Climate change impacts in Europe

The maps below present a story about how Europe might be affected by key climate hazards such as droughts, floods, forest fires and sea level rise during the 21st century and beyond. These maps are based on different greenhouse gas emissions scenarios and climate models and have been published already in various EEA reports and indicators.

The European overview

Climate change is happening now and will get more serious in the future, even if global efforts to reduce greenhouse gas emissions prove effective. However, the impacts will be much less severe if efforts to reduce emissions are successful in keeping the global temperature increase well below 2°C (as required by the Paris Agreement). Any higher emissions scenario would lead to considerably greater climate change.

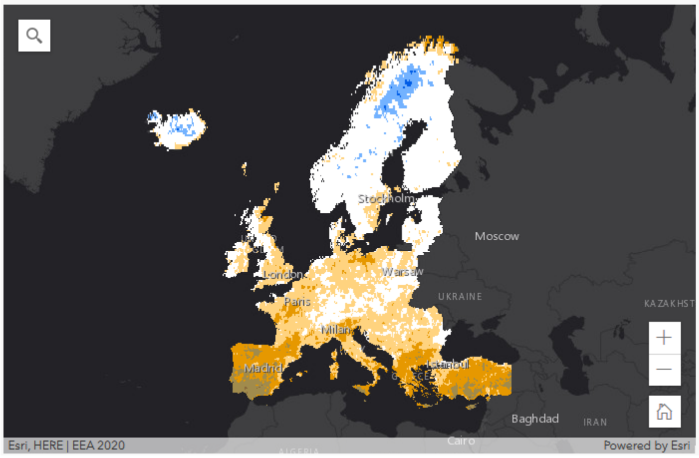
Extreme weather and climate-related hazards such as heat waves, floods and droughts will become more frequent and intense in many regions. This will lead to adverse impacts on ecosystems, economic sectors, and human health and well-being. Therefore, minimising the risks from global climate change requires targeted actions to adapt to the impacts of climate change, in addition to actions to reduce greenhouse gas emissions. Adaptation must be tailored to the specific circumstances in different regions and cities of Europe.

Available studies project increases in the frequency, duration and severity of meteorological and hydrological droughts for most of Europe over the 21st century, except for parts of northern Europe. The largest increase in drought conditions is projected for southern Europe, where competition between water users such as agriculture, industry, tourism and households will increase. Farms in southern Europe could suffer significant drought-induced losses by 2100.

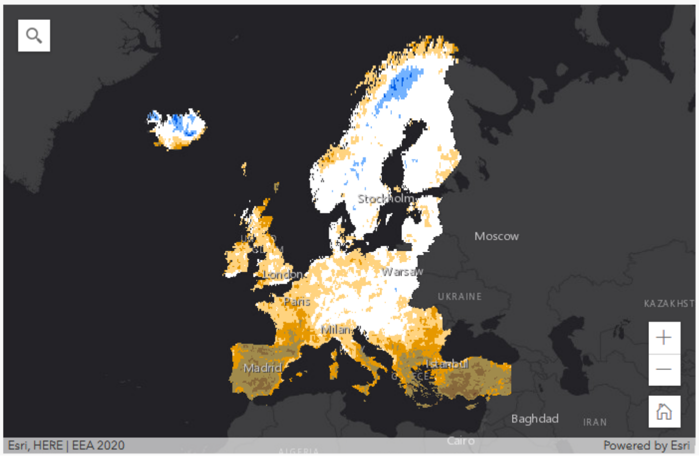
Projected changes in the frequency of meteorological droughts for two emissions scenarios

In southern Europe, severe droughts are projected to become more frequent. Drought frequency is also projected to increase in central and western Europe whereas it may decrease in some limited regions of northern Europe.

Projected change in meteorological droughts for a medium emissions scenario (period 2041-2070, compared with 1981-2010)



Projected change in meteorological droughts for a high emissions scenario (period 2041-2070, compared with 1981-2010)



Change in number of drought events per 30 years
(a drought event is defined when the Standardized Precipitation Index (SPI-3) is below -1).

-1.5 to -1 | -1 to -0.5 | -0.5 to 0.5 | 0.5 to 1 | 1 to 1.5 | 1.5 to 2 | 2 to 2.5 | > 2.5

Sources: Spinoni et al. (2018)

Further information: EEA indicator Meteorological and hydrological droughts; SOER 2020 (Chapter 7)

Climate change and agriculture

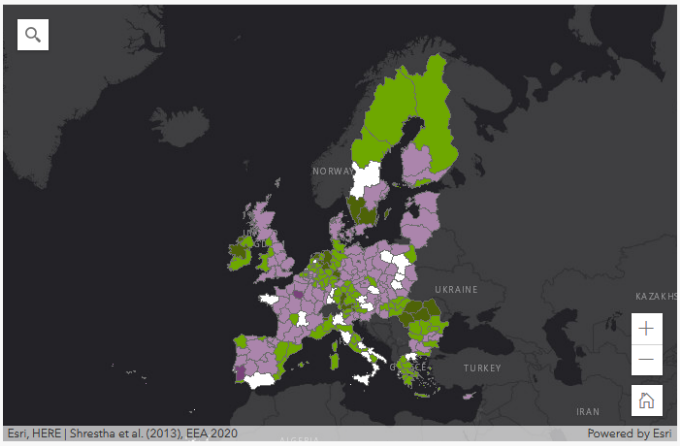
Climate change affects agricultural systems in complex ways. Rising atmospheric CO2 concentrations, higher temperatures and changes in precipitation patterns, including drought conditions, affect the quantity, quality and stability of food production. Food security in the EU is not expected to be at risk, but cascading impacts of climate change from outside Europe may further affect agricultural income and price levels in Europe through changes in trade patterns.

The impacts of climate change, including increasing droughts, affect agricultural production, trade and ultimately the prices of agricultural products and the incomes of farmers. Farmer's incomes are further influenced by agricultural policies, land use policies and climate mitigation policies. However, farmers can limit the adverse impacts and enhance the beneficial impacts of climate change through suitable adaptation measures, such as adapting crop varieties, changing sowing dates and improving irrigation.

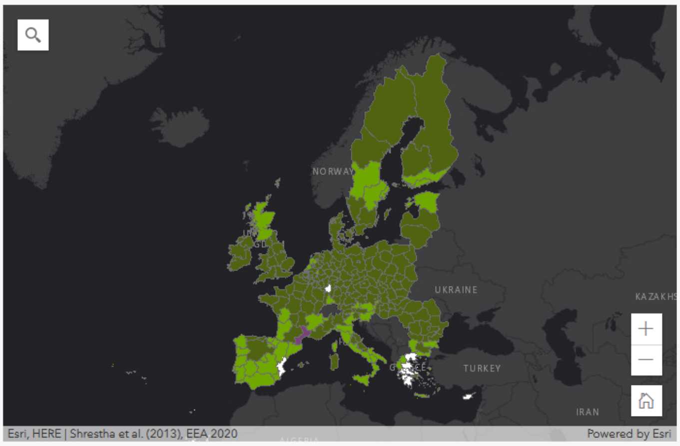
The potential benefits of adaptation are illustrated by the maps below. These estimate the changes in farmer's income between a 2004 baseline and 2020 for a given climate and socio-economic scenario (including global price adjustments), both with and without technical adaptation measures (see the EEA report for additional explanation). Note that other studies using different scenarios and assumptions can come to rather different estimates of the economic impacts of climate change on agriculture, However, all of them agree on the importance of adaptation at the farm level and beyond.

Estimated income change for farmers with and without adaptation

No adaptation



Best adaptation



Income change farmers
(%)

>5 | 0,5 to 5 | -0,5 to 0,5 | -10 to -0,5 | <= -10

Source: Shrestha et al. (2013)

Further information: EEA Report Climate change adaptation in the agricultural sector in Europe

Heavy rain and flash floods

Most flash floods are a consequence of heavy rain over a short period of time, from hours to days. Climate change is projected to lead to a higher intensity of rain in most parts of Europe, which would increase the risk of flash floods.

Projected changes in the magnitude of heavy rain in winter and summer in the period 2071-2100, compared with 1971-2000 for a high emissions scenario

This map represents change in heavy rain in winter and summer in the period 2071-2100 compared to the present climate (1971-2000) based on high emissions scenario. The largest increases, up to 35 %, are projected for central and eastern Europe. Southern Europe could see increases in heavy rain of up to 25 %.

Winter

Summer

Change in heavy rain (%)

Heavy rain is defined as 95th percentile intensity of total rain events

< -25 | -25 to -15 | -15 to -5 | -5 to 5 | 5 to 15 | 15 to 25 | 25 to 35 | > 35

Source: EURO-CORDEX , Jacob et al., 2014

Further information: EEA indicator Heavy precipitation; EEA indicator River floods

Forest fires

The extent of forest fires in Europe varies a lot from year to year, driven largely by changes in weather conditions. In recent years large forest fires have affected several regions in northern and western Europe in which fires were not prevalent in the past. More European countries experienced large forest fires in 2018 than ever before, and Sweden experienced the worst fire season in reporting history. The unprecedented forest fires in several European countries in 2017 and 2018 coincided with record droughts and heatwaves. More severe fire weather and, as a consequence, substantial expansion of the fire-prone area and longer fire seasons are projected in most regions of Europe, in particular for a high emissions scenario.

The relative increase in fire danger (based on the Canadian Fire Weather Index) is projected to be particularly large in western-central Europe, but the absolute fire danger remains highest in southern Europe. Adaptation measures, such as improved fire prevention and effective fire suppression, can substantially reduce fire risks.

Projected change in meteorological forest fire danger by the late 21st century for two emissions scenarios, compared with the period 1981-2010

Projected change in meteorological forest fire danger for a low emissions scenario

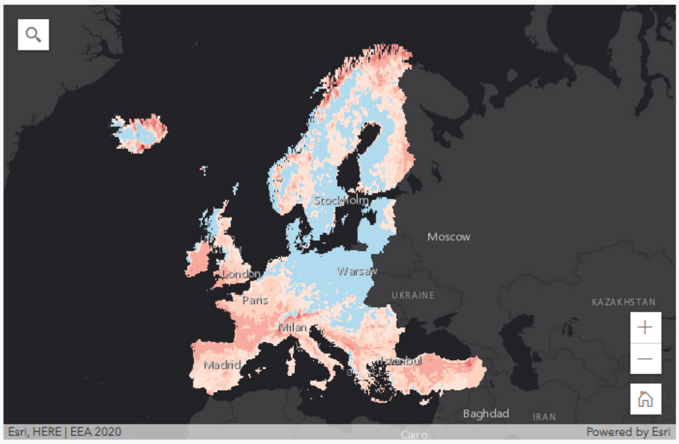
Projected change in meteorological forest fire danger for a high emissions scenario

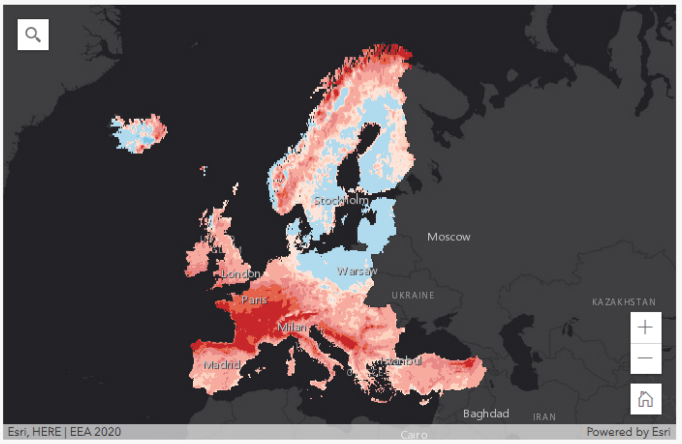
The map shows an increase in fire danger in most European regions, with the exception of parts of northeastern and northern Europe, for a low emissions scenario.

The projected increase in weather-driven fire danger in southern Europe is about 30-40 %. Decreases in weather-driven fire danger are projected in central and northern Europe (except for the far north).

The map shows increases in fire danger in most European regions for a high emissions scenario.

The increase in weather-driven fire danger in southern Europe is more than 40 % and large increases are also projected for northern Europe.





Projected change in fire danger (%)
based on the Canadian Fire Weather Index

< -30 | -30 - 0 | 1 - 5 | 6 - 10 | 11 - 20 | 21 - 30 | 31 - 40 | > 40

Sources: Projections of Fire Weather Index (PESETA III) provided by Joint Research Centre (JRC), Forest fire danger is based on the Canadian Fire Weather Index

Further information: EEA indicator Forest fire danger

Sea level rise

All coastal regions in Europe have experienced an increase in absolute sea level, and most regions have experienced an increase in sea level relative to land. The increase in sea level and coastal flood levels is threatening coastal ecosystems, water resources, settlements, infrastructure and human lives.

The rate of global mean sea level rise during the 21st century will very likely be higher than during the period 1971-2015. Process-based models considered in the Intergovernmental Panel on Climate Change (IPCC) special report on the ocean and cryosphere in a changing climate project a rise in sea level over the 21st century in the range of 0.29-0.59 m for a low-emissions scenario and 0.61-1.10 m for a high-emissions scenario. However, substantially higher values cannot be ruled out. Several recent model-based studies, expert assessments and national assessments have suggested an upper bound for 21st century global mean sea level rise in the range of 1.5-2.5 m. By 2300, global mean sea level rise will likely be in the range 2.3-5.4 m for a high emissions scenario.

The rise in sea level relative to land along most European coasts is projected to be similar to the global average, with the exception of the northern Baltic Sea and the northern Atlantic coast, which are experiencing considerable land rise because of post-glacial rebound. The projected sea level rise will increase the number of coastal floods very substantially, unless adequate adaptation measures are taken. All available studies project that the economic damage from coastal flooding in Europe would increase manyfold in the absence of adaptation.

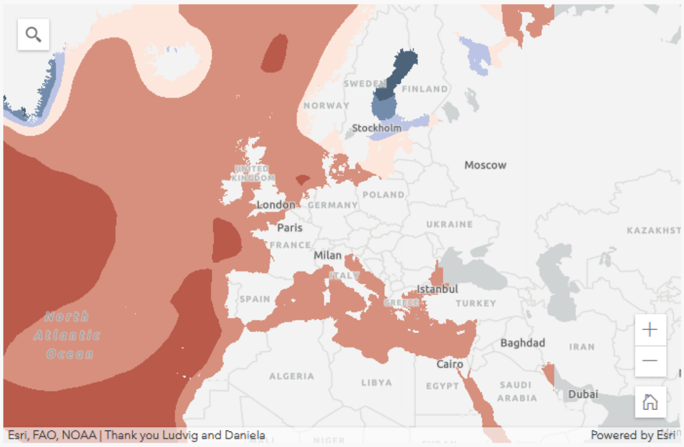
Projected rise in relative sea level by the late 21st century for two emissions scenarios, compared with the period 1981-2010

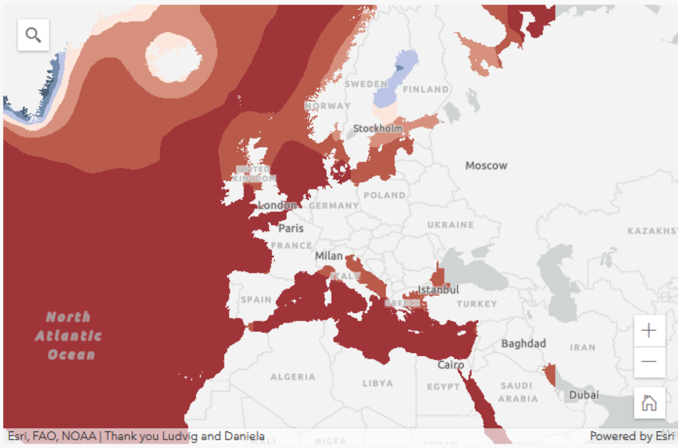
Under the low emissions scenario, European coasts would experience mean sea level rise between 0.2 m and 0.4 m, with the exception of the northern Baltic Sea and the northern Atlantic coast, which are experiencing considerable land rise because of post-glacial rebound.

Under the high emissions scenario, European coasts would experience mean sea level rise between 0.4 m and 1.0 m (based on some studies up to 2.5 m), with the exception of the northern Baltic Sea and the northern Atlantic coast, which are experiencing considerable land rise because of post-glacial rebound.

Low emissions scenario

High emissions scenario





Sea level rise

(m)

-1 - -0,4 | -0,4 - -0,2 | -0,2 - 0 | 0 - 0,2 | 0,2 - 0,4 | 0,4 - 0,6 | 0,6 - 1

Source: Source: IPCC SROCC, Chapter 4: Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities

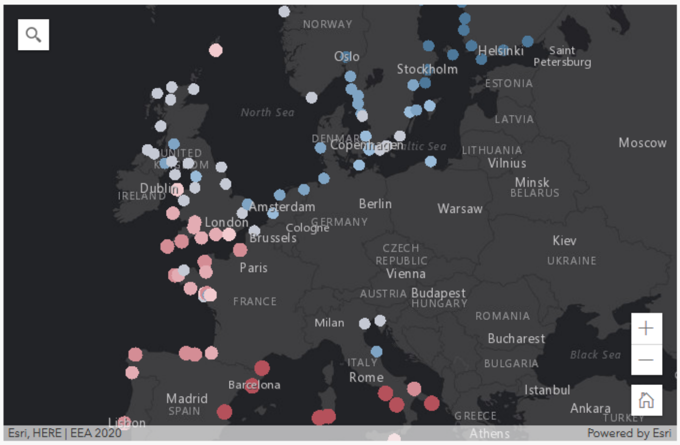
Further information: EEA indicator Global and European sea-level rise

Projected changes in the frequency of coastal flooding for two emissions scenarios

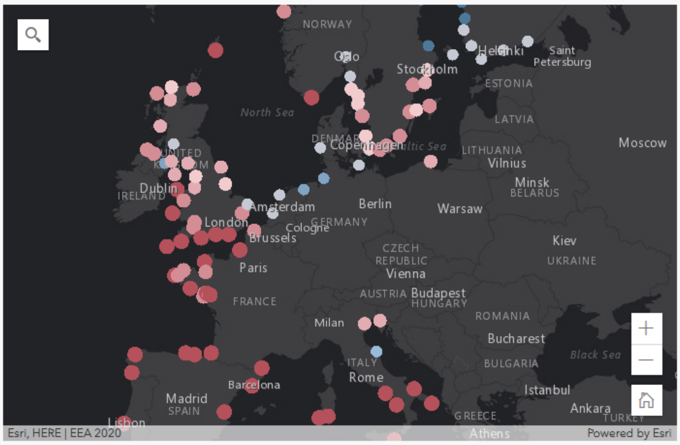
Mean sea level rise will contribute to projected increases in coastal floods along the European coast. Large changes in flood frequency mean that what is an extreme event today may become the norm by the end of the century in some locations. The frequency of coastal flooding events is estimated to increase by more than a factor of 10 in many European locations, and by a factor of more than 100 or even 1000 in some locations during the 21st century, depending on the emissions scenario.

In the absence of further investments in coastal adaptation, the estimated average annual losses from coastal flooding in the 17 main coastal cities in the EEA member countries could increase from about EUR 1 billion in 2030 to EUR 31 billion in 2100 under the high emissions scenario. The annual number of people exposed to coastal flooding is projected to rise from 102 000 to 1.52-3.65 million over the same time horizon with current flood defence structures.

Low emissions scenario



High emissions scenario



Projected change in the frequency of coastal flooding events between 2010 and 2100

multiplication factor

> 500 | 200 to 500 | 100 to 200 | 50 to 100 | 10 to 50 | 5 to10 | 1 to 5 | 0 to 1

Source: IPCC SROCC, Chapter 4: Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities

Further information: EEA indicator Global and European sea-level rise

Estimated population living in coastal lowlands

The map shows the estimated area of, and the current population in, low-lying regions at 1 to 6 m above current mean sea levels. In the absence of any existing or future coastal protection, these areas would be permanently inundated in the coming centuries if sea level rises by the projected amount. However, temporary coastal flooding of these areas caused by extreme high sea levels could occur much earlier as a result of the combined effects of mean sea level rise, waves and storm surges.

The countries and regions with the largest shares of low-lying areas include:

- the coasts of Belgium, Netherlands and north-west Germany
- most of the coastal regions in Denmark and southern Sweden
- the coasts in southern and western and France
- north-east Italy, including the region of Venice

Population living within the respective height above mean sea level (in metres):

1 metre	2 metre	3 metre	4 metre	5 metre	6 metre
9.8 mil	11.3 mil	13.4 mil	14.6 mil	16.7 mil	17.5 mil

Note that many regions and countries have implemented measures to protect the population from coastal flooding. For example, in the Netherlands, the central government, water boards, provinces and municipalities are working together on climate proofing water risk management under the Delta Programme. This includes measures such as the improvement of dykes, dams, and dunes and beach replenishment. Until 2050, the Delta programme will render the Netherlands safe, climate-proof, and water-resilient, and it factors in a maximum mean sea-level rise of 1 m by the end of this century. The Netherlands also started a Sea Level Rise Knowledge Programme to enable an adaptive response to a potentially accelerated rise in sea level beyond 2050.

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Source: CReSIS and Eurostat population data

Further information: EEA indicator Global and European sea-level rise

Climate hazards in selected regions and cities


Droughts in the Iberian Peninsula


Heavy rain and flash floods in central Europe


Forest fires in Scandinavia


Storm surges in Brittany (France)


Coastal flooding in Venice


River and coastal floods affecting cities

Climate change is affecting all European regions. The key climate-related hazards are heat waves and droughts, forest fires, windstorms, heavy rain and floods, sea level rise and storm surges. The impacts of these hazards on ecosystems, human health and society will differ from region to region. This site presents examples for how climate change is expected to affect selected European regions.

Further information: EEA Report Climate change, impacts and vulnerability in Europe 2016

Sources

This site is developed and maintained by EEA based on information published in various EEA reports and indicators cited above

All climate projections above are based on scenarios (denoted as 'representative concentration pathways', RCP) described in the IPCC glossary.

- RCP2.6 is a low emissions scenario with a global temperature increase in the 2050s of below 2°C above pre-industrial temperatures.
- RCP4.5 is a medium emissions scenario with global temperature increase in the 2050s of approximately 2.5°C above pre-industrial temperatures.
- RCP8.5 is a high emissions scenario with a global temperature increase in the 2050s of approximately 3°C.

The differences in warming levels between the different RCPs become much larger during the second half of the 21st century.