



© Saktanong - stock.adobe.com

## KEY MESSAGES

### Absolute damages from droughts could increase significantly

With 3°C global warming in 2100 and assuming no adaptation, absolute annual drought losses (€) for the EU+UK could be 5 times higher compared to nowadays (an increase from 9 to 45 €billion/year).

### Mediterranean and Atlantic regions see the strongest increase in damages

The most severe impacts are projected in the Mediterranean and Atlantic regions of Europe.

### Mitigation can strongly reduce the impacts

Limiting warming to 1.5°C in 2100 reduces the impact to 25 €billion/year.

## About PESETA IV

The JRC PESETA IV project aims to better understand the biophysical and economic consequences of climate change. It does this by using projections of climate change for Europe from several climate models along with a set of climate change impact models. The project covers several sectors that are relevant to society and the natural environment, such as freshwater, agriculture, and coasts.

[ec.europa.eu/jrc/en/peseta-iv](http://ec.europa.eu/jrc/en/peseta-iv)



# Impacts of climate change on droughts

Droughts induce a complex web of impacts that span many sectors of the economy, including extensive crop failure, reduced power supply and shipping interruptions, as seen in the EU+UK in 2018 and 2019. With global warming, droughts will increase in frequency and intensity, and last longer, in southern and western parts of Europe, while drought conditions will become less extreme in northern and north-eastern Europe.

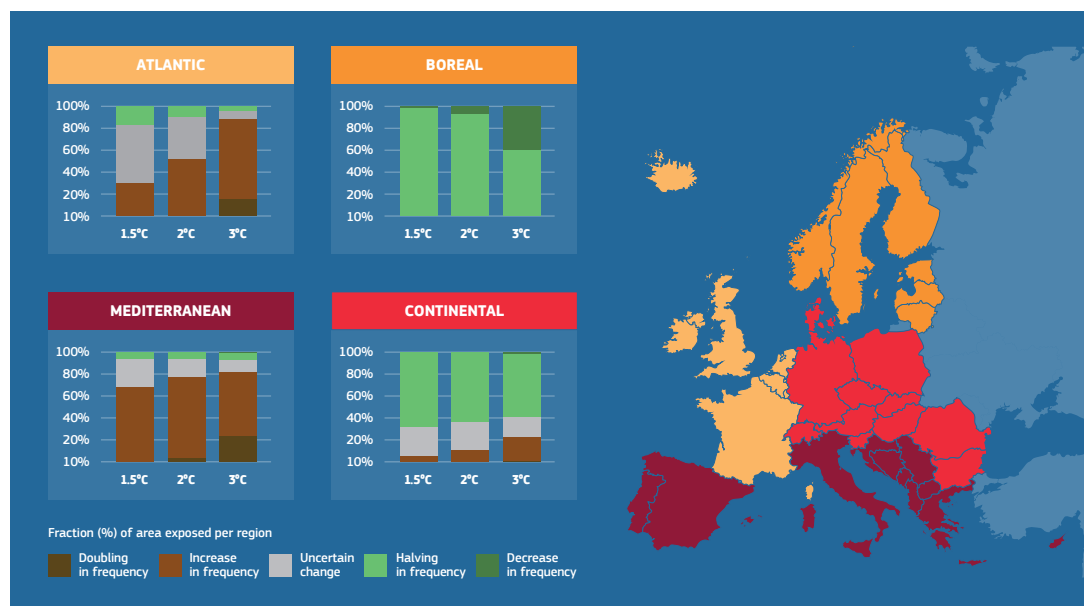


Figure 1. Fraction of area exposed to changes in drought occurrence compared to present (1981-2010) for European sub-regions.



## Current economic losses from droughts

Annual losses from drought are around 9 €billion/year for the EU+UK nowadays with the highest losses in Spain (1.5 €billion/year), Italy (1.4 €billion/year) and France (1.2 €billion/year). Depending on the region, between 39-60% of the losses relate to agriculture and 22-48% to the energy sector. Public water supply accounts for between 9-20% of the total damage. Losses in the transport sector relate only to inland water transportation and represent 1.5% of total losses, while subsidence damage to infrastructures accounts for around 8%. The consequences on ecosystems are typically not monetised and hence are not reflected in the loss estimates.

## Drought hazard in a warmer climate

With 3°C global warming, drought frequency is projected to double over nearly 25% of the Mediterranean and 15% of the Atlantic region (Figure 1). Limiting warming to 1.5°C would avoid a doubling of drought frequency everywhere in Europe but would still result in an increase in drought frequency over two-thirds of the Mediterranean and one-third of the Atlantic region. In contrast, drought hazard declines with warming in Boreal Europe and the north-eastern parts of Continental Europe, due to increases in precipitation.

Impacts on economy of nowadays				Impacts on economy of 2100			
Present	1.5 °C	2.0 °C	3.0 °C	Present	1.5 °C	2.0 °C	3.0 °C
Drought losses (€ billion)				Drought losses (€ billion)			
9.0	9.7	12.2	17.3	9.0	25	31	45
Drought losses (% of GDP)				Drought losses (% of GDP)			
0.7	0.08	0.10	0.14	0.07	0.06	0.07	0.10

Figure 2. Average annual losses from drought for the EU+UK if current socioeconomic conditions continue into the future (left) and assuming socioeconomic conditions in 2100 according to the ECFIN 2015 Ageing Report (right).

## Economic losses from droughts assuming no socioeconomic change

Assuming the economy of nowadays, total EU+UK damage from drought slightly increases with 1.5°C global warming but increases sharply to 17.3 €billion/year at 3°C (Figure 2). The Mediterranean and Atlantic regions see the largest overall losses from global warming (Figure 3), with Belgium, Greece, Ireland, Portugal and the UK showing the strongest relative increase.

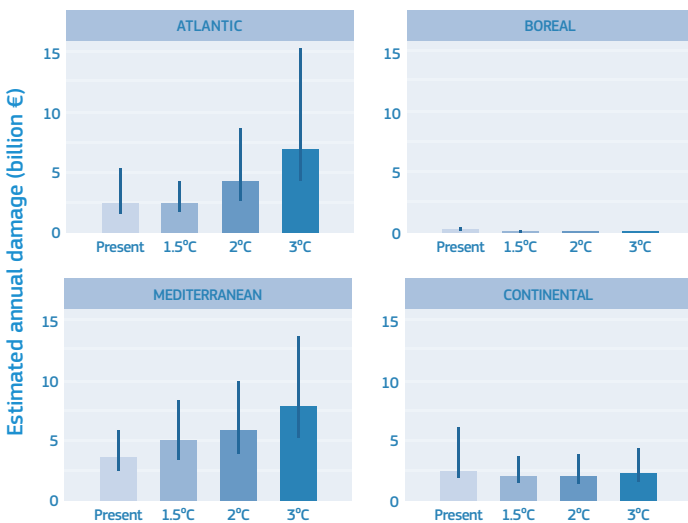


Figure 3. Current annual losses (€ billion/year, 2015 values) with global warming for the EU+UK by region, assuming current socioeconomic conditions continue into the future. The top of each bar shows the average estimate and the vertical lines indicate climate uncertainty.

## Economic losses from droughts with socioeconomic change

The projected losses in absolute terms (€) are larger when future socioeconomic change is accounted for compared to when it is assumed that current socioeconomic conditions continue into the future, because of the growth of the size of the economy (Figure 2).

When drought losses are expressed relative to the size of the economy (share of GDP), the effects of climate change are dampened (Figure 2) compared to the absolute estimates because drought-sensitive sectors, especially agriculture, are projected to become less economically prevalent in future EU economies. Regional and national-level relative impacts can be greater than the EU average, however, with losses of 0.19% of GDP in the Mediterranean at 3°C warming (2100 socioeconomics) and in some countries even above 0.30% (e.g., Greece, Bulgaria and Romania).

## Adaptation and resilience to drought

PESETA IV did not assess the effects of different adaptation measures on drought impacts of climate change, yet a wide variety of possible measures exist. Adaptation should be targeted at strengthening drought resilience of society and sectors. This includes specific measures in drought-sensitive sectors, such as improved power station cooling techniques, drought-resistant crops, and lighter river navigation vessels. Institutional transformations, livelihood and economic diversification, insurance and other market tools, social safety nets, monitoring and data collection, and early warning and alert systems, are additional measures. The actual costs and benefits of adaptation measures will vary substantially depending on the local geographical, climate, and socioeconomic conditions.



© Q - stock.adobe.com

### Approach

The LISFLOOD hydrological and water use model was run with climate simulations for present climate and 1.5°C, 2°C and 3°C global warming above preindustrial levels, to simulate minimum river flow at high spatial resolution (an indicator of drought hazard).

Economic losses were estimated at country-scale based on a statistical relationship between drought intensity and drought impact derived from reported losses of past drought events. Drought impacts were disaggregated over economic sectors based on expert-derived sector sensitivity to drought and their economic output. Losses are reported in

Contact information: Carmelo Cammalleri, JRC Disaster Risk Management Unit.

€ 2015 values and are inherently uncertain due to limited availability of data on past droughts.

Losses were estimated under two main assumptions of socioeconomic change: 1) a continuation of 2015 conditions into the future; and 2) socioeconomic development according to the ECFIN 2015 Ageing Report. Drought losses are average estimates over an ensemble of 11 climate models and the spread is due to climate uncertainty. The drought impacts are based on present vulnerability estimates of sectors to drought and hence assume no adaptation.