with the largest increases occurring in the Northeast.

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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.
Labour is directly affected by changes in environmental conditions. Warming affects both the number of hours worked (labour supply) and 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 by 24.8 percentage points in the high-exposure sectors under a 3.0°C warming scenario. Total labour in the US is expected to decline by 2.2% under a low emissions scenario, and by 4.2% under a medium emissions scenario.

Changing climate patterns will likely cause deterioration of food security, nutrition, and the emergence and reemergence of water-borne, vector-borne, and food-borne diseases. In addition, drivers of climate change, such as air pollution, will increase the risk of cardiovascular diseases, cancers, and respiratory diseases.

Heat-related mortality

- 2018: +54%
- 2050: -2.2%
- 2080: -4.2%

Heat-related mortality % change with respect to 2000-2004

Impact on total labour % change with respect to 1986-2005 baseline

Given the USA’s geographical and climatic heterogeneity, climate change poses one of the most significant environmental and human health threats. Rising sea levels, warming oceans, expected increases in the frequency and intensity of extreme weather events and changes in temperature and precipitation patterns pose direct and indirect risks to the health and well-being of the population.

HEAT RELATED MORTALITY
Climate change is projected to lead to a significant increase in heat-related deaths. Under a high emissions scenario, heatwave-related excess deaths will increase by 496%, whereas mortality will increase by 309% under a medium emissions scenario.

In 2018, there was a 54% increase in heat-related deaths in the US compared to the 2000 to 2004 baseline. 34.7% of US heat-related mortality from 1991 to 2006 can be attributed to human-induced climate change.

OVERVIEW
Changing climate patterns will likely cause deterioration of food security, nutrition, and the emergence and reemergence of water-borne, vector-borne, and food-borne diseases. In addition, drivers of climate change, such as air pollution, will increase the risk of cardiovascular diseases, cancers, and respiratory diseases.

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.

UNITED STATES HEALTH
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.

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

In the USA, climate change could create suitable conditions for dengue transmission year-round.

Under a medium emissions scenario, 92% of the population will be at risk of transmission-suitable mean temperature for dengue by 2050, whereas 94.6% will be at risk under a high emissions scenario. In the case of Zika, 83.8% of the population will be at risk by 2050 with medium emissions, whereas 88.2% will be at risk under a high emissions scenario.

CLIMATE CHANGE AND MALARIA

Malaria transmission stability will likely increase in the US due to warming. In 2050, 29.5% of the US population will be at risk of malaria under a low emissions scenario, whereas 31.4% will be at risk under a high emissions scenario.

POLLUTION AND PREMATURE MORTALITY

Under a medium emissions scenario, annual premature deaths due to long-term exposure to near-surface ozone and heat will increase from 299 per million (2010) baseline, to 307 per million in 2050.
ENERGY SYSTEM IN A NUTSHELL

Fossil fuels have dominated the USA’s energy mix for the last century, although the share of renewables has been growing over the last decade. Oil and gas remain a key feature of the energy landscape, benefitting from cost reductions from drilling and fracking innovations. Energy security is the primary goal of energy policy, and the level of domestic energy production risen steadily over the last two decades.

CLIMATE CHANGE TODAY

EXTREME EVENTS

Extreme weather is the primary cause of power outages across the USA. Higher temperatures, wildfires, flooding, and storms resulted in strong disruptions to transmission lines. In the Gulf Coast, hurricanes cause heavy damage to offshore oil drilling facilities. Hurricanes Katrina and Rita caused damage to over 100 platforms and 558 pipelines.

DROUGHTS

Hydropower generation has been significantly affected by droughts and higher temperatures have forced nuclear plants to reduce generation or shut down.

HEAT

Hotter summers are boosting air conditioning use, resulting in more frequent and longer power outages. The Southwest blackout at the end of the summer of 2011 left 2.7 million people without power for 12 hours.

ENERGY SUPPLY

The USA’s total primary energy supply energy mix shows a strong dependence on fossil fuels (83% of total primary energy supply in 2019) of which 36.2% is oil, used mainly for transport, 12.6% coal and 23% gas. Nuclear’s contribution has remained steady at 10% since 2010. Only 8% of the total primary energy supply is currently met by renewable sources - doubling their 1990 share, whereas coal has halved.

ENERGY DEMAND

With only 5% of the world’s population the USA uses nearly 17% of the world’s energy. In 2018, transport claimed 40% of energy demand - mainly to fuel road transport. The industrial sector claims over 17% of energy demand, almost at par with the residential sector. The tertiary sector accounts for 13.6% of final energy demand; energy use in agriculture and forestry is negligible. Air conditioning accounts for a substantial share of final residential electricity, 26.4%.
**FUTURE ENERGY DEMAND**

In the USA, warmer summers are predicted to increase electricity demand, resulting in higher summer peak loads. Milder winters are expected to decrease energy demands for heating, but by a smaller scale than the increase in summer cooling needs. Overall, net energy demand is predicted to increase. Higher temperatures might affect the energy mix, reducing demand for oil and natural gas used to heat homes, and instead increasing electricity demand for cooling needs.

**COOLING NEEDS**

Warmer and longer summers are expected to increase cooling needs across all regions of the USA. The magnitude of the effects will differ across locations but will be stronger in the southern and central states. Cooling needs are expected to increase for southern regions and exceed any savings from a reduction in heating needs.

**HEATING NEEDS**

Heating needs are predicted to decrease across the United States as winters become milder. In the northeast, Midwest and northwest where the majority of energy demand is for heating needs, net energy consumption is predicted to decline as the decrease in heating needs exceeds the increase for summer cooling. The extreme decrease in heating degree days in Alaska is expected to be of negligible relevance in terms of energy demands, as the state has a small population.

**FUTURE ENERGY SUPPLY**

The future configuration of the USA’s energy mix is likely to be determined by the evolution of climate mitigation policies and hence is outside the scope of this report. The U.S. Climate Crisis Action Plan sets a target of net-zero greenhouse-gas emissions by no later than 2050. Ultimately the policy decisions and the resulting interim targets will shape the future energy supply mix in the USA. These policy targets will likely result in a marginal relevance of fossil fuels and their vulnerabilities to climate change, while carbon free sources and their vulnerabilities will prevail.

**EXPECTED IMPACTS OF CLIMATE CHANGE**

Increasing wildfire risks will threaten transmission lines across the USA. Energy infrastructure in coastal areas will face increasing risks as extreme tides and storm events increase in frequency and severity. Water shortages will affect thermal power generation. Peak loads during summer droughts might threaten the stability of the energy system.
**UNITED STATES ECONOMY**

**OVERVIEW**

The USA has the largest economy in the world in terms of GDP. The COVID-19 pandemic reduced growth rates in 2020, whereby the USA lost 3.5% of real GDP. However, it has recovered quickly with a growth rate of 6.4% in 2021.

**IMPACTS ON GDP**

Climate change will have an effect on the growth rate and overall systematic economic performance of the country. National losses in GDP may be significant, reaching 2.4% of GDP or 415 billion EUR by mid century under a low emissions scenario, and drastically rising to 10.5% of GDP, or 1.8 trillion EUR, under a high emissions scenario by the end of the century. The costs of climate change are borne unequally across the US, exacerbating pre-existing inequality.

By the end of the century, under a high emissions scenario the poorest counties are likely to experience substantial damages in the range of 2-20% compared to gains exceeding 10% of county income in some regions.

**SECTORAL ECONOMIC IMPACTS**

**IMPACTS ON INDUSTRY AND INFRASTRUCTURE**

Sea level rise poses risks to communities, infrastructure and industry along the USA coastline. In particular the coast is crucial for the north-eastern economy, where many major cities and industries are located on the water. Much of this infrastructure is extremely vulnerable to sea level rise.

As a result of climate change, the expected damage from hurricanes is predicted to increase in the future for the USA. Probabilistic estimates of the damages caused by hurricanes and coastal storms show that there could be additional damages amounting to 108 billion USD by the end of the century. Natural disasters are already imposing significant costs on the USA, whereby in 2017 there were 300 billion USD worth of damage to homes, businesses, infrastructure and goods.

**IMPACTS ON AGRICULTURE**

The agricultural sector in the US is significant, producing almost 330 billion USD in agricultural commodities annually. The forestry sector is an important contributor to wealth production, providing a range of important goods and services from timber products to places of recreation. Wildfires in particular will pose a risk to the majority of the US. It is estimated that mitigation efforts could save the USA's economy between 8.6 and 11 billion USD in wildfire costs relative to a business-as-usual scenario until 2100.

Expected effects on crop yields are highly heterogeneous across crops and regions. This tendency leaves the aggregate damage estimates quite modest relative to the size of the US economy, and potentially some benefits from climate change could be experienced.

Some estimates place the damage to crop yields under a high emissions scenario in the range of -8.2 to +19 billion USD by mid century and -12 to +53 billion USD by the end of the century. More recent studies emphasize smaller potential gains.

Nevertheless, damage from extreme weather events may be substantial. The EPA estimates that greenhouse gas mitigation measures could avoid damage of up to 6.6 to 11 billion USD in the agricultural sector by 2100 compared to a business-as-usual scenario, and additionally 0.52 billion to 1.5 billion USD in the forestry sector.
Under a medium emissions scenario, commercial fishing revenues in the US could experience a total loss of 3.75 billion and 7.5 billion USD under the high emissions scenario by the end of the century.

**IMPACTS ON ENERGY**

As with all other economic sectors, energy supply and energy networks in the USA will undergo more intense stress from extreme weather events. Nevertheless, climate change is expected to increase electricity costs and demand. Higher temperatures will increase demand and power generation will become less efficient with the additional costs being passed on to residential and commercial ratepayers. By the end of the century under a high emissions scenario, average yearly energy expenditures are projected to increase by between 26.5 and 72.1 billion EUR. There are, however, no overall estimates of the economic impact of climate change on energy infrastructure for the USA.

**IMPACTS ON TOURISM**

Tourists in the US, both foreign and domestic, are highly climate sensitive and hence the tourist industry depends on the climate itself and the amenities it provides. In particular, winter sports, and destinations popular for coastal and outdoor recreation will be vulnerable to changes in climate.

It is estimated that increased coral bleaching will cost the US approximately 18.8 billion USD (15.6 billion EUR) in losses associated with coral reef recreation and 320 million USD (265 million EUR) in recreational freshwater fishing, by the end of the century. Winter sports are a notable contributor to the tourism sector, with over three-quarters of states benefiting economically from these activities. Winter sporting activities annually contributed 12.2 billion USD (10.1 billion EUR) to the US economy (2009-2010). Changing snowfall patterns are already taking their toll on the economy, resulting in a loss of over 1 billion USD (0.82 billion EUR) over the decade from 1999-2010. Winter temperatures are predicted to rise, exacerbating the losses already experienced by the sector.
The USA is the world’s 4th largest country and accounts for 13% of global emissions, with one of the highest rates of GHG emissions per capita. Emissions have been declining since 2004, and a net zero emissions by 2050 target has been set.

The diagram is based on OECD DAC climate-related development finance data for 2017-2018: the USA are providers of 3.8 billion USD, mainly devoted to cross-cutting projects. The largest share is directed to sub-Saharan Africa.

In its 2021 NDC update, the USA strengthened their target from a 26-28% emissions reduction below 2005 levels by 2030, to a 50-52% reduction.

**INTERNATIONAL COMMITMENTS**

**INTERNATIONAL CLIMATE FINANCE ASSISTANCE**
TRANSNATIONAL INITIATIVES
International Boundary and Water Commission
International Boundary and Water Commission implements water treaties between the United States and Mexico. It explores an array of adaptive water management strategies to manage climate-related impacts on Colorado River water.

NATIONAL INITIATIVES
Climate Change Response Framework (CCRF)
The CCRF is a collaborative, cross-boundary approach among scientists, managers, and landowners to incorporate climate change considerations into natural resource management.

U.S. Climate Resilience Toolkit
The Toolkit provides a five-step process that communities can use to identify and assess their climate vulnerabilities. The site also provides other resources from the federal government to help communities put the process into action.

SUBNATIONAL INITIATIVES
Southeast Florida Regional Climate Action Plan (RCAP)
RCAP is the Compact’s guiding tool for coordinated climate action in Southeast Florida to reduce GHG emissions and build climate resilience. It provides a set of recommendations, guidelines for implementation and best practices for local entities to act in line with the regional agenda.

Climate Ready Boston - Municipal Vulnerability to Climate Change
The project forecasts climate change impacts, ranging from sea level rise to extreme weather events. The report used existing research to identify potential municipal infrastructure and other city services that are exposed to climate change.

ENERGY TRANSITION
The USA shows an Energy Transition index slightly below the G20 average, positioning itself in the mid-to-low section of the ranking. This is determined in particular by the still heavy contribution of fossil fuels to the USA energy sector, and more in general to its economy and industry.

The USA, is not only the world’s largest oil and gas producer, but it is also by far the biggest fossil fuel consumer at a global level. This situation is reflected also on the Renewables indicator, where the country – despite the ongoing process of transformation and massive penetration of wind and solar power – still performs below the group average (though better compared to other big fossil producing countries).

On Emissions and Electrification, the USA scores are slightly below the G20 average, showing the need to continue and strengthen the process of deployment of renewables and power grids in line with its 2050 decarbonization targets. Finally, the country is placed in the mid-to-top part of the ranking when it comes to Efficiency with further improvements expected to happen.

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.