Climate crisis could double frequency of extreme regional summer droughts in Europe

September 7 2021

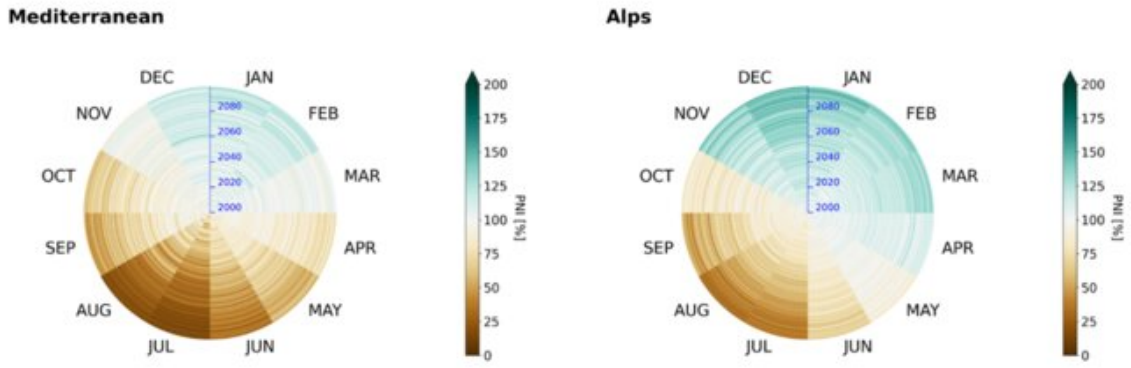

Figure: Drying stripes for two selected hot-spot regions showing the percent of normal index (PNI), which gives the percentage of precipitation of a given month and year compared to the long-term mean in a counterfactual world with pre-industrial greenhouse gas concentrations. The PNI values were calculated for each climate simulation of the ensemble, before the median of those 50 values. Credit: Magdalena Mittermeier

The ongoing climate crisis has already had drastic global impacts. For example, droughts have become critical high-impact hydro-meteorological hazards worldwide. In Europe, the consequences of the climate crisis have been severe, with droughts having caused considerable social, economic, and environmental costs already, especially in the years 2003, 2010, and 2018.

Climate projections show that more frequent and extreme weather events are expected by the end of the 21st century. Researching the future occurrence of droughts is crucial for adequate climate crisis mitigation. A new study published in *Frontiers in Water* shows that Europe is headed towards a future of increased severe to extreme droughts.

"Summer droughts are a highly relevant topic in Europe," said author Magdalena Mittermeier, who shares the first authorship with Andrea Böhnisch, both from the Ludwig-Maximilians-Universität München (LMU) in Germany. "We find a clear trend towards more, longer and more intense summer droughts, in terms of a precipitation deficit, towards the end of the century under a high-emission carbon scenario (RCP8.5)."

According to the World Health Organization (WHO), droughts are the most serious hazard to crops and livestock in every part of the world with estimated 55m people globally affected by them every year.

The impacts of droughts are economically, socially, and environmentally complex, and a universal definition that covers all consequences does not exist. Instead, droughts are classified by their impact, as meteorological, hydrological, agricultural, or socio-economic. Meteorological droughts are a potential predecessor of other drought types and are therefore important to research.

Key findings

- In the long-term future (from 2080 to 2099), Europe will see an increase in the frequency and intensity of summer droughts and a decreasing number of winter droughts in several regions of various climates.
- In the present day and far future, there is a high variability of

drought intensities across various European climate regions.

- There will be greater differences between winter and summer precipitation: it will increase during winter and decrease during summer.
- For mid-Europe, the annual occurrence probability of an extreme drought strongly increases during the summer months, amounting to 25%. In Eastern Europe and the Alps, severe and extreme droughts have higher probabilities in the far future with values around 20% (severe) and 40% (extreme).
- For France, the models predict an increase in the frequency of extreme droughts of up to 60%.
- In the Mediterranean, the percentages of extreme droughts in the far future reach around 80% for the summer months. In the Iberian Peninsula the percentage of extreme droughts is the highest of all regions, reaching 96% in July and 88% in August. In these two regions, however, the absolute precipitation values in July and August are already low in the reference period (each contributing only around 2-3 % to the annual precipitation). This means that comparatively small absolute changes can lead to high percentages of the PNI, which is a relative measure.
- Four future drought hot spots were identified: France, the Alps, the Mediterranean, and the Iberian Peninsula. These could see an increase of more than 50 % in the frequency of extreme summer droughts.

Researching drought occurrence

Regional differences between drought events are high, and there is an urgent need to identify geographical hot spots for future drought events. Böhnisch and her colleagues at the Ludwig-Maximilians University and the Ouranos Consortium in Canada assessed current and future climate trends and drought hot spots for Europe.

The authors divided Europe into eight regions with different climates: the British Isles, Scandinavia, mid-Europe, the Alps, Eastern Europe, France, the Mediterranean and the Iberian Peninsula. The researchers then analyzed the ´percent of normal index´ (PNI, which gives the percentage of precipitation in a given period compared to the normal precipitation in the reference period) in a single climate model over the eight regions. A long-term future (from 2080 to 2099) under the Representative Concentration Pathway 8.5 was compared to the present day (2001 to 2020).

Four future hot spots

The results show an overall increase in drought numbers, with high variability of drought intensities between regions in the present day period and the projected far future. In the long-term future, summer droughts are projected to become more extreme and winter droughts will become less frequent in several regions.

Four hot spots with strong drought trends were identified: France, the Alps, the Mediterranean and the Iberian Peninsula.

"Our study shows that unabated climate change will worsen the risk of hot-spot droughts drastically. But also, in some regions where droughts currently play a minor role, the future drought risk is expected to get serious. We show that the Alps should be considered an additional future hot-spot," said Mittermeier.

"Unmitigated climate change, under the RCP8.5 scenario, will drastically increase the frequency, duration and intensity of summer droughts in many European regions. Such extreme effects can be avoided by climate mitigation. This is why consistent mitigation of climate change as agreed on under the Paris Agreement is highly relevant in terms of droughts in Europe."

She continued: "These three key features of: first, increasing drought occurrence in summer; second, wetter conditions in winter as well as; and third, interannual variations due to the natural variability of the climate system are visualized in what we call 'drying stripes'."

"These allow an overview of our results at first glance. The drying stripes show the percentage of precipitation for every month and year summarized over our ensemble compared to the long-term mean in a counterfactual world with pre-industrial greenhouse gas concentrations. With this, they show the projected summer drying trend throughout the 21st century compared to a world without climate change."

More information: Andrea Böhnisch et al, Hot Spots and Climate Trends of Meteorological Droughts in Europe–Assessing the Percent of Normal Index in a Single-Model Initial-Condition Large Ensemble, *Frontiers in Water* (2021). DOI: 10.3389/frwa.2021.716621

Provided by Frontiers